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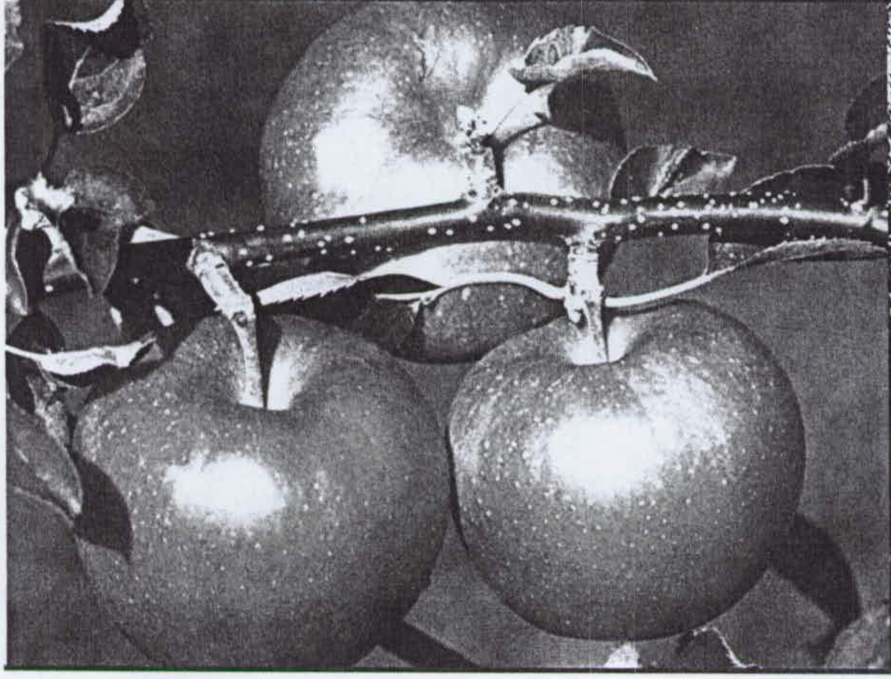
9th International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems

Program and Abstracts

August 4-8, 2008 • New York State Agricultural Experiment Station, Geneva, NY



A symposium of the International Society for Horticultural Science
sponsored by three ISHS Working Groups:
Orchard and Plantation Systems Working Group
Rootstock Breeding and Evaluation Working Group
Environmental Physiology of Fruit Crops Working Group
in collaboration with:

ISHS

Cornell University
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New York State
Horticultural Society

New York State
Department of Agriculture and Markets

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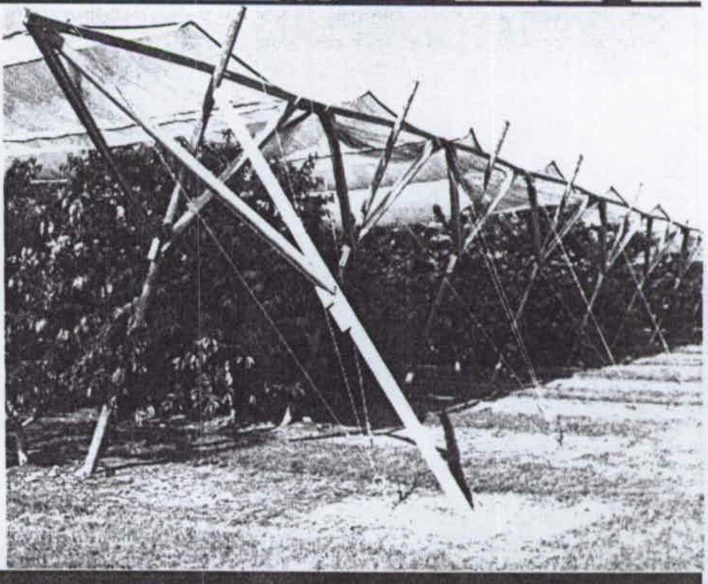

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9th International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems

Program and Abstracts

Welcome to the Symposium

On behalf of the International Society for Horticultural Science and the Orchard and Plantation Systems Working Group, the Rootstock Breeding and Evaluation Working Group and the Environmental Physiology of Fruit Crops Working Group of the Pome and Stone Fruit Section of ISHS, I welcome you to the 9th International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems held at Geneva, New York, USA from Aug. 4-8, 2008.

At this meeting we welcome more than 220 of the world's leading fruit scientists, extension workers and fruit growers who are working on genetics and genomics of rootstocks, rootstock breeding and evaluation, tree and rootstock physiology, and crop and canopy management. Over the five days of the symposium we will hear 79 oral presentations and see 131 poster presentations of recent research on fruit crops. Collectively, these research reports will provide substantial information on recent advances in fruit science and culture that will ultimately benefit fruit growers and fruit consumers worldwide. In addition, as we listen to and see these reports they will undoubtedly spark new research ideas for future experiments leading to further advances. Thus this meeting like the past eight meetings of the Orchard Systems working group will led to dramatic changes in orchard systems, rootstocks and management across the world for the benefit of mankind.

In addition, these quadrennial meetings are wonderful opportunities to renew friendships and acquaintances between fruit scientists and enthusiasts the world over. This interaction can be very enriching and can also be a catalyst to new collaborative research efforts to further advance fruit science. These meetings also provide an opportunity for new scientists to interact with established scientists to help launch their careers. The past six symposia I have attended have been invaluable in my career as a fruit scientist and have resulted in many new research projects and numerous friendships. I hope this meeting will be a place of new friendships and greater understanding of people from different parts of the world.

Lastly, I welcome each of you to Geneva, New York State, and the home of Cornell University's New York State Agricultural Experiment Station. It has been my dream to host my many friends from around the world at the wonderful New York State Agricultural Experiment Station in beautiful Geneva, New York. Geneva is a small city of 25,000 inhabitants in the heart of the scenic Finger Lakes Region of Western New York State. It is located at the northern end of the beautiful and scenic 55 km long Seneca Lake. Geneva is located midway between Rochester, Syracuse and Ithaca (home of Cornell University) and is close to the main apple, pear, peach, cherry, plum and apricot production areas of New York State, which are located along the shores of Lake Ontario the last of the chain of great lakes in the Eastern USA. Also nearby is the Finger Lakes grape and wine region. We hope you will enjoy the beautiful surroundings of the Finger Lakes Region.

We appreciate our hosts Hobart/William Smith Colleges who have graciously allowed us to use their campus and food service facilities for this meeting. We hope you enjoy your time in Geneva and the tours to the surrounding fruit growing districts. Thank you for coming.

Sincerely,
Terence Robinson
Convener 9th International Symposium on
Integrating Canopy, Rootstock and Environmental
Physiology in Orchard Systems

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Campus Map

Numerical Listing of Facilities

1 Hobart Quadrangle
2 Coxe Hall
3 Williams Hall
4 Medbery Hall
5 Demarest Hall
6 St. John's Chapel / St. Mark's Tower
7 Geneva Hall
8 The Salisbury Center at Trinity Hall
9 Merritt Hall
10 Harris House
11 President's House
12 Eaton Hall
13 Albright Auditorium
14 Lansing Hall
15 Rosenberg Hall / Napier Classroom Center
16 Durfee Hall
17 Bartlett Hall
18 Hale Hall
19 Gulick Hall
20 Scandling Center
21 Warren Hunting Smith Library and Melly Academic Center
22 William Smith Green
23 Smith Hall
24 Hirshson House
25 Blackwell House
26 Miller House
27 Comstock House
28 Barn
29 Village at Odell's Pond
30 Stiles Field
31 Robert A. Bristol Field House
32 William Elliott Varsity House
33 Boswell Field Stadium
34 McCooey Memorial Field
35 William Smith Field
36 Winn-Seeley Gymnasium
37 McCormick House
38 Bristol Gymnasium
39 Tennis Courts
40 Emerson Hall
41 Cozzens Memorial Field
42 121 Hamilton St.
43 WEOS-FM
44 Intercultural Center
45 295 Pulteney St.
46 Brent Cooperative - Multi-Cultural Sisterhood House
47 Academic Support Theme House
48 Security and Safety/ Buildings and Grounds
49 Cloverleaf - Latin Cultural Initiative
50 Delta Chi
51 Kappa Sigma
52 Kappa Alpha Society
53 Henry House
54 DeLancey Guest House
55 Sigma Phi
56 Chaplain's Residence
57 Chi Phi
58 Zappler House
59 Blanchard House
60 Alumni House
61 Admissions Center
62 Durfee House - Communications Office
63 McDaniels House - Creative Arts House
64 Bozzuto Boat House and Dock
65 The William Scandling
66 737 South Main St. - Community Service House
67 Sigma Chi
68 Houghton House
69 Carriage House
70 Sunken Gardens
71 William Smith Honors House
72 Folwell House - Asian Language House
73 Beta Sigma - Substance Free House
74 730 S. Main St. - Wellness House
75 Bampton House - Hobart Leadership House
76 Sill House - Green House
77 704 South Main Street - Culinary Cottage
78 746 S. Main St. - La Maison Francophone
79 Sherrill Hall
80 College Store
81 Jackson Hall
82 Rees Hall
83 Potter Hall
84 451 Pulteney St.
85 430 Pulteney St.
86 412 Pulteney St. - Christian Fellowship House
87 408 Pulteney St. - Jewish Culture House
88 402 Pulteney St.
89 400 Pulteney St.
90 15 Ver Plank St.
91 25 Ver Plank St.
92 99 St. Clair St. - Current Events and Issues House
93 Residential Education
94 Hubbs Health Center
95 121 St. Clair St.
96 Trowbridge House - Writers' House
97 133 St. Clair St. - Pathways House
98 Sheppard House - Youth Enrichment House
99 Hillcrest House
100 Farm House
101 Stern Hall
102 Finger Lakes Institute
103 North Residence Hall
104 de Cordova Hall
105 The Katherine D. Elliott Studio Arts Building
106 623 S. Main Street
107 Poster Tent

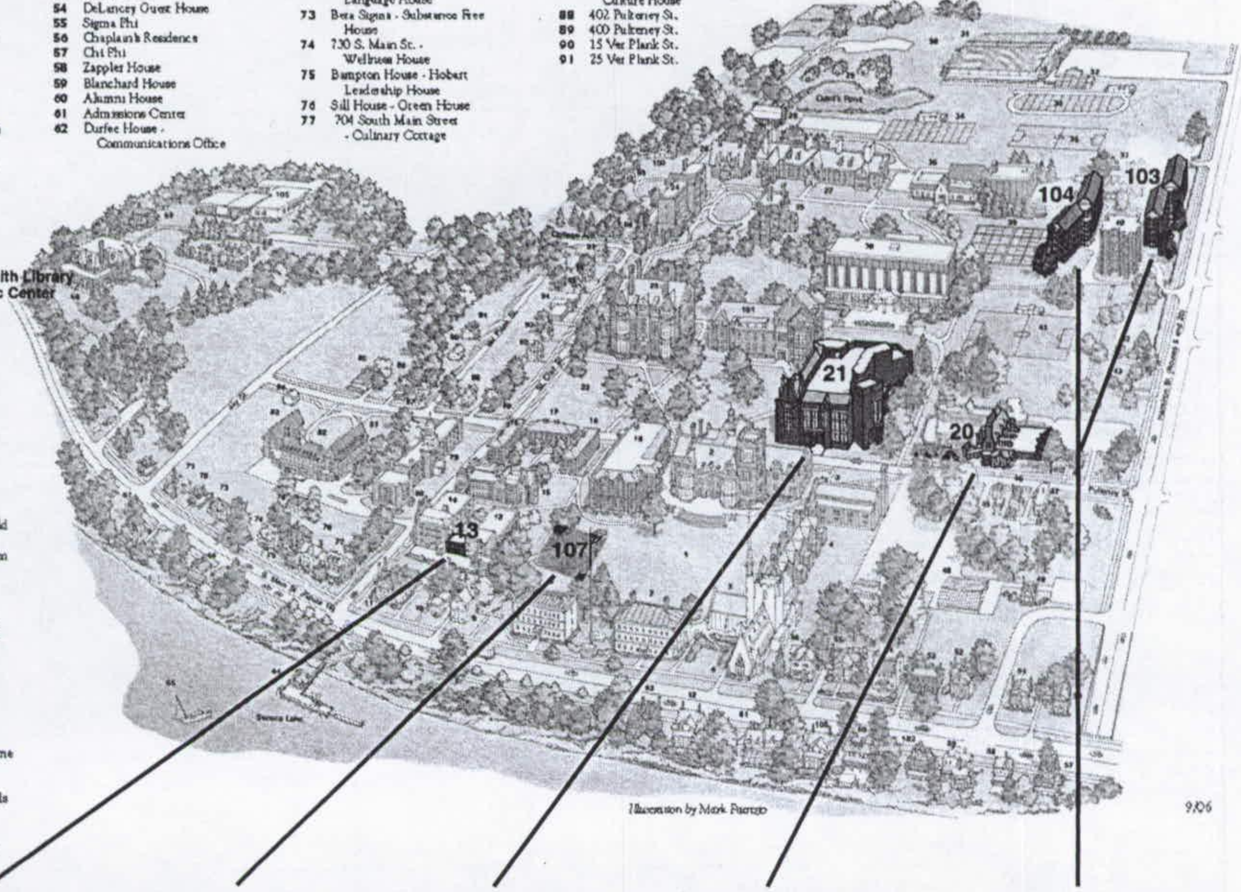

Illustration by Mark Parrazo

9/06

Oral Session
Albright Auditorium

Poster Session
Poster Tent

Registration
Library

Lunch & Dinner
Scandling Center

Dormitories
N. Residence Hall
de Cordova Hall

SYMPOSIUM SCHEDULE

Date	Time	Session	Topic	Room
Saturday August 2	8am-6pm	Pre-symposium tour	Pre-symposium tour of NYC and Hudson Valley	
Sunday August 3	8am-4pm	Pre-symposium tour	Pre-symposium tour of Ithaca	
	4pm-9pm	Registration	Registration	Warren Hunter Smith Library
	7pm-9pm	Dinner	Welcome Reception at Hobart	Scandling Center
Monday August 4	8:00-8:30am	Opening Session	Welcome to the Symposium and Cornell University	Albright Auditorium
	8:30am-10:00am	Oral Session 1	Rootstock Genomics and Genetics	Albright Auditorium
	10:30am-11:30am	Oral Session 2	Rootstock Genomics and Genetics	Albright Auditorium
	11:30am-12:30pm	Poster Session 1	Posters 1-26	Poster Tent
	1:30pm-3:00pm	Oral Session 3	Environmental Physiology	Albright Auditorium
	3:30pm-4:30pm	Poster Session 2	Posters 27-52	Poster Tent
	4:30pm-6:00pm	Oral Session 4	Environmental Physiology	Albright Auditorium
	6:30pm-8:30pm	Optional Dinner	Dinner at Hobart Scandling Center	Scandling Center
Tuesday August 5	8:15am-10:00am	Oral Session 5	Orchard Systems	Albright Auditorium
	10:30am-11:30am	Oral Session 6	Orchard Systems	Albright Auditorium
	11:30am-12:30pm	Poster Session 3	Posters 53-78	Poster Tent
	1:30pm-2:30pm	Oral Session 7	New Technologies for Orchards Workshop	Albright Auditorium
	2:30pm-6:00pm	Orchard tour	Orchard tour of Plots at New York State Agricultural Experiment Station	
	7:00pm-10pm	Optional Dinner	Dinner along Seneca Lake	Ventosa Vineyards
Wednesday August 6	8:00am-6:00pm	Orchard tour	Orchard tour of New York Fruit Industry in Wayne County	
	6:30pm-8:30pm	Optional Dinner	Dinner at Hobart	Scandling Center
Thursday August 7	8:15am- 10:00am	Oral Session 8	Rootstock Breeding and Evaluation	Albright Auditorium
	10:30am-11:30am	Oral Session 9	Rootstock Breeding and Evaluation	Albright Auditorium
	11:30am-12:30pm	Poster Session 4	Posters 79-104	Poster Tent
	1:30pm-3:00pm	Oral Session 10	Environmental Physiology Oral Session (High Temperature Stress)	Albright Auditorium
	3:30am-4:30pm	Poster Session 5	Posters 105-132	Poster Tent
	4:30pm-6:00pm	Oral Session 11	Environmental Physiology	Albright Auditorium
	7pm-10pm	Banquet	Symposium Banquet and Awards Ceremony	Yatch Club
Friday August 8	8:00am-8:30am	Business Meeting	Orchard Systems, Rootstocks and Environmental Physiology Working Groups	Albright Auditorium
	8:45am-10:00am	Oral Session 12	Orchard Systems	Albright Auditorium
	10:30am-12:15pm	Oral Session 13	Orchard Systems	Albright Auditorium
	1:30pm-3:00pm	Oral Session 14	Rootstock Breeding and Evaluation	Albright Auditorium
	3:30pm-5:30pm	Oral Session 15	Environmental Physiology	Albright Auditorium
	6:30pm-8:30pm	Optional Dinner	Dinner at Hobart	Scandling Center
Saturday August 9	8am-6pm	Post symposium tour	New York Fruit Industry in Orleans County and Niagara Falls	
Sunday August 10	8am-5pm	Post symposium tour	Niagara Falls and New York Fruit Industry in Niagara County	

PRE-TOUR PROGRAM

	Saturday 2-Aug	
Pre-Symposium Tour:	NYC and Hudson Valley Fruit Industry	
Tour Leader: Steve Hoying		8:00am-6:00pm
Time	**Topic**	**Presenter**
8:00-11:00am	Tour of New York City	Professional Tour Guide
11:00-12:00noon	Tour of Green Market	Steve Hoying
12:00-1:00pm	Lunch at Green Market	Steve Hoying
2:00-3:00pm	CG rootstocks at Crists	Steve Hoying and Jeff Crist
3:00-4:00pm	Porpiglia Orchards	Steve Hoying and Joe Porpiglia
4:00-5:00pm	Production for Retail Markets	Steve Hoying and Steve Clarke
5:00-6:00pm	Dressel Systems Trial	Steve Hoying and Rod Dressel
7:00-9:00pm	Dinner at New Paltz Restaurant	Steve Hoying

	Sunday 3-Aug	
Pre-Symposium Tour:	Cornell Campus and Ithaca Fruit Research	3-Aug
Tour Leader: Steve Hoying		8:00am-4:00pm
Time	**Type of Presentation**	**Presenter**
8:00-11:00am	Bus Trip from Hudson Valley to Cornell University	Steve Hoying
11:00-12:00noon	Tour of Cornell University Campus	Lailiang Cheng
12:00-1:00pm	Lunch at Ithaca Research Farm	Lailiang Cheng
1:00-2:00pm	Research Plots at Ithaca	Lailiang Cheng, Ian Merwin, Chris Watkins
2:00-3:00pm	Research Plots at Lansing	Ian Merwin and Lailiang Cheng
3:00-4:00pm	Bus Trip to Geneva	Steve Hoying
4:00-9:00pm	Symposium Registration	Nancy Long and Kateri Reagan
7:00-9:00pm	Welcome Reception at Hobart Scandling Center	Terence Robinson

MONDAY AUGUST 4, 2008

Opening Plenary Session		**8:00-8:30am** **Albright Auditorium**
8:00-8:15	Welcome to the Symposium	Terence Robinson, Ted DeJong
8:15-8:30	Welcome to Cornell University	Director Tom Burr

Oral Session 1:		**Rootstock Genomics and Genetics**	**8:30-10:00am**
Session Chair:		**Herb Aldwinckle**	**Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
8:30-9:00	1	Implementation of Molecular Marker Technologies in the Apple Rootstock Breeding Program in Geneva - Challenges and Successes	Gennaro Fazio
9:00-9:15	2	Initial Alteration of Shoot Architecture by Dwarfing Apple Rootstocks Involves Shoot/Root/Shoot Signaling Between Auxins, Gibberellins and Cytokinins	Ben van Hooijdonk
9:15-9:30	3	Using Genomics Tools To Understand Rootstock-Induced Floral Bud Initiation In Rosaccae	Amit Dhingra
9:30-9:45	4	Rootstock-regulated Gene Expression Profiling in Apple Trees Reveals Genes whose Expression Level is Associated with Fire Blight Resistance	Philip Jensen
9:45-10:00	5	Non-Dormant Evergrowing Peach as a Tool for Discovering Genes Involved in Vegetative Growth Cessation	Sergio Jiménez
10:00-10:30		Coffee, Juice and Snack Break in the Courtyard	

Oral Session 2:		**Rootstock Genomics and Genetics**	**10:30-11:30am**
Session Chair:		**Gennaro Fazio**	**Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
10:30-10:45	6	Molecular Markers for Fire Blight Resistance (*Erwinia Amylovora*) in Apple (*Malus*)	John Norelli
10:45-11:00	7	Fire blight Resistance of Budagovsky 9 Apple Rootstock	Nicole Russo
11:00-11:15	8	Physiological and biochemical parameters involved in waterlogging tolerance in Prunus rootstocks	María José Rubio-Cabetas
11:15-11:30	9	Physiological and Morphological Effects of Size-Controlling Rootstocks on 'Fuji' Scion	Thomas Tworkoski

Poster Session 1			**11:30am-12:30pm** **Poster Tent**
	Poster Abstract Number	**Title**	**Presenter**
	1	Establishment and Growth Parameters of Some Wild Almonds in Iran	Alireza Rahemi
	2	Results Concerning the Behaviour of Some Rootstocks for Peach Tree in the Nursery Field	Alexandra Indreias
	3	A RAPD Marker Linked to the Resistance Gene to Alternaria Leaf Spot (*Alternaria mali* Roberts) in 'Qinguan' Apple	Gennaro Fazio

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	4	Influence of the Rootstock on the Morphological Differentiation of the Flower Buds in Two Cherry Cultivars	Alexandros Papachatzis
	5	Selecting and Fingerprinting the Next Generation of Size-Controlling Rootstocks for Sweet Cherry	Matt Whitting
	6	Effect of Different Seed Treatments on the Germination and Seedling Growth of Almond	Ashaq Pandit
	7	Dormant Carbohydrate Reserves of Two Peach Cultivars Grafted on Different Rootstocks	Greg Reighard
	8	Sampling to Determine Relative Root Distribution	Brent Black
	9	Effect of Nitrogen Forms on IPT3 Expression and Hormone Contents of Pingyitiancha (*Malus hupenensis* Rehd.)	Futian Peng
	10	Effect of Soil Type on Root Architecture and Nutrient Uptake by Roots of Young Apple Tree	Hongqiang Yang
	11	Propagation of Fruit-Tree Rootstocks in Vitro and Their Behavior in Stock Plantations	Ivan Kulikov
	12	Possible Physiological Mechanism of Premature Fruit Drop in Mango (*Magnifera indica* L.) in Northern Vietnam	Jens Wünsche
	13	Initial Results About Low Chilling Nectarine Culture in Environmental Conditions of Spanish Southeast	Jesus García Brunton
	14	Development of a New Apple Rootstock Framework Map	Kate Evans
	15	Performance of Four Semi-Dwarf Apple Rootstocks from Foreign Breeding Programs at Three Sites in Eastern Canada.	Jean-Pierre Privé
	16	St Jean 84 (SJ84) Dwarf Winter Hardy Rootstock Series	Jean-Pierre Privé
	17	Time of Hedging Affects Fruit Retention and Yield in Macadamia	Lisa McFadyen
	18	Molecular Bases of the Waterlogging Tolerance in Prunus Rootstock: Candidate Genes Approach	María Luisa Amador
	19	Effects of Pruning on the Apple Tree: from Tree Architecture to Modeling	Pierre-Eric Lauri
	20	Effects of Rootstock on Leaf and Fruit Macro-element Composition in 'Reinders Golden Delicious' Apple	Pieter Stassen
	21	Using Naphtalene Acetic Acid (NAA) to Reduce Shoot Growth When a Heading Cut is Used to Lower Tree Height in Super-Spindle Apple Trees	Win Cowgill
	22	Method of Constructing Core Collection for *Malus sieversii*	Xuesen Chen
	23	Effects of Climate Change on Apple Phenology - 50 Years of Weather and Phenology Records at Klein-Altendorf/Bonn	Michael Blanke
	24	Effects of Supplementation of Benzoic Acid on Anti-oxidative Capacities of Roots in Malus hupehensis Rehd. Seedlings	Zhiquan Mao
	25	Effects of Temperature and Light Level on Efficiency of Chemical Thinners on 'Empire' Apple trees	Tae-Myung Yoon
	26	Mapping Genes Expressed Preferentially in Apple Rootstock	Angela Baldo
12:30-1:30	Lunch	Lunch at the Scandling Center	

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Oral Session 3:		**Environmental Physiology**	**1:30-3:00pm**
Session Chair:		**John Palmer**	Albright Auditorium
Time	**Oral Abstract Number**	**Title**	**Presenter**
1:30-2:00	10	Early Fruit Growth and Drop – The Role of Carbon Balance in the Apple Tree	Alan Lakso
2:00-2:15	11	Sorbitol Availability and Sorbitol Dehydrogenase Expression During Apple Bud Development From Budbreak to Bloom	Marta Nosarzewski
2:15-2:30	12	Does Availability of Soluble Carbohydrate Reserves Determine Apple Fruit Set?	Douglas Archbold
2:30-2:45	13	Seasonal Responses of Apple Fruit Growth, Abscission, and Fruit Carbohydrate Concentrations to Low Light	Duane Greene
2:45-3:00	14	Isolation and Characterization of Genes Associated with Shade-Induced Apple Abscission	Susheng Gan
3:00-3:30		Coffee, Juice and Snack Break in the Courtyard	

Poster Session 2			**3:30pm-4:30pm** **Poster Tent**
	Poster Number	**Title**	**Presenter**
	27	Agronomical Performance and Fruit Quality of 'Conference' on Some Clonal Pear Rootstocks	L. Asín
	28	Interactions Between Rootstock and Scion Growth and Productivity of Peach	Alexandra Indreias
	29	Improvement of the Fruit Set of 'Jonagold'	Jef Vercammen
	30	Effects of Two Planting Systems on Florina and Generos Apple Cultivars Grafted on M.26 Rootstock	Ioan Platon
	31	Results From the 11-Year Examining of Rootstocks of the Series Gisela and Weiroot in Bulgaria	Alexandros Papachatzis
	32	Interstems but not Grafting Height Controlled Vegetative Growth on Young Redhaven Peach Trees	Greg Reighard
	33	Effect of Indolbutyric Acid (IBA) on the Cuttings Of MM-106 and MM-111 Apple Rootstocks	Ashaq Pandit
	34	Whole-Photosynthesis and Transpiration in Field-Grown Papaya Plants	Eliemar Campostrini
	35	Climate Change in the Western Cape of South Africa: Trends, Projections and Implications for Chill Unit Accumulation	Elmi Lötze
	36	Improving Water Use Efficiency by Root Treatment in Orchard	Hongqiang Yang
	37	Influence of the Rootstock on the Agronomical Behavior of 'Jesca' Peach Under Replant Conditions	José Manuel Alonso
	38	Performance of G.30 Apple Rootstock in the Annapolis Valley	Charlie Embree
	39	A Multi-Cultivar Annual Topworking System for Asian Pear Production in Subtropical Taiwan	Kuo-Tan Li
	40	Growth, Development, Yield and Fruit Quality of 'Forelle' Pear is Influenced by Rootstock, Mulching and Nitrogen Application.	Mike North

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41	The Effect of Eight Clonal Rootstocks on the Growth and Yielding of 'Kordia' Sweet Cherry Trees	Miroslaw Sitarek
42	Performance of 'Coscia' Pear (Pyrus communis) on Nine Rootstocks in the North of Israel	Raphael (Raffi) Stern
43	The Effect of Timing of Scoring on Yield, Fruit and Shoot Growth and Reproductive Bud Development on 'Royal Gala', 'Fuji' And 'Cripps' Pink' Apple Trees	Stephanie Midgley
44	Model Prediction of the Spring Phenology for 'Fuji' Apple	Toshikazu Asakura
45	Features of Anatomic Structure of the Grafted Young Apple Trees as the Factor Which Forms Potential Efficiency	Volodymyr Zamorskyi
46	Performance of Gala Apple Trees on Supporter 4, P.14, and Different Strains of B.9, M.9, And M.26 Rootstocks As Part Of The 2002 NC-140 Apple Rootstock Trial	Wesley Autio
47	Effect of Exogenous Nitric Oxide on Active Oxygen Metabolism and Respiration in the Cause of Waterlog Resume of Sweet Cherry Root	Zhiquan Mao
48	Blossom Thinning of 'Babygold 5' and 'Redhaven' Peach with Different Chemicals	Tae-Myung Yoon
49	Changes of Shoot Growth Habit in MdMADS2 Gene Introduced Transgenic Apples *(Malus* sp.)	Daeil Kim
50	'O3A' Apple Rootstock	Jean-Pierre Privé
51	Comparative Evaluation of Hungarian Bred Mahalebs as Cherry Rootstocks	Geza Bujdosó
52	Confirmation by QTL Mapping of the *Malus robusta* (Cv. Robusta 5) Derived Powdery Mildew Resistance Gene *Pl1*	Gennaro Fazio

Oral Session 4:		**Environmental Physiology**	**4:30-6:00pm**
Session Chair:		**Greg Lang**	**Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
4:30-4:45	15	The Effect of Temperature and Developmental Stage on Carbon Dioxide Exchange of Attached 'Royal Gala', 'Fuji' And 'Cripps' Pink' Apple Fruits	Stephanie Midgley
4:45-5:00	16	Predicting Chemical Thinner Response with a Carbohydrate Model	Terence Robinson
5:00-5:15	17	Contributions of short and long shoots to yield of 'Kerman' pistachio (*Pistacia vera* L.)	Timothy Spann
5:15-5:30	18	Genetic versus Environmental Effects on Hexose Characteristics of Peach Fruit	Benhong Wu
5:30-5:45	19	Weather Conditions Affect Fruit Weight, Harvest Date and Soluble Solids Content of 'Cresthaven' Peaches.	Scott Johnson
5:45-6:00	20	Using Concept-based Computer Simulation Modeling to Study and Develop an Integrated Understanding of Tree Crop Physiology.	Ted DeJong
6:30-8:30		Optional Dinner at the Hobart Scandling Center	

TUESDAY AUGUST 5, 2008

Oral Session 5:		**Orchard Systems**	**8:15-10:00am**
Session Chair:		**Michael Blanke**	**Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
8:15-8:45	21	Changing Concepts of Efficiency in Orchard Systems	John Palmer
8:45-9:00	22	Sweet Cherry Trees Planted as 'Sleeping Eyes' Have Less Survival but Greater Growth Compared to Standard Nursery Trees	Matthew Whiting
9:00-9:15	23	High Tunnel Sweet Cherry Studies: Innovative Integration of Precision Canopies, Precocious Rootstocks, and Environmental Physiology	Gregory Lang
9:15-9:30	24	Effect of Timing of Topping to Reduce Tree Height on Subsequent Year Tree Vigor of Early-Season Arctic Star Nectarine	Kevin Day
9:30-9:45	25	Bibaum®: A New Training System for Apple Orchards	Stefano Musacchi
9:45-10:00	26	Apple Crop and Fruit Quality Influenced by Low and High Planting Densities on M9 and M27 in Northern Germany	Rolf Stehr
10:00-10:30		Coffee, Juice and Snack Break	

Oral Session 6:		**Orchard Systems**	**10:30-11:30am**
Session Chair:		**Alan Lakso**	**Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
10:30-10:45	27	Comparing the Economics of Mechanical and Traditional Sweet Cherry Harvest	Matthew Whiting
10:45-11:00	28	The Productivity and Economic Comparison of High Density Production Systems for Pink Lady and Sundowner Apples in South Australia	Paul James
11:00-11:30	29	Reflections on My 40 Years of Fruit Research	Fritz Lenz

Poster Session 3			**11:30am-12:30pm** **Poster Tent**
	Poster Abstract Number	**Title**	**Presenter**
	53	The Distribution of Wild Apple Germplasm in Northwest China and Their Potential Application to the Apple Rootstock Breeding	Gennaro Fazio
	54	Different Planting Systems for 'Conference'	Jef Vercammen
	55	Effect of Rootstock on Yield and Taste-Related Properties of Nordic Apple Cultivars	Leila Mainla
	56	Metroglyph and Index Score Analysis of Almond Germplasm Collected From Kashmir Valley	Ashaq Pandit

TUESDAY AUGUST 5, 2008

	57	Performance of Cornell Geneva Apple Rootstocks in South Africa	Carlo Costa
	58	Apple Rootstocks in Latvian Orchards: Situation and Tendencies	Edgars Rubauskis
	59	Pruning and Cytokinnin Sprays to Improve 'Sweetheart' Cherry Fruit Size	Gabino Reginato
	60	Reduction of Shoot Growth and Winter Pruning by Prohexadione Calcium Application	Gabriel Berenhauser
	61	Differences in Mineral Nutrient Contents of Dormant Cherry Spurs as Affected by Rootstock, Scion, and Orchard Site	Gregory Lang
	62	Rootstock Studies in Kinnow Mandarin Under North Indian Conditions	Jagdev Singh Josan
	63	Results of Apple Rootstock Testing with Variety 'Belorusskoye Malinovoye' in Project "Baltic Fruit Rootstock Studies"	Janis Lepsis
	64	Evaluation of the OH°F Selections as an Alternative to Quince Rootstocks for Pear: Agronomical Behavior of 'Conference' and 'Doyenne du Comice'	José Manuel Alonso
	65	Evaluation of Dwarfing Rootstocks in Washington Apple Replant Sites	Jim McFerson
	66	Digital Techniques for Yield Prediction of Fruit	Michael Blanke
	67	St Jean Morden (SJM) Dwarf Winter Hardy Rootstock Series	Jean-Pierre Privé
	68	Overview of Peach and Nectarine Rootstocks in South Africa	Pieter Stassen
	69	Cold Temperature Tolerance of Apple Roots	Renae Moran
	70	Influence of Training System on Production of Three Apple Cultivars	Robert Crassweller
	71	Apple Scion and Rootstock Selection and Planning for Michigan	Ron Perry
	72	High Density Trial of Bramley's Seedling Apple (Malus pumila Mill) Clones on M9 and M27 Rootstocks	Seán Mac an tSaoir
	73	The U.F.O. System - A Novel Architecture For High Efficiency Sweet Cherry Orchards	Matthew Whiting
	74	Performance of Several Dwarfing Rootstocks with 'Fuji' and 'McIntosh' as Scion Cultivars in the 1999 NC-140 Dwarf Apple Rootstock Trial	Wesley Autio
	75	Early Performance Of 'Buckeye Gala' Grafted On 13 Apple Rootstocks	Carlos Chávez
	76	Peach Flower Buds Thinned with Dormant Applications of Vegetoil® Adjuvant Plus Ethephon	Gregory Reighard
	77	Development of Cold Resistant Apple Rootstocks in China	Maojun Zhang
	78	Effect of Different Growth Inducing Rootstocks on Alternate Bearing of 'Royal Gala' and 'Vista Bella' Apples	Jozsef Racsko
	132	The c-DNA-AFLP Profiling of Salt-Stress Response in Apple	Zhen Hai Han
12:30-1:30	Lunch	Lunch at Hobart Scandling Center	

TUESDAY AUGUST 5, 2008

Oral Session 7:		**New Technologies for Orchards**	**1:30-2:30pm**
Session Chair:		**Alan Lakso**	**Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
1:30-2:00	30	New Opportunities with Microtechnologies and Photonics for Fruit Tree Research.	Dennis Zander
2:00-2:30	31	Geospatial Technologies	Karen Kwasnowski

Field Tour:	**New York State Agricultural Experiment Station**	**2:30-6:00pm**
Tour Leader:	**Terence Robinson**	
Time	**Topic**	**Presenter**
2:45-3:15	Cherry Rootstocks, Systems and Fruit Size	Steve Hoying, Gabino Reginato, and Tae-Myung Yoon
3:15-3:45	Cornell-Geneva Rootstocks	Gennaro Fazio and Herb Aldwinckle
3:45-4:15	High Density Apple Management and CG Rootstocks	Terence Robinson, Leo Domínguez and Darius Kviklys
4:15-4:45	Whole Tree Photosynthesis and Carbon Model	Alan Lakso
4:45-5:15	Pear Rootstocks and Systems	Terence Robinson
5:15-6:00	High Tunnels for Stone Fruits	Terence Robinson
7:00-10:00	Optional Dinner at Ventosa Winery	

WEDNESDAY AUGUST 6, 2008

Wayne County Tour Program		
Tour of Fruit Industry in Wayne County		**8:00am-6:00pm**
Tour Leader: Steve Hoying		**Albright Auditorium**
Time	**Topic**	**Presenter**
8:00-9:00am	Overview of the NY Fruit Industry	Steve Hoying and Alison DeMarree
9:00-12:00 noon	Nursery Production at Waflers Nursery	Paul Wafler and Bill Pitts
	Tall Spindle System at Waflers	Terence Robinson and Paul Wafler
	Super Spindle System at Fowler Farms	JD Fowler and Steve Hoying
	CG Rootstocks at Cahoon Farms	Gennaro Fazio
12:00-1:30pm	Sodus Bay Restaurant	Alison DeMarree
1:30-4:00pm	Pruning Gala for Improved Fruit Size at Vanderwalle's	Scott Vanderwalle and Steve Hoying
	Apple Orchard Systems and Rootstock Trial	Terence Robinson
	V-system and Mechanical Thinning of Peach at Furber Farms	Alison DeMarree and Todd Furber
	Organic Apple Production in Humid Climates at Schwartz Farms	Steve Hoying
4:00-5:00pm	Club Varieties at DeMarree Fruit Farm	Tom DeMarree
	Retail Fruit Marketing	Ed and Jan Burnap Mike and Kendra Maloney
5:00-6:00om	Bus Trip to Geneva	Steve Hoying and Alison DeMarree
6:30-8:30pm	Optional Dinner at Hobart Scandling Center	

THURSDAY AUGUST 7, 2008

Oral Session 8:		**Rootstock Breeding and Evaluation**	**8:15-10:00am**
Session Chair:		**Frank Maas**	**Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
8:15-8:30	32	Guardian® Peach Rootstock Performance and Preplant Soil Fumigation Effects in a Fallow Site	Michael Parker
8:30-8:45	33	Degree of Dwarfing and Productivity of Eight Apple Rootstocks with Winter Hardy Scions	Emily Hoover
8:45-9:00	34	Performance of Nectarine Rootstocks on Different Soil Types	Pieter Stassen
9:00-9:15	35	GiSelA® Cherry Rootstocks Compared for Virus Tolerance and Field Performance	Christa Lankes
9:15-9:30	36	Peach Rootstocks Differ in Their Growth Responses to Both High and Low Root Temperatures.	Peter Malcolm
9:30-9:45	37	The Impact of Rootstock and Irrigation on Water Use, Tree Growth, Nutrition, Yield, and Fruit Quality of 'Pacific Gala' Apple	Essie Fallahi
9:45-10:00	38	Controller 5, Controller 9 and Hiawatha Peach Rootstocks: Their Performance and Physiology	Ted DeJong
10:00-10:30		Coffee, Juice and Snack Break	

Oral Session 9:		**Rootstock Breeding and Evaluation**	**10:30-11:30noon**
Session Chair:		**Greg Reighard**	
Time	**Oral Abstract Number**	**Title**	**Presenter**
10:30-10:45	39	Effect of Different Rootstocks and Interstems on the Growth and Yield of Some Sweet Cherry Cultivars	Elzbieta Rozpara
10:45-11:00	40	French Evaluation of the CG Rootstock Selections: History and Results	Marie Helene Simard
11:00-11:15	41	Peach Rootstocks Inducing Different Vigour to Grafted Cultivars Reflect Genomic And Physiological and Morphological Diversity in Roots.	Filiberto Loretti
11:15-11:30	42	Performance of Geneva Rootstocks in On-farm trials in New York State	Terence Robinson

Poster Session 4			**11:30am-12:30pm** **Poster Tent**
	Poster Abstract Number	**Title**	**Presenter**
	79	Optimization of Geneva Rootstock Micropropagation	Amit Dhingra

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80	Reflective Ground Covers Increase Yields of Target Fruit	Jim McFerson
81	Performance of Plum (*Prunus salicina*) Rootstocks on Different Soil Types	Pieter Stassen
82	An apple-specific ET model	Alan Lakso
83	Influence of Rootstock Thickness, Nut Hardiness and Environmental Conditions on Vegetative Propagation of Walnut	Ashaq Pandit
84	Effect of Foliar Application of Boron and Zinc on Fruit Set and Productivity of Almond	Ashaq Pandit
85	A Survey of Cultivar/Rootstock and Orchard Management Factors Influencing the Incidence of Sunburn Damage on Apple Fruit in Hungary and South Africa	Josef Racsko
86	Overview of Apple Rootstocks in South Africa	Carlo Costa
87	Relationship Between Vigor and Genetic Similarity Index in Seedlings of Polyembryonics Varieties of *Mangifera indica* L.	Claudia Barbosa
88	Investigation of Apple Rootstocks in the Nursery	Darius Kviklys
89	Comparison of Some Size Controlling CG Apple Rootstocks on the Performance of 'Jonagold' and 'Novaspy' in Atlantic Canada.	Jean-Pierre Privé
90	Effects of Three Planting Systems on Apple Tree Growth and Productivity	Florin Stanica
91	Rootstocks Affect Four Apple Cultivar Yield in Kiasar	Hosein Sadeghi
92	Evaluation of Pear Rootstocks in Latvia	Janis Lepsis
93	Regulated Deficit Irrigation Affects Fruit Quality, Yield and Growth of 'Montmorency' Tart Cherry	Kylara Papenfuss
94	Ethephon as a Bloom and Post Bloom Thinner for 'Summerred' Apple Trees	Mekjell Meland
95	Precision Selective Thinning to Regulate Fruit Set and Improve Apple Fruit Quality	Michael Blanke
96	The Effect of Planting Density of Bramley's Seedling Apple (*Malus pumila* Mill) on M111/9 Rootstocks with an M9 control in sites suffering from Specific Apple Replant Disease.	Seán Mac an tSaoir
97	Performance of Several Semidwarfing Rootstocks with 'Fuji' and 'McIntosh' as Scion Cultivars in the 1999 NC-140 Semidwarf Apple Rootstock Trial	Wesley Autio
98	Studies on Diagnosis of Tree Architecture in Young Red Fuji Apple Tree	Yuanmao Jiang
99	Rehabilitation of Shiwaliks Through Agro-Horticulture Models	Pushpinder Singh Aulakh
100	The History of Apple Breeding in People's Republic of China	Gennaro Fazio
101	Evaluation and Selection of Fruit Rootstocks for the Climate of Belarus	Zoya Kazlouskaya

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	102	Regulation of Calcium Uptake and Translocation in Plants	Hongqiang Yang
	103	Effects of Shoot and Leaf Distribution on Microclimate and Fruit Quality in Fuji Apple	Qinping Wei
	104	*Malus xiaojinensis* – A Promising Apple Rootstock	Zhen hai Han

12:30-1:30		Lunch at Hobart Scandling Center	

Oral Session 10: **Session Chair:**		**Environmental Physiology** **Jens Wünsche**	**1:30-3:00pm** **Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
1:30-2:00	43	High Temperature and Solar Radiation: Sunburn, Fruit Quality, and Skin Pigments of Apple	Larry Schrader
2:00-2:15	44	High Temperature Coupled with High Light Alters the Balance Between Photooxidation and Photoprotection in the Sun-Exposed Peel of Apple	Lailaing Cheng
2:15-2:30	45	Effect of Temperature and Light on Sunscald in Apple Fruit and the Acquisition of Partial Temporal Tolerance	Amos Naor
2:30-2:45	46	Why Do Early High Spring Temperatures Reduce Peach Fruit Size and Yield at Harvest?	Ted DeJong
2:45-3:00	47	Effect of Row Orientation and Canopy Inclination on Gas Exchange and Energy Management of the "Asymmetric Peach Orchard"	Luca Corelli-Grappadelli

3:00-3:30		Coffee, Juice and Snack Break	

Poster Session 5			**3:30pm-4:30pm** **Poster Tent**
	Poster Abstract Number	**Title**	**Presenter**
	105	Apomictic Dwarfing Apple Rootstocks Provide New Prospects for Apple Rootstock Propagation	Gennaro Fazio
	106	An Apple Dwarfing Rootstock: 'Liaozhen 2'	Gennaro Fazio
	107	Apple Stocks Function Difference Between Root and Shoot with Different Fertility Level	Xiang Shen
	108	Annual Large Limb Removal to Contain Canopy Spread in the Kentville Free Standing Tree Wall	Charlie Embree
	109	Screening of Apple Rootstocks for Response to Apple Proliferation Disease	Christa Lankes

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110	Effect of Interstock in Breaking Juvenility in Ambri Apple	Ashaq Pandit
111	Evaluation of Different Weed Control Measures in Apple Nursery	Ashaq Pandit
112	Hybridizing McIntosh Wijcik and Heat-Tolerant Apple Cultivars to Develop Precocious Seedling Trees with Improved Tree Architecture	Christopher Walsh
113	Interactions of Apple Rootstocks and Budding Height	Darius Kviklys
114	Field Performance of Different Species and Hybrids as Rootstock For Peach	Roberto De Salvador
115	Preliminary Report on the Selection of Cold-and-Drought Resistant oDwarfing Apple Rootstocks	Jianbao Tian
116	INRA-INTA Pear Rootstock Breeding Program Aiming for Tolerance to oIron Chlorosis and Low Vigor	Luis Asín
117	Preliminary Evaluation of Supported and Free Standing 'Honeycrisp' Trees	Jean-Pierre Privé
118	Evaluation of Resistance to Pathogens Attack in the Rootstock Breeding Apricot Program	Marioara Trandafirescu
119	Reflective Ground Covers Improve Fruit Quality, Yield, and Canopy	Michael Blanke
120	Improving Fruit Quality and Microclimate Under Hailnets in an Apple	A. Solomakhin
121	The Results of the Estonian Apple Rootstocks Breeding Programme	Neeme Univer
122	Varietal Difference of Apple Fruit in Response to High Temperature and	Pengmin Li
123	Millennium Planting Density Trial of Bramley's Seedling Apple (*Malus pumila* Mill) on M9 and M27 Rootstocks – Yield and Economic Returns, Phase 2 (2004-2007)	Seán Mac an tSaoir
124	Breeding of Stone Fruit Rootstocks Adapted to South African Soil and	Sonwabo Booi
125	Overview of Plum (*Prunus salicina*) Rootstocks in South Africa	Pieter Stassen
126	Progress in Developing Armillaria Resistant Rootstocks for Use with Peach	Thomas Beckman
127	Pear Rootstocks for the Central Zone of Russia	Vadim Girichev
128	Method of Constructing Core Collection for *Malus sieversii* Using Molecular Markers	Xuesen Chen
129	Rootstock Effect on Fruit Drop Patterns and Quality of 'Galaxy' and 'Golden Reinders' Apples	Josef Racsko
130	Management of Crop Load and Vegetative Growth on Honeycrisp to Optimize Fruit Size, Fruit Quality, Return Bloom and Fruit Set	James Flore
131	Carbon Supply, Demand, and Storage in Relation to Current Seasons Growth and the Following Years Yield	James Flore
132	The C-DNA-AFLP Profilins of Salt-Stress Response in Apple	Zhen hai Han

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Oral Session 11:		**Environmental Physiology**	**4:30-6:00pm**
Session Chair:		**Lailaing Cheng**	**Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
4:30-4:45	48	High Temperature Effects On Citrus Leaf Gas Exchange, Flowering, Fruit Yield And Quality	Jim Syvertsen
4:45-5:00	49	Decreased Stomatal Aperture and Increased Leaf Temperature Should be two Important Factors in Regulating Photosynthesis Under Low Sink Demand in Fruit Trees	Shao Hua Li
5:00-5:15	50	Susceptibility of Sweet Cherry to Polycarpy is Related to Tissue Temperature and Stage of Bud Development	Michael Whiting
5:15-5:30	51	Structure of Colored Hailnets Affects Light Transmission, Light Spectrum, Photo-Synthesis, Phytochrome, Vegetative Growth, Yield and Fruit Coloration in Apple	Matthew Blanke
5:30-5:45	52	Modifications to Peach Phenology by Inoculation with Single and Multiple Graft-transmissible Agents	Phillip Gibson
5:45-6:00	53	A Primary Study on Freezing Damage of Citrus in Mazandran Following January Frost, 2008	Hosein Sadeghi
7:00-10:00		Symposium Banquet and Awards at Seneca Yacht Club	

FRIDAY AUGUST 8, 2008

Business Meeting		**8:00-8:30am** **Albright Auditorium**
Time	**Title**	**Presenter**
8:00-8:30	Business Meeting of Orchard Systems, Rootstock and Environmental Physiology Working Group	Terence Robinson

Session 13: **Session Chair:**		**Orchard Systems** **Gabino Reginato**	**8:45-10:00am** **Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
8:45-9:00	54	Performance of 'Golden Russet' Bosc Pear on Five Training Systems and Nine Rootstocks	Rachael Elkins
9:00-9:15	55	An Architectural-Based Tree Training and Pruning – Identification of Key Features in the Apple	Pierre-Eric Lauri
9:15-9:30	56	Search for a More Dwarfing Rootstock for 'Jonagold'	Jef Vercammen
9:30-9:45	57	The Tall Spindle System: Principles and Performance	Terence Robinson
9:45-10:00	58	Changes in Fruiting Behaviour and Vegetative Development of 'Scifresh' Apple in Response to Artificial Spur Extinction Using Centrifugal Training	Stuart Tustin
10:00-10:30		Coffee, Juice and Snack Break	

Session 13: **Session Chair:**		**Orchard Systems** **Stuart Tustin**	**10:30-12:30pm** **Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
10:30-10:45	59	Prohexadione-Calcium and NAA Sprays Increase Fruit Weight of 'Castlebrite' Apricot Over Other Management Techniques	Gabino Reginato
10:45-11:00	60	Effects Of Different Crop Loads and Time of Thinning on Yield, Fruit Quality and Return Bloom of the Apple Cultivar 'Elstar'	Mekjell Meland
11:00-11:15	61	The Impact of Dormant Spur-Wood Pruning Severity on Vegetative Growth, Blossom Density and Fruit Size Of 'Honeycrisp'	Douglas Nichols
11:15-11:30	62	The Effect of Organic and Conventional IPM Management Programs on Apple and Asian Pear Tree Growth, Productivity, Expenses and Revenues in a Hot, Humid Climate	Christopher Walsh

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11:30-11:45	63	Crop Load Alters Water Potential and Daily Vascular Flows in Peach Fruit	Luca Corelli-Grapadelli
11:45-12:00	64	Preharvest Thinning Effects on 'Scifresh' Apple Fruit Production and Quality	John Palmer
12:00-12:15	65	Crop Load Management of Pacific Northwest Tree Fruits	Jim McFerson
12:30-1:30		Lunch Scandling Center	

Session 14:		**Rootstock Breeding and Evaluation**	**1:30-3:00pm**
Session Chair:		**Elizbieta Rozpara**	**Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
1:30-1:45	66	Breeding of Apple Rootstocks in Poland	Edward Zurawicz
1:45-2:00	67	Five-Year Evaluation of Apple Rootstocks for Orchard Performance and Resistance to Rootstock Blight	Herb Aldwinckle
2:00-2:15	68	Qingzhen 1' and 'Qingzhen 2', Two Apomictic Apple Rootstocks	Guangli Sha
2:15-2:30	69	Performance of Prunus Rootstocks in the 2001 NC-140 Peach Trial	Greg Reighard
2:30-2:45	70	The Krymsk® Rootstock Series. I. Krymsk®1 (VVA-1), a Dwarfing Rootstock At The Basis Of High Density Plum Orchards in the Netherlands.	Frank Maas
2:45-3:00	71	Review of Fruit Rootstock Research in Europe Performed by EUFRIN Rootstock Group	Darius Kviklys
3:00-3:30		Coffee, Juice and Snack Break	

Session 15:		**Environmental Physiology**	**3:30-5:30pm**
Session Chair:		**Luca Correlli-Grappadelli**	**Albright Auditorium**
Time	**Oral Abstract Number**	**Title**	**Presenter**
3:30-3:45	72	Water Consumption in Lysimeter-grown Apple and Pear Trees with Different Training Systems	Joan Girona
3:45-4:00	73	Mitigation of Water Stress in Peach Trees by Using Summer Pruning and Fruit Thinning	Gerardo Lopez
4:00-4:15	74	Effects of Partial Rootzone Irrigation on Growth and Physiological Characteristics in Apple and Water-saving Efficiency	Qinping Wei

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4:15-4:30	75	The Pedicel's Role in Postharvest Weight Loss of Two Sweet Cherry Cultivars	Erick Smith
4:30-4:45	76	The Relationship Between Shoot Length and Utilization of Stored Assimilates after Heading Cut in Young Apple Trees	Osamu Arakawa
4:45-5:00	77	The Systematic Influence of Crop Load, Spur Type, 3D-Canopy Structure, and Leaf Zonal Chlorosis on Leaf Photosynthesis of 'Honeycrisp' Apple Trees	Stefan Fleck
5:00-5:15	78	The Molecular Basis of Flowering in Longan	Jens Wunsche
5:15-5:30	79	Aspects of Macadamia Flowering and the Applications to Canopy Management	J. Wilkie
6:30-8:30		Optional Dinner at Hobart Scandling Center	

POST-TOUR PROGRAM

	Saturday 9-Aug	
Post-Symposium Tour:	**Western New York Fruit Industry and Niagara Falls**	**Saturday 9-Aug**
Tour Leader:	**Steve Hoying**	**8:00am-5:00pm**
Time	**Topic**	**Presenter**
8:00-10:00am	The Western NY Fruit Industry	Steve Hoying and Craig Kahlke
10:00-10:45am	CG Rootstock Plot at Burch's Orchard	Steve Hoying and Jim Burch
11:00-12:00noon	Systems Trial and New Orchards	Steve Hoying and Eric Brown
12:00-12:30pm	Browns Berry Patch U-Pick	Steve Hoying and Bob Brown
12:30-1:30pm	Lunch at Browns Berry Patch	Bob Brown
1:30-2:30pm	Super Spindle Apples at Lamont Fruit Farms	Steve Hoying and Rod Farrow
2:30-4:00pm	High Density Cherries at New Royal Fruit Farm	Steve Hoying and Tim Buhr
4:00-5:00pm	Niagara Falls	Steve Hoying
6:00-8:00pm	Dinner at Niagara Falls	Steve Hoying

	Sunday 10-Aug	
Post-Symposium Tour:	**Niagara Falls and the Western New York Fruit Industry**	**Sunday 10-Aug**
Tour Leader:	**Steve Hoying**	**9:00am-5:00pm**
Time	**Topic**	**Presenter**
9:00-11:00am	Maid of the Mist boat tour	Steve Hoying
11:00-12:00noon	Caves behind the falls	Steve Hoying
12:00-1:00pm	Falls Restaurant	Steve Hoying
1:00-2:00pm	Travel to Niagara County	Steve Hoying and Craig Kahlke
2:00-3:00pm	Peach Systems Trial	Steve Hoying
3:00-4:00pm	Fruit Wines	Steve Hoying
4:00-5:00pm	Travel to Rochester	Steve Hoying

Oral Session 1
Rootstock Genomics and Genetics

Oral Abstract 1

Implementation of Molecular Marker Technologies in the Apple Rootstock Breeding Program in Geneva - Challenges and Successes

Gennaro Fazio[1], Herbert S. Aldwinckle[2], Terence L. Robinson[3] and Yizhen Wan[4]
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[3]Department of Horticultural Sciences, New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456, USA
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The Geneva® Apple Rootstock Breeding program was initiated in the early 1970's with the overarching goal of developing disease resistant, productive and precocious apple rootstocks. Near the turn of the century the program was joined with USDA ARS resources and in addition to focusing on releasing improved rootstocks it took the challenge of implementing molecular marker technologies to aid in the active breeding and release process. The first step was to characterize current genetic resources in the elite gene pool of the program and place them in context of other rootstock br eeding programs and the larger *Malus* gene pool. This step yielded knowledge about the uniqueness of the germplasm that Cummins had created and opportunities for novel germplasm to be implemented. The second step was to gather phenotypic information about different half sib populations within the breeding program to identify the best parents. This was followed by a series of controlled crosses where the progeny was used to discover marker-trait associations. Conversely existing half sib breeding populations were also used for marker-trait association discovery. The main goal and third step of this effort was to implement Marker Assisted Breeding which for traits such as dwarfing and precocity could save several evaluation years in the breeding program. It turns out that in the meantime the most useful implementation of marker technologies has been the ability to fingerprint insidious apple rootstocks with mistaken identity resulting from mixed propagation beds, or tissue culture mistake. We are currently developing a marker assisted breeding protocol that will streamline the breeding process, hopefully yielding more diverse productive rootstocks, resistant to biotic and abiotic stresses and adapted to modern orchard management practices.

Oral Abstract 2

Initial Alteration of Shoot Architecture by Dwarfing Apple Rootstocks Involves Shoot/Root/Shoot Signaling Between Auxins, Gibberellins and Cytokinins

B.M. van Hooijdonk[1], D.J. Woolley[1], I.J. Warrington[1] and D.S. Tustin[2]
[1]Institute of Natural Resources, College of Sciences, Massey University, Palmerston North, New Zealand.
[2]The Horticulture and Food Research Institute of New Zealand Ltd, Hawke's Bay Research Centre, Havelock North, New Zealand.

The reduction of scion vigor by dwarfing apple rootstocks is attributed to reduced basipetal transport of indole-3-acetic acid (IAA) to the roots, and lower concentrations of root-produced cytokinins and gibberellins transported in the xylem to the scion. Although the literature presents a basic hypothesis of how dwarfing rootstocks may alter tree hormone balance and scion vigor, it is poorly understood when scion dwarfing first occurs in relation to tree phenology, how scion architecture is first modified, and what hormone group(s) may regulate these changes. Understanding when and how dwarfing of the scion first occurs is essential to clearly identify those signals and processes that are the first physiological causes of scion dwarfing from those that are subsequent developmental effects. 'Royal Gala' scions were grafted onto 'Royal Gala' (self rooted, very vigorous; control), M.793 (vigorous), MM.106 (semi-vigorous) and M.9 (dwarf) rootstocks to determine how each rootstock modified scion architecture during growth of the primary shoot in the first year after grafting. These modifications were compared with those of plant growth regulators applied to either the scion (± GA_{4+7}, ± benzylaminopurine (BAP)) or an auxin transport inhibitor (± 1-N-Naphthylpthalamic acid (NPA)) applied to the stem tissue of the rootstock. Compared with the 'Royal Gala' rootstock (control), M.9 reduced the number of axillary shoots formed along the primary axis. The final length of both the primary and axillary shoots was also reduced because of earlier meristem termination. Collectively, these reductions in vegetative growth caused by M.9 resulted in measurable scion dwarfing in the first year of growth. Reductions in branching for M.9 were fully reversed with exogenous BAP, however, newly initiated axillary shoots generally terminated without exogenous GA_{4+7}. GA_{4+7} increased the length of shoots for scions of M.9 by stimulating meristem activity, thereby decreasing the proportion of meristems that terminated early. In contrast, reducing the basipetal transport of IAA to the roots of vigorous rootstocks, by applying NPA to stem tissue of the rootstock, resulted in a major change in scion form that was similar to M.9 (reduced branching and shoot lengths). The application of BAP to scions of NPA treated rootstocks reinstated branching but, as observed with M.9, new axillary shoots terminated without exogenous GA_{4+7}. For rootstocks treated with NPA, GA_{4+7} reactivated growth of the primary and axillary shoots, although few additional axillary shoots developed without BAP. Endogenous signaling that may occur between scion and rootstock, together with the analytical work required to confirm the mechanism of vigor control, are discussed.

Oral Abstract 3

Using Genomics Tools to Understand Rootstock-Induced Floral Bud Initiation in Rosaccae

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Amit Dhingra[1], Tyson Koepke[1], and Matthew Whiting[2]
[1]Dept. of Horticulture, Washington State University, Pullman, WA, USA
[2]Irrigated Agriculture Research and Extension Center, Washington State University, Proser, WA, USA

Understanding the programmatic progression of floral bud initiation and development in Rosaceae is vital for mediating control of fruit yield and quality. Rootstocks used for sweet cherry (*Prunus avium* L.), exert paramount control over floral bud density in the scion. We have documented 10-fold variability in sweet cherry precocity and floral bud density induced by rootstock. Determining the genetic controls and mechanisms for the interaction of the rootstock on fruit production can be extremely important for tree fruit growers. A systems biology approach combining transcriptomics, proteomics and translational genomics is being undertaken to dissect this developmental program. Buds collected from rootstock/scion combinations exhibiting high and low floral bud density are being probed to identify the repertoire of genes involved in determining the number of floral bud primordia. In the future, protein-protein interactions of the gene products will be examined to ascertain the major players in floral bud density determination. Functional validation of the identified genes will be performed via either strawberry or sweet cherry transformation systems. Rootstock/scion interactions represent a novel biological process operative only in certain perennial fruit bearing crops without a parallel in existing model systems. Genomics assisted dissection of the influence that rootstocks exert on scion flowering density will enable identification of pertinent genes that can then be used for breeding new sweet cherry cultivars. Information gained from this work can be applied to other Rosaceae fruit crops that rely on precocious rootstocks for efficient production.

Oral Abstract 4

Rootstock-regulated Gene Expression Profiling in Apple Trees Reveals Genes whose Expression Level is Associated with Fire Blight Resistance

Philip J. Jensen[1], Noemi Halbrendt[5], Izabela Makalowska[2], Naomi Altman[3], Craig A. Praul[4], Siela N. Maximova[2], Robert M. Crassweller[2], James W. Travi[5], Gennaro Fazio[6], and Timothy W. McNellis[1]
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[5]The Pennsylvania State University Fruit Research and Extension Center, P.O. Box 330, 290 University Dr., Biglerville, PA 17307, USA

[6]USDA-ARS, Plant Genetics Resources Unit, 630 W. North Street, Geneva, NY 14456, USA
Desirable apple varieties are clonally propagated by grafting vegetative scions onto rootstocks. Rootstocks influence many phenotypic traits of the scion, including disease resistance. Fire blight has become increasingly more of a problem with the shift to high-density orchard planting as the strongly dwarfing rootstocks used are generally more susceptible to the disease. The susceptibilities of the major rootstocks are relatively well established; however the influence of the rootstock on the susceptibility of the scion is less well characterized. In the spring of 2007 we performed fire blight inoculations on 3 yr old trees of 'Gala' grafted on seven different rootstocks and measured the growth of the resultant cankers. 'Gala' grafted on G30 showed the lowest rate of canker growth while 'Gala' on M27 showed the highest rate of canker growth. Using an apple DNA microarray, we examined the gene expression patterns in greenhouse grown 'Gala' scions grafted to the same series of seven different rootstocks that we examined for the susceptibilities to fire blight. Over 100 genes were identified whose expression levels correlated with the degree of fire blight susceptibility of the scion/rootstock combinations. We will use Quantitative PCR to test these correlations in an orchard-grown population of different scion/rootstocks combinations that have been rated for fire blight susceptibility. This study demonstrates the utility of using rootstock-regulated gene expression profiling for the identification of genes associated with agriculturally important traits. These genes may be useful for apple breeding programs.

Oral Abstract 5

Non-Dormant Evergrowing Peach as a Tool for Discovering Genes Involved in Vegetative Growth Cessation

S. Jiménez[1], Z. Li[1], G. L. Reighard[1] and D. G. Bielenberg[2]
[1]Department of Horticulture, Clemson University, Clemson, SC, USA
[2]Department of Horticulture and of Biological Sciences Clemson University, Clemson, SC, USA

The peach [*Prunus persica* (L.) Batsch] mutant evergrowing (evg) fails to cease growth and enter dormancy under dormancy inducing conditions. We used the evg mutant to filter gene expression associated with exposure to short days (SD) but not involved in the induction of dormancy itself. Peach wild-type and evg plants were grown under controlled conditions of long day (LD, 16h/8h) followed by eight weeks of SD (8h/16h). Growth cessation was evaluated and apical tissues were sampled at LD and one, two, four and eight weeks of SD. We identified and analyzed genes involved in vegetative growth cessation by PCR c-DNA subtraction between both genotypes tissues. Wild-type plants showed apical growth cessation after two weeks of SD. We found a small number of differentially expressed genes associated with the development of dormancy, 19 up-regulated genes in the wild-type with respect to the mutant. We used the quantitative real time PCR reaction to study the expression of the differentially expressed genes along the short-day treatment and observed two patterns of expression: early expression that decreased at time of growth cessation, and late expression that peaked at eight weeks of SD. In conclusion, the use of the dormancy-incapable mutant evg has allowed us to reduce the number of genes typically detected by differential display techniques on dormancy experiments. These genes will be the target of future investigation.

Oral Session 2
Rootstock Genomics and Genetics

Oral Abstract 6

Molecular Markers for Fire Blight Resistance (*Erwinia amylovora*) in Apple (*Malus*)

John L. Norelli[1], Susan E. Gardiner[2], Mickael Malnoy[3,4], Herb S. Aldwinckle[3], Robert E. Farrell, Jr.[5], Mary B. Horner[6], Jean-Marc Celton[2], Angela M. Baldo[7], Deepa R. Bowatte[2], Charmaine M. Carlisle[2], Donna A. Lalli[1], Vincent G.M. Bus[6], Carole L. Bassett[1], Gennaro Fazio[7] and Michael E. Wisniewski[1]

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[5] Department of Biology, Pennsylvania State University, 1031 Edgecomb Ave., York, PA, 17403, USA

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Fire blight, caused by *Erwinia amylovora* (Ea), is a destructive disease of apple (*Malus*), pear (*Pyrus*) and some woody ornamentals in the rose family (Rosaceae). The goal of this project is to use a functional genomics approach to develop tools to breed fire blight resistant apples. Six hundred fifty expressed sequence tags (ESTs) associated with fire blight were identified from Ea-challenged apple leaf tissue by suppression subtractive hybridization (SSH) and cDNA-AFLP analysis. ESTs were ranked for their potential impact on resistance based on bioinformatics and inferences drawn from model systems. Simple sequence repeat (SSR) and single nucleotide polymorphism (SNP) markers derived from highly ranked fire blight-associated ESTs were mapped in a 'M.9' x 'Robusta 5' population in which a major QTL for fire blight resistance has been located on Linkage Group 03. Highly ranked fire blight-associated ESTs were mapped to this QTL, as well as to the positions corresponding to the location of at least two QTLs reported in other populations (Calenge et al. 2005, Khan et al. 2006). Markers for heat shock protein 90 (Hsp81-2), a secretory class III peroxidase and a serine/threonine-protein kinase mapped to the LG03 fire blight resistance QTL and reduced its size from 12cM to 4cM. Markers for a "putative disease resistance protein" (NCBI AY347778) and Skp1 (SCF-type E3 ubiquitin ligase) mapped to positions corresponding to the location of two known QTLs on LG07 and LG12, respectively (Calenge et al. 2005, Khan et al. 2006). To date, of 28 candidate fire blight resistance gene markers that have been mapped, 6 have co-located to or near known fire blight resistance QTLs. This research will facilitate new methods of marker-assisted selection to efficiently breed superior apple cultivars with fire blight resistance.

Oral Abstract 7

Fire blight Resistance of Budagovsky 9 Apple Rootstock

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The rootstock phase of fire blight, caused by the bacterium *Erwinia amylovora*, results in significant economic losses through decrease in production and high orchard replacement costs. Identification of novel apple rootstocks similar to M.9 in orchard productivity, with confirmed resistance to fire blight is a priority. B9, a cold-hardy, dwarfing rootstock has been shown to have high levels of resistance to fire blight, despite historical characterization as a fire blight susceptible rootstock. Leaf inoculations of non-grafted B.9 rootstocks became severely infected with whereas scion inoculated trees grafted to B.9 remained unaffected by rootstock blight. Microsatellite analysis using 23 SSR markers confirmed the genetic uniformity of B9 rootstocks in commerce, indicating cultivar misidentification was not a cause of the contradictory results. Investigation was made into the effect of scion cultivar, tissue age, bacterial migration, and grafting on resistance. In 2002, four scion cultivars, 'Royal Gala', 'Red Yorking', 'Jonagold', and 'Gingergold', were planted in combination with four rootstocks, B.9-OR, B.9-NE, M.9 and G.16, and non-grafted rootstocks, at Geneva, NY. In 2003 and 2004, trees were scion inoculated with E. amylovora and trunks were sequentially sampled to assess the level of bacterial migration. Results indicated that neither scion nor rootstock cultivar influenced bacterial migration into the rootstock through vascular tissues. In 2005 and 2006 rootstock tissue was wound inoculated with E. amylovora. Results indicated that older B9 rootstock tissue was resistant in both grafted and non-grafted plants and that scion cultivar did not influence symptom development. Reciprocal grafting experiments validated these results. Further experiments investigating tissue age and its effect on resistance suggest that B.9 asserts a form of persistent adult plant resistance in response to E. amylovora. Thus the contradictory determinations of resistance of B.9 in the past appear to be entirely due to the age of tissue inoculated.

Oral Abstract 8

Physiological and Biochemical Parameters Involved In Waterlogging Tolerance In Prunus Rootstocks

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Waterlogging induces an abiotic stress associated with poor drainage in soils affecting stone fruit (*Prunus* spp.) crop productivity and physiology. The main consequence of this stress is anoxia and hypoxia in root environment. Stone fruit rootstocks are known to show different tolerance levels to low oxygen conditions. Peach is the most sensitive species among the stone fruits. Flooding tolerance is based on complex anatomical and biochemical adaptations, taking place mostly in roots, as root respiration decreases as well as ATP production. Under hypoxia conditions tolerant plants maintain respiration rates with the oxygen available. Alcoholic fermentation

from pyruvate to ethanol is considered an important metabolic pathway for energy production in a two-step process where pyruvate is converted into acetaldehyde by pyruvate decarboxylase (PDC) and acetaldehyde is subsequently converted into ethanol by alcohol dehydrogenase (ADH). Two different assays were established to compare long and short term waterlogging stress response. Trials were carried out with a set of two myrobalans, 'P.2175' and 'P.2980', as tolerant rootstocks, and a set of two interspecific hybrids, 'Garnem' and 'Felinem', as sensitive ones, in long terms response. Only the myrobalan 'P.2175' and the hybrid 'Felinem' were used in short term trials. Plants were kept under different flooding treatments, in similar soil and water conditions. Stomatal conductance and chlorophyll content were measured during two consecutive years in the first trial, both during flooding and recovery periods. Enzymatic activity of ADH and the antioxidant activity of SOD, CAT and POD were measured during flooding and recovery periods. Moreover, gas chromatography was used to determine acetaldehyde and ethanol concentrations released in root medium. Physiological parameters and enzymatic activity results of both trials are used to discuss differences in flooding tolerance degree in this abiotic stress.

- GxN : en waterlogging cambian a verde desde rojo

Oral Abstract 9

Physiological and Morphological Effects of Size-Controlling Rootstocks on 'Fuji' Scion

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The size-controlling effects of apple rootstocks were partially characterized in greenhouse experiments. Two-year-old 'Fuji' scions on 25 size-controlling rootstocks, from the USDA apple rootstock breeding program in Geneva, NY, were grown for one season and shoot development was measured each month. Discriminant analysis associated the rootstocks into three clusters based on similarity of shoot secondary and primary growth and tree height. Total shoot growth for one season was 367, 283, and 149 cm for rootstock cluster (RC) A, B, and C, respectively. RC-A had significantly greater photosynthesis and transpiration rates than RC-C (18.3 and 12.3 µmol $CO_2 \cdot m^{-2}$ leaf area $\cdot$ sec^{-1} and 4.2 and 3.1 mmol $H_2O \cdot m^{-2}$ leaf area $\cdot$ sec^{-1}, respectively). At the end of the first growing season, trees were placed in controlled cold environments to provide chilling. At the beginning of the second growing season, trees were removed from chilling, the roots were pressurized, shoots were removed 40 cm above the graft union, and hydraulic conductivity was measured. Xylem exudate was collected and analyzed for cytokinin (CK), abscisic acid (ABA), and inole-3-acetic acid (IAA). Less hydraulic conductance was associated with the more dwarfing rootstocks, RC-C, compared with the more invigorating RC-A (0.58 and 1.41 ml $\cdot$ $cmStem^{-1} \cdot hr^{1} \cdot MPaLeaf^{1}$, respectively). Abscisic acid flux was higher in xylem exudates from dwarfing (RC-C) than vigorous (RC-A) rootstocks (2.28 and 0.23 pmol $\cdot$ $mL^{-1} \cdot hr^{1}$, respectively). The concentrations of CK and IAA were variable and rootstock-related differences were not determined. Stem samples of scion and rootstock from above and below the graft were collected and anatomical differences of stem cross-sections are being analyzed with scanning electron microscopy. Initial results show that fiber wall thickness in late wood was greater in 'Fuji' scion on RC-C than RC-B and RC-A rootstocks. The data indicate that chemical signals, such as hormones, as well as hydraulic signals, may play a role in size-controlling processes of apple rootstocks.

Oral Session 3
Environmental Physiology

Oral Abstract 10

Early Fruit Growth And Drop – The Role of Carbon Balance in the Apple Tree

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Recent research has focused on determining the role in early apple fruit growth and drop of tree carbon balance and competition amongst organs. Experimentation and carbon balance modeling have combined to provide a better picture of these relationships. It appears that the time of greatest carbon supply-to-demand deficit occurs at about 1-3 weeks after bloom. Carbon reserves reach their minimum about bloom, so the carbon supply for fruit is developing fairly linearly with leaf area growth, but early demand is increasing more rapidly due to large fruit numbers and exponential growth. For non-stressed trees, generally radiation has the greatest effect on supply, while fruit and competing organ numbers and temperature tend to control the demand. Best carbon balance occurs at moderate day temperatures (20-25°C) and cool nights (8-12°C) to support adequate canopy growth but limit demand and with high radiation to maximize supply. Competition for carbon at this early stage appears to be primarily between shoots and fruits, with shoots having apparent priority, at least under low light conditions. In general it appears that trees with normal flower density, initial set and relatively normal weather become source limited typically a week after bloom. Fruit growth and set is limited by carbon availability. Combining organ and tree-level physiology and modeling with modern genetic tools will greatly enhance our ability to understand these critical cropping processes.

Oral Abstract 11

Sorbitol Availability and Sorbitol Dehydrogenase Expression During Apple Bud Development From Budbreak to Bloom

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Sorbitol is the primary photosynthate and translocated carbohydrate in apple (*Malus domestica* Borkh.) and is converted to fructose by SORBITOL DEHYDOGENASE (SDH) in sink tissues. To date there have been no studies comparing sorbitol availability, SDH activity, and SDH gene expression patterns in apple buds from dormant buds to bloom. Thus, the objectives of this work were to determine 1) the patterns of sorbitol availability and SDH activity and 2) if tissue-specific SDH expression occurs in flower buds during this period. Sorbitol was the main soluble carbohydrate in expressed xylem sap from the fully dormant stage until bloom, with concentration levels 5-10 fold higher than for fructose or glucose, and it increased 2-3 fold over this period. Bud SDH activity per g FW and per mg protein increased significantly from dormant bud to bloom. Four out of the nine known SDH genes, SDH1, SDH2, SDH3, and SDH6, were consistently expressed in flower buds during dormant and all postdormant developmental stages, while one gene, SDH9, was expressed at full bloom only. The SDH genes exhibited tissue-specific expression at full bloom with three, SDH1, SDH2 and SDH3, expressed in all floral tissues. This work indicates that sorbitol and other sugars are abundantly available from dormant bud to bloom stages, and that sorbitol expression and metabolism are at least in part developmentally regulated within the emerging buds.

Oral Abstract 12

Does Availability of Soluble Carbohydrate Reserves Determine Apple Fruit Set?

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Sorbitol is the dominant photoassimilate imported by reproductive and vegetative sink tissues in apple (*Malus domestica* Borkh.). Within these sinks sorbitol dehydrogenase (SDH, EC 1.1.1.14) is the primary enzyme that catalyzes the oxidation of sorbitol to fructose. SDH activity is present during this early period in both the cortex and seed tissues with a higher level per mg protein in the seed. SDH activity increases during bud development followed by a relatively constant level of activity in bud tissue and fruit cortex from prebloom to at least 6 weeks after bloom, while seed SDH activity continues to increase. Thus, it is likely that SDH plays a critical role in establishing young apple fruit as sinks during the fruit set phase. A comparison of SDH activity in seed and cortex of fruit that were clearly abscising during natural fruit drop to those that were persisting indicated no significant differences in SDH activity between the two types. The lack of change in SDH activity in dropping fruit indicates that the capacity to utilize sorbitol may not be limiting. A study of expressed sap from shoots subtending flower buds and fruit indicated that sorbitol concentration was in greatest abundance, followed by glucose, fructose, sucrose, and myo-inositol with evidence of galactose, raffinose, and stachyose. The levels of all of the major carbohydrates declined appreciably in the 2 to 3 week period leading up to natural fruit drop. In the 3 week period following chemical fruit thinning applications, fruit SDH activity was not affected but levels of sorbitol and other soluble sugars were lower for a longer period of time. Thus, considering both SDH activity and soluble carbohydrate availability, fruit drop at 4-6 weeks after bloom may be due to limited availability of carbohydrates and not to an inability to utilize them, and this limitation may be enhanced by chemical thinning.

Oral Abstract 13

Seasonal Responses of Apple Fruit Growth, Abscission, and Fruit Carbohydrate Concentrations to Low Light

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The responses of fruit growth and drop to low light after bloom are well known. The strongest effect is greatest at about 10-15 mm fruit diameter and decreases with later fruit development. The hypothesis was

tested that the reduced response of larger fruit was due to the utilization of carbohydrate reserves in the fruit. Low light (20% of full light) was applied with shade cloth over groups of Empire trees at 10, 17, and 34 mm fruit diameter stages in 2 studies. Low light reduced fruit growth rates and induced drop at all stages with the strongest effects at the 17-18 mm stage. At about 10 mm the effects were not as strong. Later at 35 mm, shade effects were variable. Fruit drop was closely related to fruit growth rate at 10 and 17 mm stages, but at the 34 mm stage drop occurred, but was much less for the same reductions in growth. This indicates that the relationship between fruit growth rate and drop changes after the cell division period. During each shading period fruit growth was monitored and representative fruits were sampled for carbohydrate analyses. Soluble carbohydrates were essentially constant at each time period regardless of light or growth rate. Starch levels in the controls increased from about 2-4% at 12 mm to 35-40 m to about 15-20% starch. The starch concentration in the shaded fruit did not increase but also did not decrease very much even with very low fruit growth rates. Some shaded fruit with zero growth rates that would induce drop still had 12-15% starch. So, it does not appear that apple fruit utilize their starch reserves to maintain fruit growth when light is low.

Oral Abstract 14

Isolation And Characterization of Genes Associated with Shade-Induced Apple Abscission

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Apple trees generally produce too many flowers and fruitlets, which negatively affects commercial value. Thus thinning is an important practice by which excessive flowers and fruitlets are induced to abscise. Many factors including shading can cause fruit to drop. In order to understand the molecular basis of shade-induced thinning, 'Empire' apple trees were shaded to approximately 20% of full light for three days, starting at the fruit diameter stage of 12 mm. King fruit were marked on treated and control trees and measured for 3 days before shading to ensure consistent growth. At 24 and 72 hours after shade began, fruit were sampled from shaded and control trees. At 24 hours the sampling was random as growth could not be measured accurately, but at 72 hours sampled fruits had only grown 40% as much as controls. Two cDNA libraries were constructed using the suppression subtractive hybridization (SSH) method and 347 expressed sequence tags (ESTs) were obtained. 168 ESTs represent transcripts that are preferentially expressed after 24h of shading, and the other 179 are derived from RNAs of small apple fruits that were shaded for 72h. Sequence analyses revealed that these clones represent 68 (24h) and 44 (72h) unique genes. These genes belong in 8 functional categories. The largest set of genes is related to carbohydrate metabolism. The second largest group contains unclassified or unknown genes. RNA gel blot analysis confirmed that at least 26 genes are up-regulated after shade treatment. Some of these genes may serve as molecular markers for apple thinning.

Oral Session 4
Environmental Physiology

Oral Abstract 15

The Effect of Temperature and Developmental Stage on Carbon Dioxide Exchange of Attached 'Royal Gala', 'Fuji' and 'Cripps' Pink' Apple Fruits

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In the Western Cape region of South Africa post-bloom spring temperatures can be high, resulting in high fruit respiration rates during a period when carbohydrate supply can be potentially limiting. Chlorophyllous apple flesh tissues exposed to light are capable of assimilating CO_2 diffusing through stomata or lenticels, or re-fixing CO_2 lost through respiration. This could represent a significant contribution to the carbon balance of growing fruits. In this field study, light-saturated net CO_2 assimilation rate (Amax), dark respiration rate (Rd), and light-saturated photosynthetic rate (Pmax, the difference between Amax and Rd), were measured at different fruit surface temperatures on attached 'Royal Gala', 'Fuji' and 'Cripps' Pink' apple fruits in the Ceres and Elgin regions (Western Cape, South Africa). Measurements were performed during the cell division stage (20-30 days after full bloom, DAFB) and during the cell enlargement stage (50-60 DAFB) of fruit growth. In all cultivars, Pmax and Rd increased, and Amax decreased with increasing fruit surface temperature. After the cell division stage, Pmax and Rd decreased and Amax increased with increasing fruit fresh weight. 'Fuji' fruit reached compensation point (Amax = positive due to Pmax exceeding losses by Rd) during the mid-season (55 DAFB) at temperatures of up to 30°C, but Amax remained negative at 35°C. 'Royal Gala' almost reached compensation at 20 and 25°C (53 DAFB), but Amax remained negative at 30 and 35°C. The rapid increase in dark respiration rate with increasing temperatures during the cell division stage of fruit growth creates a high demand for assimilates and could have serious implications for fruit growth and final size in warm climates such as the Western Cape.

Oral Abstract 16

Predicting Chemical Thinner Response with a Carbohydrate Model

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Chemical thinning remains one of the more unpredictable parts of apple production with large variations from year to year and within years. To quantify the variability within years and between years we have conducted spray timing trials each year from 2000-2008 on mature vertical axis 'Royal Gala'/M.9, McIntosh/M.9 and 'Ace Delicous'/M.26 trees. We applied a tank mix of either 7.5 ppm of naphthaleneacetic Acid (NAA) plus 600ppm of carbaryl or 75 ppm of 6-benzlyadenine (BA) plus 600ppm of Carbaryl at 3 or 4 day intervals beginning at petal fall until 21 days after petal fall. Normally about 7 timings were achieved during the thinning period. Through our trials we have learned that conditions that make the tree difficult to thin are: cool temperatures

(especially night temperatures) with high sunlight, and a light initial crop while conditions that make the tree easier to thin are: high temperatures (especially high night temperatures) with low light levels during the day, and heavy initial set. The combined effects of temperature and sunlight on thinning efficacy have been difficult to predict. Many of the factors that affect tree sensitivity to chemical thinners seem to be related to the balance of carbohydrate supply from tree photosynthesis in relation to the demands for growth by all the competing organs of the tree (fruits, shoots, roots, and woody structure). Over the last 15 years a simplified computer model was developed by Alan Lakso that uses daily maximum and minimum temperatures and sunlight level to estimate whole tree carbohydrate supply and demand by the various organs of the tree. To evaluate the usefulness of the carbohydrate model in explaining the variability in thinning response we compared the model estimates of early season carbohydrate surplus or deficits to look for periods of particularly good or poor supply:demand balance. These patterns of supply to demand were then compared to our observed thinning responses from the spray timing studies each year. Model simulations from several years showed that there are often periods of particularly negative or positive supply:demand balance which were associated with severe thinning or mild thinning. There were also years in which there was essentially a balance in carbohydrate demand and supply. These years were used to discover the underlying pattern of chemical thinning response from petal fall to 20mm fruit size. This pattern shows that at petal fall there is the least thinning while the greatest thinning occurs at 10-15mm fruit size which is followed by reduced thinning at greater fruit sizes. Periods of significant carbohydrate deficit (or surplus) as estimated by our model can dramatically change the underlying pattern which gives rise to the year to year variability in thinning response. The carbohydrate model was useful in explaining chemical thinning response in New York state over the last 9 years. The carbohydrate model may be useful to help growers predict and understand chemical thinning response in two ways: (1) The results from the model from petal fall until fruits are 10mm in size will provide growers with an estimate of the thinning achieved with petal fall thinning sprays before additional sprays are applied at the 10-12mm fruit stage; and (2) With accurate weather forecasts, the model may also provide predictions of thinning efficacy of sprays applied at the 10-12mm fruit stage.

Oral Abstract 17

Contributions of Short And Long Shoots to Yield of 'Kerman" Pistachio (*Pistacia vera* L.)

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The canopy of a mature pistachio (*Pistacia vera* L.) tree is composed of two types of shoots: short-shoots composed entirely of preformed units, and long-shoots composed of both preformed and neoformed units. Since the production of these two types of shoots is known to be related to rootstock and rootstock influences yield of pistachio the relationship of these two types of shoots to yield was investigated during two cropping years. Short-shoots produced significantly less total yield and had fewer fruit clusters per shoot compared with long-shoots. Long-shoots positively affected yield components in one year, but had no effect in the other year. Whether the differences in the one year were due to canopy position and light interception or differences in the carbohydrate allocation within the two types of shoots could not be determined from the current data. Long-shoots initiated more inflorescence buds, although inflorescence bud formation was restricted to the preformed growth and only the 3-4 earliest neoformed nodes. However, when expressed as a percentage, long-shoots retained a lower percentage of initiated inflorescence buds, compared with short-shoots. Regardless of shoot type, less than half of the inflorescence buds that were retained from the previous season produced mature fruit clusters, indicating that inflorescence bud retention from the previous season may not be the primary limiting factor to yield in pistachio.

Oral Abstract 18

Genetic versus Environmental Effects on Hexose Characteristics of Peach Fruit

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In a study of 146 peach genotypes over two successive years, fruit from nearly all Chinese, Japanese, European and American bred cultivars, and most native Chinese cultivars, exhibited glucose-to-fructose concentration ratios (G/F) of about 1. Sixteen of 43 native Chinese cultivars, 4 wild species from different regions in China, Prunus kansuensis, P. ferganensis, and the European rootstock 'Siberian C' contained a much higher glucose concentration than fructose for a G/F of 2.3-7.6, while P. davidiana had a G/F of 0.8-0.9. The results showed that it is likely that Chinese wild species are the origin of gene(s) controlling low fructose concentration, and that genes controlling low fructose may be derived from either maternal or paternal parents. An advanced backcross population derived from a cross between commercial cultivars with P. davidiana were also studied over two successive years. The results showed that about 20% of this population had a G/F > 3.4. Detection of QTLs by RFLP, AFLP and SSR markers for glucose and fructose in this population showed that positive QTLs for both sugars were detected in linkage groups 2, 4, 5 and 7 and might vary with year, while a QTL in linkage group 1 was always found to be negatively correlated to fructose with a large contribution to its variation (r^2), from 46-55%. The characteristic G/F for a peach genotype was independent of environment (year, location, and developmental period). Moreover, leaves showed similar G/F characteristics as peach fruit.

Oral Abstract 19

Weather Conditions Affect Fruit Weight, Harvest Date and Soluble Solids Content of 'Cresthaven' Peaches

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In the spring of 2002, 'Cresthaven' peach trees on Lovell rootstock were planted in six locations in the states of CA, GA, MD, NJ, NY and SC. All trees came from the same nursery. During the three seasons of 2004 to 2006, five healthy trees were selected at each site and thinned heavily and early to obtain maximum fruit size. Fruit were first harvested when a few began to soften and all remaining fruit were harvested within one week.

Defective, green or abnormally small fruit were thrown out. Fruit were individually weighed and a wedge was taken from each to obtain a composite percent soluble solids content (%SSC) reading for each tree. Other data collected included bloom date, daily solar radiation, max/min temperatures and rainfall. Of the 16 location/year combinations (NY was frozen out two years), there was substantial variation in all parameters measured. For example average fruit weight (FrtWt) ranged from 131 to 394 grams, %SSC from 10.2 to 15.1%, bloom dates from March 7 to May 2 and time from bloom to harvest (Bl-Hrv) varied from 109 to 143 days. Correlation analysis was conducted to identify weather parameters that could account for the variability in FrtWt, Bl-Hrv and %SSC. First, FrtWt and Bl-Hrv were well correlated (positively) with each other (r = 0.86) and thus their correlations with weather parameters were similar. In general, large FrtWt (and longer Bl-Hrv) was associated with cooler temperatures and lower solar radiation in the spring. Greater %SSC was associated with a lack of rain before harvest and lower minimum temperatures during the season

Oral Abstract 20

Using Concept-based Computer Simulation Modeling to Study and Develop an Integrated Understanding of Tree Crop Physiology

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Studying and developing an integrated understanding fruit tree physiology and growth and development is a difficult endeavor. Plants are very complex organisms that are governed and influenced by a multitude of factors. Traditional experimental approaches to study and integrate plant function has been largely limited to only dealing with a couple factors at a time and communicating those interactions verbally or with two or three dimensional static diagrams. These approaches result in valuable insights into the interactions of a limited number of variables (usually 1 or 2) on a similarly limited number of somewhat isolated processes (like organ growth or functions such as photosynthesis, respiration, etc.). However it is very difficult to develop and communicate an integrated understanding of natural processes that involve multiple interacting factors. The study and understanding of environmental and endogenous influences on carbon assimilation, partitioning, transport and utilization in plants is a good example of these limitations. Quantifying carbon partitioning and utilization a complex problem because of the dynamic nature and relationships among carbohydrate partitioning, growth and plant architecture as well as the multitude of factors that can influence each process and individual organs. One way to dynamically integrate the influence of multiple factors on multiple processes is to use recent advances in computer technology to develop concept-based, computer simulation models of tree crop growth and physiology. For the past two decades research in our laboratories has focused on developing environmental and endogenous influences on carbon assimilation, partitioning, transport and utilization in peach trees. This has resulted in the L-PEACH model which has been described elsewhere. Modeling has allowed us to develop a systematic analysis and integration of concepts regarding the factors that control peach fruit growth, crop yield, and tree growth; as well how these processes respond to management practices.

Oral Session 5
Orchard Systems

Oral Abstract 21

Changing Concepts of Efficiency in Orchard Systems

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Looking back over the symposia organized by the Orchard and Plantation Systems Working Group from 1976, we have been seeking to improve the efficiency of carbon acquisition and distribution to the fruit for each hectare of orchard land, primarily by our choice of rootstocks, training systems, tree quality etc. Issues such as light use efficiency and harvest index have featured prominently, as we have sought to understand and compare different systems of production for our perennial fruit crops. These concepts have proven to be very useful and robust and will continue to guide our future thinking as they describe the basic physiological processes. We have also considered issues of sustainability, which initially focused on issues such as IFP to reduce chemical pesticide use and on occasions mechanization to improve economic sustainability. Currently, however, we are being forced to look at not only the whole system within the orchard (trees, soil, understorey, windbreaks) but also the energy costs and carbon footprint of our production and distribution systems – the orchard system in a much wider dimension. What we are seeing is an ever-widening horizon of the orchard system. The relevance of, for example, light use efficiency is as important today as it was back in the 1970s, but we now have to add other measures of efficiency in addition to those we have worked with historically. In many ways the need for whole plant physiology has never been more important than today as we seek to understand the carbon flows within the orchard. As we have sought to tackle our more limited horizon of the "orchard system puzzle" with scientific rigor, we now need to understand the whole system of our production cycle with equal rigor. Future advances are likely to involve step changes and paradigm shifts as profoundly transformational as those experienced with intensive planting systems technologies implemented in the past 30-40 years.

Oral Abstract 22

Sweet Cherry Trees Planted as 'Sleeping Eyes' Have Less Survival but Greater Growth Compared to Standard Nursery Trees

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Assessing the costs of establishing a high density sweet cherry orchard and forecasting return on investment and breakeven price underscore the importance of tree costs in orchard profitability. Adopting novel planting strategies such as sleeping eyes may reduce orchard establishment costs. We initiated a comparison among planting system (sleeping eye vs. standard nursery tree), cultivar ('Bing', 'Chelan', and 'Tieton'), rootstock ('Gisela®6', MxM 60, and Mazzard), and virus status (+/- Prunus necrotic ringspot virus) in a factorial design.

All trees were Fall-budded in 2005 at a commercial nursery in Ephrata, Washington. Sleeping eye (SE) trees were dug, shipped, and planted in the spring, 2006 at the Washington State University Roza experimental farm. Standard nursery (SN) trees were nursery-grown in 2006, dug in November, stored commercially, and shipped and planted adjacent to the sleeping eye orchard in spring, 2008. Tree spacing of both orchards was 1.25 m x 3 m. In 2007 and 2008 tree growth (trunk diameter, tree height, and mean shoot length) was assessed at 14-day intervals. In addition, total above- and below-ground dry weights were assessed in the winter after the first (2006) and second (2007) growing seasons. Overall, tree survival was 76% for SE trees vs. 87% for SN trees. Greatest tree survival was for virus-free SN trees (94%) and lowest for virus-infected SE trees (71%), irrespective of cultivar and rootstock. After the first growing season, there were subtle differences among cultivars in vigor – 'Tieton' was slightly more vigorous than 'Bing' and 'Chelan' which were similar. MxM 60 rooted trees exhibited significantly more vigor (total lateral growth, total above ground dry weight) and root growth than Mazzard and 'Gisela®6', which were similar. Overall, virus-free trees had slightly greater (+6 – 10%) tree height, root and shoot dry weight, but significantly more total lateral growth compared to trees made from virus-infected budwood. After the second growing season, SE trees exhibited significantly greater vegetative growth (more than two-fold) compared to SN trees. We hypothesize that this increased growth of SE trees will lead to greater and earlier productivity. Our results show great potential for the sleeping eye planting system to create high density sweet cherry orchards, particularly when virus-free budwood is utilized.

Oral Abstract 23

High Tunnel Sweet Cherry Studies: Innovative Integration of Precision Canopies, Precocious Rootstocks, and Environmental Physiology

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Plastic-covered high tunnels are most often used for protected production of herbaceous vegetables and small fruits. However, for intensive sweet cherry (*Prunus avium* L.) production in non-ideal environments, tunnel-covered orchard systems offer a primary advantage of reducing rain-induced fruit cracking and the potential for many other secondary advantages. Research to incorporate high tunnels, dwarfing precocious rootstocks, and precision canopy training systems for sweet cherries was initiated at two Michigan State University experiment stations in 2005. At the CHES site, three 8.6 m wide x 50 m long high tunnels were established over existing 'Rainier' trees on Gisela 5 (Gi.5) and Gi.6. At the SWMr.EC site, four 7.4 m x 62 m long tunnels were established and planted to a new orchard of 'Rainier'/Gi.5, 'Skeena'/Gi.5, and 'Early Robin'/Gi.12 trees, with 35 other varieties planted in guard rows. Comparison plots were duplicated as uncovered standard orchards. Sub-plots have included timing of pruning for canopy development, orchard floor management (herbicide vs. weed barrier fabric), use of a reflective orchard floor fabric, and use of plastic covers having different light spectral transmittance and dispersion properties. Research objectives have included documentation of environmental modifications (air and soil temperatures, relative humidity, leaf wetness, PAR, and wind speed), evaluation of tree growth (TCSA, lateral shoot number and length, terminal growth), evaluation of reproductive performance (yield, fruit quality, time of ripening, floral bud formation), and impact on insect pests and diseases with minimal or no use of pesticides. Three-year results will be discussed; in general, mature tree yields in the tunnel systems have been very good (~18 mt/ha), fruit size has been excellent (10 to 12.5 g), young tree growth has been improved (up to 35%), and incidence of some major pests (Japanese beetle, cherry leaf spot) has been reduced dramatically (>90%). There are many tunnel management variables that influence the various environmental parameters and tree responses. More than standard orchards, high tunnels provide perhaps the ultimate challenge for integration of environmental physiology, performance-enhancing rootstocks, and precise canopy structures into intensive orchard systems.

Oral Abstract 24

Effect of Timing of Topping to Reduce Tree Height on Subsequent Year Tree Vigor of Early-Season Arctic Star Nectarine

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It is widely recognized that production costs could be substantially reduced if the height of fruit trees could be lowered enough to eliminate the need for, or reliance upon, ladders in the orchard. Our recent research demonstrates that high yields can be obtained on shorter trees with appropriate management techniques, but vigor control can be a problem. One technique that growers use to uniformly reduce tree height is mechanical topping, and there are many theories about optimal timing of topping operations. Physiological reasoning predicts that the earlier and more severely one tops after the primary period of shoot growth (approximately June 30th), the greater the loss in carbohydrate storage for the subsequent year, which should also result in less vigorous re-growth in the subsequent year. However, there have been no systematic studies to test this theory. In 2004, selected rows of Arctic Star nectarine trees growing the Dinuba, CA area were topped in July, September and November. In July and September the plots chosen for topping were divided into two sub-treatments. One sub-treatment was topped to 3 m (down from approximately 5.5 m) and the other was topped at 3.75 m. In November, each of the 3.75 m July and September sub-treatments were re-topped to 3 m along with a block that was previously not topped. One treatment was also left untopped, and received normal dormant pruning during which height was reduced to 3.7 m. All trees were hand pruned during dormancy to select fruiting wood, and pruning weights were recorded. Trunk and rootstock samples of wood tissue were taken from four trees of each treatment by using a 12 mm hole saw to extract a plug of wood from about 20 cm above the graft union and 10 cm below the graft union on December 1 2004. Contrary to our hypothesis, stored carbohydrates in the roots were greatest in the early topping treatments and lowest in the late topping events. The effect of these treatments on light penetration, regrowth, return bloom, and subsequent year regrowth will also be discussed, and a proposed integrated strategy for successfully reducing tree height using topping will be given.

Oral Abstract 25

Bibaum®: A New Training System for Apple Orchards

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In apple orchards the dwarfing rootstocks M9 is widespread due to the high tree efficiency that is able to induce. Today it is possible to purchase a given type of tree congruent with desired orchard design. Alongside the traditionally chip-budded trees in a two-year cycle are types like two-year knip plants, trees obtained with the June bud (1-year-old) and bench-budded plants in a one-year cycle. All this different types of plants are suitable for spindle training system. The innovative 'Bibaum®' system is a pre-formed, split-branch trees in nursery that obviate the need for orchard topping and the year delay in shoot-system formation. In apple orchards spindle is largely adopted and are suitable to increase planting density, until 3,000. New ideas regarding tree

shape include plants with 2 axes so as to divide the vigor over more branches. The first of two trials involves trees trained to the Bibaum® system and spindle with cv. Fuji clone Toshiro in a MDP orchard, now at year 4. A comparison of the two systems has so far shown no significant differences both in yield and trunk area. The fact that vigor is distributed over two axes in the Y-shape appears to positively affect tree-growth control, fruit size. The second is a comparison, in a yield-performance trial of Rosy glow, of two training system: Bibaum and Spindle.

Oral Abstract 26

Apple Crop and Fruit Quality Influenced by Low and High Planting Densities on M9 and M27 in Northern Germany

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Apple cultivars 'Elstar' (Elshof) and 'Jonagold' (Rubinstar) on rootstocks M9 and M27 were planted in autumn 1994 at the Fruit Research Station Jork in Northern Germany at densities 1500, 2000, 2500, 3000, 4000, 6000 and 8000 trees/hectare. During the past 13 years, orchard data were recorded as yield per tree and per hectare as well as fruit size and fruit color. During the first years yields per tree were similar in the different planting densities. Later on the yield per tree remained static in the high density plot while the lower density plots showed continued yield increases. High yields per hectare were quickly obtained with high densities, while lower densities took much longer to reach full production per hectare. Highest cumulative yields per ha were obtained with 5000 trees/ha on rootstock M9 and these were not surpassed even with very high densities on rootstock M27 (5000, 6000 or 8000 trees/ha). With higher densities and higher yields, the average fruit size decreased slightly in the range of about 1 mm diameter. In a similar manner, average fruit color was inferior at higher densities, decreasing between 5 – 10%. The semi-colored 'Elstar Elshof' was more affected by decreasing fruit color at higher tree densities than the nearly full and dark red colored 'Jonagold Rubinstar'. Among other factors the economic success of different planting densities depends on the cost of trees and labor and is very much influenced by the price per kg/fruit. Although no calculation was done to determine which was the most successful tree density from the economic point of view, the mass of recorded data during a long orchard lifetime provides a strong database for further economic calculations.

Oral Session 6
Orchard Systems

Oral Abstract 27

Comparing the Economics of Mechanical and Traditional Sweet Cherry Harvest

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In the western United States, the cost of skilled labor for sweet cherry harvest continues to increase while the availability of this workforce declines. Tremendous competition for harvest labor exists and the sweet cherry industry ranks improving labor efficiency among its greatest research needs. At Washington State University the sweet cherry improvement program has evaluated the potential to improve labor efficiency and harvest fresh market quality fruit using a USDA-ARS-designed mechanical harvester. As part of this comprehensive program we are: 1) studying the physiology and genetics of fruit abscission, 2) evaluating the effect of the mechanical harvest system on fruit quality and storability, 3) designing novel fruiting wall orchard systems, 4) assessing consumers' perceptions of stem-free sweet cherries, and 5) investigating the economics of the mechanical harvest system. This presentation will compare the economics of harvesting sweet cherries manually vs. mechanically. Data were collected from harvesting entire rows of Y-trellised 'Bing' sweet cherries by machine or hand near Prosser, Washington between 2005 and 2008. Our preliminary analyses reveal tremendous potential advantages to a mechanical harvest system – harvest costs declines from ca. \$0.19/lb to \$0.02/lb for hand- and mechanized-harvest, respectively. Assuming cash costs increased 3 percent per year over a 20-year period and brought back to present value using a 10% discount rate, the net present value after establishing a high-density orchard, utilizing traditional hand labor to harvest fruit, was \$148,748 per hectare. However, the net present value with the same assumptions except that a mechanical harvester was used during harvest was \$244,019 per hectare. Furthermore, utilizing a mechanical harvester could reduce the breakeven price to establish an orchard by \$0.77 per kilo (\$2.40 vs. \$1.63). High efficiency mechanically harvested sweet cherry orchard systems have significant potential economic advantages compared with traditional orchard systems.

Oral Abstract 28

The Productivity and Economic Comparison of High Density Production Systems for 'Pink Lady' and 'Sundowner Apples' in South Australia

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A trial evaluating both the economic and production performance of 72 different intensive apple production systems under Australian conditions has been established at Lenswood Research Centre, South Australia. The project is evaluating the performance of the varieties Cripps Pink and Cripps Red on 4 different rootstocks (M.9, Ottawa.3, M.26 and MM.106) at 3 different in row spacings (0.75m, 1.0m, 1.25m) using 3 different training systems - conventional single row planting, V trellis - open centers and V trellis - inline planting.

The production performance of each system has been recorded and compared and the economic evaluation has considered all of the production performances and the economic factors for each combination, including cost inputs and capital investment required. Clear differences are shown in rootstock and "orchard system" performance The economic comparison over 7 years is presented in terms of Internal Rates of Return and Net Present Values.

Oral Abstract 29

Reflections on my 40 Years of Fruit Research

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Lenz, recipient of the Environmental Physiology award for lifetime contributions, will present his reflections on 40 years of research and guidance of students and young scientists at the University of Bonn, Germany.

Oral Session 7
New Technologies for Orchards

Oral Abstract 30

New Opportunities with Microtechnologies and Photonics for Fruit Tree Research

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The new field of microtechnology has opened many opportunities in research and commercial production due to the unprecedented ability to produce tiny fully-integrated devices inexpensively with computer chip-like manufacturing. The manufacturing process and advantages will be shown. Examples of relevance to crop research include environment and plant microsensors, wireless sensor networks, and micro spectral cameras.

Oral Abstract 31

Geospatial Technologies

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The Institute for Application of Geospatial Technologies (IAGT) is a nonprofit organization in Auburn, NY that is dedicated to accelerating the application of geospatial information technology across government, education, and commercial sectors. Geographic Information Systems (GIS) is a powerful tool that can help growers visualize and manage agricultural data. Several GIS services are provided, ranging from providing base map layers, building databases to store information, doing GPS surveys of farms, and creating web applications that allow growers and researches to access data via the Internet. An example in fruit production has been to collaborate with Cornell in providing GIS services for several viticulture research projects and to vineyard managers in the Finger Lakes region of New York State. Examples of these and future applications will be provided

Oral Session 8
Rootstock Breeding and Evaluation

Oral Abstract 32

Guardian® Peach Rootstock Performance and Preplant Soil Fumigation Effects in a Fallow Site

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A study was initiated in North Carolina at the Sandhills Research Station in Jackson Springs to evaluate the performance of the peach rootstock Guardian®, 'BY520-9', compared to Lovell. Guardian® is reported to be tolerant to both root-knot and ring nematodes. Ring nematodes contribute to the incidence of peach tree short life (PTSL), a limiting factor to peach production in the Southeastern United States. The use of Guardian® rootstock and preplant soil fumigation in PTSL prone sites are advantageous and recommended practices for commercial peach production. However, on a site that has no history of PTSL and has been fallow for the last 5 years, would preplant soil fumigation and Guardian® be beneficial? The study site selected had been fallow for more than 5 years after a peach orchard was removed with good tree survival. Lovell was used as the industry standard and five selections that are components of commercially sold bulked Guardian® seed were used. One half of each replicate was preplant fumigated with Telone II (3.7 m strip, 281 L/treated ha). Four peach cultivars, developed in North Carolina, were used in this study and included 'Challenger', 'Intrepid', 'Contender' and 'China Pearl'. Each cultivar was a fully replicated trial and the four trials were adjacent to one another. In 2007, all four trials had significant tree death from PTSL which was the most severe on 'China Pearl', followed by 'Contender', 'Intrepid' and 'Challenger', respectively. In addition, a severe freeze during bloom eliminated the entire 2007 crop. For all cultivars, survival in the initial 7 years was greatest for the trees grown on Guardian® compared to those on Lovell. Survival for trees on Lovell ranged from 13-58% and 73-96% for trees on Guardian®. No significant differences in trunk cross-sectional area (TCSA) or yield per tree were detected on the surviving trees when comparing trees grown on Lovell compared to those grown on Guardian®. However, due to large differences in tree survival between Guardian® and Lovell, if yield was evaluated based upon a per hectare area, differences are considerable. Fumigation effects in the initial years across cultivars were less pronounced. TCSA and cumulative yield per tree, using the surviving trees, were numerically greatest for trees grown on fumigated soil compared to those grown in non-fumigated soil although the differences were not significant in the initial 7 years.

Oral Abstract 33

Degree of Dwarfing and Productivity of Eight Apple Rootstocks with Winter Hardy Scions

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Rootstock evaluation is an ongoing research project at the University of Minnesota. Our apple growing region is one of the most northern (45°N latitude) and coldest average mid-winter temperature locations in the

United States. To further understand the degree of dwarfing and productivity of rootstocks, we analyzed eight rootstocks (Bud.9, M. 9EMLA, M. 26EMLA, M. 7EMLA, V.1, V.3, G.16, and G.30) present in ten different trials regardless of cultivar. In the analysis we used trunk circumference measurements and yield at the 4th and 7th leaf for each trial. The mixed effects modeling allowed us to differentiate rootstock effects from cultivar characteristics. Of the eight rootstocks analyzed, Bud. 9 consistently produced the smallest tree but was not always the most productive.

Oral Abstract 34

Performance of Nectarine Rootstocks on Different Soil Types

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During the past decade, the nectarine cultivars 'Mayglo', 'Sunlite' and 'Alpine' were tested on a range of available potential rootstocks in five diverse and representative soil types and conditions. 'Mayglo' was planted on eight rootstocks in an area where sporadic waterlogged conditions occur during winter and early spring. Under these conditions the rootstock SAPO 778 performed better than the standard Kakamas seedling rootstock. 'Sunlite' on Cadaman, GF 677 and Viking outperformed 13 other rootstocks in terms of yield, including Kakamas seedling, in high pH soils (where free lime occurred). The fruit mass of both Cadaman and Viking rootstocks however was significantly higher than on Kakamas and GF 677. 'Alpine' on Atlas, SAPO 778, Viking and Flordaguard gave the best results in soils infested by ring nematodes although fruit mass of all rootstocks was lower than at other sites. On a poor, sandy soil, highly infested with root knot nematodes, where 'Alpine' was the scion cultivar, Flordaguard, Atlas, and SAPO 778 clone, performed better than Kakamas seedling but GF 677 performed significantly poorer than Kakamas seedling. 'Alpine' on Atlas, Kakamas seedling, Tsukuba 4 ex 4 performed well on higher potential red sandy soils with low nematode counts. This was however not significantly better than on the rootstocks Viking, Flordaguard, SAPO 778 as seedling and Tsukuba 4 ex 5. Waterlogged and high pH conditions as well as nematodes, affect fruit mass negatively but certain rootstocks (SAPO 778, Cadaman, Viking, Atlas and Flordaguard) can largely overcome certain of these conditions to improve fruit mass.

Oral Abstract 35

GiSelA® Cherry Rootstocks Compared for Virus Tolerance and Field Performance

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Cherry rootstocks developed by the Giessen breeding program were already screened for response to Prune Dwarf Virus (PDV) and Prunus Necrotic Ringspot Virus (PNRSV) in previous studies (Lankes, 2003). Under heavy virus pressure applied to the 1-year-old ungrafted liners forced in the greenhouse GiSelA® 5 proved to be virus tolerant, whereas GiSelA® 3 and GiSelA® 6 showed some reductions in shoot growth. For these studies 'Regina' was grafted onto the GiSelA® rootstocks mentioned above as well as onto Alkavo, an invigorating commercially-important sweet cherry rootstock used as a reference. Half of the plants were inoculated with

PDV and PNRSV by bark grafting in 2005 at the time of leafing-out and in addition to that by budding in the summer of the same vegetative period. In 2005, the year of virus inoculation, a clear enhancement of growth was noted for the trees on Alkavo compared to those on the GiSelA® clones with Alkavo impairing flowering and fruiting. During the shock phase of the disease in 2006 growth on GiSelA® 3 was reduced by virus infection. With the other rootstocks no virus effect was to be observed. Alkavo had no longer any invigorating effects. This was probably due to the limited space for root development in the containers used. In 2007 the virus infection had no more impacts on vegetative (shoot growth, stem diameter, specific leaf weight) or generative (no. of flower clusters, no. of fruits, fruit size, yield per tree) parameters. It is to be concluded that the impact of virus infection was restricted to the shock phase and that there was more virus tolerance in grafted trees compared to the ungrafted rootstocks which suffered much stronger virus pressure . When grown in the field GiSelA® 3 proved to be the most dwarfing rootstock, especially in combination with 'Regina'. However, in the first two years the three GiSelA® clones did not differ significantly. The same was true for the fruiting parameters with GiSelA® 3 allowing acceleration of maturity by four to six days and GiSelA® 5 enabling largest averaged fruit sizes.

Oral Abstract 36

Peach Rootstocks Differ in Their Growth Responses to Both High and Low Root Temperatures

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This paper examines the hypotheses that both high and low root zone temperatures (RZT) reduce growth in peaches and, that peach rootstocks differ in their growth responses to RZTs. These hypotheses were tested by growing plants of five peach rootstocks, Fay Elberta, Green Leaf Nemaguard, Golden Queen, Okinawa and Red Leaf Nemaguard at constant RZTs of 5°, 13°, 21°, 29° and, diurnally variable 29/21°C. Growth for all varieties was maximized at RZTs of 21 °C. There was a positive correlation between RZTs and growth over the RZT range 5 to 21°C and a negative correlation over the RZT range 21 to 29 °C. Growth in plants, whose roots were exposed to diurnally variable 29/21°C RZTs, was similar to that in plants exposed to constant RZTs of 29 °C; the reduced growth in both groups being attributed to exposure to unfavorable RZTs for part or all of the day. For the pooled data, over the RZT range 5 - 29°C, the relationship between RZTs and total growth could be described as bell shaped curve peaking near 21°C, with the mathematical relationship between the two being ln TG = 2.080 + 0.015RZT 2 – 0.0004RZT 3 (r2 = 0.82, p < .001). Significant differences in RZT induced growth responses among varieties were observed, as were varietal differences in the distribution of that growth among roots, stems and leaves. These trials demonstrate that both sub and supra-optimal RZTs, independently of air temperature and light intensity, reduce growth and, that peach rootstocks differ in their RZT induced growth responses. This research has implications for future rootstock development and selection, orchard management practices and, for the development of models examining peach tree growth and development, particularly with respect to the effects of potential changes in the global climate.

Oral Abstract 37

The Impact of Rootstock and Irrigation on Water Use, Tree Growth, Nutrition, Yield, and Fruit Quality of 'Pacific Gala' Apple

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Fruit growers may prefer to use sprinkler system to produce high quality fruit and to establish a cover crop in the orchard. However, worldwide water shortage mandates the use of more efficient methods of irrigation such as drip. In this long-term experiment, effects of four rootstocks and two irrigation systems on 'Pacific Gala' tree growth, water use, fruit quality and mineral nutrients were studied. Full drip systems (FD) used less water than full micro-sprinkler (SP). Each tree with SP used about 5397 L, 6249 L, 6673 L, while each tree with FD used about 2403 L, 3872 L, and 4118 L in 2005, 2006, and 2007, respectively. Thus, trees with full drip used 38% to 72% less water than those with SP system between 2003 and 2007, depending on the stage of tree maturity, without any reduction in fruit quality. When the difference of water usage between these two systems reached at 38% at full tree maturity, it stayed constant. This leads to a major saving in the cost of fruit production. Fruit weight in trees with full drip was some times greater than those with PS. Leaf minerals were affected by irrigation systems. Rootstock had a major effect on fruit quality and the effect was more severe in some years. 'Pacific Gala' trees on B.9 rootstock were more precocious than those on Supporter-4 rootstock. G 30 rootstock appeared to advance maturity of 'Pacific Gala' and induced slightly better fruit color in most years of our evaluations. Trees on M.9 formed their terminal buds about one month earlier than other rootstocks and thus can be sampled earlier for leaf mineral analysis. In general, 'Pacific Gala' on RN-29 had better tree performance and fruit quality than those on other rootstocks. Calculation of water requirement on a tree-use basis provided an excellent guide for drip irrigation.

GS: Ground Shade

Oral Abstract 38

Five-Year Evaluation of Apple Rootstocks for Orchard Performance and Resistance To Rootstock Blight

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Fire blight, caused by the bacterium *Erwinia amylovora*, is a devastating bacterial disease of apple and pear throughout the world. Reliance on susceptible dwarfing rootstocks in combination with susceptible scion cultivars in high-density systems has increased the incidence of rootstock blight, the rootstock phase of fire blight. The only proven method of prevention for rootstock blight is the use of resistant rootstock cultivars. The objective of the Geneva Rootstock Breeding Program, a joint venture between Cornell University and the USDA-ARS, has been to develop high performing rootstocks, which carry resistance to the main apple rootstock pathogens. Initiated in 1968 the program has released several rootstocks to date, including Geneva®16, Geneva®11, and Geneva®30. In 2005, 64 elite rootstock clones from several breeding programs were tested for orchard performance using three cultivars, 'Royal Gala', 'Honeycrisp', and 'Golden Delicious', and for resistance to rootstock blight. Two field plots were maintained in Geneva NY from 2002-2006, and rootstocks were evaluated yearly for tree size, yield (kg), and fruit size (g). In 2005 a single plot was inoculated at bloom with E. amylovora strain Ea4001, using a backpack sprayer till runoff. Symptom development was assessed three times during the 2005 season. Three rootstocks, similar in size induction to M.9, G.935, G.41 and B.9 performed well for all three scion cultivars with regard to yield and fruit size, and exhibited high resistance to rootstock blight. Several new and unreleased rootstock clones performed above commercial standards, demonstrating the potential of new rootstocks with enhanced disease resistance in future production.

Oral Session 9
Rootstock Breeding and Evaluation

Oral Abstract 39

Effect of Different Rootstocks and Interstems on the Growth and Yielding of Some Sweet Cherry Cultivars

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In an experiment carried out in Central Poland in 1995–2006, two generative rootstocks and four dwarfing interstems, grafted on these rootstocks, were assessed in terms of their effect on the growth, yielding, fruit quality and tree health status of three sweet cherry cultivars: 'Burlat', 'Vega', and 'Kordia'. Four Prunus fruticosa Pall. types and 'Northstar' sour cherry were used as interstems, and Prunus avium L. and Prunus mahaleb seedlings were used as rootstocks. Trees grafted o n *Prunus avium* seedlings, without interstems, served as the control combination. The interstems clearly inhibited the growth vigor of the trees of the studied cultivars, but the degree of growth inhibition depended on the type of interstem. It was found that the interstems grafted on Prunus mahaleb seedlings restricted tree size more effectively than the same interstems grafted on Prunus avium seedlings. The trees with interstems came into bearing earlier than the control trees, and produced higher total yields. The rootstocks and interstems also had an effect on fruit quality and tree health status. In most cases, the fruits collected from the trees with the interstems grafted on Prunus mahaleb seedlings were smaller than those from the control trees. 'Northstar' sour cherry used as interstem proved to be incompatible with cv. 'Burlat'. The best interstem for the three sweet cherry cultivars turned out to be 'Frutana' (*Prunus fruticosa* No. 8). The trees on this interstem were healthy and produced good yields of high-quality fruit.

Oral Abstract 40

French Evaluation of the CG Rootstock Selections: History and Results

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The INRA-Cornell University collaboration started 20 years ago, by the introduction of 18 Cornell-Geneva selections to France. They were first selected over 8 years for their ability to propagate. Then they were planted at 2 locations (INRA Angers and Ctifl Bergerac) within the framework of the experiment Network called 'Niveau 1' and selected for their induced vigor, their yield and the fruit size. The CG selections show a variability in the ability to root but numerous selections have a rooting percentage higher than 70%. Layers generally develop a lot of side-branching but some genotypes are promising like G.11, CG13 and CG7. The CG selection led to a scale of vigor from M27 to MM106. At the extreme levels of vigor, there is CG707 which looks like MM106 and CG9 which is quite similar to M27. In the PAJAM 2 to X2765 (an INRA selection which is 20% less

vigorous than PAJAM 2) range of vigor, there are some interesting numbers, including CG30A, CG13, and G.202, and also G.11 and G.41, whose agronomic traits are very good and similar. In 1998, layers were given to Davodeau-Ligonniere nursery in order to begin propagation for European market. In 2001, an international trial was planted in 6 countries to see whether the French agronomic performances of the CGs extended to South and North European countries. In 2003, CG7, G.11, CG13, CG30A and CG202 were planted in the main French production regions within the framework of the INRA-Ctifl-Regional Stations Network called 'Niveau 2'. Results of all the French experiments will be discussed.

Oral Abstract 41

Peach Rootstocks Inducing Different Vigor to Grafted Cultivars Reflect Genomic and Physiological and Morphological Diversity in Roots

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Rootstocks have a relevant agronomic significance, because they greatly affects normal cultivar characteristics, and among them vigour and productivity. Relevant effects have also the mechanisms that regulate the initiation and development of new roots. Recently, molecular and genetic studies have increased the knowledge about root formation. Genes involved in asymmetric division of cells, cell fate decision, lateral root development and auxin signal have been isolated with the help of the large number of *A. thaliana* mutants. Despite this, very little is understood about how adventitious root formation is regulated in woody plants, because in this case the approach using morphogenetic mutants is very difficult. With the aim to enrich the knowledge about adventitious rooting formation and the regulation of vigour in fruit trees. Studies have been done on three peach rootstocks, PSA5, PSA6 and PSB2, selected from a population of seedlings by the Department of Fruit Science and Crop Protection of Pisa University, which have different rooting ability and are able to induce different vigour in grafted peach cultivars. Molecular, physiological and morphological approaches have been used with the aim to characterise the rootstocks. PSB2 showed the highest percentage of rooted cuttings, while the lowest value was observed for PSA5. The number of roots per cutting was highest in both PSB2 and PSA6 genotypes. Histological analyses of apex of adventitious and primary roots showed differences among the three rootstocks. Plant development was also different among the seedlings of the three rootstocks. From the analysis of trnT/trnD, non-coding region of chloroplast DNA, a difference at the nucleotide level was detected, while no difference was detected in the DNA mitochondrial NAD-reductase sequence. A total of 14 ISSR primers were screened and amplification profiles obtained through simple repeat containing primers were able to reveal polymorphism among the genotypes and cultivar Armking (Ar) used as a control. Out of a total number of 76 analysed fragments 15 were polymorphic. The amplified band data were reported in a matrix and processed by the RAPD Distance Program, version 1.04, to obtain a similarity matrix. 2 fragments one of about 800 bp the other of about 700 bp, present in PSA6 and Armiking and absent in PSA5 and PSB2, were cloned and sequenced. From the analyses of data bank the largest fragment shown a high similarity with a desaturase gene. Molecular analyses on the self-pollinated progeny of all genotypes are in progress. The roots of the three rootstocks showed different spatial ion flux exchange organisation, which were characterised by strong intensity peaks of acidification of the surrounding environmental soil.

Oral Abstract 42

Performance of Geneva Rootstocks in On-farm Trials in New York State

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A series of replicated field trials on growers farms in New York State were begun in 1997 to evaluate the Cornell-Geneva series of apple rootstocks which have been bred for tolerance to fire blight and *Phytophthora* root rot, high yield efficiency and good tree survival. In the 1997 trial severe natural infections of fire blight in 2000 confirmed the high resistance of the Geneva rootstocks to rootstock blight and proved that although the scion had significant canopy loses the trees could re-grow and begin production in 1 year while the Malling rootstock which served as controls were killed. In the 1999 trial two dwarfing rootstocks G.41 and G.935 have shown the greatest yield efficiency and have exceeded the performance of M.9 or M.26. G.41 has shown some tendency for brittleness of the graft union but in all trials it has had better survival than M.9. In the 2002 and 2003 trials G.41, G.11 and G.935 have had the greatest yield efficiency and good fruit size. These 3 stocks appear to be good alternatives to M.9 for parts of the world that have accepted dwarfing rootstocks. In the 2001-2005 trials the best dwarfing rootstocks have continued to perform very well but we have also identified a group of 5 new semi-dwarfing rootstocks which have high productivity and fire blight resistance. These are scheduled to be released at the end of 2008. These rootstocks will be free-standing but will need trunk and limb support for the high crops which they produce in the early years. These may be useful in parts of the world where dwarfing rootstocks are not adapted.

Oral Session 10
Environmental Physiology

Oral Abstract 43

High Temperature and Solar Radiation: Sunburn, Fruit Quality, and Skin Pigments of Apple

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Three types of sunburn in apple (*Malus ×domestica*) have been identified and the specific causes of each determined. The first type, sunburn necrosis, appears after high fruit surface temperature (FST) (~52 °C) causes thermal cell death. The second type, sunburn browning, is caused by concomitant exposure to high FST (45 to 49 °C depending on cultivar) and UV-B radiation. It does not result in cell death. The third type, photooxidative sunburn, requires only visible light and affects shaded apples that are suddenly exposed to solar radiation. Sunburn browning is most prevalent and often the major cause of cullage of apples; it has been the focus of most of our research. Fruit quality was affected by sunburn browning in all cultivars studied (i.e. 'Fuji', 'Gala', 'Jonagold', 'Golden Delicious', and 'Granny Smith'). Flesh firmness and soluble solids content (SSC) increased, but titratable acidity (TA) decreased in all cultivars as the severity of sunburn browning increased. During 6 months of cold storage, firmness, SSC and TA all decreased. The ratio of SSC to TA increased dramatically after 3 and 6 months in cold storage because TA declined sharply. Changes in pigment concentrations that result from sunburn browning were also studied. In all five cultivars studied ('Fuji', 'Gala', 'Delicious', 'Golden Delicious', and 'Granny Smith'), chlorophyll a and b concentrations were lower in sunburned peel. Anthocyanin (idaein) concentrations in the red cultivars were also lower in sunburned peel. Total quercetin glycoside concentrations were typically higher in sunburned peels than in non-sunburned peels. Chlorogenic acid concentrations were typically highest in sunburned peel, except in 'Granny Smith' where it was not detected. Changes in carotenoid concentrations were cultivar dependent and less consistent from year to year. RAYNOX®, a sunburn protectant invented during the course of these studies, reduces sunburn browning by about 50%, on average.

Oral Abstract 44

High Temperature Coupled with High Light Alters the Balance Between Photooxidation and Photoprotection in the Sun-Exposed Peel of Apple

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Sunburn browning is the most common type of sunburn that occurs on the sun-exposed peel of acclimated apple fruit. Both high temperature and high light are required for sunburn browning to occur. We hypothesized that high temperature disrupts the oxygen-evolving (OEC) complex of PSII, which triggers severe oxidative damages to fruit peel when coupled with high light, eventually leading to sunburn browning. The sun-exposed peel of 'Gala' apple with or without sunburn was compared in terms of photooxidation and photoprotection, and a controlled experiment was conducted to probe the initial responses of PSII to high light and high temperature. The content of carotenoids, lutein and xanthophylls on a chlorophyll basis was higher in the sunburned peel

although they were lower when expressed on a peel area basis. Significant loss of ß-carotene and neoxanthin was observed relative to chlorophylls in the sunburned peel. O_2 evolution rates and the activity of key enzymes in the Calvin cycle were lower in the sunburned peel, but the activity of these enzymes decreased to a lesser extent than the O_2 evolution rates. The activity of antioxidant enzymes in the ascorbate-glutathione cycle and the level of total ascorbate, total glutathione, and reduced glutathione were higher in the sunburned peel. However, the sunburned peel had higher H_2O_2 and malondialdehyde contents. Fruit peels treated with high temperature (45°C) alone showed a clear "K" step in their chlorophyll fluorescence transients whereas high temperature coupled with high light (1600 $\mu mol\ m^{-2}\ s^{-1}$) led to the disappearance of the "K" step and a further decrease in FV/FM, which is similar to what was observed in the sunburned peel. High light first followed by high temperature treatment induced a clear "K" step in chlorophyll a fluorescence transient, whereas high temperature first followed by high light treatment did not induce a "K" step, but decreased fluorescence intensity to a very similar level as in the simultaneous high temperature and high light treatment. We conclude that high temperature coupled with high light results in severe photooxidative damage on the sun-exposed peel by causing photoinhibition to PSII complexes at both the donor and acceptor sides. The damage to OEC by high temperature may have made the PSII more sensitive to high light damage. Both the xanthophyll cycle and the antioxidant system are up-regulated in response to the photooxidative stress, but this up-regulation does not provide enough protection against the photooxidative damage.

Oral Abstract 45

Effects of Temperature and Light on Sunscald in Apple Fruit and the Acquisition of Partial Temporal Tolerance

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The effects of temperature and light on conditioning and on the development of sunscald injury were studied in 'Smoothie' apples (*Malus x domestica* Borkh.) under controlled conditions. Immature green apples were picked from the inner (shaded) part of the canopy in mid-summer and were used in the experiments: Conditioning temperature significantly affected injury severity: conditioning at 21 or 36°C for 24 h in the light resulted in 80 and 20% injured fruit, respectively. Tolerance to sunscald increased with conditioning time, reaching 100% in fruit pre-exposed to 38°C for 24 h. Tolerance was temporary and gradually diminished with de-conditioning time at 25°C. Sunscald injury developed only in fruit exposed to the combination of light and temperatures above 40°C, and the percentage of injured de-conditioned apples increased in a sigmoidal pattern to 100% bleaching in fruit exposed to 46°C for 8 h. Conditioned fruit required harsher induction conditions for the development of sunscald damage, the response curve shifting by ~2°C. Development of brown stains in the bleached areas followed a sigmoidal curve in response to temperature. Maximum Fv/Fmax was apparent after 24 h conditioning at 38°C in the light, indicating that little or no substantial photodynamic stress occurs in the apple chloroplast grana. Thus, the build-up of an anti-oxidative defense mechanism is enabled which may contribute to increased tolerance to sunscald injury.

Oral Abstract 46

Why Do Early High Spring Temperatures Reduce Peach Fruit Size and Yield at Harvest?

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Heat stress is often considered to involve situations when temperatures are above the typical optima for plant assimilatory functions but high temperatures at specific times can also negatively influence source-sink relations to the detriment of fruit growth and yields. Previous research has documented that years with above normal early spring temperatures (within 30 days after bloom) correspond to years with early fruit harvest and below average fruit sizes. This has been a particular problem for California peach growers because the market is increasingly intolerant of small fruit. Our research indicates that fruit development and growth potential of a given cultivar is governed by a relative growth rate function which is driven by both time and temperature. However it is clear that fruit development and growth potential do not always equate to actual fruit growth. Furthermore, fruit potential that is not realized within a period of time is lost and cannot be made up. In this paper we will show how high temperatures within 30 days of full bloom can result in increased fruit growth potential per day but decreased actual fruit growth over the fruit development period. This represents a form of heat stress that would not be typically considered as heat stress because the temperatures involved are not above temperature optima for assimilatory processes but can have important practical consequences for fruit size and yield.

T° >80°C ⇒ bajo Pmod ciruelas europeas.

Oral Abstract 47

Effects Of Row Orientation And Canopy Inclination On Gas Exchange And Energy Management In The "Asymmetric Peach Orchard"

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Net photosynthesis is strictly related to irradiance. CO_2 assimilation increases with photon pressure up to the saturation point. Above this level, incoming light becomes excessive. Exposed leaves can't escape absorbing photons, therefore several photoprotective mechanisms have evolved, to cope with the incoming photon pressure trying to reduce photoinhibition risks. The "Asymmetric Peach Orchard" features rows of varying orientation (0-180°; 30-210°; 330-150°) and canopy inclination (vertical, N-S; slanted, 30° from vertical to the West and 30° to the East in the other two, respectively) which create quite different light conditions at any given hour. As the day progresses, the interception of each row changes, giving it a different, and asymmetric relative to solar noon, daily light interception profile. Peach trees intercepting the highest light levels in the morning (30-210°, slanted 30° to the West) did not show higher CO_2 net uptake, and their assimilation appeared to be stomata-limited in the afternoon. The highest photodamage was recorded on the same trees. The N-S, vertical trees showed the same net photosynthesis as the others, but a 33% lower photodamage. The best photosynthetic performances were recorded in the trees that received the highest light levels in the afternoon (330-150°, slanted 30° to the East), although they showed the highest daily H_2O loss and their photodamage was only 8% lower than that of the morning high light samples. The quenching analysis conducted at the single leaf level pointed out that light excess was dissipated via several photoprotective pathways, of which the main one was the controlled, ΔpH-dependent thermal dissipation (Non Photochemical Quenching), supported by the non-

net carboxylative transports (Water-water cycle, Cyclic transport around PSI, Glutathione-ascorbate cycle and photorespiration) particularly under conditions of about 50% full sunlight. In conclusion, Too much light may not improve net photosynthesis but will increase stomatal limitation and photodamage. Further research is needed to investigate the consequences of photoinhibition and the subsequent resource allocation for recovery on plant productivity.

Oral Session 11
Environmental Physiology

Oral Abstract 48

High Temperature Effects on Citrus Leaf Gas Exchange, Flowering, Fruit Yield and Quality

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High midday temperatures in subtropical citrus growing regions can lead to excessively high leaf temperature (Tlf) and large leaf-to-air vapor pressure difference (D) in sun exposed leaves. This heat stress can reduce net CO_2 assimilation (AC), growth, fruit yield and quality. Shading from 50% shade screens or spraying canopies with kaolin particle film reduced average mid-day Tlf and D. This increased AC, stomatal conductance (gs) and leaf water use efficiency but decreased the internal concentration of CO_2 (Ci) in the mesophyll compared to untreated trees throughout the season. However, shade had little effect on leaf transpiration. Heat stress increased non-stomatal limitations to AC in the mesophyll of sunlit leaves that were greater than stomatal limitations. Shade treatment reduced leaf carbohydrates but did not affect tree canopy volume or fruit size. Shading in the late fall until harvest increased grapefruit yield and juice content that more than compensated for the lower total soluble sugars (TSS) and resulted in net increases in TSS per tree. Shaded 'Navel' orange fruit developed better external color but lower TSS than sun-exposed fruit. Shade did not affect orange fruit yields. In warm citrus producing regions, shading could improve photosynthesis and fruit quality especially in young trees where most of the leaves are exposed to direct sunlight. Improved fruit color, yield and/or TSS per hectare of high-value varieties could offset the costs of particle film sprays or shading in commercial orchards.

Oral Abstract 49

Decreased Stomatal Aperture and Increased Leaf Temperature Should be two Important Factors in Regulating Photosynthesis Under Low Sink Demand in Fruit Trees

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Compared with the retained fruit, low sink demand by removing fruit in fruit trees resulted in a significantly lower photosynthetic rate, stomatal conductance, and transpiration rate, but generally higher leaf temperature. The activities of related enzymes of carbon metabolism did not decrease in the low sink demand leaves although

a significant accumulation of sorbitol and starch in leaves was observed. So that the decreased photosynthetic rates observed in the low sink demand should not result from the direct feedback effect via decreased activities of these biosynthetic enzymes. There was a positive linear relationship between stomatal conductance and the net photosynthesis rate. Moreover, the response of net photosynthesis rate to leaf temperature showed that net photosynthesis rate increased with leaf temperature until leaf temperature reached a critical level (34 to 39°C depending upon genetic background of the cultivar in peach trees). Above the critical temperature, net photosynthesis rate sharply decreased. It is hypothesized that the regulation of the stomatal aperture may be considered as the trigger and leaf temperature as the actor to regulate photosynthesis under low sink demand. Based on the previous hypothesis, decreased net photosynthesis rate could be due to both non-stomatal and stomatal limitations. The decrease in stomatal aperture should be the first reaction under low sink demand. On the one hand, small stomatal aperture reflected by low stomatal conductance resulted in low sub-stomatal CO_2 that occurred in general at early period or under low photosynthetically active radiation at mid or late period after removing the sink demand. In the previous case, stomatal limitations in photosynthesis took place. On the other hand, small stomatal aperture in the case of low sink demand results in reduced leaf transpiration and leaf temperature increases following a decrease of transpiration rate. Higher leaf temperature than the optimum may be instrumental in regulating photosynthesis by weakening the activities of enzymes linked to assimilate metabolism or by inflicting reversible or irreversible damage to chloroplast structure. So low sink demand resulted in lower quantum efficiency of PSII as a result of both a decrease in the efficiency of excitation capture by open PSII reaction centers and an increase in closure of PSII reaction centers. At the same time, both xanthophyll-dependent thermal dissipation and the antioxidant system were up-regulated providing protection from photo-oxidative damage.

Oral Abstract 50

Susceptibility of Sweet Cherry to Polycarpy is Related to Tissue Temperature and Stage of Bud Development

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Sweet cherry (*Prunus avium* L.) acreage and production in the Pacific Northwest have increased ca. two-fold in the last 10 years. This places great importance on producing superlative fruit and maximizing packout. A significant cause of cullage and economic loss in several important cultivars is polycarpy (i.e., 'doubling'). The sweet cherry improvement program at WSU has evaluated critical temperatures and periods of susceptibility to doubling by heating (ambient tissue temperature + 5C) and cooling (ambient -5C) entire 'Bing' spurs in situ throughout sequential stages of floral organ differentiation. To relate susceptibility or resistance to doubling to stage of bud development, we evaluated the seasonal trend (May to November) in floral bud initiation and organ differentiation via scanning electron microscopy. 'Bing' buds were susceptible to high temperature-induced doubling between late July (ca. 1400 growing degree days (GDD)) and early September (ca. 2100 GDD). Scanning electron microscopy of differentiating 'Bing' floral buds in late July revealed distinct individual floral initials but no organ development. By early September, initial stages of pistil development were visible. Our attempts to induce doubling in June and early July were unsuccessful, suggesting buds are not susceptible at early stages of development. Once pistil initials form, it appears that buds are no longer susceptible to doubling. Interestingly, we documented variability in stage of organ differentiation (equivalent to 1 to 2 weeks) among individual flowers within a single bud (i.e., some flowers are more advanced than others). Therefore, not all flower buds in a bud may be at a susceptible/resistant stage of development.

Oral Abstract 51

Structure of Colored Hailnets Affects Light Transmission, Light Spectrum, Photo-Synthesis, Phytochrome, Vegetative Growth, Yield And Fruit Coloration in Apple

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The incidence of hailstorms during the vegetation period is on the increase, possibly due to climate change. Hence, fruit crops are increasingly grown under hailnets, which adversely affect vegetative and reproductive growth primarily due to light deprivation. Recently, colored, "photo-selective" hailnets came onto the European market, which allegedly improve photosynthesis and yield. The objective of this joint project was to examine these colored hailnets and study their plant physiology effects at Klein-Altendorf nr Bonn, Germany. White, black, red and green hailnets comprised double twisted longitudinal (parallel to the tree rows) and single transverse high density polyethylene (HDP) fibres of 288 μm to 356 μm diameter, irrespective of hailnet color. Black and green-black hail nets contained double black longitudinal fibres. White-translucent, grey or red hail nets contained double longitudinal translucent or red fibres. Visible or photosynthetically active radiation (PAR; 400-700 nm) was reduced by white (by 5.7%), red-white (12.8 %), green (13.6 %) or red-black (16.8%) hail nets 50 cm underneath the net. Double black, thick fibres in the green-black hail net may cause their lower UV and visible light transmission relative to white hail nets with their translucent fibres and larger mesh size. The use of reflective cloth on the grass alleys could overcome the light losses. Overall, the apparent visual color of a hail net was not indicative of its light transmission. Spectral analysis showed that colored hail nets transmitted more NIR than PAR/visible light with a UV peak at 375 nm. Light transmission increased by 3% above 500 nm (green) in green and by 2-5% above 570 nm (orange-red) in red hail nets, affecting neither the red (666 nm) : far red (730 nm) (R:FR) ratio nor the phytochrome system. The mesh size, i.e. the distance in between the fibres, varied from translucent (white) hail nets with the largest mesh size of 3 x 9 mm, followed by 3.9 x 6.9 with green-white, 3.3 x 7.7 mm with red-white, 3.5 x 6.5 with green-black nets, 2.8 x 6.9 mm with grey as well as red-black and black hail nets both with the smallest mesh of 2.5-3 x 6.5 mm; these large variations in mesh size between hail nets predominantly influenced their light transmission, which was also affected by the proportion of translucent or black fibres in a hail net. A simple test is proposed to estimate the geometric light transmission without a magnifying glass based on measuring mesh size with a ruler and correcting for fiber strength and proportion of translucent or black fibres. Fruit coloration of the poorly colored apple cv. 'Pinova' followed this geometric light transmission, while that of the late-ripening, well-colored cv. 'Fuji Kiku 8' was sufficient and unaffected by hail net color; fruit yields of the young apple tress were unaffected by net color. Black hail nets appear suitable for single-colored green, or bi-colored apple varieties with good coloration, or those otherwise susceptible to sunburn in Southern Europe. Crystal hail nets (with their translucent fibres, widest mesh size and largest light transmission), or grey hail nets (with twin translucent longitudinal, single black 0.32 mm transverse fibres and 2.5-3.5 mm x 6-8 mm mesh) appear suitable for apple crops in NW Europe with sunlight deficiency and without risk of sunburn. Red-white nets appear unsuitable due to the greater shading than the translucent fibres and for landscape reasons; their alleged photo-selective effects as reported from Southern countries are interpreted to be due to reversal of photo-inhibition under high light intensities and heat in these regions. Labeling of hail nets with tear and Langley values for UV durability is also suggested.

Oral Abstract 52

Modifications to Peach Phenology by Inoculation with Single and Multiple Graft-transmissible Agents

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Peach trees in the southeastern U.S. are susceptible to late spring frosts, which pose a significant threat to the peach crop. Additionally, peach trees require intense pruning to maintain productivity in the orchard. Inoculation with graft-transmissible agents has been shown to both delay spring bloom and reduce summer pruning requirement. Virus-indexed trees of the peach cultivar 'Springprince' grafted to Guardian® rootstock were inoculated in March 2005 with chip buds to initiate eleven treatments. These consisted of two isolates of Apple chlorotic leafspot virus (ACLSV), an unknown high-chill peach-like genotype (acronym 'PK'), Peach latent mosaic viroid (PLMVd), ACLSV & PLMVd, 'PK' & ACLSV, PLMVd & ACLSV, PLMVd & 'PK', ACLSV & PLMVd & Sour cherry green ring mottle virus (SCGRMV), the peach cultivar 'Ta Tao 5,' and 'PK' & ACLSV & PLMVd. Virus-indexed trees of the peach cultivar 'Juneprince' grafted to Guardian® rootstock were inoculated in September 2006 with chip buds to initiate seven treatments consisting of 'Ta Tao 5,' ACLSV, 'PK', PLMVd, Heat-treated 'Ta Tao 5,' ACLSV & PLMVd, Heat-Treated 'Ta Tao 5' & ACLSV. Virus and viroid transmissions were verified by ELISA, dot-blot hybridization, and PCR. Numerous growth characteristics and harvest data were recorded through Spring 2008. Bloom delay and pruning reduction were successfully accomplished through the use of graft-transmissible agents. These agents offer protection against damaging spring frosts, extends the harvest season for peach cultivars and reduces labor requirements in commercial orchards. Modification of peach phenology with graft-transmissible agents bridges the gap between natural and technological innovation.

Oral Abstract 53

A Primary Study on Freezing Damage of Citrus in Mazandran Following January Frost, 2008

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Northern Iran regions have been hit by an unusually bad cold snap this year. Temperatures in many mazandaran cities dropped in to -6 to -13°c from 7°C. After 12 days of heavy snow and cold weather Mazandaran citrus crop have been damaged. In present study, we evaluated the extent of damage for citrus fruits and trees. Frost-damaged fruits showed frost symptoms on fruit skin and fruit Juice became bitter and frozen fruit were falling. Afterward medium and small fruits with 13% sugar content and those orchards which were not irrigated well during summer showed less damage. However, in total 600 thousands tons of orange fruits were destroyed. The most damaged young trees belonged to lime and lemon. Cultivars such as Eureka lemon, Torn less lime, Sweet lemon, Persian lime and local Sweet lemon .Among orange cultivars Washington navel orange sustained

less damage but Shamooty orange destroyed completely . Hamlin frost navel and Valencia orange had up to 50% shoot burn. Among mandarins, the least damage was observed in Wase .Mandarins cultivars like Dancy, Frement furtun, and Ferchiler sustained 30 to 70% damage. Moroccan shaddock was destroyed completely. Among commercial orchard those trees which were cultivated 200 to 350 meters above see level did not suffer while to 20 % of low land orchards showed some damages including leaf drop and shoot burning. Thompson navel orange are dominant citrus trees in the region. Lemon, Lime and Sweet lime adult trees destroyed completely. Mature mandarin trees showed almost no sign of damaged (there was no fruits on these trees , they were harvested in November) In western Mazandaran with cold snap and heavy snow, most of the branches were broken, up to 50% of trees in a orchard.

Oral Session 12
Orchard Systems

Oral Abstract 54

Performance of 'Golden Russet' Bosc Pear on Five Training Systems and Nine Rootstocks

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The need for size-controlling, precocious rootstocks to enable earlier profits and lower management costs has led to increased use of Old Home x Farmingdale (OHxF, Brooks series) rootstocks in U.S. pear orchards. A RCBD trial was established in a commercial orchard to evaluate the performance of' 'Golden Russet 'Bosc on five training systems and nine rootstocks (45 combinations of five single tree replicates). The first group of trees consisted of 2-year-old nursery-grafted trees on clonal OHxF 69, 97, 217, 333 and 513 and seedling Pyrus betulifolia, planted in May 1993. The second group consisted of 1-year-old OHxF 40, 87 seedlings and 2-year-old Comice/Quince BA29C trees field-grafted to GR Bosc at planting time. Spacing was 1.5 x 5m (797 t/ha) for the freestanding perpendicular fan and Tatura trellis (centered-planted single tree) systems, and 3 x 5m for the central leader, three-leader, and parallel hedgerow ("grower control") systems. Final tree height was approximately 4.5-4.7m for the freestanding trees and 2.7m for the Tatura trellis. No fruit thinning was performed and delayed heading and summer pruning was performed on all systems except the parallel hedgerow, in keeping with the grower's practice of dormant pruning only. Trunk circumference and tree height were measured from 1994-2002 and in 2005. Light interception for each training system was measured in 2002. Total yield and fruit number per tree were measured and average fruit size, yield per hectare, yield efficiency (per TCSA and meter of tree height), and per year and accumulated economic return calculated for all treatments from 1996-2002 (4-10th leaf) and for OHxF 40, 69, 97, and Q.BA29C in 2005 (13th leaf). Data was analyzed separately for the rootstocks grafted in the field (40, 87, 29C) as they fruited one year after the nursery-grafted trees. Of the first group, Tatura trellis and parallel hedgerow training systems had the highest accumulated gross returns from 1999-2002; they also had significantly higher light interception and subsequently higher per hectare yields. OHxF 69 had the highest accumulated gross return (AGR) of the six rootstocks, and the combination of Tatura trellis/OHxF 69 the highest AGR of all combinations. There were no significant differences among the second group. In 2005, there were no significant differences in gross return among training systems or combinations, however OHxF 69 and 97 grossed significantly higher among rootstocks based on yield. The second group of rootstocks, though only one year behind the first group, failed to attain equivalent yields or returns by 2005, indicating either inherent lesser qualities or persistent effects of competition.

Oral Abstract 55

An Architectural-Based Tree Training and Pruning – Identification of Key Features in the Apple

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High density planting systems are facing major challenges: a fast entrance into production and a high, regular production level of high quality fruit. In this context the development of minimal pruning strategies is crucial to reach and maintain the economic profitability along the orchard life span. A better knowledge of the cultivar-related growth, branching and fruiting habits, referred to as tree architecture, is of major importance to tackle the understanding of reactions to manipulations depending on the cultivar. This is especially true in the apple which is the first worldwide temperate fruit species with a great range of architecturally contrasted cultivars. Based on works developed at INRA during the 50's, Lespinasse's typology established four main tree types. Type I trees have a strong disjunction between upright scaffolds and lateral fruiting spurs whereas type IV trees have a profuse tip-bearing habit leading to a more globular crown. This typology has not only a descriptive interest, it is also related to fruiting behaviour: type I cultivars have an alternate bearing pattern whereas type IV cultivars have a more regular bearing pattern. Recent works carried out on cultivars and hybrids proposed other criteria to better characterize intrinsic cultivar characteristics. Three features are observed at the tree or branch level: aptitude to reiterate, i.e. to develop vigorous shoots within the tree structure; effect of bending on fruiting; fruiting on 1-year-old wood. Three features are observed at spur level: bourse-over-bourse, spur extinction, bourse volume. Based on this knowledge, practical training and pruning schemes suited to the architectural characteristics of each cultivar or group of cultivars are now proposed in the context of the improvement of Centrifugal Training system which is under development in France and some other countries. Whether these rules are valid in various environmental conditions (climate, soil) remains to be validated.

Oral Abstract 56

Search for a More Dwarfing Rootstock for 'Jonagold'

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For most fruit growers the ideal tree is a tree that does not grow to vigorously, demands little labor and yields a good production and high quality every year. In order to achieve this, our varieties are grafted or inoculated on a rootstock. For the Belgian apple culture this is mostly M9, a rootstock with moderate vigor. Though M9 satisfies in most cases, there are conditions where trees with less vigor are needed. In the first instance the use of M27 as rootstock springs to mind, but M27 is not always suited to replace M9. In many cases a tree

with vigor between M9 and M27 is needed. One possibility to achieve this is the use of M27 as interstock, in the hope that the advantages of M9 (production and size) and of M27 (color and labor) will be found in the interstock tree. In practice however this does not seem to be so. In our search for a more dwarfing rootstock we have examined the possibilities of several rootstocks : Bud 9, Bud 146, Bud 491, J.TE.E, J.TE.F, J.TE.G, Pi80 (Supporter 4), PiAu733, PiAU916, P59 and P60. We compared them with M9 and M27. Up until now we did not find a better rootstock than M9 in our rootstock experiments. Nevertheless there are a couple of promising rootstocks for Jonagold, namely J.TE.G. and P16. J.TE.G. is 15% less vigorous than M9. The production efficiency and coloring remain the same, but there are more kilos of A2++ in the 70-85 mm size class because of its smaller fruit size. P16 is 30 % less vigorous. The coloring and the production are comparable to those of M9 and over the years the fruit size remains somewhat smaller on average. The combination of the lesser vigor and the same yield causes the production efficiency of P16 to be clearly better than that of M9-29. Where the vigor of M9 is too strong, other selections of M9 with less vigor can be used. The most suitable selections to this purpose are M9 Fl56, M9T337 and M9T339. These selections have the weakest growth. The fruit size of M9T337 is smaller than that of M9-29. With respect to coloring, there is no improvement.

Oral Abstract 57

The Tall Spindle System: Principles and Performance

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The Tall Spindle system is an amalgamation of several orchard systems that incorporates aspects of the slender spindle system, the vertical axis system, the solaxe system and the super spindle system. The important components of this system are: 1) the optimum economic planting density in New York State (~2,500-3,500 trees/ha), 2) highly feathered nursery trees (10-15 feathers), 3) minimal pruning at planting, 4) bending feathers and branches below horizontal soon after planting, 5) no permanent scaffold branches and 6) limb renewal pruning to remove and renew branches as they get too large. Each of the components is important and ignoring one or more of the components will result in less than optimum performance. We began testing the Tall Spindle system in 1994 at Albion NY, in 1997 at Geneva, NY, in 2002 at Peru, NY and in Alton and New Paltz NY in 2006 in replicated plantings of both higher and lower densities. The Tall Spindle system has been the second highest yielding system only exceeded by the much higher density Super Spindle system but was more profitable. The first trial was planted with moderately highly feathered trees while the later trials had more highly feathered trees. With highly feathered trees significant yield (20 t/ha) has been achieved in the second year and 50 t/ha in the fifth year. This has resulted in a total of 120 t/ha over the first five years. Pruning and training costs have been lower than lower density systems. As trees have matured, limb renewal pruning has allowed the maintenance of good light distribution with high light interception. If tree height exceeded 90% or the between row spacing, fruit quality in the lower part of the canopy was reduced. Profitability has been greatest with the tall spindle system with NY State economic costs and returns.

Oral Abstract 58

Changes in Fruiting Behaviour and Vegetative Development of 'Scifresh' Apple in Response to Artificial Spur Extinction Using Centrifugal Training

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The new apple cultivar 'Scifresh' (marketed internationally as JazzTM) has several genotypic traits that impair commercial productivity and fruit quality from intensive planting systems. This study concerns consequences of the exceptional floral precocity of 'Scifresh' trees, where almost all terminal, spur and axillary buds flower annually, producing many weakly-developed floral spurs. Observed low fruit set, sensitivity to chemical thinning and high axillary bud and spur extinction are thought to be responses to 'Scifresh' floral behaviour and may be related to competition for resources during early fruit development. This hypothesis suggests that changes in tree management to improve resource allocation to floral spurs early in seasonal development may enhance fruit set and fruit development, thereby increasing productivity and fruit quality. Centrifugal Training (CT) tree management, which regulates the density of fruiting sites on branches, was investigated as a manipulation technique to alter the early-season physiological status of 'Scifresh' trees to improve both cropping and fruit quality. At budbreak, spurs on branches of CT trees were thinned to numbers calculated to produce 4, 5, or 6 fruit per cm2 of branch cross-sectional area when cropped using either one (CT1) or two (CT2) fruit per spur. These treatments were compared with standard New Zealand Vertical Axe, tall spindle tree management (VA) thinned to the same crop treatments after final drop. Between 50 and 65% of floral spurs on standard VA trees failed to set any fruit. The proportion of spurs failing to set any fruit was reduced to 25-35% in CT1 and to 18-25% in CT^2 treatments. The proportion of spurs that set two or more fruit more than doubled in response to CT. Although CT increased fruit set, both crop density and yields at harvest were lower than with standard VA training for equivalent crop treatments. Mean fruit weight declined in response to increasing crop density, although it was further reduced in treatments cropped using two fruit per spur. Centrifugal Training modified the composition of vegetative annual shoots at the branch unit level, resulting in a ratio of extension shoots to spurs of 1.36 compared with 0.39 for VA-trained trees. Node number, internode length and basal diameter of extension shoots increased in response to Centrifugal Training.

Oral Session 13
Orchard Systems

Oral Abstract 59

Prohexadione-Calcium and NAA Sprays Increase Fruit Weight of 'Castlebrite' Apricot Over Other Management Techniques

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Over a three season period several experiments were performed in order to elucidate the effect of pruning method, trunk girdling, thinning date and plant growth regulator sprays on fruit weight and yield efficiency of 'Castlebrite' apricots. Trials were done in a mature commercial orchard in the central part of Chile (33°45' S; 70°41'W). Trees were planted 4 by 2,5 m and ypsilon trained. Pruning treatments were: heading back of shoots arising from laterals along the ypsilon axes, and stubbing back laterals without heading back of lateral renewals from axes. Trunk girdling was performed at the beginning of pit hardening (BPH). Thinning date at BPH and petal fall were compared. CPPU (15 mg.L^{-1}; 15 days before harvest), Prohexadione-calcium (P-Ca; 3 sprays), NAA (15 mg.L^{-1};1 or 2 sprays) and Maxim® (10 mg.L^{-1}; 1 spray) applications were also assayed. No effect of pruning method was detected. Fruit size was increased 5% with girdling, and 20% when thinning was performed at petal fall in a season of extremely high fruit set. P-Ca, NAA (2 year trial) and Maxim® (tried 1 year) showed 10 to 20% fruit size increase. The greatest effect on fruit size was obtained when P-Ca was combined with two NAA sprays, but severe growth stunt was evident. No effect on fruit size was detected with CPPU.

Oral Abstract 60

Effects of Different Crop Loads and Time of Thinning on Yield, Fruit Quality and Return Bloom of the Apple Cultivar 'Elstar'

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The apple cultivar 'Elstar' is the latest commercial maturing cultivar in Norway of high fruit quality when properly managed. However, it is a strong alternate bearer in this climate if not the crop is regulated. In May 2006 a four years crop load experiment started and is one part of the integrated EU project ISAFRUIT. Four different crop loads (2-4-6-8 flowers/fruitlets per TCSA) were established at two stages (first bloom open and 20 mm fruitlets diameter) and compared to unthinned. It is factorial experimental design with six reps and single trees treatments. Preliminary results from the two first seasons are presented. Fruit growth determination was conducted on individual fruits on each treatment during the season. Bloom thinned had larger fruits during the whole season. Thinning at bloom gave a significant lower fruit set than thinning at the fruitlets stages to the same levels the first year. However, the fruit weight and the soluble solid contents were significant larger and ground color improved. The final fruit numbers at harvested was less than the amount established at bloom and fruitlets. There were significant differences between the different treatments in final fruits per TCSA and fruit set which reflected the different crop levels. Fruit weight and soluble solid contents were largest with lowest

crop load and decreased with increasing crop levels. There was a strong crop load effect from the year before on the amounts of return bloom per tree. The trees thinned at bloom had significant more flower clusters than thinned at the fruitlet stage. The untreated, control trees had the lowest amount of flower clusters. The amount of return bloom declined with increasing crop load on the trees. The second year yield and fruit weight were larger when thinned at bloom. The highest crop load the second year was when thinned at bloom to the levels of 2 and 4 apples per TCSA the year before. The trees with the highest crop load the last year managed to give only a small crop. The fruit quality was in general high for all treatments.

Oral Abstract 61

The Impact of Dormant Spur-Wood Pruning Severity on Vegetative Growth, Blossom Density and Fruit Size of 'Honeycrisp'

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The cultivar 'Honeycrisp' weak growth habit coupled with a strong tendency to biennial crop poses a management challenge for most orchardist. The potential impact of dormant spur-wood pruning to overcome this problem was tested in three commercial orchards in the Annapolis valley of Nova Scotia, Canada. Initial trunk cross-sectional area (TCSA) and canopy volume (CV) was measured and treatments were applied in April - May 2006. Three levels of spur-wood pruning were compared in a randomized block design with four replications evenly distributed across the range in original tree vigor. Prior to implementing the spur-wood pruning treatments, scaffold pruning was conducted on the treatment trees at each site and pruning weight recorded, the pruning severity varied between orchard sites. The goal was to prune spur-wood densities down to approximately 40, 60 & 80 spur buds per m^3 of CV. In 2006 and 2007seasons blossom intensity (BI) and fruit yield (FY) per cubic meter m3 of CV was recorded. In spring 2007 TCSA, shoot number (SN) and shoot length (SL) was recorded. Dormant maintenance pruning (DMP) was conducted in the spring of 2007 in an effort to maintain blossom densities and pruning weight was recorded for each tree. The greater the degree of spur-wood pruning severity increased the number of new lateral shoots and slightly increased the average shoot length. BI and FY were reduced by spur-wood removal treatment. All spur pruning treatments enhanced fruit weight (FW) in 2007. This work indicates that spur-wood removal effectively lowered blossom density and could become an effective management practice for assuring annual bearing of 'Honeycrisp'.

Oral Abstract 62

The Effect of Organic and Conventional IPM Management Programs on Apple and Asian Pear Tree Growth, Productivity, Expenses and Revenues in a Hot, Humid Climate

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Organic orchard crops may provide adequate returns to allow producers to continue farming on high value land while simultaneously offering them an opportunity to reduce pesticide-related complaints in densely-populated areas. We hypothesized that newly-set organic orchards on size-controlling rootstocks could be operated successfully in the hot, humid conditions of the mid-Atlantic region of the USA. A one-hectare apple and Asian pear orchard was established in April 2003. Trees planted in this plot were selected from three broad categories; conventional apple cultivars, disease-resistant apple cultivars, and Asian pears. One plot in each of five blocks was managed using integrated pest management (IPM) methods. The other plot was managed using OMr.I-approved organic inputs and certified by the Maryland Department of Agriculture. Trees survived and grew under both organic and IPM production programs but tree size and fruit yields were greater in the IPM plantings. We encountered three general difficulties in the organic blocks; slow growth of young trees, as difficulty in controlling weed competition and problems with direct pests affecting the fruit. A cultivar-by-treatment interaction on tree size and yield was strong in Enterprise apple. Enterprise trees grew well and were very productive under the conventional IPM program but were far smaller and less productive in the organic blocks. An economic analysis was conducted to compare organic and IPM management programs. This economic evaluation focused on farming practices and input materials that differed; pest control, nutrient applications, field labor operations, and tree support. Organic production took more time than conventional production. This stemmed from difficulties with organic weed control and the added needs for organic pesticide applications. Between 2005 and 2007, organic apple yields ranged from 57% to 70% of apple yields harvested in the IPM management blocks. A great difference in the relative system profitability was caused by these differences in yields. Lower organic yields also appeared to be a far greater barrier to profitability than the higher expenses required for organic chemicals or labor.

Oral Abstract 63

Crop Load Alters Water Potential and Daily Vascular Flows in Peach Fruit

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The daily patterns of peach fruit growth and of phloem, xylem and transpiration in/outflows were determined during cell expansion on 12 trees with different crop levels: unthinned (HCL), heavily (LCL) and commercially thinned (CTRL). Vascular flows and transpiration were quantified by comparing the diurnal patterns of diameter change of fruit left intact at first, which were then girdled and subsequently detached. These measurements were carried out using highly sensitive, custom-built fruit diameter gauges which allow determination of minute variations in fruit diameter. In addition, the daily patterns of leaf, stem and fruit water potential were determined in the same period using a Scholander pressure chamber. For all treatments, intact fruit shrunk in the morning and expanded during the afternoon and night. Daily shrinkage was caused entirely by transpiratory water loss following VPD, as xylem backflow was never detected. At sunrise, the xylem flow was quite low and did not balance transpiration water losses, whereas in the afternoon it increased and supplied enough water for the fruit to exceed transpiration and achieve positive growth. For all the fruit monitored, the daily phloem flow was lower than the xylem one and contributed to fruit growth especially during mid-day hours. As expected, fruit in low competition conditions showed higher daily growth rate than HCL fruit. Such a difference was apparent mainly during the afternoon, because of the higher phloem flow and the lower transpiratory losses shown by LCL and CTRL fruit at this time of day. However, phloem flow at midday was higher in HCL than in LCL and CTRL fruit. Crop load affected fruit and stem water potential during the light period, with HCL and CTRL fruit reaching lower values than LCL fruit. In all treatments fruit, stem and leaf water potential decreased as VPD increased and an inverse relationship was found between fruit transpiration and fruit water potential. Xylem flow was positively related to stem-to-fruit water potential gradient whereas phloem flow responded just to fruit water potential suggesting that a passive mechanism may drive phloem unloading during cell expansion. Our results show that at this stage, vascular flows, and thus peach fruit growth, are driven by daily changes in water potential parameters and are affected by crop load.

Oral Abstract 64

Preharvest Thinning Effects on 'Scifresh' Apple Fruit Production and Quality

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'Scifresh' apple trees display a genetic tendency to produce commercially small fruit. Cultural management practices such as application of appropriate thinning regimes to overcome this commercial problem have not yet been fully explored. Therefore, this study investigated the effects of thinning time (0, 30, 60 and 90 days after full bloom (DAFB) and thinning intensity (target crop loads of 4 (low), 8 (medium) and 12 (high) fruit/trunk cross sectional area (TCA) on fruit size, production and quality at harvest and after storage at two locations in New Zealand. In general, the highest net yields of between 60 – 80 tonnes per hectare were obtained when trees were thinned to a medium and high crop load and when thinned early in the season (0 to 30 DAFB). Low and medium crop loads and early thinning, however, increased the mean fruit weight by up to 20%, reaching a maximum fruit weight of 202 g. Reduced cropping levels produced fruit with higher firmness (c. 1 kgf), soluble solid (0.7-0.9%) and titratable acidity (0.06-0.11%) levels. In relation to thinning time, fruit firmness and soluble solids were highest on trees thinned early or in the middle of the season. Overall, the severity of postharvest disorders following 16 weeks of cold storage was low, except for superficial scald, which was highest for high cropped trees thinned at 60 DAFB (mean 36%). In conclusion, it is recommended that 'Scifresh' trees with mature canopies are cropped to an equivalent of around 8 fruit per TCA and thinned early in the season (0 to 30 DAFB) to maximise fruit size without overly compromising on fruit production and quality.

Oral Abstract 65

Crop Load Management of Pacific Northwest Tree Fruits

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The economic viability of commercial tree fruit orchards in the Pacific Northwest requires consistently high yields of target fruit for the fresh market. Optimizing crop load is essential. Traditional reliance on hand fruitlet thinning is increasingly costly as labor markets tighten and occurs too late phenologically to confer the desired impact on fruit size and return bloom. Since 1998, the Washington Tree Fruit Research Commission has conducted more than 300 replicated crop load management trials in commercial apple, pear, cherry, peach, nectarine, and apricot orchards throughout Washington, testing 60 materials as apple chemical bloom thinners, including caustic salts, growth regulators, photosynthetic inhibitors, plant oils, surfactants, particle films, fish byproducts, and weak acids and bases. Results from trials on 11 apple scion cultivars clearly indicate lime sulfur is the most effective bloom thinner, whether applied alone or in combination with horticultural spray oils. These programs have consistently reduced fruit set, increased harvest fruit size, and promoted return bloom in chemical bloom thinning trials and are acceptable in organic systems. In apple postbloom chemical thinning trials, tank mixes of carbaryl and 6-benzyladenine (BA) have produced similar responses more consistently than tank mixes of carbaryl and naphthaleneacetic acid (NAA). Serial summer applications of NAA and ethephon have rarely increased return bloom in apple. Gibberellic acid applications to reduce return bloom in biennial apple orchards have shown promise. Fruit size has been increased by both BA and ammonium thiosulfate (ATS) in trials on three pear cultivars, even when fruit set has not been reduced. ATS and tergitol have reduced fruit set and increased fruit size in Prunus trials, but results have been inconsistent. We continue to refine integrated programs tailored to specific root-scion combinations and microclimates using chemical, mechanical, and internet-based decision assist models.

Oral Session 14
Rootstock Breeding and Evaluation

Oral Abstract 66

Breeding of Apple Rootstocks in Poland

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Breeding of apple rootstocks was started in Poland in 1954 when the first crossing programs were implemented at the Research Institute of Pomology and Floriculture in Skierniewice (Central Poland). From the beginning, the most important aim of the breeding work was to develop rootstocks that would be well-adapted to the local agro-climatic conditions. In the first crossing program, rootstocks M.4, M.9 and M.11, as well as two apple cultivars, Antonovka and Longfield, were used. As a result, a series of several rootstocks was released and introduced into commercial apple production in Poland in the middle of the 1980s. They were designated with the letter 'P' (the first letter of the Polish word 'podkladka', meaning 'rootstock'). The series consisted of the following rootstocks: P1, P2, P14, P16, P18 and P22. Of these rootstocks, only P14 (semi-dwarfing), P 16 and P 22 (both dwarfing) gained a wider acceptance among apple growers and are still used in apple production in Poland. The second and a more intensive stage of the apple rootstock breeding program took place between 1969 and 1979. During that time, some other rootstocks were also included in the crossing program, such as A2, B9, B146, M.7, M.26, MM.106, P1, P2, P16, P22, and also the wild species of apple – *Malus robusta* 5. The main goal of that breeding work was to produce new, dwarfing rootstocks that would be resistant to Phytophthora cactorum. More than 40 cross-combinations were made, and over 25,000 seedlings were produced. Out of those, more than 500 individuals were initially selected and propagated. Following the next cycle of selection, around sixty clones were chosen for nursery and orchard trials. The subsequent evaluation and selection resulted in a series of new rootstocks which included P59 (very dwarfing), P60, P61 and P62 (all three semi-dwarfing). In 1997, all of these rootstocks were officially entered in the Polish register of fruit plant varieties. In addition, rootstock P59 has been protected by plant breeders rights in Poland. In that new series of rootstocks, only P59 and P60 gained some economic importance in Poland (both originated from the cross between A2 x B9; however, P59 is a dwarfing rootstock, while P60 is semi-dwarfing, but both have characteristic red leaves and wood). Continued evaluation and selection of the breeding material resulted in the release of new rootstocks designated: P63, P64, P65, P66, P67 and P68. Since the year 2000, they have been on the Polish national list of registered fruit plant varieties. After additional orchard trials, the most valuable seem to be P66 (P22 x M.26), P67 (A2 x P2) and P68 (A2 x B9). All of them are dwarfing rootstocks and highly resistant to Phytophthora cactorum, apple scab and apple mildew. They are also easy to propagate in stoolbeds. Their precocity and productivity are similar to those of M.9 or P22. The third crossing program has been conducted since the year 2000. It focuses on obtaining new, semi-dwarfing and dwarfing rootstocks with good winter-hardiness and improved resistance to diseases, including fire blight. New parental forms not included in the earlier crosses are being used. They are: Bemali, BW, Jork, M.27, Mark, P14, P22, P60, P62, Pajam, and also wild apple species like *Malus pumila*, *M. robusta*, and *M. prunifolia*. Over one thousand seedlings have already been produced, and they are now under comprehensive assessment.

Oral Abstract 67

Controller 5, Controller 9 and Hiawatha Peach Rootstocks: Their Performance and Physiology

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The primary factor limiting the use of size controlling rootstocks in California peach and nectarine production is the lack of suitable, commercially available size-controlling rootstocks with a wide range of compatibility with scion cultivars. From 1986 to 1994 a broad range of genotypes with widely varying genetic backgrounds were evaluated for their rooting capacity, compatibility with O'Henry peach and size- controlling characteristics. In February, 1996, a rootstock trial was planted at the Kearney Agricultural Center (Parlier, CA) to evaluate the commercial potential of eight rootstocks identified in the previous trial. The main part of this experiment involved ten different rootstocks and two scions. The ten rootstocks were: Alace, Hiawatha, Sapalta (open pollinated seedlings of a *Prunus besseyi* x *P. salicina* hybrid), K-145-5, K-146-43, K-146-44, P-30-135, (*P. salicina* x *P. Persica* hybrids) K-119-50 (*P salicina* x *P. dulcis* hybrid), and two commercially available rootstocks, Citation and Nemaguard. The two main scion cultivars were Loadel (an early clingstone processing cultivar) and Flavorcrest (an early fresh market freestone cultivar). The trial contained thirty-six trees of each rootstock/ scion combination. Four replications of 5 trees each were planted and trained to the KAC-V perpendicular V system, and 4 replications of 4 trees each were planted and trained to the standard open vase system. In-row tree spacings for each rootstock/scion/training system combination varied according to expectations of final tree size. By the fourth leaf four rootstocks (Alace, Citation, Sapalta, K-145-5) were discarded because of signs of delayed scion incompatibility. Due to positive size-controlling performance, K146-43, P30-135 were patented and commercially released as Controller 5 and Controller 9 in 2004 and we began recommending commercial trials of these two rootstocks along with Hiawatha because they provided a range of size-controlling options (~50%, 70% and 90% of trees on Nemaguard for Controller 5, Hiawatha and Controller 9, respectively). This paper will report on relative tree growth, crop yield and pruning requirements of trees on these three rootstocks compared to the industry standard (Nemaguard) over twelve years and discuss research related to the physiology of the size-controlling mechanism and their overall potential as commercial rootstocks for California.

Oral Abstract 68

'Qingzhen 1' and 'Qingzhen 2', Two Apomictic Apple Rootstocks

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'Qingzhen 1'and'Qingzhen 2' are two new apomictic apple rootstocks released in 2007. Their seedlings behave dwarf and uniform in appearance when propagated with seeds. 'Gala', 'Jonagold' and 'Fuji' have already been grafted on these two rootstocks. The yield, vigor, precocity and resistance of unions are evaluating in different apple production areas of China. 'Qingzhen 1' was a hybrid from cross 'Pingyitiancha'(*Malus hupehensis*

Rehder) x 'CO 1'(*Malus pumila* Mill) made in 1999 at the Academy of Agriculture Science of Qingdao. The paternal parent 'CO 1' is a selection of columnar apple. As a result, 'Qingzhen 1' combined column trait and apomictic ability in the same individual. Its apomictic fruit-setting ability was higher than its female parent 'Pingyitiancha'. The population of one-year-old seedlings are uniform in appearance, columnar and strong as well as compatible when grafted with 'Gala', 'Fuji', 'Jonagold'. 'Qingzhen 2' was a dwarf mutant screened from X-ray radiated seeds of 'Pingyitiancha' in 1997 at the Academy of Agriculture Science of Qingdao. 'Qingzhen 2' has similar apomictic rate with its background 'Pingyitiancha'. Its population of one-year-old seedlings are uniform and dwarf as well as compatible when grafted with 'Gala', 'Fuji', 'Jonagold'. Four-year-old 'Gala' trees grafted on 'Qingzhen 2' were similar to those on M7 in size.

Oral Abstract 69

Performance of Prunus Rootstocks in the 2001 NC-140 Peach Trial

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[2]Co-authors were NC-140 cooperator members from USA states of California, Colorado, Georgia, Maryland, Missouri, New Jersey, South Carolina, Texas, Utah, Washington and Ontario, Canada.

Fourteen Prunus rootstock cultivars and selections budded with either 'Redtop', 'Redhaven' or 'Cresthaven' peach were planted at 11 locations in North America in 2001 in a randomized block design with a tree spacing of 5 by 6 m and 8 replicates. These rootstocks included three peach seedling rootstocks: Lovell, Bailey, and Guardian® 'BY520-9' [selection SC-17]. Clonal rootstocks were peach x almond hybrids 'BH-4' (Bright's Hybrid selection) and 'SLAP' ('Cornerstone'); peach x plum hybrids 'K146-43' ('Controller 5'), 'K146-44', and 'P30-135' ('Controller 9'); interspecific plum hybrids 'Hiawatha', 'Jaspi' and 'Julior'; interspecific Prunus hybrids 'Cadaman®' and 'VVA-1' (Krymsk® 1); and Prunus pumila selection 'Pumiselect®'. The largest trees were from Georgia, Maryland, and South Carolina. 'Cornerstone', 'BH-4', Guardian®, Lovell, and 'Cadaman®' were the most vigorous rootstocks. 'Jaspi', 'Controller 5', 'K146-44' and 'Krymsk®1' were the least vigorous, having trunk circumferences 30-40% smaller than Lovell. No rootstock had a significantly higher survival rate than Lovell at all locations. 'Julior', 'Jaspi', and 'Krymsk® 1' had significantly more root suckers. Cumulative fruit yields were highest on the peach seedling, peach x almond, and 'Cadaman®' rootstocks. Lowest cumulative yields were from trees on 'Jaspi', 'Krymsk® 1', and 'K146-44' rootstocks. Fruit weight was significantly larger on 'BH-4', 'Cornerstone' and Bailey rootstocks. Bailey and 'Jaspi' had the highest and lowest cumulative yield efficiency, respectively.

Oral Abstract 70

The Krymsk® Rootstock Series. I. Krymsk®1 (VVA-1), a Dwarfing Rootstock at the Basis of High Density Plum Orchards in the Netherlands

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Krymsk®1 (*Prunus tomentosa x Prunus cerasifera*) was selected by dr. Gennady Eremin at the Krymsk Breeding Station in Russia in 1966. From 1994 onwards, it has been tested as a rootstock for several plum cultivars in The Netherlands. Graft compatibility was good for scion cultivars 'Avalon', 'Excalibur', 'Jubileum', 'Opal', and 'Victoria'. Growth and production efficiency of plum on Krymsk®1 was compared with that on rootstock St. Julien A and, depending on the cultivar, also with Ferlenain, Otesani 8 and Pixy. With all cultivars, trees on rootstock Krymsk®1 were by far the least vigorous, most precocious, and most production efficient. The production efficiency of 'Avalon' and 'Excalibur' on rootstock Krymsk®1 grown for 10 years was 0.41 and 0.26 kg/cm² trunk cross sectional area, respectively, 3.4 and 4.3 times higher than on St. Julien A. With 'Opal' the production efficiency calculated over the first 4 years after planting was 2 to 3 times higher than on St. Julien A, but this difference became non significant after 6 years of cultivation. This was due to the much higher increase in production per tree during 5th and 6th leaf of the trees on St. Julien A than on Krymsk®1. Fruit size per cultivar of 'Opal', 'Avalon' and 'Excalibur' was similar for trees grown on Krymsk®1 and St. Julien A. With 'Victoria' fruit size was significantly larger (5 g) with Krymsk®1 than with St. Julien A. Krymsk®1 also increased the percentage of first pick by 15%, the sugar content by 9%, enhanced the development of fruit overcolour and reduced the percentage of fruits with gummosis in 'Victoria' plums. Dutch fruit growers show great interest in Krymsk®1 as a rootstock for plum, as this rootstock makes high density plum orchards feasible. Combined with the early and high production levels, the profitability of plum production has increased. Growers switching to trees on Krymsk®1 have to take more care of their trees, especially in the first years after planting. Pruning, irrigation, and fertilization of the trees need much more attention in order to keep the trees vigorous and ensure good production levels. From 2002 to spring 2008, 120,000 plum trees on Krymsk®1 have been planted in The Netherlands and planting densities have increased from 830 up to 2450 trees/ha. The main cultivar planted is 'Victoria'

Oral Abstract 71

Review of Fruit Rootstock Research in Europe Performed by EUFRIN Rootstock Group

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Rootstock research takes an important place across the Europe. 41 scientist representing 19 Fruit research institutions from 15 countries joined the EUFRIN (European Fruit Research Institutes Network) Rootstock working group. EUFRIN is an informal, voluntary organization of university departments and research institutes that specialize in research, development, and extension on temperate fruit crops and which are based within

countries of the European Union, Switzerland, and Eastern Europe. It was set up and held its first meeting in Bonn in 1993. This review intends to show more about ongoing projects at the institutions - members of EUFRIN Rootstock group, objectives of rootstock research in separate countries and all over the Europe. Extensive list (more than 150) of newest scientific papers published by members of EUFRIN Rootstock group and the data of pome and stone fruit rootstocks in the trials and collections is available. Gathered information and knowledge hopefully will promote more efficient cooperation and facilitate rootstock research by sharing experience, methodology and plant material. Ongoing international cooperative trials are presented and suggestions for future cooperation are discussed. On the whole main rootstock evaluation programs are performed on apples. 106 apple rootstocks and their clones are included in various trials of EUFRIN Rootstock group, followed by rootstocks for apricot, plum and peach (81 accessions), cherry (70) and pear (51).

Oral Session 15
Environmental Physiology

Oral Abstract 72

Water Consumption in Lysimeter-grown Apple and Pear Trees with Different Training Systems

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A five years experiment was conducted to determine apple (cv 'Golden Smoothee') and pear (cv 'Conference') water consumption. We monitored three apple trees and three pear trees grown in large weighing lysimeters. We evaluated daily reference evapotranspiration (ETo) and crop evapotranspiration (ETc). Midday canopy light interception was determined on a weekly basis from bud-break until leaf fall in each of the five experimental years. We established relationships between canopy light interception and the calculated Kc (ETc/ETo) from bud-break until harvest. There were significant differences in Kc values between apple and pear trees. When daily Kc from bud-break until harvest was adjusted to a quadratic curve, the adjusted curves in pear tress were very similar among years. However, in apple trees, the value at which Kc saturation was observed increased with years. Regarding light interception, both apple and pear trees exhibited a similar progressive increase in midday light interception during the five-year experiment. Although there was a clear positive correlation between midday canopy light interception and K_c in apple and pear trees, the behavior of the established relationships was different among crops. While apple data fitted the same equation independently of years, the pear data fitted different equations for each year of evaluation. This discrepancy between apple and pear trees may be related with their different tree growth habits and training system. While pear trees exhibited a very rapid vertical growth, apple trees exhibited a slow growth rate in height. We think that midday canopy light interception did not reflect the differences in tree height and that the variation in tree light interception from year to year only accounted for some expansion of lateral branches. For this reason, when comparing fruit tree orchards with different training systems, similar values of midday canopy light interception may be related with different canopy volume and thus different water demand. From a practical standpoint, midday canopy light interception may be a useful tool for irrigation scheduling in apple trees under the conditions of this experiments. However, in 'Conference' pear trees, once full canopy cover is achieved, Kc may be estimated through a traditional calendar approach.

Oral Abstract 73

Mitigation of Water Stress in Peach Trees by Using Summer Pruning and Fruit Thinning

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Recently many fruit orchards in the Mediterranean are have suffered irrigation water shortages because of drought. Under drought conditions, fruit growers could experience problems with attaining the fruit sizes

desired by the market. Moreover, water stress could also have negative effects during the subsequent years. In this research, we compared severe summer pruning and heavy fruit thinning as techniques for water stress relief during periods of extreme drought. We also studied the long-term effects of water stress. Although both severe summer pruning and heavy fruit thinning improved the water status of the tree (expressed as midday stem water potential), only fruit thinning produced a benefit in fruit growth. Our results indicated that improvements in water status in response to pruning may be insufficient to promote fruit growth if the pruned trees are unable to provide an adequate supply of assimilates to the developing fruits. A suitable technique for mitigating the adverse effects of a water deficit on fruit growth should produce a benefit in tree water status and at least maintain assimilation capacity. Fruit thinning, therefore, can be considered as an adequate technique for mitigating the adverse effects of a water deficit on fruit growth. Regarding long-term effects of water stress, severe water stress reduced tree reserve concentrations (expressed as root starch concentration in winter) and subsequent fruit set. Reductions in fruit set may be a negative long-term effect depending on the level of fruit load management. When low crop loads are required in order to promote fruit quality (fresh market), the reductions in fruit set could not be a negative effect.

Oral Abstract 74

Effects of Partial Rootzone Irrigation on Growth and Physiological Characteristics in Apple and Water-saving Efficiency

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In experiment we used partial rootzone apple trees where the root system was divided to four containers. There were four experiment groups (1/4, 2/4, 3/4 and 4/4 root zone) of irrigations, and three different amounts (500ml, 750ml and 1000ml per basin every time.) water of irrigation. We had studied effects of partial rootzone irrigation on growth and physiological characteristics of apple tree and water-saving efficiency. The results showed that soil water potential (SWP) of treatments 4/4, 3/4 and 2/4 were increased in the same amounts water of irrigation. Under the every amount of irrigation, the leaf water potential (LWP) at dawn and moon, the photosynthesis of 1/4 treatment were at the lowest value all the time, while 4/4 treatment was at the biggest value. The photosynthesis was no significant difference among different treatments.1/4 irrigation treatment and 500ml amount of water treatment significantly inhibit the growth of new shoots, trunks and roots. The content of ABA in root and leaf were increased in the same amounts water of irrigation. Without sacrificing the accumulation of biomass, the WUE under two fourths (2/4) of the rootzone irrigation and 750ml amount of irrigation treatment was higher than that of other treatments, but the biomass decreases only by 26.2% and water consumption reduces by 64.0%, and the water-saving profit was significant.

Oral Abstract 75

The Pedicel's Role in Postharvest Weight Loss of Two Sweet Cherry Cultivars

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Mechanized sweet cherry (*Prunus avium* L.) harvest yields stem-free fruit, raising concerns over storability. In 2007, we evaluated storability of 'Bing' and 'Skeena' fruit with and without pedicels. The entire fruit surface and/or pedicels were sealed with petroleum jelly (PJ) to form barrier to water loss. Six treatments were compared for both cultivars: 1) no PJ, with stem, 2) no PJ, stem-free, 3) pedicel and fruit sealed with PJ, 4) pedicel treated with PJ, 5) fruit surface sealed with PJ, and 6) stem-free fruit with PJ applied to abscission zone. At harvest, individual fruit were labeled, weighed, placed into modified atmosphere packaging, and stored at 4° C for three weeks. Every 3 to 4 days, replicate sets of fruit were removed from storage and analyzed for weight and quality attributes. Untreated, stem-free, 'Bing', lost significantly more weight (9.0%) than stemmed 'Bing' (6.5%) over the trial period. In contrast, weight loss from stem-free and stemmed 'Skeena' fruit was not different (7.8% vs. 8.7%, respectively). For both cultivars, treatments 4 and 6 did not significantly reduce weight loss compared to control treatment 1. However, treatments 3 and 5 significantly and similarly reduced weight loss for both cultivars – mean weight loss was 1.5% and 0.5% for 'Bing' and 'Skeena', respectively. These results demonstrate that weight loss occurs predominantly via the fruit exocarp and not the pedicel. Furthermore, we recorded a subtle increase in 'Bing' pedicel-fruit retention force throughout storage, a trend that was not observed for 'Skeena'. In addition, static dye uptake experiments using basic fuchsin (0.1%) revealed no uptake into pedicels from either the stylar or stem end of 'Bing' fruit. In contrast, we observed dye uptake into the pedicel from stylar end immersion of 'Skeena' fruit. Implications of these results for storability of mechanically-harvested stem-free fruit will be discussed.

Oral Abstract 76

The Relationship Between Shoot Length and Utilization of Stored Assimilates After Heading Cut in Young Apple Trees

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The shoot growth and shoot length in apple trees are controlled by apical dominance, and the upper shoots grow longer than the lower shoots. The difference of the utilization of stored assimilates (nitrogen and carbon) might affect on the shoot growth as well as the level of plant hormones such as auxins and cytokinins. In this research, the relationship between the shoot length and the utilization of stored assimilates was investigated with using young apple trees. Also the effect of ringing and bending the trunk on this relationship was examined. Apple trees ('Fuji' on *Malus prunifolia*(Willd.) Borkh.) were treated with 15N and 13C in the year prior to the experiment. Ringing and bending the trunk were conducted at March after heading cut. The trees were examined early (in May), at mid-term (June) and when mature (September). Shoot growth stages and nitrogen and carbon status were analyzed at each harvesting. There was no relationship between the length of the shoot and the 15N excess% of the shoot at each stage in all examined trees. The levels of 15N excess% were stable from May to June. The 13C excess % decreased during the period from May to June, There was a significant positive

correlation between the lengths of the shoot and 15N or 13C distribution in the shoot. It was suggested that, as they grew the longer shoots absorbed higher amounts of stored assimilates than the shorter shoots. Although the degree to which stored versus current absorbed assimilates contributes to new shoot growth might be the same in all shoots, stored nitrogen plays an important role in new shoot growth. Also, the ringing and bending the trunk has no effect of this relationship.

Oral Abstract 77

The Systematic Influence of Crop Load, Spur Type, 3D-Canopy Structure, and Leaf Zonal Chlorosis on Leaf Photosynthesis of 'Honeycrisp' Apple Trees

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Leaf photosynthesis of Honeycrisp has been characterized by gas-exchange measurement using the LCPro+ system (ADC) and the Li-6400 system (LiCor) in order to establish a fully parameterized mechanistic model of leaf photosynthesis (Farquhar et al. 1980) for this cultivar. Light- and CO2-response curves of 42 leaves have been measured at 3 different temperatures in order to derive photosynthesis capacities Jmax and Vcmax for 3 classes of leaves, representing trees with low, medium, and high crop load (3, 6, and 9 fruits/cm² TCA). The leaves were also chosen to cover the relevant physiological stages of spurs: 2 year old fruiting spurs (FS), older non-fruiting spurs (NFS), and non-fruiting extension growth (EXT). The area affected by leaf zonal chlorosis of each leaf was estimated by eye and specific leaf area was determined. Canopy position of each leaf was characterized by the gap fraction above it, as determined by hemispherical photography. The parameterized model was validated by daily course measurements on the same trees as well as on Honeycrisp trees at another orchard in the Annapolis Valley, about 50km away from the former. The results show that neither crop load nor spur type had any significant influence on leaf photosynthesis, while leaf zonal chlorosis reduced photosynthesis rates proportionally to the leaf area affected. Canopy structure above the measured leaf had by far the biggest effects on leaf photosynthesis rates. 3D-canopy structure of the validation trees was determined in a subsequent experiment using a 3D-laser scanner. Transpiration of the trees was assessed by sapflow measurements as an integrating measure for gas-exchange. The relation between canopy leaf area distribution and measured gas-exchange is discussed. Gap fraction above the investigated leaf was the most relevant factor for leaf photosynthesis.

Oral Abstract 78

The Molecular Basis of Flowering in Longan

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Longan (*Dimocarpus longan* Lour.) is a commercial fruit crop mainly cultivated in subtropical countries of

Southeast Asia. In Thailand, longan flowers from late December to late February due to flower inducing climatic conditions with a relatively dry cool (<18°C) environment throughout the natural period of flower induction from mid November to mid December. However, the application of potassium chlorate ($KClO_3$) can induce off-season flowering within 20-30 days even so climatic conditions may not be suitable. Thus, this chemical offers a unique opportunity not only to improve the irregular bearing behaviour of longan but also to use it as a potent inducer of longan flowering all year. In addition, farmers obtain a higher price for off-season fruit due to the imbalance between supply and demand in the market place. It is hypothesized that an alteration in the hormonal status triggers the programmed sequential morphogenetic events and turns the switch from vegetative to reproductive bud meristem. Specific genes, coding for hormone biosynthesis and/or flowering will therefore be up-regulated, temporarily or spatially, with a transition to flowering in tree crops. Several genes involved in the switch from vegetative to floral bud meristem have already been identified and characterized in Arabidopsis. A network of interactions and regulatory hierarchies among these genes encoding for specific proteins is slowly forming. Some of the molecular basis in this flowering process has been shown to play a similar role in other annuals. A central protein in this process is FLOWERING LOCUS T (FT), which triggers flowering once it accumulates to high enough levels in the plant tissue. In Arabidopsis, the temporal increase in FT expression can be triggered by environmental stimuli such as extended periods of cold temperature or long photoperiods. We attempt to identify the molecular basis of lower induction in Longan by expression patterns of genes that encode for proteins similar to Arabidopsis flowering genes. Six-year-old potted longan trees located at Chiang Mai University were used. The experimental design consisted of 10 trees treated with $KClO_3$ and 10 trees served as controls. Potassium chlorate was applied as soil drench at 1g/pot to fully mature plants in November 2007. Samples for RNA extraction from terminal buds, lateral buds and leaves were collected 6 times at 5 day intervals following application. Eight degenerate primers of FT (FTDEG) were designed by using five highly conserved regions of *Arabidopsis thaliana*, *Vitus vinifera*, *Citrus unshiu*, *Oryza sativa*, *Hordeum vulgare*. Four of the FTDEG primers were successfully amplified in longan and fragments were subsequently cloned and sequenced. BLAST searches with this sequence aligned with the Arabidopsis genome identified FT with an amino acid identity of 68% and homology of 68%. It was concluded that longan homologue of FT was successfully isolated.

Oral Abstract 79

Aspects Of Macadamia Flowering And The Applications To Canopy Management

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The macadamia (*Macadamia integrifolia*, *M. tetraphylla*, and hybrids) is a subtropical, evergreen, recurrent flushing tree, native to and cultivated in eastern Australia, for its premium quality nut. We discuss the physiology of macadamia flowering, including some new data, and applications to macadamia canopy management. Macadamia flowers in response to cool temperature, producing racemes containing several hundred flowers that originate from axillary buds. Flowering in macadamia, similar to other tropical and subtropical trees such as lychee and mango, is dependent on sensing the floral inductive stimulus (cool temperature), and release of buds for inflorescence production. Flowering is affected by the timing of vegetative growth; immature flush during early winter (floral initiation and differentiation) suppresses flowering. The mechanism for this inhibition is unknown but may be due to feedback by growth regulators exported from the developing flush that inhibits bud release; reproductive or vegetative. Flowering also varies with characteristics of the stems; short non-

vigorous stems are more likely to flower than long stems, possibly because axillary bud release is inhibited less in short stems, or related to a positional effect within the canopy. Stem age also affects the likelihood of flowering although it is unclear whether this is due to stem age per se, or a positional effect related to the environment. The most common form of canopy management in Australian macadamia orchards is mechanical hedging, generally undertaken in early spring, around the time of anthesis. The purpose being to control tree size for a range of indirect benefits generally unrelated to improving yield and quality. The relationship between flowering and yield in macadamia is largely unknown, so increasing flowering may not necessarily increase yield as with some other subtropical and tropical tree crops, however we can assume that a at least a moderate level of flowering is necessary for optimum yields. Canopy management techniques that promote the production of sufficient short stems that are likely to flower may maintain productivity. The timing of hedging also needs to be considered because the resultant vegetative flush may feedback to flowering. Well timed autumn hedging or hedging in early winter would ensure the absence of immature vegetative flush that has the potential to suppress flowering.

Poster Session 1

Poster Abstract 1

Establishment and Growth Parameters of Some Wild Almonds in Iran

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Iran is an important area for world almonds gene pool. It was suggested that Amygdalus communis spread from Iran, Caucasia and south of Turkey to Syria, Lebanon and Jordan. Up to now, 21 wild species and 7 inter species hybrids have been identified in Iran, which ten supposed to be endemic species. Wild almond species have been used traditionally as rootstocks in some areas of Iran. Species *A. spartioiedes* and *A. spinosissima* grafted by local almond growers in arid regions and species *A. scoparia*, *A. eriocalda*, *A. horrida* and *A. elaengifolia* are used as their rootstocks. For investigating the emergence, establishment and vigor of 15 ecotypes from 4 provinces, seeds of seven species have been evaluated. The germinated seeds were planted in a Completely Randomized Design with four replicates. Seedlings have been planted in plastic bags in outdoor condition. The percentage of establishment and growth parameters of seedlings were recorded during growing season. The results showed that two ecotypes of A. reticulata had the highest growth and highest stem length at all growing stages.

Poster Abstract 2

Results Concerning the Behaviour of Some Rootstocks for Peach Tree in the Nursery Field

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The research carried out in Research Station for Fruit Growing Constanta, Romania, studied the behaviour in the nursery field of five rootstocks for peach tree: three from Romania (T16, Tomis 28 and Tomis 39) and three from another countries (PSC 12 from Italy, AID1 and AID2 from Greece). These rootstocks were grafted with 6 cultivars in the research tree nursery field: Delta, Cora, Stark Delicious (nectarine cultivar), Raluca and Redhaven (peach cultivar). As results of the investigations we were found that Romanian rootstocks had seeds smaller than rootstocks from Italy or Greece. Studied rootstocks had a good and very good germination, seedlings with vigorous growth and very high standard seedlings yields. The rootstocks were behaved very well at rooting and in grafting process. They gave trees with different vigor, depending on rootstocks and cultivars and high yields of standard grafted trees/ha. They present good compatibility with grafted cultivars, with no external deformations. All of these results show that studied peach rootstocks are good for peach and nectarine trees.

Poster Abstract 3

A RAPD Marker Linked to the Resistance Gene to Alternaria Leaf Spot (*Alternaria mali* Roberts) in 'Qinguan' Apple

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Resistance in F1 population of the cross of 'Qinguan x Fuji' and its reciprocal cross 'Fuji x Qinguan' was determined under natural evaluation in 2006 and 2007. The ratio of resistant seedlings to susceptible seedlings in both crosses have been tested in accordance with X20.01 distribution of 1:1 segregation (X2 Qinguan x Fuji = 2.645; X2 Fuji × Qinguan = 0.743; X20.01=3.84). Among the progenies of both crosses, the SI values revealed genetic features of quantitative traits demonstrating successive distribution. This indicates that Alternaria leaf spot resistance in these two crosses may be controlled by a major gene in combination with some minor genes. Forty resistant, thirty-one susceptible progenies of the cross 'Qinguan x Fuji' and 325 RAPD primers were chosen to detect markers linked to resistance based on the Bulked Segregant Analysis (BSA). A fragment, 'S428-854', presenting in the 'Qinguan' and the resistant DNA pool, and absent in the 'Fuji' in the susceptible DNA pool was obtained from the amplification by the primer 'S428'. The distribution of 'S428-854' in the F1 individuals showed that the molecular data of the 56 individuals (78.9%) were consistent with the field identification data. The S428-854 RAPD marker was sequenced. Its actual length was 854bp. Results of blasting this sequence with the NCBI database indicated that its homology to known sequences was no more than 30%. Structure analysis using DNASTAR software showed that this sequence did not have an open read frame, meaning that it does not have a complete gene structure. We have submitted this sequence to NCBI GeneBank as accession EU710766.

Poster Abstract 4

Influence of the Rootstock on the Morphological Differentiation of the Flower Buds in two Cherry Cultivars

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The studies were conducted in the years 2004-2006 on 8-10-old trees of the cultivars 'Bigarreau burlat' and 'Stella' grafted on the rootstocks P 1 (seedling of *Prunus mahaleb* L.) Gisela 5 , Weiroot 13 and Weiroot 72. From the end of May till the end of September (in a 7-day period) spurs have been collected from the two-year-old wood and their lateral buds have been examined under a stereo-microscope. It has been established that the type of rootstock does not influence significantly the rate of initiation of the appendages (bud scales and bracts) on the axes of the buds. A greater number of flower primordia have been formed in one flower bud under the influence of Gisela 5 (in comparison with P 1). The bud scales of the flower buds in the two cultivars differ in shape. In 'Bigarreau burlat' they are almost triangular with a small notch in the upper part, whereas in 'Stella' they are more rounded, with a bigger notch in the upper part, which forms considerably well two segments. These differences are best established in the 4th - 6th bud scale. They could have been used for identifying the two cultivars in autumn and winter, when fresh fruit are not accessible. It is advisable to study the morphological characteristics of the bud scales in other cultivars too, with a view to improving their pomological characteristics.

Poster Abstract 5

Selecting and Fingerprinting the Next Generation of Size-Controlling Rootstocks for Sweet Cherry

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Dwarfing precocious sweet cherry rootstocks are needed to increase the profitability of fresh market sweet cherry production. Although several dwarfing rootstocks from Europe are commercially available, these rootstocks may not be ideal for U.S. fresh market sweet cherry production. The tendency for sweet cherry cultivars to over crop on these precocious rootstocks makes it difficult to achieve the large fruit size needed for maximum profitability. To address this problem, a rootstock selection program began at Michigan State University (MSU) in 1997 to identify precocious dwarfing rootstocks. Eleven rootstock candidates have been selected from an initial set of 91 MSU rootstocks. Four of these rootstocks produce trees that are smaller than those on 'Gisela®5', six produce trees that range from that expected on 'Gisela®5' to trees similar to 'Gisela®6', and one selection is more vigorous than 'Gisela®6'. In addition, some of these rootstocks confer wide branch angles in the scion and reduce flower bud density compared to the Gisela® series that may be more suitable for highly productive cultivars. Polymerase chain reaction primer pairs that exhibited sufficient polymorphisms in fragment size to discriminate among the 11 rootstock candidates have been identified. These four primer pairs are PceGA59, PMS40, PMS67 and the S-locus RNase. With these markers the identity of each of the 11 rootstocks can be easily verified. Growth, floral bud density, and fruit quality data from test plots of these rootstocks in Clarksville, Michigan and Prosser, Washington will be presented.

Poster Abstract 6

Effect Of Different Seed Treatments on the Germination and Seedling Growth of Almond

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An evaluation of the effects of various seed treatments on almond nuts (boiling in water for 15 minutes, dipping in 10% sulphuric acid for 30 minutes, soaking in GA3 50ppm for 24 hrs, thiourea 2% for 24 hrs, IBA 100ppm for 24 hrs, shell breaking with hammer and an untreated control) was conducted. The maximum germination percentage (49.21), maximum seedling height after 150 days (158.60), and minimum number of days to germinate (58.40) was observed in almond nuts sown after treatment with 15 minute boiling in 2005. Similar results were noted in the following two years (2006 and 2007). Almond nuts treated with 15 minute boiling produced plants with the maximum budding ability as compared to other treatments and control.

Poster Abstract 7

Dormant Carbohydrate Reserves of Two Peach Cultivars Grafted on Different Vigor Rootstocks

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In temperate fruit trees, early spring shoot growth depends on carbohydrate reserves accumulated in the previous season. Vigorous rootstocks can accumulate more reserves, which contribute to a higher initial flush of shoot growth. Total dormant, non-structural carbohydrates (TNC) in above and below ground tissues were studied in mature 4-year-old 'Redhaven' and 5-year-old 'Redtop' peach trees at three different locations (California, Georgia and South Carolina), and in 1-year-old 'Redhaven' trees grown near Clemson, South Carolina. The rootstocks included Lovell (*Prunus persica*), Pumiselect® (*P. pumila*), Krymsk® 1 (*P. tomentosa* x *P. cerasifera*), Cadaman®-Avimag (*P. persica* x *P. davidiana*), Controller® 5 (*P. salicina* x *P. persica*) and Cornerstone (*P. persica* x *P. dulcis*). Shoot and root samples were taken from the mature trees' while the 1-year-old peach trees were removed from the ground for tissue analysis. Carbohydrates were also quantified in bark and wood tissues in the mature 'Redtop' trees. Greater concentrations of TNC were found in 'Redhaven' and 'Redtop' roots in California compared to the other two sites; however, shoot TNC did not differ significantly among sites. Concentration of TNC in roots were at least two fold compared to shoot TNC concentration. Lovell roots had the greatest accumulation of reserves and Krymsk® 1 the lowest. Rootstock bark accumulated the largest amount of TNC, followed by scion bark, and Lovell had the greatest TNC content. One-year-old 'Redhaven' trees had the highest TNC accumulation in Lovell roots. About 70% of TNC were accumulated in root tissues, where smaller roots accounted for most of the carbohydrates (>80%). The more vigorous rootstocks, in this case Lovell, not only had the greatest accumulation of dormant carbohydrates, but also had the greatest root and shoot dry weights per tree, suggesting that the initial differences in spring shoot growth could be attributed to both.

Poster Abstract 8

Sampling to Determine Relative Root Distribution

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A sampling method for mapping root distribution was tested in a replicated peach (*Prunus persica* L.) rootstock trial from the multi-site NC-140 Regional Rootstock Research Project. The 2001 planting was destructively sampled at the end of the 2006 season. Sampling was carried out on a subset of five replicate trees of five rootstocks, representing a wide range of tree sizes. Root distribution was determined by collecting nine soil cores in a radial array around a randomly selected quarter section of each tree trunk. The core diameter was 10 cm and sampling points were at 45 cm intervals, with three cores taken along each of three transects that were parallel, diagonal and perpendicular to the tree rows. Each soil core was taken to a depth of 90 cm. The upper 60 cm of the soil core was divided into 15 cm segments while the lower 30 cm was left undivided due to limited rooting. Tree roots were separated from the soil, assigned to one of three size classes, dried at 70C and weighed. Root dry weights were analyzed by standard analysis of variance to determine main effects

and interactions of root stock, sampling depth and location. The general linear model procedure (SAS Inst., Cary, NC) was used for analysis of variance. Root distribution graphs were generated from these data using a contouring program in Surfer 7 (Golden Software, Inc.). Distribution of larger scaffold roots was proportional to above-ground tree size. Fine root biomass distribution differed among rootstocks, but was less correlated with tree size. This core sampling approach provided an efficient method for comparing distribution of support and fine-roots among rootstocks.

Poster Abstract 9

Effect of Nitrogen Forms on IPT3 Expression And Hormone Contents of Pingyitiancha *(Malus hupenensis* Rehd.)

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Experiments were carried out to study the mechanism about the effects of nitrate and ammonium on the growth of Malus hupenensis Rehd. Seedlings and the relationship among nitrogen forms, MhIPT3 expression and the concentrations of cytokinin . Under water culture condition, analyzing the effect of nitrogen forms on the growth of Malus hupenensis Rehd , on the MhIPT3 expression by quantitative real-time PCR and on the contents of Z+ZR,iP+iPA, IAA, as well as ABA by ELISA. Results indicated that the leaf areas did not exist significant difference between the treatment and the control in 24 hours after nitrate supply, but the leaf areas of nitrate treatment were larger than ammonium treatment in 72 hours and 168 hours. When nitrate was supplied to seedlings, MhIPT3 transcripts rapidly accumulated within 0.5 hour, the manner of MhIPT3 induction corresponded well with that the accumulation of Z+ZR and iP+iPA. The levels of IAA were similar between nitrate treatment and ammonium treatment. The amounts of ABA by supplied nitrate were upper than ammonium treatment in 24 hours, then decreasing lower than ammonium treatment. We presumed that nitrate can act as signal to induce the expression of MhIPT3 and promote the synthesis of cytokinin. That is the origination reason why nitrate is better than ammonium for the early growth of Malus

Poster Abstract 10

Effect of Soil Type on Root Architecture and Nutrient Uptake by Roots of Young Apple Tree

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To raise the nutrient uptake efficiency of apple, a systematic study was made, with Malus hupehensis Rehd adopted as materials and by means of pot-culture approach, about the change of uptake of nutrient by roots and root architecture (RA) parameters of apple under conditions of soil texture. The results show that when growing in sandy soil, primary root of young apple tree is obviously thin and short, the first and the second lateral roots of young apple trees are obviously less, thinner and shorter, and the numbers of fine root of young

apple tree is also obviously less; when growing in the soil of organic manure, primary root becomes thick and long, the first and the second lateral roots become more, thicker and longer, and the numbers of fine root become more. And the uptake ability of P, K, Ca, Fe and Zn of the RA type produced in sandy soil is higher. There exists a close relation between the uptake ability of nutrient and the RA type changes, owing to various forms of soil-texture, correspondingly different types of RA have been produced.

Poster Abstract 11

Propagation of Fruit-Tree Rootstocks in Vitro And Their Further Behavior in Stock Plantations

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The apple rootstocks Paradizka Budagovskiy, 54-118, 57-233, 57-490, 57-545, 62-396, 3-4-25, 3-5-53, 3-47-77, 3-1-91, pear rootstocks Beriozka, Zheltaya, cherry and sour cherry rootstocks Moskoviya, P-7 and VP-1 were successfully propagated by means of in vitro technique. Planted in the field conditions micropropagated plants have shown the higher degree of branching in comparison with traditionally propagated ones, especially cherry rootstocks. Furthermore, softwood cuttings of these rootstocks had better rooting capacity due to modified physiological status (rejuvenilization).

Poster Abstract 12

Possible Physiological Mechanism of Premature Fruit Drop in Mango (*Mangifera indica* L.) in Northern Vietnam

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A major problem in mango production in Northern Vietnam is a premature fruit drop. However, the underlying plant processes in response to environmental and/or crop management factors are not understood. There is a general belief that this phenomenon is caused by different combinations of stressing factors which may vary between different regions and sites. In the mountainous area of northern Vietnam (Son La Province), fruit drop in mango may be caused by relatively hot, dry prevailing winds which typically occur in February/March. Consequently, it has to be determined which plant process responds sensitively to specific environmental conditions and subsequently causes, through its alteration, premature fruit drop. The identification of the physiological basis of premature fruit drop not only is of scientific interest but also of commercial significance, allowing the development of effective, fruit drop reducing crop management strategies and thus ensuring a economically sustainable cultivation of mango in this region. The working hypothesis investigates whether premature fruit drop is caused by high temperature/vapor pressure deficit (VPD) conditions and related to possible limitations of carbon supply to developing mango fruit and/or altered basipetal auxin export from fruit and fruit ethylene concentration. The experimental design includes 20 randomly selected 10-year-old mango trees (cvs. 'Hoi' and 'Tron'), respectively. Half of the trees were irrigated with micro-sprinklers (2 h every 4 days with 120 l/h) and the remaining trees served as non-irrigated control trees. An automated weather station

(DELTA-T) recorded various microclimatic parameters, including soil moisture and soil temperature, within the orchard throughout the growing season. Air temperature and relative humidity within the canopy were recorded using HOBO loggers. Fruitlet drop was counted on 20 randomly selected inflorescences on each of five irrigated and non-irrigated mango trees of both varieties, respectively. Leaf and fruit samples at different stages of development were taken from four irrigated and non-irrigated trees of both cultivars, respectively, for subsequent analysis of plant hormones such as indole-3-acetic acid (IAA), cytokinins (CKs), abscisic acid (ABA) and gibberellins ($GA_{1,3,20}$) measured as GA_3 equivalents. To understand the formation of the separation layer, samples of the fruit peduncle from attached and abscised fruit of both cultivars at different developmental stages (pin- to marble size) were taken for microscopic analysis. Determination of timely changes of plant hormones and microscopic analysis of the fruit stem are ongoing and results will be presented at the Symposium.

Poster Abstract 13

Initial Results About Low Chilling Nectarine Culture in Environmental Conditions of Spanish Southeast

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The Spanish southeast is an area of traditional peach crop in Spain. The favorable winter environmental conditions, allow the cultivation of 'low chilling' peach, but it is also a dry area with strong demand of irrigation water, which does not disposable, and should therefore be optimized. In this paper we will show the preliminary results obtained with Casasil ® a low chilling, early ripening and white flesh nectarine, growth under different levels of irrigation water and we will discuss their both agronomic and pests - diseases control consequences and their financial implications.

Poster Abstract 14

Development of a New Apple Rootstock Framework Map

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Rootstocks have been bred and selected at East Malling since the 1920's. The apple and pear rootstock breeding program is still active and a new East Malling Rootstock Club will be established in April 2008 with support from the INN (International New Varieties Network) and elsewhere to fund and commercialize rootstock improvement. Developing and releasing a new rootstock can take as long as 30 years as there are few reliable early selection techniques for breeders to use. The development of molecular markers linked to key traits would enable the breeder to select improved material at a much earlier stage. The production of a saturated molecular map is the first stage towards the identification of such markers. Here we present a framework SSR (microsatellite) map of the progeny from the back-cross between the dwarfing 'M27' and the new, more vigorous, aphid resistant 'M116'. Markers were chosen to span the genome using the recently published 'Fiesta' x 'Totem' map as a reference. The presented map has all 17 linkage groups representing the 17 chromosomes in apple. Work is on-going to saturate the map further and to add phenotypic traits to enable the development of markers.

Poster Abstract 15

Performance of Four Semi-Dwarf Apple Rootstocks from Foreign Breeding Programs at Three Sites in Eastern Canada

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This study was conducted to evaluate the performance of the apple cvs. 'Idared' and 'McIntosh' (spur type clone, 'Hartenhoff') planted at 890 trees/ha, on the semi-dwarf rootstocks AR 86-1-25, B.490, Y.P. and KSC.07. Their performance was evaluated in three provinces of Eastern Canada (Quebec, New Brunswick and Nova Scotia) over a period of 5 to 10 years depending on the site. In addition to those cultivars and rootstocks, 'Fuji' was also evaluated on KSC. 18, MM.106 and M.26 in NS only. The results from these trials and their implications for recommendation in Eastern Canada will be discussed in terms of tree vigor, fruit size, yield and yield efficiency.

Poster Abstract 16

St Jean 84 (SJ84) Dwarf Winter Hardy Rootstock Series

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In early 1970, a breeding program was initiated in Agriculture and Agri-Food Canada, Quebec to develop winter hardy rootstocks for cold climates. Seeds harvested in 1975 from controlled crosses between '*Malus robusta* R-5' and 'M.26' or with 'Budagovsky 579490' were germinated under greenhouse conditions and about 1000 seedlings were subsequently planted in 1980 in a nursery. 'Spartan' was used as scion in 1982 and trees were planted in 1984 at the experimental farm of AAFC - HRDC in Frelighsburg, Quebec in a non-replicated grid pattern (5.5 x 3.0m spacing). Of the 1000 trees started in 1984, 499 were used for further evaluation and the remainder was eliminated due to undesirable characteristics e.g. lack of winter injury, disease susceptibility or difficulty to propagate in stool bed or susceptibility to woolly aphids. Some of promising rootstocks were further tested in vitro for four isolates of crown rot (*Phytophthora cactorum* (Leb. & Cohn) Schroet) and Fire blight (*Erwinia amylovora* (Burril) Winslow). Based on the overall evaluation of rootstocks in several locations in Quebec nine of the SJ84 series rootstocks (SJP84-5218, SJP84-5217, SJP84-5230, SJP84-5198, SJP84-5162, SJP84-5231, SJP84-5174, SJP84-5189 and SJP84-5180) were released for commercial evaluation and presently available from Canadian Food Inspection Agency in BC or from Meiosis Inc. in UK. Interested Nurseries may inquire about "non-exclusive licenses" directly from AAFC in Canada or Meiosis Inc. in Europe (http://www.meiosis.co.uk).

Poster Abstract 17

Time of Hedging Affects Fruit Retention And Yield In Macadamia

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In the Australian macadamia industry, the sides and sometimes tops of trees are mechanically hedged to control tree size for efficient and sustainable orchard management. However, hedging reduces yield. Typically, trees are hedged post harvest in early spring around the time of anthesis and it is likely that shoot regrowth from pruned branches competes with early fruit development and contributes to the yield loss associated with hedging. We undertook a series of experiments to determine if this was the case and if the reduction in yield could be minimized by varying the time of pruning. We pruned trees at anthesis and allowed some trees to reshoot during early fruit development (R treatment) and physically removed shoots on others (NR treatment). Compared to NR trees, R trees had far fewer fruits set per raceme; a lower percentage of racemes at anthesis with fruit at harvest; and lower yield. In a subsequent experiment trees pruned in winter had less fruit drop and a higher yield than trees pruned in early spring (anthesis). In a third experiment, trees pruned in late spring, at the end of the premature fruit drop period, also had higher fruit retention per raceme and higher yield than trees pruned in early spring. It appears that shoot growth stimulated by pruning competes with developing fruit and reduces fruit retention and yield. This can be avoided by pruning at a time that does not stimulate shoot growth during the premature fruit drop period.

Poster Abstract 18

Molecular Bases of the Waterlogging Tolerance in Prunus Rootstock: Candidate Genes Approach

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Breeding strategy for adaptive traits is based upon the understanding of the physiological and molecular aspects involved. Waterlogging induces an abiotic stress associated with poor drainage in soils affecting stone fruit (*Prunus* spp.) productivity. The main consequence of this stress is anoxia and hypoxia in the root environment. Traditionally, the only screening had been done empirically through the selection of the rootstocks with standing longer under flooding. Fermentation pathways play essential roles for survival under these conditions. Alcoholic fermentation, a two step process where pyruvate is converted into acetaldehyde by pyruvate decarboxylase (PDC), and acetaldehyde is subsequently converted into ethanol by alcohol dehydrogenase (ADH). PDC is the first enzyme channeling carbon towards ethanolic fermentation pathway and is considered to be the rate-limiting step in this pathway. This suggests a key regulatory role for the first enzyme of ethanolic fermentation. A candidate gene approach was used attempting to identify genes which may be responsible for this adaptation. ESTs and cDNA sequences from Genomic Rosaceae Database (GRD) and ESTree database were downloaded. After performing BLAST comparisons with published gene sequences and screened for vector tentative consensus sequences were obtained by specific oligo design. The expression of an unknown subset of ADH and PDC was evaluated using relative quantitative RT-PCR in the sensitive almond x peach hybrid 'Felinem' and tolerant genotypes myrobalan plum 'P.2175'. Results of cloning and characterization of PDC and ADH

genes families involved in this adaptation will be presented as a valuable tool to understand the importance of ethanolic fermentation in flooding tolerance in Prunus rootstocks.

Poster Abstract 19

Effects of Pruning on the Apple Tree: from Tree Architecture to Modeling

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In recent years, L-systems have been increasingly used to model the development of plants oriented toward agronomical applications (e.g. ADEL-maize, Fournier et al., 1999; L-Peach, Allen et al., 2005). In this context, we recently developed a L-system-based simulation project of the development of apple tree architecture. This approach featured a new combination of stochastic and mechanistic models describing realistic branching habits and branch bending due to gravity, (Smith et al., 2007). This model, called MappleT, does not take into account cultural practices such as pruning, reaction to artificial bending or fruit thinning. Nevertheless, these practices are crucial interventions in the orchard management and are used for controlling tree size, light penetration within canopy and the equilibrium between vegetative and reproductive growth. The aim of this project is to integrate the possibility of such practices in our model of tree development. Based on a quantitative experimental analysis of apple tree reactions to pruning and on a stochastic formalization of the competition between the growing points in the plant, we are developing a model of growth, reactive to pruning interventions Estimation of model parameters and model validation will be carried out on different corpora of field data. In this paper, we shall describe the field experiments that we designed to study pruning effects on two apple cultivars with contrasted architecture, 'Fuji' and 'Braeburn'. These experiments make it possible to analyze the cross effects of i) architectural position (i.e. on order 1 or 2 axes), ii) cut type (i.e. heading cuts, thinning cuts) and iii) time in the growing season (during and after vegetative growth) of pruning cuts on vegetative growth and flowering. First results will be presented as well as a sketch of the model.

Poster Abstract 20

Effects of Rootstock on Leaf and Fruit Macro-element Composition in 'Reinders Golden Delicious' Apple

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The effects of six rootstocks: M9 (Cepiland), CG222, M7A, CG707, M793 and CG239, on macro-element concentrations in 'Reinders Golden Delicious' apple fruit and leaves were studied over two consecutive seasons:

2004/05 and 2005/06. Mineral analyses were performed on fruit and leaf samples collected at harvest during mid February. Average yields were 191% greater, and average fruit masses slightly (7.5%) lower, in 2005/06 than the previous season. In the fruit, nitrogen tended to be high in CG239, relative to all other rootstocks. Similarly, phosphorus was high in CG707 and CG239, relative, amongst others, to M9. High fruit potassium (K) concentrations were observed in CG707, whereas magnesium tended to be low in CG222. These tendencies were consistent in both seasons. Other differences were observed in a single season only. Fruit calcium (Ca) concentration in M793 and M7A, and total fruit Ca content, were higher than in other rootstocks in 2004/05, but did not differ significantly in 2005/06. Both fruit Ca concentration and fruit Ca content were marginally higher (15.7% and 4.4%, respectively), on average, in 2004/05 than 2005/06. Fruit K/Ca ratios also showed rootstock-induced difference in 2004/05, when ratios decreased in the sequence: CG707, CG239 > (significantly, P = 0.05) CG222 > M7A, but not in 2005/06. The average K/Ca ratio was 35.1% higher in 2005/06 than the previous season. Rootstock had no effect on fruit mass in 2004/05, but fruit mass from CG239 significantly exceeded that from M7A and M9 in 2005/06. The effects of rootstock on leaf element composition were generally not significant.

Poster Abstract 21

Using Naphthalene Acetic Acid (NAA) to Reduce Shoot Growth When a Heading Cut is Used to Lower Tree Height in Super-Spindle Apple Trees

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In a super-spindle apple planting, tree height can easily exceed the desired ratio of 1:1.2 (tree height:row width), particularly when the scion/rootstock/soil combination results in more vigorous growth than anticipated. This results in excess shading of the lower canopy and reduced fruit production. The common solution to reduce tree height is to use a dormant pruning cut to adjust tree height, however, this practice often results in vigorous re-growth which can compound the problem of shading in the lower tree canopy. In this experiment in 2007 and in two states (New Jersey and Massachusetts), we measured re-growth of shoots in the vicinity of a heading cut made to reduce tree height. NAA (1.5%) in tree wound healing compound was compared to a heading cut alone on four apple cultivars in New Jersey and three in Massachusetts. In New Jersey, the NAA treatment reduced new shoot growth by 97.5% in Cameo ('Caudle' cv.), 63.2% in 'Buckeye Gala', and 60% in 'Lindamac.' It did not significantly reduce shoot growth in 'Golden Supreme.' In Massachusetts, NAA treatment reduced shoot growth by 28.3% in 'Buckeye Gala;' however, it did not differ in re-growth from pruned-only trees in 'Golden Supreme' or 'Cameo.' Because varieties differ in their response to the NAA treatment, more research is needed to adjust the rate and treatment details for use in the tops of super-spindle apple trees.

Poster Abstract 22

Method of Constructing Core Collection for *Malus sieversii*

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The genetic diversity of 10 traits from 300 *Malus sieversii* accessions was used to study method for constructing Malus sieversii core collection. The total of 30 Malus sieversii core collections were constructed at 20% sampling proportion by two cluster distances, Mahalanobis distance and Euclidean distance, combining with five cluster methods including UPGMA, Ward's method, Single linkage, Median method and Complete linkage, and three sampling strategies including random sampling, preferred sampling and deviation sampling, respectively, using stepwise clustering. A homogeneous test and t-tests are suggested for use in testing variances and means, respectively. The coincidence rate (CR%) for range and the variable rate (VR%) for the coefficient of variation are designed to evaluate the property of core collections. The results showed that Mahalanobis distance was the much better than Euclidean distance, preferred sampling was more suitable than random sampling and deviation sampling, and UPGMA, Ward's method and Complete linkage was better than Single linkage and Median method for constructing core collection. Mahalanobis distance and Ward's method using stepwise clustering combining with preferred sampling can construct a most reprehensive core collection and was the most suitable method for constructing Malus sieversii core collection.

Poster Abstract 23

Effects of Climate Change on Apple Phenology - 50 Years Of Weather and Phenology Records At Klein-Altendorf/Bonn

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Weather and phenological data at Klein-Altendorf of the University of Bonn, Germany (50.5°N, yearly mean temp 9.4°C) had been recorded for 50 years from 1958-2007. These detailed weather and phenology records were digitalized and used to assess any changes in fruit tree viz. plant physiology possibly associated with climate change and for a careful prediction of future effects on tree physiology. The latter includes a) cultivation of late ripening/late coloring varieties, b) varieties less susceptible to heat, drought stress or sunburn and c) varieties with less chilling requirement. The phenology data included flower opening, full bloom and end of flowering, harvest date and beginning and end of leaf drop for apple cvs 'Boskoop', 'Berlepsch' , 'Cox' and 'Golden Delicious' as well as pear cv 'Alexander Lucas'. The data also include years without harvest. The weather data included minimum, average and maximum (day, month and year) temperatures, precipitation and years with a late spring frost. No change in overall annual precipitation was observed, but a shift towards more rain in winter and spring and also August. Over the last 50 years, the average air temperature (2 m height, 365 days) increased from 8.75°C in 1958 to 10.18°C in 2007, equivalent to by 1.45°C in 50 years. Similarly, the average temperature in the vegetation period (1 April- 30 October) increased from 13.65°C in 1958 to 15.10°C in 2007 over the last 50 years at Klein-Altendorf, i.e. also by 1.45°C. Two phases could be distinguished on the basis of climate and phenology: phase 1 with a moderate temperature increase and from 1958 -1987 and

phase II with a more pronounced temperature increase. The vegetation period was calculated for each year and cultivar employed. Average and peak temperatures were correlated with phenology data. Hence, three scenarios were calculated: a) 1958-2007, b) 1958-1987 and c) 1988-2007. Phenology data, i.e. flowering dates showed a good correlation with temperatures in January, February and March with an earlier flowering of ca. 0.8 days/year since 1988.

Poster Abstract 24

Effects of Supplementation of Benzoic Acid on Anti-oxidative Capacities of Roots in *Malus hupehensis* Rehd. Seedlings

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Malus hupehensis Rehd. seedlings were chosen as experiment materials. This experiment was conducted to explore the effects of benzoic acid on antioxidant enzyme activity, and the contents of superoxide (O_2—), malondialdehvde (MDA), sulfhydryl group activity(-SH), and mineral elements in roots under different concentrations. The results showed that 5 mg·kg-1(soil) benzoic acid increased the activity of SOD, POD, and CAT, while it decreased the contents of O_2—, MDA, the contents of –SH and mineral elements (K expelled) were higher than the control(CK), respectively. In addition, there were no significant differences between 5 mg·kg-1(soil) and CK in above data. At 25 mg·kg-1(soil) and 125 mg·kg-1(soil), activities of SOD and POD increased firstly, then decreased , CAT activity decreased firstly and increased over the time, but lower than CK. O_2— and MDA contents improved in the early period and declined following the time, -SH content declined during the treatment time, mineral elements were decreased. Benzoic acid in low concentration improved antioxidant enzyme activity and –SH content, declined O_2— and MDA contents, and the absorption of mineral elements were promoted. In conclusion, with the concentration of benzoic acid was improved, the effect of benzoic acid to Malus hupehensis Rehd. seedlings were reverse to low concentration's.

Poster Abstract 25

Effects of Temperature and Light Level on Efficiency of Chemical Thinners on 'Empire' Apple Trees

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Six-year old potted 'Empire' apple trees on M.9 rootstock were sprayed with either 7.5mg·L^{-1} Napthaleneacetic acid (NAA)+1240 mg·L^{-1} Carbaryl or 100mg·L^{-1} Benzyladenine(BA)+1240 mg·L^{-1} Carbaryl when fruits were 10mm in diameter. A third group of trees was untreated. Following the application of chemical treatments, the trees were placed in three glasshouse rooms for 5 days. Each room had the different temperature regime controlled by air-coolers, heaters and ventilators; the high temperature house ranged from 31-35°C Day to 21-25°C Night (HT), the intermediate temperature house from 26-28°C Day to 18-20°C Night (IT), the low temperature house from 23-25°C Day to 10-15°C Night (LT). Half of the trees in each room were covered with

70% shade net and the other half received 100% of sunlight. After the 5 days treatment period in the glasshouse, the trees were moved back to the field for the rest of the season. Net photosynthesis (Pn) was significantly reduced under 70% shade at each temperature regime regardless of chemical treatments. Pn of trees in the full sunlight was higher (9.0-11.9 μmol·m^{-2}s^{-1}) in the IT room than those in the LT room (6.1-9.8 μmol·m^{-2}s^{-1}), however in the HT room, Pn was dramatically reduced to almost compensation level. No significant differences among chemical treatments were observed in the three temperature regimes. The daily increase in fruit diameter was slowed down in the LT room and in the HT room after 2 days in the glass house, however fruits in IT room kept their previous growth patterns. Fruits growth under 70% shade decreased sharply after placing the trees in the glasshouse, meanwhile fruits on trees exposed to full sunlight grew continuously. Among the chemical thinner treatments, there was no different in fruit growth between NAA+carbaryl and BA+carbaryl combinations. Regardless of the temperature regime, fruit set of trees under 70% shade was significantly lower (0.2-6.2%) than of trees in full sunlight (8.6-46.4%). Fruit set of trees in full sunlight was much higher in the LT room (33.2-46.4%) than in the IT room (8.6-27.4%) or in the HT room (15.8-22.7%) where day temperature was over 30°C and night temperature was above 20°C. Fruit set was somewhat different among fruit thinners but the differences were not large enough for statistical significance. In this study shading had the largest effect on fruit set, followed by temperature and lastly chemical thinner treatment.

Poster Abstract 26

Mapping Genes Expressed Preferentially in Apple Rootstock

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There are a number of phenotypic traits conferred by apple rootstock upon the scion and desirable rootstock-specific traits. In an attempt to identify genes which may be responsible for these traits, we have used the public expressed sequences (EST and cDNA) to identify genes expressed uniquely in apple rootstock. 203,2211 ESTs and cDNA sequences from apple were downloaded, screened for vector, and separated into9,228from root and 193,993 non-root tissues. Each set of sequences was separately clustered (root: 1,868 contigs, 3247 singletons; non-root:23,340 contigs, 10,668 singletons). 189 contigs and 955 singletons expressed in root tissue had no match among the non-root sequences(Blast E-value > 1E -20). These sequences were annotated against SwissProt and the Genbank NR databases. Annotations were used as a basis for selection of 44 genes potentially involved in hormone and other developmental pathways. Unique PCR primers were designed and used to screen a BAC library of the commercial dwarfing apple rootstock Geneva41. Of these, 35 amplified, and 9 were polymorphic between parents of mapping population 'Ottawa 3' X 'Robusta 5'. All 9 regions were mapped, among 9 linkage groups. These markers are included in a larger map containing 551 markers total, which is being used to identify QTLs affecting tree architecture and disease resistance. Effort is being made to map the monomorphic markers using novel allele discrimination techniques like High Resolution Melting Curve analysis.

Poster Abstract 27

Agronomical Performance and Fruit Quality of 'Conference' on Some Clonal Pear Rootstocks

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Six pear rootstocks grafted with 'Conference' pear have been evaluated during the 2002-2007 period at the IRTA Experimental Station of Lleida (Spain). Five of them were quince rootstocks, including the EMH (QR 193-16). Pyriam^{cov} was the only clonal rootstock from *Pyrus communis*. Trees were planted in February 2002 using a planting distance of 4 x 1.2 m, and conducted in central axis. Significant differences were recorded on tree vigour, thus the most vigorous was Pyriam^{cov} and the weakest one was EMC, providing EMH intermediate vigour between EMA and EMC. Similar vigour was recorded for EMA, Sydo and Adams. All the quince rootstocks provided significantly greater annual and cumulative yields, and greater yield efficiency than Pyriam^{cov}. Sydo and M-H provided the higher values of yield efficiency. The blooming time and harvest data were not affected by the rootstock, and in general there were no differences in fruit firmness, soluble solids content and titratable acidity. The average of fruit skin covered by russeting was lower on Pyriam^{cov} rootstock than on quince rootstocks and Pyriam^{cov} provided more elongated fruits than quince rootstocks. Fruit size and fruit weight were always larger for quinces than Pyriam. Considering quince rootstocks, fruit size was similar for EMA, Adams and Sydo, which provided greater values than EMC. All the rootstocks were more or less sensitive to iron chlorosis recording better tolerance for Pyriam^{cov} and lower for EMC.

Poster Abstract 28

Interactions between Rootstock and Scion Growth and Productivity of Peach

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The researches were carried out in a period of 7 years, in the Research Station for Fruit Growing Constanta, Romania. An experimental orchard was planted in spring 1997, at 4,5/4 m, to investigate the interactions between 5 rootstocks and 2 cultivars (Springcrest and Redhaven). As rootstocks we used T16, well known in Romania, Tomis 39 (T16 x Hui Hun Tao), H.CT. 83.07.024 (T16 x Siberian C), H.CT. 84.13.005 (Bailey x Siberian C) and Tomis 28 (T16 x Bailey). The following traits were recorded: production per tree and per hectare, trunk cross-sectional area, the growth of shoots, average fruit weight, fruit sizes, acidity and dry matter of the fruit juice and stone weight ratio. As results of the investigations we found that the tested rootstocks induced high productivity, different growth of trees and fruit sizes to all cultivars. Significant differences were found between cultivars and rootstocks for almost observed parameter. Acidity and dry matter were similar for rootstocks and the studied cultivars.

Poster Abstract 29

Improvement of the Fruit Set of 'Jonagold'

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Each year, around flowering time most (apple) growers get nervous. After all this is a crucial period, because a good yield is based on a good fruit set. Even a lot of flower buds is not a guarantee of a good yield. The quality of the flower buds and the weather during and after flowering are very important factors. Consequently growers want to exploit all possibilities that can contribute to a good fruit set, especially in a year with (severe) frost damage or when there are only few flower buds. At our research station we did a lot of trials with Amid-thin and GA4-7 to improve fruit set of 'Jonagold'. On a parcel with severe frost damage (1997) it is possible to have a better fruit set with a treatment of Amid-thin or GA4-7 at full dose immediately (1 day) after the frost damage. But there were more fruits with a deformed fruit shape and without seeds. A treatment with a low dose of Amid-thin (0.25 kg/ha) or GA4-7 (0.5 l/ha Novagib) 3 to 7 days after full bloom can also improve fruit set. But there must be still flowers on the 1-year-old wood without pollination (= flowers that are closed) and there must be pollen available from the pollenizers. Also the weather must be good. Both products can improve pollination, but the pollination period is shorter. High doses (compared with low doses) give not a better final fruit set, no improvement of the fruit quality, more deformed fruits and more biennial bearing. The treatment with a low dose of Amid-thin or GA4-7 is an insurance and the effect is comparable with a spraying with boron at low doses during flowering time. Do not combine both products during or after flowering and add no acids or surfactants. Sprayings before bloom (or beginning of bloom of the more-year-old wood) can give a strong improvement of fruit set. Because there are too many fruits on the tree immediately after bloom, the risk of biennial bearing is very high. Afterwards there is always a severe June drop, so the final improvement (at harvest) is not big. These sprayings are only recommended in a year with strong biennial bearing or severe frost damage. After bloom an increase in fruit set can indeed be observed after a treatment with Amid-thin or GA4-7, but often this is lost for the most part during June drop. Therefore we also did trials with Regalis (Prohexadione-Ca). It acts also as an anti-ethylene agent when it is sprayed between 2 and 4 weeks after full bloom. Regalis can reduce June drop, but the moment of spraying is important and the effect is only short (4 to 5 days). So it is better to spray 2 times 0.5 kg/ha 2 and 3 weeks after full bloom. Higher doses are not better. The sprayments must be done before the occurrence of stress. Stress can be caused by dryness, not enough light (= 2 to 3 dark days), too cold. In contrast to pears it is not recommended to combine Amid-thin or GA4-7 and Regalis. The best strategy for parcels of Jonagold with a difficult fruit set depends on the situation.

Poster Abstract 30

Effects of Two Planting Systems on Florina and Generos Apple Cultivars Grafted on M.26 Rootstock

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Bistrita is one of the most important apple production areas in Northern part of Romania. The traditional orchards are planted with Jonathan, Golden delicious and Starkrimson cultivars grafted on MM106, Palmette and Slender spindle being the most common canopies. At Bistrita Fruit Research and Development Station was studied the behaviour of two scab resistant apple cultivars: Florina and Generos grafted on M26 rootstock. To improve the orchard productivity, two canopies was tested: Spindle and V planting system, both with trees planted in two densities: 1666 and 2500 trees/ha, respectively. Soil was maintained with grass between rows and clean on the row. During three years, each genotype was studied regarding the trees dimensions and fruit production was recorded for each planting system. Florina showed a more vigorous growth than Generos cultivar in all variants. V planting system and the density of 1666 trees/ha determined both a higher growth rate of the trunk cross section area. Fruit production was significantly influenced by variety and very significantly by the planting density. The influence of the canopy, and of the interaction variety x density, variety x canopy, canopy x density or of the interaction of the three factors was not statistically significant. The first experimental results showed that in the Northern part of Romania the use of M26 rootstock can be extended in order to increase the planting density. This will be the first step to obtain higher apple production. The use of scab and other diseases & pests resistant varieties is a key factor to reduce the chemical pressure on the orchard environment and to develop its sustainability.

Poster Abstract 31

Results from the 11-Year Examining of Rootstocks of the Series Gisela and Weiroot in Bulgaria

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In the years 1997-2007 the influence of the rootstocks Gisela 5, Gisela 4, Gisela 12, Weiroot 10, Weiroot 13, Weiroot 53, Weiroot 72 , Weiroot 158, the elite from the series Giessen: Gi-497/8, and also P 1 (seedling of *P. mahaleb* L.) on the growth and fruiting of the cultivar 'Bigarreau burlat' was studied. The trees were planted in December 1996 in the experimental field of the Agricultural University in the town of Plovdiv at distances of 6,0 x 4,5 m and they were grown under the conditions of irregular gravity irrigation . By the end of the 11th vegetation the most vigorous growth was induced by P 1, Weiroot 10 and Weiroot 13, the differences between them being insignificant. The trees on the remaining rootstocks (in comparison with the crown volume on P 1) have the following growth vigor: Gisela 4 – 39%, Gi-497/8 – 36%, Gisela 12 , Weiroot 158, Weiroot 53 and Weiroot 72 – 34% each and Gisela 5 – 19%. Also on the basis of the data on the trunk thickness and tree height, we can determine P 1, Weiroot 10 and Weiroot 13 as vigorous, Gisela 5 - dwarfing, whereas the remaining rootstocks (Gisela 4, Gisela 12, Gi-497/8, Weiroot 53, Weiroot 72 and Weiroot 158) – as dwarfing

to semi-dwarfing. Weiroot 13 and Weiroot 10 have the strongest suckering ability, whereas – Gisela 4, Weiroot 53, Weiroot 72 and Weiroot 158 are characterized by a poorer one, and the rootstocks P 1, Gisela 5, Gisela 12 and Gi-497/8 – do not form suckers. For the total period 1999 – 2007 the highest yield of the trees was induced by (kg/cm^2, kg/m^2 or kg/m^3) Gisela 12, Gisela 4 and Gisela 5, the lowest - P 1, Weiroot 13 and Gi-497/8, whereas the remaining rootstocks occupy an intermediate position. On the basis of the fruit loading of the trees per 1 cm2 of the trunk cross-sectional area, it has been established that the examined rootstocks do not have a significant effect on the fruit size. The trees on Weiroot 53, Weiroot 72 and Gisela 5 have poor soil fixture – about 50-60% of them are significantly tilted and some of them even fallen. During the last 3 vegetations the trees on Gisela 5 , Gisela 4, Gisela 12, Gi-497/8, Weiroot 53, Weiroot 72 and Weiroot 158 appear to have been exhausted– their mean annual shoot length is under 20 cm. Gisela 12 is distinguished by the best complex results.

Poster Abstract 32

Interstems but Not Grafting Height Controlled Vegetative Growth Of Young Redhaven Peach Trees

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Interstem and rootstock grafting heights are practices used especially in apple to restrict excessive scion vigor. The objectives of this study were to evaluate the effect of interstems and grafting heights on the vegetative growth of young ‘Redhaven’ peach trees grown near Clemson, South Carolina, and to determine if a dwarfing mechanism independent of the root system was involved. In October 2005, ‘Redhaven’ peach was chip budded on Lovell seedling rootstock, Pumiselect® and Krymsk® 1 clonal rootstocks, and Pumiselect/Lovell and Krymsk® 1/Lovell interstem trees. In another experiment, Lovell, Pumiselect® and Krymsk® 1 rootstocks were budded with ‘Redhaven’ at 5, 25 and 45 cm from the ground. Trunk cross-sectional area (TCSA), number of shoot tip growing points, tree height, fresh and dry weight, and midday stem water potential were evaluated during the period 2006-2007. Pumiselect® and Krymsk® 1 interstem trees were 81% and 88%, respectively, the size of trees grafted on Lovell at the end of the first year, while Krymsk® 1 interstem trees were almost 50% smaller than those trees on Lovell at the end of second year. Height and fresh and dry weight of whole trees were also reduced by interstems, compared to Lovell. In the second experiment, graft height did not affect the vegetative parameters of ‘Redhaven’ trees. Differences in growth were due to rootstocks where trees on Krymsk® 1 was significantly smaller than both Lovell and Pumiselect® independent of grafting height. Midday stem water potential reduction followed a similar pattern observed in most of the measured growth parameters. Interstem genotype but not grafting height affected the size of ‘Redhaven’ trees in the studied combinations. These data suggest the dwarfing mechanism in some Prunus rootstocks involves both the root system and other plant tissues.

Poster Abstract 33

Effect of Indolbutyric Acid (IBA) on the Cuttings of MM-106 And MM-111 Apple Rootstocks

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Semihardwood cuttings of MM-106 and MM-111 apple rootstocks were given a 10 sec. dip in IBA (0, 1000, 2000, 3000, 4000 and 8000 ppm) to find the optimum rate of IBA for rooting. The results revealed that 3000ppm IBA on both the rootstocks gave significantly better results as regards sprouting percentage, shoot length, percentage survival, number of roots per plant and root length as compared to control.

Poster Abstract 34

Whole-Photosynthesis and Transpiration in Field-Grown Papaya Plants

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Papaya (*Carica papaya* L.) is a principal horticultural crop of tropical and subtropical regions. Knowledge of papaya response to environmental factors provides a scientific basis to develop management strategies to optimize fruit yield and quality. In papaya, the photosynthetic capacity also influences papaya fruit quality. In this research we measured the whole-plant photosynthesis and transpiration rate in field grown papaya plants (6 months of age, plant leaf area of 3.5 m^2 with drip fertigation) using chambers (3,400L) made of transparent (97%) Mylar® (Dupont, Wilmington, DE, USA) film. In addition, we measured the relationship between the chamber whole-plant transpiration and whole-plant transpiration measured with sap flow gauges inserted in the trunk of the plants (TDP30, Dynamax, Houston, Texas, USA). For the conditions of the study, [sunny days (maximum PAR=1600μmol m^{-2} s^{-1}), average air temperature of 23 °C and maximum VPDair 3.5kPa), papaya plants transpired (6:00 am to 17:00 pm) 8.6 L of water/day and assimilated 67g of CO_2 /day (18.27g of C/day) with a water use efficiency of 3.2 mmol CO_2/mol H_2O. There was no evidence of heat accumulation in the chambers. The mathematical sap flow model proposed by Reis et al. (2006) using Granier's coefficient overestimated whole-plant transpiration but there was a high correlation (R^2=0.85) between sap flow rates and instant transpiration measured in the chambers. There was also a high correlation (R^2=0.90) between hourly transpiration measured in the whole-plant chamber and the calculated reference evapotranspiration (ET_0 mm h^{-1}), which may represent a low cost methodology to estimate papaya water demand. These results are important for irrigation management and drip fertigation in papaya, and can promote greater water and fertilizer use efficiency in commercial plantings.

Poster Abstract 35

Climate Change in the Western Cape of South Africa: Trends, Projections and Implications for Chill Unit Accumulation

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The Western Cape region of South Africa, a major producer of deciduous fruit, has been identified as highly vulnerable to climate change. Climatic trends were analyzed on a monthly basis for 12 rural meteorological stations across the region for the period 1967 to 2007. Significant warming trends were found for mid- to late-summer and end-winter to spring for daily minimum temperature (Tmin), and for mid-summer, autumn and spring for daily maximum temperature (Tmax). Mean annual Tmin and Tmax over the same time period showed significant warming trends at most stations. Chill unit accumulation has decreased significantly, particularly in autumn. Surface temperatures are predicted to increase by a further 1-2°C within the next 30 years, together with decreasing rainfall especially in autumn/winter. An analysis of possible impacts of regional projections of climate change on deciduous fruit production was conducted, with the emphasis on chilling accumulation and dormancy. The progression of bud dormancy is now quantified in terms of both the entrance into and the exit from dormancy. This will be used to assess possible impacts of warming on dormancy in apples and pears. The warmer or otherwise more marginal production areas, and high chill cultivars are likely to be the first to experience negative impacts of warming.

Poster Abstract 36

Improving Water Use Efficiency by Root Treatment in Orchard

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Root is able to perceive the water change in soil and synthesize some messengers, such as abscisic acid (ABA), transporting to aerial parts. These messengers can regulate the relation of photosynthesis and transpiration and the distribution of photosynthate, and then regulate the water use efficiency (WUE) of plant. The save-water technique of PRD (partial root-zone drying) irrigation had been developed according to above opinion. Here we offer some new designs improving WUE by root treatment: (1) decreasing the ratio of root in upper-layer soil, (2) optimizing the balance between root and shoot, (3) pruning of root and shoot, decreasing redundant root system, and (4) row-separated alternating irrigation in orchard.

Poster Abstract 37

Influence of the Rootstock on the Agronomical Behavior of 'Jesca' Peach Under Replant Conditions

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Little information is available on the behavior of the new interspecific hybrid Prunus rootstocks released in Europe in calcareous soils and in replant conditions. Some areas have soils with undesirable properties for peach growing, such as alkalinity, high density, waterlogging and drought. In addition, the availability of irrigated land is limited in some traditional peach growing areas. Thus, the evaluation of rootstocks in relation to regional soil and climate conditions and to replanting becomes necessary. A trial was set up in the "Calanda Peach Denomination" growing area (NE Spain) to assess the behavior of six different rootstocks, 'GF-677', 'Barrier', 'Cadaman-Avimag', 'Felinem', 'Garnem' and 'Monegro', just one year after uprooting a 20-year-old peach orchard. Rootstocks were planted in February 1998 at a 6 x 5 m spacing and grafted the following September with scions of the late-ripening clingstone peach 'Jesca'. Trees were trained in the standard open vase system. All rootstocks showed a suitable behavior in relation to replant conditions and to climate adaptation. The preliminary results showed that 'Barrier' and 'GF-677' induced some precocity in obtaining commercial yields in relation to 'Garnem'. Tree vigor was strongly affected by rootstock and replanting conditions, with 'Cadaman' and 'Barrier' showing the lowest vigor. However, the productivity indexes of these two rootstocks were higher than for 'GF-677', the reference rootstock in Europe. Similar productivity indexes were obtained on 'Felinem' and 'GF-677'. On the other hand, fruit size was not influenced by the rootstock, except for 'GF-677', which induced a significant reduction of fruit size. Finally, the chlorophyll measures (Spad index) in leaves of 'Jesca' were higher on 'GF-677' and 'Cadaman' than on 'Garnem'. These differences on Spad index lectures may imply less susceptibility to iron chlorosis in cultivars grafted on 'GF-677' and 'Cadaman'. According to the edaphic and climatic conditions of the trial, a replant site in a calcareous soil without nematode problems, 'Barrier' and 'Cadaman' induce less vigor, a larger fruit size and a higher productivity than 'GF-677' in this cultivar. However, 'Jesca' also showed an acceptable behavior when grafted on 'Felinem' and 'Monegro' in these conditions.

Poster Abstract 38

Performance Of CG.30 Apple Rootstock in the Annapolis Valley, Canada

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The effect of soil and climate on apple rootstock performance is well known. Apple trees grown under Nova Scotia's uniquely short, cool season conditions, tend to be about 25 % smaller than trees grown in many other apple growing areas in North America. Local rootstock research as well as ad hoc field investigations in Nova Scotia's Annapolis Valley, have pointed to opportunities for the use of rootstocks in the in the semi-dwarfing to semi-vigorous range. In this study, the performance CG.30 apple (M. domestica. Borkh.) rootstock was evaluated at four grower sites within the Annapolis Valley of Nova Scotia, over a period of 6 years. In Kingston and Rockland, CG.30 was compared with the traditional rootstocks M.26 and MM.106 using Jonagold

as commercial variety, in Morristown CG.30 was compared with M.26 and M.7 using Royal Cort and in Blomidon, CG.30 was compared with M.26 and M.7 using Northern Spy. At all sites, CG.30 was found to be as vigorous as MM.106 and M.7 and approximately 30 % larger than M.26 when trunk cross-sectional area was used as an index of canopy size. In addition, CG.30 exhibited the early bearing characteristic trait of M.26, but ultimately out-yielded this rootstock at all four sites. At the Blomidon site, CG.30 showed itself to be far superior to M.7 both with regard early bearing as well as cumulative yield of Northern Spy, a variety known for it's long transitional phase and biannual tendencies. This rootstock can be recommended as a replacement for M.26 on droughty soils in the Annapolis Valley where it can be expected to produce a medium size tree. In more vigorous situations, it may well prove to robust for higher density plantings.

Poster Abstract 39

A Multi-Cultivar Annual Topworking System for Asian Pear Production in Subtropical Taiwan

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Annual topworking or nursemaid forcing culture system has made possible for commercial production of high chilling required Asian pear (*Pyrus pyrifolia*) cultivars in Central Taiwan's low altitude areas with a subtropical climate. With this system, some premium Japanese cultivars can be harvested on early June, two months ahead of their harvest seasons in Taiwan's high elevation areas or in Japan and Korea. Recently a multi-cultivar system has been practiced. In which, dormant extension shoots of various cultivars or of different origins were trimmed to one-bud scions and grafted onto low chilling required stock trees on carefully chosen dates every winter. Fruit were selectively harvested according to their maturity on individual grafts and the market demand. In 2007 we investigated a commercial pear orchard operated with this system on Jhoulan (ca. 600 m alt.) in Central Taiwan. Scions of 'Hosui' from Fukushima, Japan and 'Shinko' from either Fukushima, Japan or Lishan (ca. 2000 m atl.), Taiwan were grafted onto 18-year-old 'Henshan' stock trees between 20 Dec. 2006 and 20 Jan. 2007. An average of 156 scions was grafted onto every stock tree. Fruit were harvested between late June and mid September. A yield of 42.7 ton/ha, including 10.2 tons 'Hosui', 18.1 tons 'Shinko', and 14.4 tons 'Henshan', was recorded. Compared with the already expensive mono-cultivar topworking system, this multi-cultivar system increased the cost and complicity of orchard management, required superior skills and experiences, but offered growers a great flexibility of harvest windows and a possibility of instant transitions among cultivars in response to ever changing consumer preferences and market trends.

Poster Abstract 40

Growth, Development, Yield and Fruit Quality of 'Forelle' Pear is Influenced by Rootstock, Mulching and Nitrogen Application

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Most commercial pear cultivars in South Africa are established on semi-vigorous (*P. communis*, BP1) rootstocks but in higher density modern orchards more dwarfing precocious Quince (*Cydonia oblonga*, QA) rootstocks are gaining in importance. Careful irrigation and fertilization management is essential in order to promote rapid growth and production in the prevailing hot dry summers and potential water shortages. Three concentrations (levels) of Limestone Ammonium Nitrate (LAN) were applied three, six or twelve times annually (regimes) to mulched or un-mulched 'Forelle' pear trees on either BP1 or QA rootstocks for four seasons and growth, production and fruit quality monitored. Trees on QA were ~ 20% larger and had improved shoot development than trees on BP1 for the first three seasons. BP1 responded to the highest level of LAN during the first year regardless of regime and to the highest level and most frequent regime during the second and third seasons. QA responded to small frequent applications of LAN only after the third season. After the second season mulching became the dominant treatment resulting in improved shoot development on BP1 but not on QA where yield was due to improved tree size. Mulched BP1and QA were larger (16% & 6% respectively) and had higher (44% & 26% respectively) fruit set. Mulched BP1 had 28% higher yield but mulching had no effect on QA yield. Mulching tended to result in bigger more mature blushed fruit of both rootstocks. BP1 responded to smaller more frequent LAN applications while QA responded to larger less frequent applications. Mulching, possibility through its effect on reducing water stress during the dry summers, together with smaller more frequent LAN applications, influence growth, development, precocity, yield and fruit quality.

Poster Abstract 41

The Effect of Eight Clonal Rootstocks on the Growth and Yielding of 'Kordia' Sweet Cherry Trees

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In a field experiment, 7-year-old 'Kordia' sweet cherry trees grafted on 'GiSelA 5', 'P-HL A', 'P-HL B', 'P-HL C', 'Maxma Delbard 14 Brokforest', 'Weiroot 158' and 'Tabel Edabriz' semi-dwarfing and dwarfing rootstocks were compared with trees of the same cultivar on the vigorous rootstock 'F 12/1'. One-year-old trees were planted at a spacing of 5 x 3 m in the spring of 2000 at the Experimental Station in Dabrowice, near Skierniewice, in the central part of Poland. The data collected included tree vigor (expressed as trunk cross-sectional area), yield and fruit weight, as well as the soluble solids content of fruit. The results revealed that in comparison with the 'F 12/1' rootstock all the rootstocks tested, with the exception of 'Maxma 14', significantly reduced the growth of 'Kordia' sweet cherry trees. The most dwarfing rootstock was 'Tabel Edabriz', followed closely by 'P-HL A', 'P-HL C' and 'GiSelA 5'. Depending on the rootstock, the mean cumulative yield per tree ranged from 29.8 kg to 56.2 kg. The highest cumulative yields for the years 2003-2006 were obtained from trees grafted on 'GiSelA 5'. However, it is important to note that fruiting of all the trees in 2005 was very low due to a spring frost. Therefore, the total yield from sweet cherry trees was generally lower than expected.

The rootstocks with the highest cumulative yield efficiencies were 'GiSelA 5', followed by 'Tabel Edabriz'. The lowest yield efficiency in this study was recorded for trees on 'F 12/1'. Trees grafted on 'Weiroot 158' and 'P-HL B' produced larger fruits than those grafted on 'F 12/1'. The rest of the rootstocks tested in terms of their effect on fruit weight were of a value similar to 'F 12/1'. The rootstocks also influenced the soluble solids content of fruit. Compared to 'F12/1', higher concentrations of soluble solids in fruit were promoted by the rootstocks 'Weiroot 158', 'Tabel Edabriz', and all of the P-HL series.

Poster Abstract 42

Performance of 'Coscia' Pear (*Pyrus communis*) on Nine Rootstocks in the North of Israel

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The vegetative and reproductive performance of 'Coscia' pear (*Pyrus communis* L.) grown on nine rootstocks [OHF 69, OHF 97, OHF 217, OHF 333, OHF 513 and BP 1 (*P. communis*), clonal seedling (Davis AxB) of *P. betulifolia* and quince BA 29 and EMA (*Cydonia oblonga*)] were compared during a 9 year period. The trial was conducted at the Experimental Station 'Avnei Eitan' in northern Israel (elevation 400 m above sea level – a.s.l.), on a well-drained soil with pH 7.1. Trees were planted in December 1998, spaced at 4.0 x 2.0 m and trained with a central axis. The most vigorous trees were on *P. betulifolia* seedlings, followed by the four OHF rootstock (69, 97, 333, 513) and BP 1 (with no significant difference between them). All the above rootstocks demonstrated greater vigor than OHF 217 and quince BA 29 or EMA. The highest cumulative yields per tree were harvested from trees on the four OHF rootstocks (69, 97, 333, 513) and P. betulifolia followed by the BP 1. The two quince rootstocks, as well as OHF 217, had the lowest cumulative yield and the lowest yield of large fruit. A positive correlation was found between the vigor of the tree, as affected by the rootstock, and both the total yield and the fruit size. We conclude that in a warm climate, yield efficiency is not the only parameter that should be taken into account, and building a strong tree for a weak cultivar is the first requirement for establishing an orchard.

Poster Abstract 43

The Effect of Timing of Scoring on Yield, Fruit and Shoot Growth and Reproductive Bud Development on 'Royal Gala', 'Fuji' and 'Cripps' Pink' Apple Trees

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The effects of scoring of apple tree trunks at one, two, four, six or eight weeks after full bloom (WAFB) were investigated with respect to fruit and shoot growth, yield and return bloom. Scoring at one and two WAFB improved fruit set (higher yield efficiency) on 'Royal Gala', but not on 'Fuji' or 'Cripps' Pink'. The high crop load on 'Royal Gala' trees scored one WAFB resulted in smaller fruit size during the second harvest (main crop) compared to the other treatments. Final extension shoot length was reduced only on scored 'Fuji' trees (all scoring times) compared to control trees. Final fruit size was improved on 'Fuji' (although not statistically

significant) and ‘Cripps’ Pink’ trees scored two or four WAFB compared to the control and other scoring treatments. Scoring improved reproductive bud development on all cultivars and on all bearing positions. On ‘Royal Gala’ and ‘Cripps’ Pink’, the efficiency of scoring to stimulate reproductive bud development on old and new spurs declined four WAFB and thereafter. In ‘Fuji’, scoring later than one WAFB led to a decreasing positive response on old and new spurs. In contrast, reproductive bud development on long shoots increased with later scoring (six and eight WAFB) on all cultivars. It seems that the most beneficial time of scoring is two to four WAFB, as early as possible during the cell division stage of fruit growth, but not before natural drop has occurred, and as soon as possible after the cessation of bud elongation.

Poster Abstract 44

Model Prediction of the Spring Phenology for ‘Fuji’ Apple

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Global warming, especially remarkable in winter and spring, has potentially large impacts on apple production because temperature affects dormancy, bud break and bloom. The accelerated tree phenology and unusual weather of spring time could increase the probability of frost injury. The aim of this research is to construct a model to predict the spring phenology from bud break, leaf unfolding to bloom of ‘Fuji’ apples from several locations, analyzing chilling and forcing temperatures. The prediction model consisted of the temperature based submodels for endodormancy and ecodormancy stages, and their transient dormancy stage. In the transient stage, the temperature curve used in ecodormancy was weighed by a sigmoid curve, representing the gradual transition from the chill effective to heat effective stage. The heat requirement for bloom was accumulated during the transient and endodormancy stages. The accuracy of the model was evaluated with the RMSE between predicted and observed dates.

Poster Abstract 45

Features of Anatomic Structure of the Grafted Young Apple Trees as the Factor Which Forms Potential Efficiency

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A wide use of grafting as the main method of growing planting materials of an apple-tree causes the necessity to study the structural processes in calluses which define the joining during the process of grafting. While studying grafted young apple trees, special attention is paid to the place of joining rootstock and scion, which plays a crucial role in the general movement of substances, such as ions, water and growth regulating hormones, in xylem. The anatomical studies of the grafting place of young trees, grown in an experimental nursery of Uman state agrarian university, made it possible to fix its nature and tissue structure. It has been found out that the width of the water-absorbing cell system is not very large and ranges from 0.3 mm in the place where callus cells of the rootstock and grafted eye join to 3 mm in the area of intensive eye growth. Agricultural techniques are substantiated to enhance processes of developing apple tree potential efficiency.

Poster Abstract 46

Performance of Gala Apple Trees on Supporter 4, P.14, and Different Strains of B.9, M.9, and M.26 Rootstocks as Part of the 2002 NC-140 Apple Rootstock Trial

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In spring, 2002, a trial of apple rootstocks was established under the coordination of NC-140. 'Buckeye Gala' was used as the scion cultivar, and rootstocks included B.9 Treco (the strain commonly used in North America), B.9 Europe (the strain commonly used in Europe), M.26 EMLA, M.26 NAKB, M.9 Burgmer 756, M.9 Nic 29, M.9 NAKB T337, P.14, and Supporter 4. The trial was planted in Arkansas, British Columbia (Canada), Chihuahua (Mexico), Illinois, Kentucky, Massachusetts, Michigan, New Jersey, and New York. Trees were spaced 2.5x4.5m and trained as vertical axes. After six growing seasons, P.14 resulted in the largest trunk cross-sectional area, significantly greater than all other rootstocks. Smallest trees were on the two B.9 strains, significantly smaller than all other trees. Trees on B.9 Europe were significantly smaller than those on B.9 Treco. Supporter 4 resulted in the largest trees of the intermediate group, followed by M.26 NAKB, M.26 EMLA, M.9 Burgmer 756, M.9 Nic 29, and M.9 NAKBT337, in descending TCA. Cumulatively (2004-07), trees on M.26 NAKB, M.9 NAKBT337, and M.9 Nic 29 yielded more than those on P.14 or B.9 Europe. The most cumulatively (2004-07) yield efficient trees were on the two B.9 strains, and the least efficient were on P.14. Yield efficiency was very closely associated with tree size. In fact, TCA accounted for almost all of the variance in cumulative yield efficiency (r2=0.94, P<0.0001). On average over the fruiting life of the trial (2004-07), M.9 Burgmer 756 resulted in larger fruit than did B.9 Europe or M.26 NAKB. Other rootstocks resulted in intermediate fruit size.

Poster Abstract 47

Effect of Exogenous Nitric Oxide on Active Oxygen Metabolism and Respiration in the Cause of Waterlog Resume of Sweet Cherry Root

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The study was conducted by watering the waterlogged plants equably with worked liquid to investigate the effect of exogenous nitric oxide on active oxygen metabolism, respiration intension and releasing content of ethylene in the cause of waterlog resume of sweet cherry .The results showed that 0.1mmol/L exogenous sodium nitroprusside(SNP),a nitric oxide donor significantly alleviated the injury to *Prunus pseudocerasus* Lindl after waterlog and increased the activity of SOD,POD,CAT ,the content of proline and the aspiration intension of brown ligneous roots. However exogenous nitric oxide markedly decreased membrane permeability rate of O_2 production , the content of MDA and H_2O_2 , releasing content of ethylene. So it decreased the hurt to brown ligneous roots and advanced the smooth recovery of the functions of sweet cherry roots after waterlog.

Poster Abstract 48

Blossom Thinning of 'Babygold 5' and 'Redhaven' Peach with Different Chemicals

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The objectives of this study was to determine the rate and application times response of ammonium thiosulfate(ATS), lime sulfur and Tergitol on 'Babygold 5' and 'Redhaven' peach. Treatments included 1) untreated control, 2) hand thinning to 6 inches spacing at 45 days after full bloom (Hand thin 6" @ 45 DAFB), 3) Hand thin 6" at shuck split (@ SS), 4) Hand thin 3" @ SS, 5) 1.5% ATS applied at 80% full bloom (1% ATS @ 80% FB), 6) 3.0% ATS @ 80% FB, 7) 4.5% ATS @ 80% FB, 8) 1.0% lime sulfur applied at 80% full bloom (1.0% LS @ 80% FB), 9) 2.0% LS @ 80% FB, 10) 3.0% LS @ 80% FB, 11) 1.0% Tergitol applied at 80% full bloom (1.0% Tergitol @ 80% FB), 12) 2.0% Tergitol @ 80% FB, 13) 3.0% Tergitol @ 80% FB, 14) 1.5% ATS @ 50 and 80% FB, 15) 3.0% ATS @ 50 and 80% FB, 16) 1.0% LS @ 50 and 80% FB, 17) 2.0% LS @ 50 and 80% FB, 18) 0.5% Tergitol @ 50 and 80% FB, 19) 1.0% Tergitol @ 50 and 80% FB. In 'Redhaven' peach, Tergitol caused higher thinning as the rate increased, and so 3.0% of Tergitol resulted in sever over-thinning such as a 95.7% reduction in fruit set. 4.5% ATS application induced a heavy thinning with an 11.1% fruit set, however 1.5% or 3.0% ATS treatments did not significantly reduce fruit set compared to control. Twice applications of ATS, LS and Tergitol reduced significantly fruit set except for 1.5% ATS. Twice application of 1.0% Tergitol burned most of all blossom and lead to only 5.2% fruit set. Considering the yield efficiency and fruit size, once or twice applications of 1.0 or 2.0% LS and 2.0% Tergitol seems to be proper to thin blossoms in 'Redhaven' peach. In 'Babygold 5' peach, Tergitol and ATS caused higher thinning as the rate increased, however 3.0% of Tergitol burned almost all blooms off. Twice applications of 1.5% ATS and 2.0% LS reduced effectively than a single. Twice application of 0.5% Tergitol caused also effective bloom thinning, however twice applications of 1.0% Tergitol and 3.0% dropped almost all fruits. Considering the yield efficiency and fruit size, Single application of 4.5% ATS, 1.0% Tergitol or 3.0 % LS at 80% full bloom seems to be proper to thin blossoms in 'Babygold 5'. Twice applications of 1.5% ATS, 0.5% Tergitol or 2.0% LS were also acceptable for 'Babygold 5'.

Poster Abstract 49

Changes of Shoot Growth Habit in *MdMADS2* Gene Introduced Transgenic Apples (*Malus* sp.)

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Transformations for fruit crops with useful genes give possibilities to overcome the limitation of fruit tree breeding. Flowering related MADS-box gene, *MdMADS2*, was isolated from *Malus domestica* Borkh. cv. Fuji and shares a high degree of amino acid sequence identity with the SQUAMOSA subfamily of genes. The *MdMADS2* gene expressed early flowering and shorter bolts without any homeotic changes in the floral

organs in transgenic tobacco. To confirm the expression pattern of *MdMADS2* gene in the apple trees, the gene was introduced using the 35S promoter into the 3 apple cultivars: 'Fuji', 'Gala', and 'McIntosh Wijcik'. The *MdMADS2* transformed apples were grafted on M.9 rootstock and its developmental expression pattern was studied for 3 years at isolated net screen house to prevent contamination. The first flowering was 17 months later after grafting in 'Gala'. In the third year, 24 months later after grafting, 35% of transgenic apples flowered compare with every wild typed apples are still in vegetative growth period. The phenotype of floral organ and fruit was also very normal similar to wild typed each cultivar. Especially, growth habit of shoot was much changed into weeping, twisting, and rolling in several lines of every cultivar. A result of southern blot analysis showed numbers of copy might not affect to changes of shoot growing habit in *MdMADS2* introduced apples. Columnar habit in 'McIntosh Wijcik' was also broken and wept by *MdMADS2* expression. Shoot growth habit is very important to establish efficient orchard system. These kinds of abnormal growth habit but originated from apple gene can be a possibility to change apple growing system.

Poster Abstract 50

'O3A' Apple Rootstock

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'O3A' (Ottawa 3 Amélioré in English 'Ottawa 3 improved') is a new rootstock resulting from a mutation in O.3 stool bed discovered at the Agriculture and Agri-Food Canada (AAFC) Research Station, St-Jean-sur-Richelieu, Quebec. It produces dwarf trees equal size to 'Ottawa 3' (O.3) but with better precocity (early fruiting), higher yield efficiency (based on yield/trunk cross sectional area), lower suckers and wider branch angles. 'O3A' is similar to 'O.3' in susceptibility to two races of *Erwinia amylovora* (Burrill) Winslow and four isolates of *Phytophthora cactorum* (Leb. & Cohn) Schroet). It was planted in 1997 in replicated trials in several plots at the Frelighsburg, L'Acadie, Quebec substations and also at two grower sites. Limited quantities of indexed budwood are available for research purposes (universities and research stations) from Canadian Food Inspection Agency or from Meiosis Inc (Europe) with a written request. Interested Nurseries may inquire about "non-exclusive licenses" directly from AAFC in Canada or Meiosis Inc. in Europe (http://www.meiosis.co.uk).

Poster Abstract 51

Comparative Evaluation of Hungarian Bred Mahalebs as Cherry Rootstocks

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The Mahaleb breeding as cherry rootstock resulted in Hungary seedlings as well as clonal rootstocks. Our breeding aims were to have more precocious rootstocks with moderate vigor, high productivity, good fruit quality, good compatibility and drought tolerance. For comparative evaluation a trial was set up in the spring of 2004 at the Experimental Fields of the Research Institute for Fruitgrowing and Ornamentals and at Corvinus University of Budapest on following rootstocks: Prunus mahaleb 'Cemany' (as control), 'Érdi V.', 'Korponay', 'SM 11/4', 'Bogdány', 'Egervár', 'Magyar', as well as Mazzard (*Prunus avium* C. 2493) seedling, P. cerasus x canescens hybrid 'Gisela 6' and P. fruticosa 'Prob'. Four new Hungarian sweet cherry cultivars from the Research Institute's breeding work were grafted on the rootstocks: 'Rita', 'Peter', 'Carmen', 'Vera'. The orchard spacing was 2 m in the row and 4 m between the rows and the trees are trained to a Hungarian type spindle. Based on the vigor of trees rootstocks are classified into three groups. Standard vigor (80-100%) rootstocks are: Bogdany, Cema, Cemany, Érdi V. Cherry trees on rootstocks Korponay, Egervar, Magyar and SM 11 are moderate vigorous (50-80%), while on Gisela 6 and Prob are dwarf (25-50%). The tree survival ratio was good only few trees did off. Trees on Gisela 6 and Prob are highly precocious, but from among clonal mahalebs Bogdany and SM 11/4 showed considerable precocity. In the first crop the most productive rootstocks/scion combinations were on 'Bogdány', 'Prob' and 'GiSelA 6'.

Poster Abstract 52

Confirmation by QTL Mapping of the *Malus Robusta* (cv. Robusta 5) Derived Powdery Mildew Resistance Gene *Pl1*

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The Geneva® apple rootstock breeding program has made extensive use of *Malus robusta* cv. Robusta 5 as a source of resistance to fire blight. Robusta 5 has also been used as the source of powdery mildew resistance by other breeding programs and a single locus *Pl1* has been associated with this resistance and recently mapped on LG12 of the European Apple Framework Map [Plant Breeding 126:476-481, 2007] using a qualitative approach. We collected quantitative data on field powdery mildew resistance in 2006 and 2007 on a segregating population made up of 186 individuals from a cross between Ottawa 3 (a susceptible apple rootstock) and Robusta 5; the correlation between the two years was 0.84 (p=0.000). This quantitative data were used in combination with a molecular marker linkage map derived from the same cross to scan the genome using interval and MQM mapping in MapQTL 5 software. The result was the identification of a large QTL on the distal end of LG12 with a peak near the SSR marker CH01b12z. No other regions in the apple genome had any significant effects on resistance in this population. Future plans include scanning of a BAC library containing Pl1 and utilizing existing markers for marker assisted breeding.

Poster Abstract 53

The Distribution of Wild Apple Germplasm in Northwest China and Their Potential Application to the Apple Rootstock Breeding

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China is one of the major gene centers of *Malus* species with the origination of more than 25 species. The Northwest China includes the three provinces of 'Shaanxi', 'Gansu' and 'Qinghai' and the two autonomies of 'the Ningxia Huis' and 'the Xinjiang Uighur'. It contains an unusually high diverse of wild apple germplasm resources. Sixteen *Malus* species were found in this district. The species and the! genotypes around the Qinling Mountains are richer, accounting for 80% of those in the Northwest China (65% of those of the overall China). Among 16 species, the genotypes of *M. baccata* were most abundant and they were mainly found in the moist conditions. *M. sieversii* mostly distribute in the valley around the Tianshan Mountains with its central distribution areas of the counties of 'Yili', 'Gongliu' and 'Xinyuan' in Xinjiang covering the area of 14,000 hectares. The wild *Malus* species of China are differentiated and adapted to local climates. Chinese wild *Malus* has been used for rootstocks for a long time in China. Among them, the seedlings of *M. sieversii*, *M. baccata*, *M. prunifolia* are widely used for rootstocks. However, it is important to make the additional effort to incorporate the desirable genes in this germplasm into apple dwarfing rootstocks. We hope that this review familiarizes more researchers with the distribution of the wild apples of China and will lead to more efficient collection and informed development of this germplasm.

Poster Abstract 54

Different Planting Systems for 'Conference'

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In order to help fruit growers with the choice of the planting system, 7 different planting systems for 'Conference' on Quince Adams were planted in the spring of 2002. Besides production and quality a lot of attention was paid to costs and labor. In order to enable a precise comparison, the test results of one planting system (bush-spindle shape with a planting distance of 3.50 x 1.50 m) are being fixed at 100 %. The other planting systems included in the test are: the hedge of Tienen, the long pruning, candlestick system (trees with 3 leaders), an intensive V-system, spindle trees and the "Drapeau"system (trees were planted under an angle of 45°). At planting the "Drapeau"system, the hedge of Tienen and the long pruning were cheaper in construction than the bush-spindle shape and the candlestick system. For this last system placing the bamboos demanded extra labor. The intensive V-system and the spindle trees were the highest in cost and labor. From the third year of growth on, the costs were more or less the same for all the systems, except for the "Drapeau"system. The high costs of this system from the second till the sixth growing year were the result of placing extra wires to complete the system. The long pruning system and the hedge of Tienen had the lowest total costs after 6 years of growth. The highest yields were obtained with the intensive V-system, followed by the long pruning and the "Drapeau"system. All other planting systems obtained comparable yields, that are 50 to 60 % smaller than with the V-system. Over six years the largest pears were found in the candlestick system, while the smallest were found on the long pruning and the spindle trees. After 6 years the best financial result is obtained by the long pruning, followed by the intensive V-system and the candlestick system. The financial result was calculated starting from the real costs and the real labor. The calculation of the total costs after 6 years does not consider depreciation of investment costs, i.e. investment costs from trees and supporting materials were fully included. However, when interpreting these results one has to take into account the fact that the trees are still very young.

Poster Abstract 55

Effect of Rootstock on Yield and Taste-Related Properties of Nordic Apple Cultivars

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The effect of rootstock on yield and taste-related properties of four Nordic apple (Malus x domestica Borkh.) cultivars (`Valge Klaarõun`, `Maikki`, `Pirja`, `Krasnoje Rannjeje`) grafted on three different rootstocks (M-26, M-9, 62-396) was studied. The experiment was carried out in South Estonia in 2003 and 2004. In both years cultivars grafted on 62-396 had the highest yield and the lowest yield was obtained on M-9. In 2003 rootstocks had no effect on apple titratable acidity (TA). Soluble solids content (SSC) was highest with M-26 and lowest with 62-396. In 2004 TA was highest in `Valge Klaarõun` and `Maikki` grafted on 62-396 and lowest in `Pirja` grafted on 62-396. As an average of experiment, rootstocks did not have significant effect on SSC/TA in apples either of experimental years. However, in 2004 SSC/TA was significantly higher in 'Krasnoje Ranneje' grafted on M9. The mean ascorbic acid content (AAC) in apples was 14.4 mg/100gFW in 2003 and 11.6 mg/100gFW in 2004. The average effect of rootstock on apple AAC was not significant, but single cultivars were affected. 'Krasnoje Ranneje' grafted on M9 had significantly higher fruit AAC in both years and 'Pirja' on M9 in 2003.

Poster Abstract 56

Metroglyph and Index Score Analysis of Almond Germplasm Collected From Kashmir Valley

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Metroglyph and index score analysis for 8 characters, viz., nut weight, kernel weight, kernel percentage, shell thickness, shell color, kernel color, kernel shrivel and time of maturity were analyzed in 92 almond genotypes collected from Kashmir valley during 2005-2007. Three distinct morphological complexes could be recognized

on the basis of nut weight and kernel percentage. Within these groups, the morphological and biochemical variations of low order were observed. Majority of high scoring genotypes are in group II and III and these are characterized by high nut weight with superior quality attributes.

Poster Abstract 57

Performance of Cornell Geneva Apple Rootstocks in South Africa

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The South African apple industry urgently requires an improved range of rootstocks adaptable to local conditions and which can replace the standard M793 and M7. Promising results have been obtained with some of the Cornell Geneva rootstocks regarding growth control and yield efficiency in a field trial established in 2000. When tree performance over the first five cropping years is considered, all Cornell Geneva rootstocks tested are more yield efficient than the current standards, the most promising rootstocks being CG 222 (M9 vigor class), CG 189 (M7 vigor class), CG 228 (in the M793 vigor class) and CG 778 (MM109 vigor class). Data of pot trials over the past season show that some of these selections are more tolerant to replant disease than others.

Poster Abstract 58

Apple Rootstocks in Latvian Orchards – Situation and Tendencies

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In the first half of the previous century only East Malling clone rootstocks were known in Latvia, which did not have sufficient winter hardiness. More extensive research of rootstocks began in the second half of the 20th century, when winter-hardy rootstocks were introduced from Michurinsk (Russia). Establishment of intensive apple plantations became urgent after private property of land was restored in Latvia. Now there are almost 1000 hectares of commercial apple orchards on different rootstocks. The first commercial orchards on clone rootstocks were planted only a decade ago. The variety of cultivars and rootstock forms in the orchards is large. About 20 % of the orchards have been planted on vigorous seedling rootstocks and are approximately 40 to 50 years old. Of newer orchards, 53 % are on medium vigor rootstocks, mostly MM 106 and M 26, with 666 or 1250 trees per ha. Apple-trees on dwarfing rootstocks, mostly B 9 and B 396, are usually planted as 1250 trees per ha. Only a small part of orchards on dwarfing rootstocks has been planted as 1660 trees per ha. Recent research, as well as experience obtained at the farms confirms that the selected rootstock forms and intensive plantations have promise in Latvia. The early winter-winter cultivar 'Auksis', which is the most widely planted and most used in trials, in average gives 29 - 39 tons per ha from 7 - 10 year old trees on rootstocks B 9, B 396, M 26 if planted as 1250 trees per ha. Similar yield has been obtained on the new rootstock forms Mark and G 30 with 1250 trees per ha, as well as on MM 106 with 666 trees per ha. The yield efficiency was higher on rootstocks B 396 and G 30. Other widely planted cultivars 'Antei', 'Kovalenkovskoe', 'Saltanat', 'Sinap Orlovskii', 'Zarya Alatau' also have good tree health and yield on these rootstocks. The rootstocks Pure 1 (Latvian origin) and P 60, which have shown promise in trials, are not yet widely used in orchard establishment. Of the other tested rootstocks, clones of M 9, P 2, P 22, B 146, B 257, B 476, B 490, B 491 can not be considered suitable

in Latvian conditions, for different reasons.

Poster Abstract 59

Pruning and Cytokinin Sprays to Improve 'Sweetheart' Cherry Fruit Size

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The effect of crop regulation strategies of pruning severity or cytokinin sprays (CPPU or Benzyl Adenine) on the fruit size of 'Sweetheart' cherry fruit was evaluated at Geneva, NY, USA in 2006 and 2007. A split plot, randomized complete block design was used, where each of 5 blocks were assigned to four trees of the same pruning system (Zahn or Vogel). Crop regulation (CR) were light pruning (control), hard pruning (stubbing back branches with less than 25cm growth; HP), spur extinction (SP) and flower bud extinction (FE) both on light pruned trees. CPPU at 10 mg L^{-1} was sprayed to selected branches at balloon stage or at balloon stage plus at petal fall or not sprayed at all. Leaf area per cm^2 branch cross sectional area (BCSA) was primarily dependant on block (training system). New leaf area (on 1-year old shoot) was mostly affected by pruning system (block) but not by CR treatments. Final fruit set was around 70%, and not affected by treatments. Flower and fruit density was affected most by flower extinction but only slightly by HP or SE. Fruit size was affected mainly by training system and crop regulation treatment. Fruit size was highly dependant on leaf area per fruit and maximum fruit size is obtained with 200 cm^2 per fruit. If fruit size was adjusted by leaf area per fruit, fruit size was not affected by any treatment, which means that all observed differences were explained by differential leaf area per fruit obtained by different treatments. Yield efficiency expressed as g cm^2 BCSA was reduced by FE while the control treatment had the greatest efficiency. Benzyl adenine did not improve fruit size whether applied at petal fall, 10, 20, or 30 days after petal fall.

Poster Abstract 60

Reduction of Shoot Growth and Winter Pruning by Prohexadione Calcium Application

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Apple trees growing on mild winter regions, without enough chilling, have excessive annual shoot growth, delayed come into bearing, less spraying effectiveness, and increased labor for summer and winter pruning. The mild winter climate of the main apple growing areas in Brazil induces longer vegetative growth than on traditional regions with enough chilling, resulting in more shoot growth. Chemicals may reduce excessive growth by limiting plant size or by restricting growth for a while, giving a better balance between growth and fruiting, and, consequently, reducing pruning requirement. The objective of this work was to evaluate the effectiveness of Prohexadione calcium (Viviful) on reducing and delaying shoot growth of 'Gala' and 'Fuji' apple trees, with a consequent reduction of pruning labor. The experiments were carried out in mild winter regions of Southern Brazil, with no enough chilling for the apple varieties Gala and Fuji. Experiment 1: Carried out

with 'Imperial Gala' and 'Fuji'/M7, in Fraiburgo (Santa Catarina state), during three growing seasons, with an average of 550 hours of chilling bellow 7.2°C. The experimental design was a RCB, with four treatments and ten replications. Treatments were: 1- Check; 2- Prohexadione calcium 582 g ha^{-1}; 3- Prohexadione calcium 1164 g ha^{-1}; 4- Prohexadione calcium g ha^{-1}, all then applied twice. Experiment 2 was carried in Campo do Tenente (Paraná state), in an orchard of two years old 'Imperial Gala'/Marubakaido/M9, were there was less than 300 hours of chilling bellow 7.2°C. Treatments were a check and Prohexadione calcium 1200 g ha^{-1}, applied twice during the growing season. The evaluations in the experiment of Fraiburgo were number, length and weight of the pruned shoots, and yield per tree and mean fruit weight. There were effects on number, length and weight of the pruned shoots of 'Imperial Gala' and 'Fuji'/M7. In relation to the check, there was a significant reduction on the number of pruned shoots, which was 76.4% and 73.8% for 'Fuji', and 52.0% and 61.0% for 'Imperial Gala', respectively for the concentrations of 1.160 g ha^{-1} and 2.320 g ha^{-1}. Yield data varied according to the year evaluated, with a tendency of increasing the yield in the third year of Prohexadione calcium application. The mean fruit weight was not affected by the application of Prohexadione calcium, although all Viviful treatments had constantly larger 'Imperial Gala' fruit than the check treatment, in the growing season 2006/07. In the young 'Imperial Gala'/Marubakaido/M9 orchard, it was observed reduction on number, length, and weight of pruned shoots due to the Viviful application. These results show that Prohexadione calcium may be helpful to train apple trees. It may be applied as early as in the second field growing season, reducing labor to prune adult orchards.

Poster Abstract 61

Differences in Mineral Nutrient Contents of Dormant Cherry Spurs as Affected by Rootstock, Scion, and Orchard Site

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Dormant sweet (*Prunus avium*) and sour (*P. cerasus*) cherry spur nutrient levels can influence a number of initial growth activities in spring, including fruit set and leaf expansion. Rootstock genotypes vary in uptake and translocation of mineral nutrients to sites of utilization within the canopy. Consequently, at the conclusion of the most recent 10-year North American (NC-140) cherry rootstock trial, a collaborative study was initiated to analyze and compare dormant flowering spur nutrient contents at three of the trial sites: Traverse City, Michigan; Geneva, New York; and Hotchkiss, Colorado. Replicated spur tissue samples of sweet cherry on eighteen rootstocks (11 common to all three sites) and of sour cherry on 12 rootstocks (10 common to both tart cherry sites) were collected in winter, prepared at Michigan State University, and analyzed for N, P, K, Ca, Mg, Fe, Zn, B, Cu, S, Mn, Al, and Na. The rootstock comparisons included Mazzard seedling, mahaleb seedling, Gisela (Gi) 3, Gi.5, Gi.6, Gi.7, Giessen 195/20, Edabriz, P50, Weiroot (W) 10, W.13, W.72, W.158, Mazzard x Mahaleb (MxM) 2, MxM.60, and the Hungarian mahaleb inbred seedling lines CT500, CT2753, and Erdi V. Nearly 300 samples were used for site comparisons of 'Hedelfinger' sweet cherry trees on sandy soil in Michigan vs. heavy soil in New York, as well as between site and scion genotype for the trees at those two sites and trees of 'Bing' sweet cherry on clay-loam soil in Colorado. Similarly, more than 150 samples were used for site comparisons of 'Montmorency' tart cherry trees on sandy soil in Michigan vs. heavy soil in

New York, and between the two scion species at each of the two common locations. At the time of abstract submission, analyses and comparisons were almost complete; results will be fully analyzed for presentation and discussion 3 months before the Symposium.

Poster Abstract 62

Rootstock Studies in Kinnow Mandarin Under North Indian Conditions

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Citrus is one of the most important fruit crop and its cultivation is considered to be highly paying. In India, citrus fruits are being grown over an area of about 2,64,500 ha which produces 47,50,000 MT of fruits. The rootstocks play an important role in the success or failure of a particular crop. In citrus, rootstocks are known to have a profound effect on the vigor, precocity, production, longevity of the trees, fruit quality, disease resistance and adaptation to soil and climatic conditions. No single rootstock has been considered to be ideal for a single species or even for varieties within a species. Hence a rootstock trial on Kinnow mandarin was started at Punjab Agricultural University, Regional Station, Abohar during 1988 on seven rootstocks viz., Rough Lemon (*Citrus jambhiri* Lush), Karun Jamir (*Citrus aurantium* L), Jambhiri (*Citrus jambhiri* Lush), Shekwasha (*Citrus depressa* Hayata), Pectinifera (*Citrus depressa* Hayata), Estes Rough Lemon (*Citrus jambhiri* Lush) and Cleopatra (*Citrus reshni* Tanaka). Rough Lemon has been observed to be the most vigorous rootstock. Tree survival on Rough Lemon rootstock was the maximum (83.33%) after nineteen years of tree age while, in some rootstock declining starts at the age of twelve years. Pooled mean of fruit yield of thirteen years was the maximum (610 fruits/tree) on Rough Lemon whereas, it was the minimum (351 fruits/tree) in plants on Cleopatra rootstock. No significant variation was recorded in the quality attributes of kinnow fruits on various rootstocks. On the basis of thirteen years data (7th to 19th year of tree age), it is concluded that Rough Lemon is the most suitable rootstock for Kinnow mandarin under the North Indian conditions.

Poster Abstract 63

Results of Apple Rootstock Testing with Variety 'Belorusskoye Malinovoye' in Project "Baltic Fruit Rootstock Studies"

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The research project "Baltic fruit rootstock studies" was started in 1998 with the aim to study rootstocks of the main fruit species in Baltic States and Byelorussia. Two cultivars: 'Belorusskoye Malinovoye' and 'Auksis' were budded on twelve rootstocks (M 9, M 26, B 9, B 146, B 396, B 491, P 2, P 22, P 60, Pure 1, Jork 9 and Bulboga). In the spring of 2001 trees of these cultivar/rootstock combinations were planted in the orchards of four scientific institutions according to joint methodology. In 2007 the smallest trunk cross section area (TCSA) of `Belorusskoye Malinovoye` trees were on the rootstocks P 22, Pure 1 and M 9. Biggest trees were on Bulboga and B 146. The highest cumulative yield per tree was obtained on rootstocks M 26. The productivity of trees expressed as yield efficiency (kgcm^2 of TCSA) show the best combinations were with rootstocks M 9, P 22 and B 396. The lowest productivity was obtained on rootstocks Bulboga and B 146. The tree vigor and productivity of cultivar/rootstock combinations strongly depend on different growing places.

Poster Abstract 64

Evaluation of the OHxF Selections as an Alternative to Quince Rootstocks for Pear: Agronomical Behavior of 'Conference' and 'Doyenne du Comice'

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Quince has been reported as the more suitable pear rootstock whenever there is no problem of lime-induced chlorosis. However, when the soils are alkaline or have a high active lime content, the use of quince as a pear rootstock becomes problematic, or even impossible, thus requiring the search for a reasonable alternative to quince. The 'Old Home' x 'Farmingdale' clonal rootstocks (OHxF) were released as a good alternative for pear production in chlorotic conditions, showing a range of vigor reduction, a high productivity in relation to tree size and a good resistance to fire blight and pear decline. The possibility of using some of the OHxF clones instead of seedling rootstocks has been evaluated in the calcareous soils of the Ebro basin in Spain, with two important cultivars, 'Conference' and 'Doyenné du Comice'. The trial was planted in February 1992, with the most important semi-dwarfing OHxF clones (40, 69, 87, 282 and 333) to be compared with a commercial seedling (only with 'Conference') and two quince rootstocks, 'Adam's 232' and 'Provence INRA BA 29'. The trial stood on a sandy – loam soil with medium to low fertility, and low risk of lime-induced chlorosis to avoid this important handicap in the performance of quince rootstocks. In 'Conference', after eleven crops, the highest cumulative yields were obtained on 'OHxF 69', 'OHxF 40' and 'OHxF 87', and the lowest on 'Adam's 232'. The vigor on seedlings was significantly higher than on any other rootstock. The OHxF clones produced trees of similar vigor, intermediate between the seedlings and the quince rootstocks. The productivity was higher on both quinces, intermediate on 'OHxF 69', 'OHxF 87' and 'OHxF 40', lower on 'OHxF 333' and 'OHxF 282', and the lowest on the seedlings. The average fruit size was slightly larger on 'BA 29' and seedlings than on the other rootstocks. In 'Doyenné du Comice', the highest cumulative yields were on the quince rootstocks, 'Adam's 232' and 'BA 29', both significantly higher than on all the 'OHxF' clones, with 'OHxF 333' producing the lowest yield of the trial. After eleven crops no differences were found for vigor. Productivity was higher on the quince 'Adam's 232', intermediate on 'BA 29', lower in the 'OHxF' clones without differences between them. In reference to fruit size, only on 'OHxF 333' was statistically smaller than on the other rootstocks. The conditions of the trial indicate a possible interaction between cultivars and rootstocks, as shown by the lower vigor induced by quince rootstocks to 'Conference'. These results imply that, from an economically point of view, the suitability of the 'OHxF' selections as an alternative to quince rootstocks may depend not only on the soil characteristics but also on the scion grafted.

Poster Abstract 65

Evaluation of Dwarfing Rootstocks in Washington Apple Replant Sites

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Replant disorder is an increasingly significant challenge to establishment and consistent production in Washington apple orchards. Standard fumigation practices with Telone or Vapam offer effective control, but must be handled safely and applied correctly, are expensive, subject to restrictive regulation, and not acceptable in organic systems. Dwarfing rootstocks with resistance or tolerance to apple replant disorder offer a clear alternative to producers in the irrigated tree fruit production areas of Washington, as long as their genotypes are suitably adapted to the diverse production conditions of the region. In collaboration with the USDA-ARS national apple rootstock breeding program in Geneva, NY, the Washington Tree Fruit Research Commission has established and maintained eight apple rootstock trials in commercial Washington orchards since 2003. These trials collectively include 65 rootstocks and three scion cultivars (Gala, Fuji, Honeycrisp) planted in modern, high density systems in sites with a range of replant disorder potential. They feature 46 Geneva series selections, as well as 19 other test genotypes. Trials are designed as split plot (fumigated vs. non-fumigated) randomized complete blocks with a minimum of four replications and typically five or more trees per plot. To date, most Geneva rootstocks are outperforming the industry standards of B.9, Pajam2, and M.26 in terms of yield, trunk cross sectional area, and fruit size. Supporter 1, Supporter 2, and Supporter 3 have performed similarly to M.9 clones and have shown no advantage over standard commercial rootstocks. Several Geneva selections (G.41, G.935, 4214, 4814) have performed well in non-fumigated plots. G.41 and G.11 have shown less vigor than G.935, 4214, G.202 and 4814. Many of the Geneva series also show significant improvement over currently available rootstocks for other critical production traits: wooly apple aphid resistance, fire blight resistance, ease of propagation, winter hardiness, etc. Our collaborative trials under commercial conditions clearly indicate the enormous potential certain genotypes have for apple production in Washington.

Poster Abstract 66

Digital Techniques for Yield Prediction of Fruit

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Yield prediction on a European scale is a pre-requisite for effective planning, fruit quality assessment (fruit number and fruit size) as well as food chain (storage and transport capacities) and traceability of the commodity. Yield prediction is necessary for the farmer to organize his work force, bins and storage space, for the whole sale market to provide these bins and for the retail chain to identify their flow and source of fruit. The objective of this joint work is to predict the yield as early as July of the harvest in September and October and detect young, small green fruit against a green-leaved background. Traditional yield predictions like the Winter model rely on empirical data and skilled personal, mostly extension service. They assess fruit trees in the same orchards every year for their respective fruit numbers for each cultivar after June drop. Fruit counts are taken for every other tree in a row from two angles on both sides, which makes it time-consuming. This takes 2-3 people almost one week for each fruit growing region. A new approach to predict yields in apple is based on digital technology in a five step processing of digital photos taken from one side of an apple tree using a tennis ball as reference only for size and dimension. Currently, two digital photos are taken from one side of the tree from 30 trees per plot or variety. Step 1 recognizes fruit by their light green color, i.e. discriminates dark green leaves (upper sides of leaves), branches and soil or brown or other color. The image analysis uses image analysis to distinguish between fruit and leaves of a tree by shape and size at a time when fruit are still green. Step 2 eliminates the tennis ball after scanning its dimensions, which waives problems with assessing the distance from which the photo was takenStep 3 checks the remaining objects for their physical form, i.e. recognizes fruit or fruit sections and discriminates lower leaf surfaces which are also light green. Step 4 eliminates are small fruit of lesser than a defined fruit diameter, which are attributed to another tree row or tree. Step 5 finally counts the number of identified fruit in a photo, averages the two photos per tree, calculates tree volume and the future harvest. Correlations for 2006 and 2007 are presented between predicted and actual yields of cv. 'Braeburn', 'Gala' and 'Elstar' apple trees. Different thinning techniques, including the new mechanical thinning, were employed for these experiments to achieve fruit trees with different magnitudes of cropping to test the techniques and their accuracy.

Poster Abstract 67

St Jean Morden (SJM) Dwarf Winter Hardy Rootstock Series

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In 1960, a breeding program was initiated in Morden, Manitoba to develop winter hardy rootstocks for cold climates and then the program was transferred to AAFA, HRDC, at St-Jean-sur-Richelieu, Quebec. Two hundred and nine seedlings were selected from the initial population and evaluated since 1970 in Agriculture and Agri-Food Canada (AAFC), Horticultural Research and Development center (HRDC), Quebec, Canada. Some of these rootstocks obtained from crossing 'Nertchinsk' with M.9 and M.26 were found to be winter hardy, disease resistant, dwarfing, with good yield efficiency and easier to propagate than O.3 and were tested further in several locations in Quebec. Excised shoot assay of the selected lines were also tested for four isolates of crown rot (*Phytophthora cactorum* (Leb. & Cohn) Schroet). Most of the rootstocks were more susceptible to PC04-02 isolate followed by PC04-03 and PC04-01 and less susceptible to PC04-04. SJM189 was the least susceptible while SJM15, SJM188, MM.111, SJM127 and MM.106 were the most susceptible. SJM167, M.44, SJM150 and M.26 were ranked as low to moderate susceptibility to *P. cactorum*. O.3, SJM150, SJM167 and M9 were the most susceptible rootstocks to *Erwinia amylovora* (Burrril) Winslow while M.7, SJM189 and SJM188 were the least susceptible. Seven of SJM series rootstocks (SJM15, SJM44, SJM127, SJM150, SJM167, SJM188 and SJM189) were released for commercial evaluation and presently available from Canadian Food Inspection Agency in BC or from Meiosis Inc. in UK. . Interested Nurseries may inquire about "non-exclusive licenses" directly from AAFC in Canada or Meiosis Inc. in Europe (http://www.meiosis.co.uk).

Poster Abstract 68

Overview of Peach and Nectarine Rootstocks in South Africa

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Twenty trials with more than 40 rootstocks were conducted over a period of 30 years. For many years Kakamas seedling was the standard rootstock for the South African peach industry. However many soil conditions occur that limit the use of this rootstock. In soils with a high pH (free lime with iron-induced chlorosis), GF 677 showed no symptoms and yielded significantly better than Kakamas seedling rootstock. Fruit mass of the scion however was not more on GF 677 than that on Kakamas seedling. The rootstocks Cadaman and Viking, gave the same high yield as GF 677 but fruit mass was higher than that of Kakamas and GF 677. Flordaguard showed serious chlorosis symptoms in high pH soil. Kakamas seedling is susceptible to root knot nematodes (Meloidogne incognita and M. javanica) that occur in most sandy soils. Flordaguard performs better than Kakamas in poor sandy condition with or without root knot nematodes but are too vigorous for higher potential soils. Atlas, Viking and SAPO 778 also perform better than Kakamas where root knot or ring (*Mesocriconema xenoplax*) nematodes occur. SAPO 778 is currently the preferred rootstock for many situations but with a high chilling requirement it is not recommended for low chilling (less than 300 CU) requirement areas. This rootstock and Viking perform better than Kakamas where sporadic rising water tables occur. The rootstocks Cadaman, Atlas, GF 677, Flordaguard and Kakamas on the other hand are sensitive to wet soil conditions. Kakamas as rootstock still performs well in higher potential soil without any limitations. In such situations Atlas and Viking also perform well.

Poster Abstract 69

Cold Temperature Tolerance of Apple Roots

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Root tissue cold hardiness of G.16 and M.26 EMLA rootstocks was compared in 2007 using controlled freezing to -14C. Rootstocks were dug from the nursery in late October and stored in a cold room at temperature of -1 to 0°C until late February. Rootstocks were subjected temperatures from -6 to -14 °C at a rate of 3°C per hour. Significant root death (>10%), based on visual estimates, occurred in both rootstocks following exposure to temperatures below -10 °C. Following 40 days in a greenhouse, root survival and shoot growth were reduced by exposure to -10 °C and colder. There was no difference between G.16 and M.26 in root survival or shoot growth. The lethal temperature was -12 for both rootstocks. Root tissue cold hardiness of G.5935 and M.26 EMLA rootstocks was compared in 2008. Trees were grown in pots outdoors until late Oct. at which time they were placed in cold storage at 0 °C. Trees were subjected to controlled freezing temperatures of -8 to -16 °C in Feb. Root tissue survival was assessed by measuring electrolyte leakage of root tissue and by growth analysis after 40 days in a greenhouse.

Poster Abstract 70

Influence of Training System on Production of Three Apple Cultivars

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A planting of 'Ginger Gold', 'Crimson Gala' and 'Fuji' (BC#2) all on M.9 NAKB T337 rootstock was established in 1997 at the Horticultural Research Farm at Rock Springs in central Pennsylvania, USA. The cultivars chosen represented three distinct growth habits. The trees were trained to one of four training systems; a vertical axe (A), a slender spindle (SS), 4 wire trellis (T) and an V-axe (VA), where alternate trees were trained to opposite sides at a 60o angle. Trees in the first three systems were planted at 1.8 x 3.6 m or 1495 trees/ha. The VA was planted at 0.9 x 4.9 m or 2241 trees/ha. Within all cultivars trees in the VA were the smallest trees as measured by trunk cross sectional area. Between cultivars 'Fuji' were the largest trees in all training systems followed by 'Gala' and then 'Ginger Gold'. In general the tallest trees were those trained to the A; while the shortest were those in the T system. Within a system 'Fuji' tended to be the shortest trees; significantly so for three out of four systems. Within each cultivar the cumulative yield per tree has been greatest for trees trained to the A, although with 'Fuji' the yields were not significantly different from the SS or T. The lowest yields per tree were consistently from trees trained to the VA; although for 'Ginger Gold' and 'Gala' they were not significantly lower than the other two systems. In the SS and the T 'Fuji' had significantly greater per tree yields than either 'Ginger Gold' or 'Gala'. Cumulative yields on a per hectare basis for 'Ginger Gold' and 'Gala' was greatest on the VA system but not significantly better than trees trained to the A system. With 'Fuji' the greatest yields were on tree in the A system but not significantly better than the VA or SS system. In general due to the shorter height of the T system yields were lower. The different responses of each cultivar to a particular training system and efficiency will be discussed.

Poster Abstract 71

Apple Scion and Rootstock Selection and Planning for Michigan

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The training system that an apple (*Malus x domestica*) grower selects must be one that best maximizes all the resources in making the enterprise a profitable venture. There are many parts to the orchard system decision "puzzle" which must fit together in a complementary arrangement to gain maximum precision and profitability. The most immediate question that must be answered regarding the establishment of a new orchard is tree spacing. Extension agents and growers often need assistance in determining optimum tree density for sites. Trees planted too close, cause excessive shading and competition for resources results in inadequate light penetration, poor quality fruit, low cropping, excessive labor in pruning to reduce shading impact, etc. Excessive distance results in inefficient planting designs where the land surface is under utilized and long-term profitability may be compromised. In 1989, we made an initial attempt at trying to simplify the decision making process by considering the most important variables and assigning them values (number codes in parentheses) in a formula. The primary factors affecting spacing include; scion vigor, rootstock vigor, soil type, irrigation, management system and the interactions that take place between them. Assessments on vigor are derived from rootstock and cultivar trials and field observations. Our experience gained from working with high-density orchards and

with new cultivars and rootstocks has encouraged us to frequently update the model. The formula is available on the Michigan State University Department of Horticulture web site for general use by the public, students and extension field agents in an interactive mode (spacing calculator): http://www.hrt.msu.edu/department/Perry/Spacing_Fruit/mispacingPC.htm, and on the University of Massachusetts Amherst 'Fruit Advisor:' http://www.umass.edu/fruitadvisor/. A mobile version for use on 'smart-phones' is also available. More revision in the future will be necessary as we learn more of the technical intricacies of new rootstocks, cultivars, marketing demands and management constraints. This spacing recommendation is only relevant to Michigan sites and for single row arrangement of trees. Consideration needs to be given to adapting the spacing tool to more growing regions.

Poster Abstract 72

High Density Trial of Bramley's Seedling Apple (*Malus pumila* Mill) Clones on M.9 and M.27 Rootstocks

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As traditional Bramley orchards in Ireland are being replaced with high density orchards; it is imperative that as these new orchards generate much higher yields as they have a much higher capital charge against them. The highest yielding orchards are those which are close planted and grown on wire trellis systems. The traditional system for growing Bramley's has been as single staked trees with trellis systems rejected on the grounds that vigor control would be too difficult. The compact Bramley clones produced by gamma radiation in 1968 had been rejected by the industry as being unsuitable for the traditional growing systems in Ireland. However, the compactness of the clones and the high density trellis systems combined, potentially could be very useful to the Irish apple industry. Thus a replicated field trial of Bramley clones (numbers 20, 36, 58, 68, and 91) on M27 and M9 rootstocks was established at Loughgall with the trees tied to a wire trellis. Standard Bramley's were used as controls. All but one clone (58) yielded more fruit than the control under the trellis system. Significant differences were found in yield quality and mineral content between the controls and the mutants and there is definite potential in combining some of the clones with a trellis system for Bramley's seedling apple under Irish conditions.

Poster Abstract 73

The U.F.O. System – A Novel Architecture for High Efficiency Sweet Cherry Orchards

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Traditional sweet cherry (*Prunus avium* L.) orchard systems in the western United States (e.g., open-center vase, steep leader, central leader, bush) can be complex and exhibit significant tree-to-tree variability in canopy architecture. Moreover, these chaotic systems comprised of multiple tiers of vegetative growth are not well-suited to automation (e.g., platforms) or mechanization (e.g., harvest, thinning). From years of orchard system

research at Washington State University, a vision for an angled or upright compact, single-plane fruiting wall architecture has evolved. The system is based upon size-controlling, precocious rootstocks, features a systematic approach to training/pruning (renewal pruning in particular), utilizes sweet cherry growth habit, and facilitates the incorporation of labor-saving technologies. Briefly, a permanent horizontal scaffold is established at planting by clipping an unheaded whip to a low trellis wire. Whips are planted at about 45°. From this scaffold, upright, fruiting offshoots are borne at 15 cm – 25 cm apart. Lateral growth on uprights is removed with dormant thinning cuts. The most vigorous upright fruiting wood is renewed each year with dormant heading cuts, leaving a 5 cm – 10 cm stub. Regrowth from dormant stub cuts is reduced to a single renewal upright with subsequent thinning cuts. Our experience with angled sweet cherry fruiting walls has demonstrated the potential for high yields of excellent quality fruit – 5th-leaf trees on Gisela® rootstocks in an experimental orchard (ca. 600 trees/acre) yielded 6 – 10 tons per acre of 9.5-row and larger fruit. This presentation will describe the establishment and maintenance of the U.F.O. (upright fruiting offshoots) system as well as report on fruit yield and quality data from WSU and grower-cooperator orchards.

Poster Abstract 74

Performance of Several Dwarfing Rootstocks with 'Fuji' and 'McIntosh' as Scion Cultivars in the 1999 NC-140 Dwarf Apple Rootstock Trial

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In spring, 1999, two trials of dwarf apple rootstocks were established under the coordination of the NC-140 Technical Committee. One trial included 'Fuji' as the scion cultivar, and the other included 'McIntosh.' Rootstocks were CG.4013, CG.5179, G.16N (liners from stool beds), G.16T (liners from tissue cultured plants), G.41, G.202, M.9 NAKBT337, M.26 EMLA, Supporter 1, Supporter 2, and Supporter 3. The 'Fuji' trial was planted in Kentucky, Missouri, North Carolina, and Pennsylvania (Biglerville), with partial plantings in Pennsylvania (Rock Springs) and South Carolina. The 'McIntosh' trial was planted in Massachusetts, Michigan, Minnesota, Nova Scotia, New York (Williamson), Vermont, and Wisconsin, with partial plantings in New York (Peru), Ontario, and Pennsylvania (Rock Springs). Trees were spaced 3x5m and trained as vertical axes. At the end of nine growing seasons (2007), 'Fuji' and 'McIntosh' trees with the greatest trunk cross-sectional area were on CG.4013. Trees on G.202, and M.26 EMLA were significantly smaller than those on CG.4013. The smallest trees were on Supporter 1, Supporter 2, Supporter 3, and M.9 NAKBT337. Trees on CG.5179, CG.3041, G.16N, G.16T, and Supporter 3 were intermediate between the smallest and CG.5202 and M.26 EMLA. Cumulatively (2001-07) for both cultivars, the greatest yields were from trees on CG.4013. The lowest 'Fuji' yields were from trees on G.16N, M.9 NAKBT337, M.26 EMLA, Supporter 1, Supporter 2, and Supporter 3. For 'McIntosh,' lowest cumulative yields were from trees on M.9 NAKBT337, M.26 EMLA, Supporter 1, and Supporter 2. Cumulatively (2001-07), 'Fuji' trees on Supporter 1 were more yield efficient than those on CG.4013, G.202, M.26 EMLA, or Supporter 1, with all other intermediate. The most cumulatively yield efficient 'McIntosh' trees were on Supporter 1, Supporter 2, Supporter 3, G.41, and CG.5179. The least yield efficient trees were on M.26 EMLA and G.202. On average over the fruiting life of this trial (2001-07), M.9

NAKBT337 and M.26 EMLA resulted in the largest fruit, and the three Supporter rootstocks resulted in the smallest. M.26 EMLA resulted in larger McIntosh fruit than did G.16T, with all other intermediate.

Poster Abstract 75

Early Performance of 'Buckeye Gala' Grafted on 13 Apple Rootstocks

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The objective of this study was to evaluate 13 apple rootstocks grafted with 'Buckeye Gala' in an apple growing district of Chihuahua, Mexico. The trial was established in sandy loam soil, 0.8m deep, pH 6.3, and organic matter 0.53%. The planting distance was 4.5 X 2.5 m. Trees were pruned in winter and trained as vertical axis. The results showed that the rootstocks with better survival in this region were CG.5935, M26NAKB, B9 Europe, and B9USA. The rootstocks that showed low to medium vigor were B9, M9T337, CG.3041, CG.3953, and G.11. The Geneva series (G and CG) had the highest accumulated yield and production efficiency.

Poster Abstract 76

Peach Flower Buds Thinned with Dormant Applications of Vegetoil® Adjuvant Plus Ethephon

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Early removal of flower buds, flowers or small fruitlets increases peach fruit size and value at harvest. Due to the scarcity of labeled or consistent thinning chemicals, peach growers generally wait ~30 days after full bloom before hand-thinning fruit, which limits potential fruit size. Experiments were conducted near Clemson, South Carolina to determine the efficacy of combining Vegetoil® (VO), an emulsified soybean oil adjuvant (93% soybean oil), with Ethrel® (a.i. 21.7% ethephon) for pre-bloom flower bud thinning of peach cultivars. 'Contender', 'Cresthaven' and 'Rubyprince' peach in January 2006 and 2007 were sprayed with 10% VO except for 'Rubyprince' in 2006 (8% VO). Ethephon concentrations used (varied by year) were 25, 50, 75, 100, or 150 ppm. Dormant oil (DO) at 3% and VO at 10% were the control treatments in 2006 and 2007, respectively. VO (10%) plus ethephon at 100 and/or 150 ppm significantly delayed bloom in 'Contender' and 'Cresthaven' in 2006 and in 'Cresthaven' and 'Rubyprince' in 2007. In 2006, VO (10%) significantly reduced the number of flower buds alive at bloom for 'Contender' and 'Cresthaven', and the addition of Ethrel® to the VO spray significantly increased flower bud mortality when compared to the 10% VO application. There were no differences observed among the 'Rubyprince' treatments in 2006, but the addition of 75 and 100 ppm ethephon slightly increased flower bud death in 2007. Basal flower buds on marked shoots had significantly lower survival than the distal or terminal flower buds in the VO treatments in both years and all cultivars except 'Cresthaven' in 2006. Generally, 'Rubyprince' is easier to flower bud thin with soybean oil than 'Cresthaven', but the opposite was observed in this study when using the Vegetoil® soybean oil product. Data from 2008 trials will also be presented.

Poster Abstract 77

Development of Cold Resistant Apple Rootstocks in China

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Apple is a very important cash crop and grown in all over China from north to south with a diverse climatic conditions (min and max temp –5°C and 40°C respectively). According to the China statistics total apple grown area and yield from the three districts, Inner Mongolia Autonomous Region, Jilin and Heilongjiang province, are about 100,000 hectare and 641,000 ton respectively in 2003. Several fruit breeding units, such as Gongzhuling pomology institute of Jilin province and Xiongyue pomology institute of Liaoning province, have been devoted to develop hardy apple rootstock varieties, by combining the 'Malling series' dwarf stock with hardy small-size apple variety or wild stock Chinese types. Presently some new cold resistant dwarf lines (GM256, 63-2-9, 77-42, CX3) have been selected and their grafting compatibility and precocity were tested and also being tested in several locations. The GM-256 had been released in 1980 and presently is being used as intermediate stock because of its difficult rooting and its shallow root system. Shandingzi (Malus baccata), is another wild apple type which have been used as vigor stock for cold district apple production. Zaai Shandingzi is a new mutation dwarf type of Shandingzi which has potential to replace Shandingzi because of its cold hardiness and dwarfing affect.

Poster Abstract 78

Effect of Different Growth Inducing Rootstocks on Alternate Bearing of 'Royal Gala' and 'Vista Bella' Apples

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Alternate bearing can be outlined as a physiological imbalance between the vegetative and reproductive organs of a tree. As vegetative growth and productivity can be greatly influenced by rootstcoks, they should affect alternate bearing cropping habit as well. Up to now, literature sources on the definite relation between stocks and alternate bearing of their scions are not available. Therefore, the aim of this study was to investigate the effect of different growth inducing rootstocks on the alternate bearing cropping habit of apple. A field trial was set up in an experimental orchard at Nagykutas, Western Hungary, in five consecutive years with the regular-cropping 'Royal Gala' and the alternate-bearing 'Vista Bella' cultivars. Each of those was grafted onto M.9, MM.106 and seedling rootstocks representing dwarf, semi-vigorous and vigorous growth habit, respectively. Flowering time of both cultivars was not influenced by alternate bearing and rootstocks. The rate of fruit set was significantly higher for off-year trees on all three stocks. The amount of flower-inhibiting gibberellins (A3 and A7) in the seeds was significantly higher and the promoting A4 was lower for on-year trees, especially on seedling rootstock. No significant differences, however, were observed in A1 content among rootstocks. Better fruit quality parameters were usually measured for fruits from off-year trees on M.9 and MM.106 rootstocks. There was no consequent difference in quality between on- and off-years on seedling. Alternate bearing index (AI) was also calculated for both cultivars. Its values, however, could not represent the alternate bearing cropping habit exactly because it takes the yield (as a consequence of the alternate bearing) into consideration by the calculating. For describing the alternate bearing habit more accurate, the modified alternate bearing index (AIm) was developed based on the flower production of the cultivars.

Poster Abstract 79

Optimization of Geneva Rootstock Micropropagation

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The Geneva apple rootstocks are highly promising as they harbor several desirable genetic traits for facilitating efficient apple production. However these rootstocks are unavailable in required quantity owing to slow-paced micropropagation, perhaps due to sub-optimal tissue culture media formulations. In our program we integrate a multi-pronged approach to control in vitro growth of perennial crops. Optimization of media formulations and light quality, intermittent desiccation stress and chemical genomics approaches are employed to regulate plant multiplication. We have optimized a single formulation solid media that efficiently multiplies Geneva 41 and Geneva 935 rootstocks with multiple root formation. Since incident light has a profound effect on hormone production in plants, we are testing the impact of different light wavelengths on rootstock growth and multiplication in the established media formulation. We are also studying the impact of intermittent desiccation stress on the rate of rootstock micropropagation. In combination with the approaches described above the effect of small bioactive molecules, which act as agonists or antagonists of hormone action, on rootstock growth is also being studied. With our studies we expect to establish an efficient micropropagation platform for Geneva apple rootstocks that is amenable for scale up in a commercial environment.

Poster Abstract 80

Reflective Ground Covers Increase Yields of Target Fruit

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In order to maintain profitability, it has become increasingly necessary for orchardists to consistently produce high yields of target fruit with defined quality for internal and external characteristics, size, and storability. Reflective ground covers, such as Extenday™ or Daybright™, increase the amount of light available for photosynthesis, especially in lower, shaded portions of tree canopies. These durable white woven polyethylene materials can be moved between crops in a single growing season and re-used for up to ten years, thus reducing waste. Since 2005, researchers at Washington Tree Fruit Research Commission, Washington State University, and Extenday Ltd. have collaboratively evaluated the horticultural effects of reflective ground covers in commercial Washington apple, cherry, pear, peach, and nectarine orchards. Extenday™ and Daybright™ have consistently improved fruit color and yields of target fruit by increasing fruit set and/or harvest size; neither fruit set nor harvest size have ever been reduced relative to untreated controls. Fruit maturity has frequently been advanced by these materials, enabling earlier harvests and in some cases, fewer picks. Harvest yields have increased every year in Extenday-treated apple plots, suggesting a cumulative effect on increasing productivity, particularly in the lower parts of the orchard canopy. Mylar-based ground covers have not increased Gala apple color as much as Extenday™, and have shown no effect on fruit size or yields. While initial capital costs for these products are high, our results showing their positive impact on production of target fruit suggest an immediate significant return on investment. These impacts are most clear in high density, well-managed systems. Ongoing research will further define long-term horticultural and economic effects.

Poster Abstract 81

Performance of Rootstocks for Plums (*Prunus salicina*) on Different Soil Types

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During the past decade, the plum cultivars 'Sapphire', 'Pioneer', 'Angeleno', 'Laetitia' and 'Fortune' were tested on a range of available potential rootstocks in five diverse and representative soil types and conditions. 'Sapphire' planted on high pH soils perform well in terms of yield and fruit mass on the rootstocks Maridon, Marianna 1, SAPO 778 and Viking. GF 677 showed signs of incompatibility with the scion cultivar Sapphire. Under waterlogged conditions the rootstocks Maridon, Marianna 1, SAPO 778 and Viking performed well but both Maridon and Marianna 1 showed signs of incompatibility with the scion 'Pioneer'. In sandy soils free from nematodes the rootstocks Flordaguard and GF 677 gave high yield efficiency as well as good fruit mass. On sandy soils heavily infested with ring nematodes (*Mesocriconema xenoplax*), SAPO 778, GF 677, Viking and Maridon gave good yield and fruit size with the scion cultivar Laetitia although yield in general was lower on this site. On a high potential shale soil both 'Sapphire' and 'Fortune' perform well on several rootstock including Atlas, Viking, SAPO 778, Flordaguard and GF 677.

Poster Abstract 82

An Apple-specific ET Model

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A common method for estimating crop water use for irrigation is to use a crop coefficient, Kc, that is a fraction at any time of the estimated potential evapotranspiration (ET_o), often modeled for a reference grass. The modified Penman Monteith (PM) equation used for the standard reference grass adopts average values typical for healthy short grass. These include a relatively heavy boundary layer common for grass that tends to uncouple the grass from the bulk air. This leads to the estimated ET_o values that are overwhelmingly controlled by net radiation (Rn) and relatively insensitive to vapor pressure deficit (VPD). Conversely, due to the tall irregular structure of an apple orchard, the canopies of apple trees are highly coupled to the bulk air. This means that apple trees are dependent on VPD and stomatal conductance as well as Rn. We have developed an apple-specific ET model based on the PM equation. The model is a 'big leaf' model and estimates the total transpiration of the tree as a distinct product of sunlit and shaded leaves. The model has a much smaller boundary layer resistance than the ET_o model. Stomatal conductance has a unique dependence on VPD with limitations imposed by stomatal coupling to leaf photosynthesis rate. The model has been very promising in explaining variations in apple tree transpiration and Kc measured in the humid climate of NY.

Poster Abstract 83

Influence of Rootstock Thickness, Nut Hardiness and Environmental Conditions on Vegetative Propagation of Walnut

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Existence of a large number of bearing trees of seedling origin is a highly negative aspect of walnut culture in Jammu and Kashmir state. Propagation through seeds results in non-descript type of seedling plantation which gives rise to heterozygosity in plant material, coupled with long juvenile period and a great degree of variability in relation to nut shape, size, color, quality and maturity. However, this large genetic diversity of invaluable material can serve as a source of selection. Clonal selection and propagation of walnut is vital from standpoint of tree improvement. Walnuts generally respond well to the vegetative propagation methods under field conditions as is possible with other temperate fruits. The present investigation was carried out at the experimental field of Division of Pomology, SKUAST-K, Shalimar during 2005 and 2006.The experiment involved three environments viz., Zero-energy poly house, Hot Callusing Cable (HCC) system and open field conditions with three ranges of rootstock thickness viz., thin (0.5- 1.0 cm), medium (1.0-1.5cm) and thick (1.5-2.0cm) and two types of seedling rootstocks (Hard shell and Soft shell). Cleft grafting technique was used for propagation. Zero-energy poly-house environment comprised of higher relative humidity (85-90%) and temperature (26-28± 20C), while under Hot Callusing Cable (HCC) system, temperature of 26-280C was maintained around the graft union without controlling the relative humidity. The grafting success was assessed after three months with maximum success (63.33%) observed under zero-energy poly house with thick rootstock followed by medium and thin rootstocks. However, there was no significant effect of rootstocks raised from hard shell and soft shell. Shoot length, number of leaves, number of leaf-lets, leaf area, rootstock girth at crown level, scion girth and days to leaf fall were found significantly higher under zero-energy poly house conditions with thick rootstocks in comparison to HCC and open field conditions. Our results suggest that grafting performed on thick rootstocks under zero-energy poly house proved superior as compared to other environments and thicknesses.

Poster Abstract 84

Effect of Foliar Application of Boron and Zinc on Fruit Set and Productivity of Almond

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As almond is the first tree to bloom amongst fruit crops in Kashmir valley, the temperature during this period usually remain low thereby hampering pollination/fertilization, thus resulting in low fruit set and productivity. The effect of boron (2000 and 4000ppm) and zinc (1000 and 2000ppm) and their combinations on the fruit set and productivity of almond cv, Shalimar was investigated in an experiment conducted in 2006 and 2007 at Shalimar, J&K, India. The treatments were applied before bloom and after harvest but before leaf fall. Treatment

combinations of 4000ppm boron and 2000ppm zinc recorded the highest fruit set and nut yield during both the years. However, fruit set and yield was not significantly affected by zinc alone compared to control. Application of boron resulted in increasing the fruit to some extent. Fruit yield (kg/tree), nut weight (g), kernel weight (g) and kernel % was found higher in all the treatments compared to control.

Poster Abstract 85

A Survey of Cultivar/Rootstock and Orchard Management Factors Influencing the Incidence of Sunburn Damage on Apple Fruit In Hungary and South Africa

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Sunburn damage is a disorder which has serious economic impacts in many apple-growing regions worldwide, including Hungary and South Africa. In both countries, field surveys have been conducted to assess the incidence and severity of sunburn damage as related to genetic traits (cultivars and rootstocks), irrigation and crop load management, row orientation, and climate ameliorating technologies such as evaporative cooling and shade netting. In Hungary, evaluation of 586 varieties in an apple gene bank showed that most varieties are more or less susceptible to sunburn, and only 18 varieties were not damaged. Based on other fruit quality parameters, only 12 of these are suitable as potential parents in future breeding programs. In Hungary, sunburn decreased on rootstocks in the following order: M.9, MM.106 and crabapple seedling, and in South Africa sunburn was also highest on M.9. In general, sunburn damage was higher on rootstocks which favoured cropping over vegetative growth thus causing fruit to be exposed to strong direct radiation. In South Africa, high crop loads and water deficits were associated with higher sunburn damage in some cultivars. Under Central European conditions, most of the examined varieties were highly damaged with a N-S row direction but not with an E-W row direction; in South Africa the trend was not as clear. In both countries, the incidence of sunburn on apple fruit was significantly decreased by evaporative cooling due to the reduction of fruit surface temperature. In South Africa, 20% black shade netting was also highly effective in reducing sunburn. Future cultivar development and orchard management advances should take cognisance of sunburn as one of the most important pre-harvest quality determinants in both countries, and increasingly so in many other regions exposed to the effects of global warming.

Poster Abstract 86

Overview of Apple Rootstocks in South Africa

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There are currently around 21,000 hectares of apples grown in South Africa. High soil temperatures in summer, insufficient winter chilling, variable, poor and shallow soils, replant problems and virulent Woolly Apple Aphid

strains place specific demands on rootstock choice. Merton 793 was established as the standard rootstock in South Africa since the late 1960s, yet the use of seedling rootstock also found wide application until fairly recently. From results of rootstock trials conducted from 1967 to 2003 in the main producing regions with a range of scion cultivars, M793 was conditionally confirmed to be the best standard sized rootstock available at the time, while M7 , which is susceptible to Woolly Apple Aphid and suckering and MM106, susceptible to Phytophthora, were conditionally recommended as semi-dwarfing stocks, while MM109, a high vigor stock, was recommended for soils of low fertility. There is thus a need for an improved range of rootstocks which is more dwarfing, precocious, yield efficient, resistant to major pests and diseases and which are adapted to various soil types and conditions. Hence a range of Geneva rootstocks was imported and a trial established in 2000 in order to find alternatives more suited to modern and sustainable apple production.

Poster Abstract 87

Relationship Between Vigor and Genetic Similarity Index in Seedlings of Polyembryonics Varieties of *Mangifera indica* L.

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The variety Haden of *Mangifera indica* produces seeds monoembryonics; with an only sexual zygotic embryo. While Manila and Ataulfo that are polyembryonics can also develop between 2 and 8 asexual nucellar embryos or clones of the plant mother in the same seed. The plants of nucellar origin are used as rootstocks in the plantations for their uniformity. In the orchards the trees should be vigorous, productive, adapted to the ecological conditions of the region and resistant to diseases. The distinction of the zygotic or nucellar origin in the seedlings would have advantages to select materials for propagation. The objective of the present study was evaluate the vigor and comparing the germination parameters and the relative growth rate (RGR) of the seedlings of each seed with the genetic similarity index (GSI) between the seedlings of zygotic and nucellar origin and the plants mother. A hundred seeds of each variety were collected in The Rosario,Sin., Méx. The seeds were sowed and was evaluated the capacity and velocity germination during 16 days. The seedlings were transplanted and growth parameters were evaluated during 3 months. The seedlings that germinated first in the same seed also presented high growth rates. DNA was extracted from leaves of seedlings and plants mother and analyzed by AFLP. Using only two AFLP primers produced 135 bands, of these 74% was polymorphics. The results show a cluster among the seedlings in the same seed; however, we observed that the embryos that germinates first are lightly different that the rest of the embryos. In this sense we are deepening in the analysis between plants mother and seedlings coming from diverse embryos in the same seed.

Poster Abstract 88

Investigation of Apple Rootstocks in the Nursery

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The effects of apple rootstocks M.9, M.26, MM.106, B.118, B.396, P 60, P 2, P 22, P 59 and Antonowka seedlings on the quality of one year old planting material were studied at the Lithuanian Institute of Horticulture in 2005-2007. Two apple cultivars 'Auksis' and 'Shampion' were included in the trial. The influence of rootstock on tree height, stem diameter, leaf area and weight was estimated. Rootstocks determined tree characteristics. Significant differences among rootstocks were found when tree height, stem diameter, leaf area and leaf weight were estimated. The highest one year old trees grew on B.118, M.9 and Antonowka seedling rootstocks. Significantly lower trees grew on P 22, P 2 and B.396 rootstocks. The taller planting material had bigger stem diameter. Trees propagated on P 2, P 60 and B.396 rootstocks had smaller stem diameter. M.9, P 22, P 59 and B.118 rootstocks determined larger leaves of apple planting material. Trees on P 2, M.26, MM.106 and seedling rootstock had significantly smaller leaves. Though there was a positive correlation between rootstock growth vigor and vegetative growth characters of planting material, one year old trees on dwarf M.9 rootstock were taller and thicker than semidwarf M.26 and semi vigorous MM.106. The same was noticed with very dwarfing P 59 rootstock which produced trees with similar growth characteristics as M.26 or MM.106.

Poster Abstract 89

Comparison of Some Size Controlling CG Apple Rootstocks on the Performance of 'Jonagold' and 'Novaspy' in Atlantic Canada

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In 1999, a trial was established in Atlantic Canada at Bouctouche, NB (46°26'N) and Kentville, NS (45°4'N) to assess the performance of the apple cultivars 'Jonagold' and 'NovaSpy' planted at 890 trees/ha. 'Jonagold' trees were grafted on six rootstocks (CG052, CG054, M.7 EMLA, M.26, P.14 and P.60) while 'NovaSpy' was grafted on 7 rootstocks (CG052, CG090, M.7 EMLA, M.26, MM. 106, P.14 and P.60). This paper presents seven year results from this trial and will discuss their implications for recommendation in Atlantic Canada based on terms of tree vigor, fruit size, yield and yield efficiency.

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Effects of Three Planting Systems on Apple Tree Growth and Productivity

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With the aim of testing and promoting new planting systems, at the Faculty of Horticulture in Bucuretti, a trial was organized with some of most diffused apple cultivars in the Romanian orchards: Florina, Idared and Aura, a new scab resistant Romanian cultivar. Trees were grafted on M 9 and M 26 rootstocks and planted in the spring 2005 at 3.5 m between rows. The distance between the trees on the row varied from 1.0 m for M 9 to 1.5 m for M 26 for Spindle and from 1.5 m for M 9 to 2.0 m for M 26, for Drilling and Mikado canopies. Soil was maintained grass covert between rows and with polypropylene fabric mulch on the row. An integrated pests and diseases management was applied. The canopy formation consisted mainly in summer pruning and shoots tiding. From the first growing season, the shoots type, shoots number and length was determined. Every spring the percentage of fruit set was calculated and during the ripening period, fruit production was weight per tree and the yield (t/ha) was calculated. The formation of the flowering shoots was positively influenced by M9 rootstock in all studied cultivars, meanwhile there were not significant differences between the two rootstocks, regarding the vegetative shoots formation. The highest number of total flowering shoots was registered at Drilling and Mikado canopy and at Idared cultivar. Generally, M26 rootstock determined a more vigorous vegetative growth expressed by the total shoots length, shoots average length and shoots number. An exception was represented by the higher values registered on M 9 rootstock at Mikado canopy. Aura was the most vigorous cultivar. The three cultivars had different behaviour related to the canopy and the rootstock used. The highest yield was obtained on M 9 rootstock and with Mikado canopy.

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Rootstocks Affect Four Apple Cultivar Yield in Kiasar

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Yield and other fruit traits of Gala, Granny Smith, Delval and Golden Delicious on M9 and MM 106 rootstocks were studied for 5 years. The research conducted in complete randomized design at 3 replication in Kiasar research station (Lat. 36.23 , Lon. 53.55 , El. 1290 m. Sari, Iran). In sixth years after planting the most important finding are : cultivars on different rootstocks had different yield. Golden Delicious on M9 (35kg/tree) had more yield than MM106 (27kg/tree) but Granny Smith yield on MM106(32kg/tree) was significantly more than M9 (30.5kg/tree). Yield of Gala and Delvar on both rootstocks was the same. Sunscald affected Granny Smith fruits on M9 more than MM106 . Trees trunk breakdown due to fruit weight or wind on MM106 were higher than trees on M9. MM106 rootstock was more sensitive to phytophthora crown decaying. Flowering of Golden Delicious and Granny Smith on M9 happened 6-7 days earlier than other cultivars. Gala, Golden Delicious, Granny Smith and Delval were more sensitive to apple scab, respectively.

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Evaluation Of Pear Rootstocks in Latvia

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The main problem in the pear orchard management is the lack of growth limiting rootstocks. Quince (*Cydonia oblonga*) rootstocks used in the Western Europe probably have insufficient winter-hardiness in Latvia climatic conditions. In addition, all pear cultivars recommended for intensive orchards in Latvia have insufficient physiological compatibility with quince. The aim of the study was to evaluate pear rootstocks used in Western European tree-nurseries in Latvia conditions with local cultivar 'Suvenirs`. In the trial five vegetative propagated rootstocks were included: three quince (*Cydonia oblonga*) rootstocks - QA, QC and BA 29; two rootstocks originated from Pyrus communis -OH×F333 and `Pyrodwarf`, as well as two seedling rootstocks of Pyrus communis - `Kirchensaller Mostbirne` and `Kazraushu`. The double inoculation (nicolation) was used (as interstock was used cultivar `Shtaras 31`, of Lithuania selection) to prevent physiological incompatibility with the quince rootstock. Trial was established in 2001 in the frame of the project "Baltic Fruit Rootstock Studies". Trunk cross section area (TCSA), tree height, crown volume and crown projection area were used as characteristic traits for trees vegetative growth evaluation. Rootstocks influences on TCSA was stated starting with the 3rd year after planting, when the biggest TCSA was obtained on `Kazraushu` seedling rootstock and the smallest on quince. In the 7th year after planting the lowest TCSA was registered for trees grafted on quinces, but the biggest one on 'Kirchensaller Mostbirne' and `Kazraushu`, rootstocks OH×F333 and 'Pyrodwarf' are between. Similar division was observed also according to the crown parameters: the smallest trees are registered on the quince rootstocks, trees on OH×F333 and 'Pyrodwarf' have bigger crowns than on quince, but in some parameters do not significantly differs from seedling rootstocks `Kirchensaller Mostbirne` and 'Kazraushu'. Marked physiological incompatibility was stated between cultivar and rootstock BA 29. Significant difference between other rootstocks was not stated. The most root offsprings were observed for rootstock 'Pyrodwarf'. Due to unfavorable weather conditions (low winter temperatures, spring frosts) yield was obtained only in the 6th year after planting. Yield was quite low, 5-13 kg per tree or 3-8 t ha^{-1}. Differences between rootstocks are not significant. Main conclusions: rootstocks OH×F333 and 'Pyrodwarf' a little influence tree height; the most dwarfing effect showed rootstocks QA, QC and BA 29; rootstock BA 29 is inappropriate due to physiological incompatibility; it is necessary to continue investigation to evaluate the rootstock influence on tree winter hardiness and yield.

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Regulated Deficit Irrigation Affects Fruit Quality, Yield and Growth of 'Montmorency' Tart Cherry

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Regulated deficit irrigation (RDI) has been tested in a variety of fruit crops to improve efficiency of limited irrigation water, control vegetative growth, and improve fruit quality. However, little is known about the potential benefits of RDI for tart cherry (*Prunus cerasus*). The effects of regulated deficit irrigation on fruit quality, yield and growth of 'Montmorency' were studied during the summer of 2007. Five irrigation levels were applied from pit hardening (24 May) to harvest (23 July) in a uniform 13 year old commercial orchard.

The irrigation levels supplied 30, 48, 61, 78 or 102% of crop evapotranspiration (ETc). Each level had six replicate plots consisting of 3 rows by 12 trees per plot, with data collected from the 10 central trees. The effectiveness of each irrigation level was determined by monitoring atmospheric conditions, soil water potential and midday stem water potential. Midday stem water potential was closely correlated with irrigation levels and ranged from 0.8 to 1.2 MPa by harvest. Fresh and dry weight yield did not differ significantly among irrigation levels. Average fruit size ranged from 4.02 to 4.26 g/fruit, but only the lowest irrigation level had noticeably more undersized (cull) fruit. Fruit soluble solids content was inversely proportional to irrigation level and ranged from 13.1 to 14.7%. The effects of deficit irrigation on tree health, including trunk injury and return bloom will be discussed.

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Ethephon as a Bloom and Post Bloom Thinner for 'Summerred' Apple Trees

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The apple cultivar 'Summerred' is a strong alternate bearer in Norway if not properly thinned in order to achieve regular bearing and high fruit quality. For three seasons started in 2003 mature 'Summered'/M9 apple trees were treated with ethephon when king flowers opened at concentration of 250, 375 and 500 ppm and at 10 mm fruitlet stage at concentration of 500, 625 and 750 ppm. The experimental design was complete randomized blocks with 6 reps and single trees applications. The trees were sprayed to running off with a hand sprayer when temperature was above 15 °C. When thinned at bloom and fruitlet stage, the final fruit set was achieved two weeks later. All the thinning treatments reduced the fruit set of the trees significantly included the hand thinned trees. The thinning effects increased linearly with the ethephon concentration and the highest dosages at bloom and fruitlet overthinned. The yield did confirm the fruit set and the yield reductions were significant. All thinned treatments gave higher percentage of grade 1 fruits larger than 60 mm fruit size and the fruit weight became increased as well. The thinning managed to increase the soluble solid content significantly, especially the hand thinned trees. The other fruit quality parameters like ground and surface color showed minor improvements due to the thinning. Fruit firmness declined slightly from the ethephon thinned trees. Ethephon is known for advancing maturity and will likely give a bit softer fruits at harvest compare with the untreated. Return bloom was improved for all the thinned trees. In conclusion, spraying with ethephon at a dosage of 375 ppm applied when king flowers were open or 750 ppm at 10 mm fruit diameter thinned 'Summerred' apple trees to a target of about 3-4 fruits per TCSA or 30–40 fruits per 100 flower clusters.

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Precision Selective Thinning to Regulate Fruit Set and Improve Apple Fruit Quality

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The objective of this contribution is to present a new device for precision flower thinning in fruit crops. The device was tested for the last three years on apple to thin flowers without use of chemicals, in order to improve

fruit quality, reduce labor for hand thinning and overcome alternate bearing. The newly developed device comprises three rotors with adjustable angles and vertically rotating ropes, which remove excess apple flowers. The device can be used to precisely remove any combination of peripheral and/or inner flowers, flowers in the top, middle and/or bottom part of the tree. The portion of removed flowers can be controlled by a combination of rotor versus tractor speed. Apple cv. '; Gala', 'Golden Delicious', 'Pinova' and 'Braeburn' apple trees were thinned at flower opening (growth stage 930 DD) with the new device in Klein-Altendorf near Bonn, Germany. Adjacent untreated, hand-thinned or chemically (benzyladenine-) thinned apple trees of the same rows served as controls. Tree branches remained un-damaged by the vertically rotating ropes. Slight leaf damages of less than 8% were observed at the fastest rotor speed of 320 rpm, which also gave the best thinning results. The portion of class one fruits >70 mm was increased by 10 % without yield loss and by up to 20 % with yield losses of ca. 5-10%, depending on the settings, relative to the untreated control. This was equivalent to fruit mass gains of 10 g without yield loss and of 20 g with 10 % - 20 % yield loss with economic gain in both cases. The mechanical thinning required 1 h ha^{-1} at a tractor speed of 5 km h^{-1} and reduced the subsequent hand thinning by 45% (by 15 h/ha or its cost by ca. US $ 150/ha). The new device gently removed up to one third of both peripheral and central flowers at a cost of less than 120 US $/ha and with a negligible risk of over-thinning and with positive effects on return bloom. The positive results with thinning of apple shows its potential use in other pome and stone fruit crops.

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The Effect of Planting Density of Bramley's Seedling Apple (*Malus pumila* Mill) on M111/9 Rootstocks with an M9 Control in Sites Suffering from Specific Apple Replant Disease

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Specific apple replant disease is caused when an old orchard is grubbed out and a significant pathogen population develops in the soil as the remaining root fragments rot. New roots from young tees planted into such sites are often attacked by these soil pathogens and suffer accordingly. M111 rootstocks with M9 interstems are promoted in the British Isles as suitable for replant sites. Because Bramley's seedling apple is such a vigorous cultivar, it is sometimes claimed that a replant site provides a useful check on Bramley growth and is therefore an advantage. On both clean and replant sites the following densities were planted in 2000; D1 – 24' x 18' open centre on a short stake, D2 – 12' x 18' central leader on 2.5 m stake; D3 – 16' x 10' central leader on 2.5 m stake and the control D4 – 14' x 8' M9 central leader. The accumulated results for 2004-2007 (three central trees recorded) prove that in the case of Bramley's seedling, SARD infected ground significantly increased yield compared to the clean ground – 107 kg vs 36 kg. On the clean sites the traditional planting density (D1) produced the lowest yield (16 kg whilst the M9 treatment generated the highest yield (61 kg).

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Performance of Several Semidwarfing Rootstocks with 'Fuji' and 'McIntosh' as Scion Cultivars in the 1999 NC-140 Semidwarf Apple Rootstock Trial

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In spring, 1999, two trials of semidwarf apple rootstocks were established under the coordination of the NC-140 Technical Committee. One trial included 'Fuji' as the scion cultivar, and the other included 'McIntosh.' Rootstocks were CG.4814, CG.7707, G.30N (liners from stool beds), M.7 EMLA, M.26 EMLA, and Supporter 4. The 'Fuji' trial was planted in Kentucky, North Carolina, Ohio, and Pennsylvania (Biglerville), with partial plantings in Missouri and South Carolina. The 'McIntosh' trial was planted in Massachusetts, Michigan, Minnesota, Nova Scotia, New York (Williamson), Ontario, and Wisconsin, with partial plantings in New York (Peru), Pennsylvania (Rock Springs), and Vermont. Trees were spaced 4x6m and trained as free-standing central leaders. 'Fuji' trees on M.7 EMLA had larger trunk cross-sectional area in 2007 than those on CG.4814. 'McIntosh' trees on M.7 EMLA and Supporter 4 were larger than those on M.26 EMLA, CG.4814, or CG.7707. Root suckering (cumulative, 1999-2007) was much more prominent with 'Fuji' as the scion cultivar than with 'McIntosh.' M.7 EMLA resulted in the most root suckering with both scion cultivars, and M.26 EMLA resulted in the least. Cumulatively (2001-07), 'Fuji' and 'McIntosh' trees on G.30N yielded more than those on M.26 EMLA, CG.4814, or M.7 EMLA. Rootstock did not affect cumulative (2001-07) yield efficiency of 'Fuji' trees. For McIntosh, however, trees on CG.4814 were more yield efficient than all others, and trees on M.7 EMLA were the least efficient, significantly less than those on CG.4814, CG.7707, and G.30N. On average over the fruiting life of the trial (2001-07), CG.7707 resulted in larger 'Fuji' fruit than did CG.4814, and rootstock did not affect McIntosh fruit size.

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Studies on Diagnosis of Tree Architecture in Young Red Fuji Apple Tree

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Based on tree architecture analysis to young Fuji apple orchard with high planting intensity, four types of Fuji tree architecture : weak tree, high yield tree in plain, moderate growth tree and young tree with active growth were defined. The discrimination function of four tree types were listed as follows according to discrimination analysis: Weak tree: $Y=2.004x1-0.000011x2+0.465x5+0.70x6-0.0012x7+99.1x8+0.0579x9$. High yield tree in plain: $Y= 2.121x1+0.000068x2+ 0.50x5+0.80x6+0.000045x7+121.1x8+0.064x9$. Moderate growth tree: $Y= 1.86x1+0.000057x2+0.55x5+0.734x6-0.000125x7+129.1x8+0.0785x9$. Young tree with active growth: $Y=2.93x1-0.000029x2+0.63x5+0.83x6-0.00098x7+ 105.9x8+0.054x9$ (x1-stem conference<cm> ,x2-branch

numbers per mu<piece> ,x5-proportion of fine short branch<%>, x6-proportion of weak short branch<%>,x7-yield per mu<kg>, x8-fruit color index, x9-individual fruit weight<g>)

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Rehabilitation of Shiwaliks Through Agro-Horticulture Models

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Agro-horticulture has emerged as one of the most viable option for sustaining the rural livelihood of rainfed areas under lower Shiwaliks of Punjab, has about 10% of its area which is mostly affected by highly streams (rainy season torrents) popularly known as "Choes". Though annual precipitation is about 1200 mm, yet uneven distribution of rain both in space and time leads to severe drought conditions during spring, summer and autumn months. Light textured soil having poor water holding capacity and fertility status further aggravate the situation rendering the cultivation of arable crops un-sustainable. Therefore to have a sustainable production to meet out the livelihood of the rural masses, there is option to shift land use from traditional established needs by incorporating agro-horticulture system, because, deep root system of the trees are less affected by the droughts, thus, if the crops are grown associated with the trees, the production in this zone can be greatly increased and made sustainable. Keeping this in view, the present studies were carried out at Zonal Research Station for Kandi Area, Ballowal Saunkhri during the year 1992-93 on the performance of different sub tropical fruits with the potential of economic returns and as a cover to protect the land from on going degradationBased on the studies (1992-93 to 2005-06) conducted have shown a good deal of success with participatory involvement of people in the plantation of different subtropical fruits viz; Aonla(*Emblica officinalis* Gaertn), Ber (*Zizyphus mauritiana* Lamk), Guava(*Psidium guajava* L.), Galgal(*Citrus limon* Burm), Pomegranate(*Punica granatum* L) & Olive(*Olea cuspidata*). The results also revealed that Chakiya cv. of Aonla, Sanaur No. 2 Ber, Allahabad Safeda and Lucknow-49 Guavas, Gangian Selection 6 and Kandi local 1 Galgals, Ganesh cv of Pomegranate and Ascolona & Cornicobra cvs of Olive shown a good performance with respect to survival, growth, fruit yield and quality characteristics. It was also observed that Inter cropping with leguminous crops viz; moong and mash during kharif season and gram, mustard and taramira during rabi season as well as grasses i.e. Anjan (*Cenchrus cilliaris*), Dhanjan (*C. setigerous*) and guinea did not affect the growth of fruit trees adversely. Based on these studies, it can be concluded that agro-horticulture systems improve the soil fertility and also checked the run off and soil erosion in the lower Shiwaliks of Punjab.

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The History of Apple Breeding in People's Republic Of China

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China is the leading apple production country in the world. Its apple area and production in 2006 was 1,898,000 hectares and 26,000,000 tons, accounting for more than 35% of the global apple area and production, respectively. New cultivars are very important to development of the apple industry. China has a history of more than 50 years in apple breeding. Over 260 apple breeders from 40 universities or institutes all over the country, including the provinces of Liaoning, Hebei, Shaanxi, Shandong and Shanxi, devoted themselves to the apple breeding career. China released 270 apple varieties in the past 50 years by crossing and using 'Fuji', 'Ralls', 'Delicious', 'Golden Delicious', 'Jonathan', and 'Toko' as the parents in the crosses. Among them, two varieties of 'Qinguan' and 'Yanfeng' bred in Shaanxi, two varieties of 'Huaguan' and 'Huashuai' in Henan, five varieties of 'Liaofu', 'Yueshuai', 'Hanfu', 'Qiujin', and 'Huahong' in Liaoning, two varieties of 'Guohong' and 'Yanshanhong' in Hebei, 'Danxia'in Shanxi, and 'Dailv'in Shandong exhibited comprehensively high qualities and had a certain large extension area in the history of China apple industry. Now China has also initiated program for breeding red flesh apples and juice apples with high acidic contents. Traditional crossing, sports selection, and open-pollinated seedlings selection combined with marker-assisted selection, anther culture, transgenic engineering, were the approaches used for breeding new apple varieties. Research on inheritance of important traits in apples, pre-selection and early evaluation for the seedlings, methods to shorten the juvenility in apples, resistance to apple canker and apple ring rot, transgenic engineering in apples was also conducted in the apple breeding program. China began apple rootstock breeding program thirty years ago. Traits of dwarfing, high disease resistance, drought endurance, and cold hardiness, are the primary consideration in the apple rootstock breeding program. China has released a handful of apple rootstocks as 'S19', 'S20', 'SH15', '63-2-19', '77-34', 'Liaozhen No. 2', 'GM2 56', 'CX3', '75-9-5', and '75-7-1'. A National Apple Breeding Association in China will lead to coordination among breeding groups across the country and to development of the apple industry in China.

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Evaluation and Selection of Fruit Rootstocks for the Climate of Belarus

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The climate of Belarus presents special challenges to orchards growers. Winter hardiness is an essential rootstock characteristic as it easy to propagate, precocious in bearing and productive in the orchard. Since the 1960s, selection of dwarfing clonal apple and pear rootstock was carried out in the Brest Agricultural

Experimental Station (AES) and Grodno AES, than in Belarusian Research Institute for Fruit Growing (Minsk reg.) including dwarfing clonal plum and cherry rootstock also. According collaboration between our Institute and different Russian Research Centers (Barnaul, Krymsk, Michurinsk, Voronezh, Orel etc.) there was a success to collect big pool of diversity fruit rootstocks. In 1990s set up good relations with some European countries. New development of evaluation of fruit rootstocks was begun in 1990s. Objects of research were the following groups of rootstocks: 39 hybrid forms of apple which parentage include Malus species: *M. baccata*, *M.Xdomestica*, *M.Xprunifolia*, *M.Xmicromalus*, *M.turkmenorum*; 60 – pear (*Pyrus communis*, *P.ussuriencis*, *P.salicifolia*) and quince (*Cydonia oblonga*); 34 – plum, which parentage include species: *Armeniaca vulgaris*, *Prunus cerasifera*, *P. americana*, *P.salicina*, *P.simonii*, *P.domestica* ssp.insititia, *Microcerasus tomentosa*, *M.incana*, *M.pumila*, *Persica vulgaris*, 36 – cherry, which parentage include species: *Cerasua vulgaris*, *C.maackii*, *C.fruticosa*, *C.lannesiana*, *Prunus mahaleb*. According to the complex indices the following apple rootstocks are recommended for cultivation in the Belarus: PB-4 (from Belarusian breeding program), 62-396, 54-118 and 57-545 (Budagovsky series), M9, M26, MM106 (M and MM series). There are in the State Testing of Belarus: apple rootstocks 106-13 (from Belarusian breeding program), plum – VPK-1, OD 2-3, VVA-1 (from Russian breeding program), for cherry – AVCh-2, VSL-2 (from Russian breeding program) , Gisella-5, Damil GY-79.

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Regulation of Calcium Uptake and Translocation in Plants

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Calcium is an essential plant nutrient and a second messenger in cell signal transduction. Recently, most of researches on calcium in plants have been focused on the role of calcium in cellular level. But the uptake and transport are also very important for calcium to accomplish its function in whole plant level. The uptake of calcium in whole plant level must enter one cell then exit from this cell and enter another cell, which is influenced by metabolism and temperature. The over expression of $Ca^{2+/}H^+$ transporter can increase calcium levels of transgenic plant significantly. Ca^{2+} enter symplast from apoplastic pathway through Ca^{2+} channels. Ca^{2+}-ATPase can drive Ca^{2+} flux from symplast to apoplast. The uptake and transport of calcium are also regulated by phytohormone, rootstock and genotype. There is a tight linkage of calcium and auxin countercurrent fluxes.

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Effects of Shoot and Leaf Distribution on Microclimate and Fruit Quality in Fuji Apple

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The method of space subdivision, dynamic monitor of microclimate and investigation of different shoots and leaves were applied to study the relationship between distribution of shoots and foliage and microclimate factors, fruit qualities in different stratum and position of canopy for 12 years old tree of 'Fuji' apple. The results were shown that 57.68% of total shoots and 75% of spur shoot were mainly distributed in 1.5~2.5 height of canopy, relative light intensity in different layers of canopy was gradually descended of negative exponent from top to bottom, the percent proportion of <35% relative light intensity in volume of canopy were separately 16%, 28% and 31% during May to June, July to August and September to October, fruit qualities in different stratum and position of canopy were significantly difference and mean fruit mass, firmness, soluble solids content and surface of blush were higher in upper than lower and outer than inner of canopy. Statistic method were used to set up regression equations relationship between shoot type, number and relative light intensity, temperature and relative humidity and obtain total shoots, proportion of long, medium, spur shoot above 30%, 40% and 80% relative light intensity of canopy. The optimum total population shoots, leaf areas index and spur proportion were 900~1000 thousands, 3.5~4.0 and about 75% separately for good quality and high yield of 'Fuji' apple. The equations of relationship fruit qualities and relative light intensity, temperature and relative humidity were shown that fruit qualities of 'Fuji' apple were affected main microclimate factors in different growing season. The theory bases were provided for propriety pruning and management in 'Fuji' apple.

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Malus xiaojinensis – A Promising Apple Rootstock

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Malus xiaojinensis Cheng et Jiang is a new species native in China in Malus spp being named in 1983. This new species had not only traits of tolerance to waterlogging or cold, particularly but also a strong ability of resistance to iron deficiency chlorosis. Our experiments showed that under Fe deficiency stress in room condition *M. xiaojinensis* had physiological responses to Fe stress with an alleviated or much later time of chlorosis, and in field condition trait of resistance to the chlorosis of M. xiaojinensis was genetically stable. After confirmation of the trait being genetically controlled by a pair of major genes with slightly modification of minor genes, the Fe-efficient genes were primarily localized by tool of molecular biology. The experiment of both in room and in the field also indicated that as an apple rootstock *M. xiaojinensis* had a well developed roots, good grafting affinity with 17 major cultivars of apple, or semi-dwarfing effect. Naturally *M. xiaojinensis* had a low seeding rate (abortion rate of 85%), also easily with genetic variation of seeds, although *M. xiaojinensis* was in majority of apomixes. With regarding to this trait, fast propagation in vitro of M. xiaojinensis seedlings was developed by tissue culture. Overall, as a valuable genetic resource, *M. xiaojinensis* would be a rootstock of apple, being promisingly used in apple planting area in China.

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Apomictic Dwarfing Apple Rootstocks Provide New Prospects for Apple Rootstock Propagation

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Forty-nine hybrids were obtained from a cross using an apomictic selection 'Pingyitiancha' (*Malus hupehensis* var. pinyiensis) as the maternal parent and a dwarfing diploid rootstock, 'Budagovsky 9 (Bud.9)' (*Malus domestica*) as the paternal parent. These 49 individuals exhibited different levels of apomictic behavior, from 0.0 to 94.2 %, showing that apomixis in this cross was segregating possibly as a dominant trait. The dominant red-leaf color and dwarfing in Bud 9 also segregated in the F1 generation. Twenty of these 49 seedlings were identified to be apomictic. Apomictic hybrids had characteristics of many seeds in a fruit as those in the 'Pingyitiancha' and big seeds as those in the Bud 9. A few hybrids had both traits of apomixis and dwarfing. The cold hardiness of all the hybrids was much stronger than that in M 26. These hybrids were able to survive -35°C.

Poster Abstract 106

An Apple Dwarfing Rootstock: 'Liaozhen 2'

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'Liaozhen 2' is a promising apple dwarfing rootstock. It was selected from the F1 progenies of a cross of '*M. prunifolia* × M9' made by the Liaoning Research Institute of Pomology, Xiongyue, China in 1980. A 22-year investigation on this apple rootstock showed that effects of its dwarfing efficiency, precocity, productivity on scions and its rooting ability were similar to those of 'M26'. The cold hardiness of 'Liaozhen 2' was better than that of 'M26'. Grafting compatibility studies of this rootstock with *Malus baccata* L., and with the major commercial apple cultivars such as 'Fuji', 'Ralls', 'Yueshuai', showed good graft unions. This apple rootstock can also be used as the inter-stem for the apple propagation.

Poster Abstract 107

Apple Stocks Function Difference Between Root and Shoot with Different Fertility Level

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The aim is to analyze the difference between root and shoot of apple stocks function with different fertility level. The one-year seedling of *Malus hupehensis* 'Pingyitiancha', *M.micromalus* 'Huailaihaitang', *M.micromalus* 'Laiwunanyan', were used as the materials of the experiment. The responsive patterns of between roots of different apple stock seedlings and different fertilizer level. The chief results was followed: In the proportion of the overground and underground part, the total current followed the enhancement of the soil's fertility with the decrease of the shoot root ratio. But the ratio's decrease in different of species had diversity. In high soil fertility the content of chlorophyll was richness. The result indicated that pigments degradation was affected by soil fertility. Diurnal changes of Pn were double peak curve; the average of Pn was proportional to soil fertility. There were many differences between different apple stocks; the Pn of 'Laiwunayan' was higher than the other two apple stocks. There are significant correlation between R/T and WUE. The chlorophyll fluorescence was determined. The result indicated that the thermal dissipation ability of same apple stock was distinctness in different soil fertility. It was possibility because that the component of photosynthetic pigment was changed by the supply of soil fertility. Three apple stocks were used to analyze the physiological function of the overground and underground part with different fertility level. The thesis summarize a effective method to figure tree structure.

Poster Abstract 108

Annual Large Limb Removal to Contain Canopy Spread in the Kentville Free Standing Tree Wall

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Pruning is a major cost in apple production therefore an orchard design that utilizes a novel more efficient pruning system throughout the production cycle is an important advancement. It is even more beneficial if the new pruning technique can be incorporated into a precocious, productive, high density system. In 1998 an orchard management study was designed to explore the potential for using the vigor reducing characteristics of spur type McIntosh strains and Empire on vigorous and Semi-vigorous rootstocks. Empire and the Spur McIntosh strains MacSpur, Hartenhof, Stirling were grafted on each of the five self supporting rootstocks MM. 106, MM.111, Alnarp 2, KAS 13 and KAS 3. After seven years and each year thereafter two or three of the largest limbs were completely removed with a slant (20 degree) cut at the trunk. At eighteen years of age MacSpur on KSC 13 and KSC 3 are the largest and barely contained in the 2 by 4 m spacing while the highly spurred Hartenhof and Stirling strains of McIntosh on MM. 106 are not fully occupying the available space. Tree canopy for Empire is approximately mid range between that of the largest and smallest McIntosh strain rootstock combinations.

Poster Abstract 109

Screening of Apple Rootstocks for Response to Apple Proliferation Disease

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Apple proliferation disease (ApPL) is an economically important disease in Europe. Since there is no possibility of plant protection or cure, growers can only rely on means of phytosanitary precautions or genetically mediated tolerance. One-year-old liners of 16 apple rootstock clones (AP 4551, AR 2956, AR 6282, B.9, B.491, G.16, CG.3041, JTE-F, M.8, M.9, M.20, M.25, M.27, MM.111, P.16, Supporter 2) were potted into 7.5 l containers (n = 15) filled with commercially available nursery substrate fertilized by adding Osmocote 8M. The containers were kept outdoor under automatic water supply by drip irrigation adjusted to weather conditions. In autumn of the same year 10 plants of each rootstock clone were inoculated with apple proliferation disease by grafting with scions of witches´ broom shoots taken from heavily infected 'Boskoop' trees which had been under observation for five years. Homogenity of the inocula was achieved by testing the leaves and tips of each witches´ broom shoot for ApPL by ELISA and selecting only those with high and similar titre. The plants were observed for three years for overall vitality and symptom expression. Progress of the disease incidence was checked for by ELISA each year in October. Shoot growth was measured once a year and in 2007 also specific leaf weight (SLW) was determined. In addition to these studies the rootstocks were tested for response to fire blight and woolly apple aphid. Two out of 16 clones showed growth depression and died off because of undetectable reasons. These were omitted of shoot measurements. Also two had no positive ELISA results for ApPL infection. For 14 clones within three years, inoculation efficiency ranged between 10 to 50%. Therefore, it is suggested that the genetically mediated response to apple proliferation disease of the rootstocks under study varies. Only six out of these 14 clones developed some kind of witches´ broom symptoms. There was no impact of ApPL infection on shoot growth or specific leaf weight in general. Only for one rootstock clone a reduction in shoot growth was observed in the first and second year after inoculation but was overcome in the third year. For the same clone SLW was increased in the third year. Lacking growth response to ApPL infection with 15 clones it was not possible to quantify their disease response by means of shoot growth. Nevertheless, the results will allow a rough estimation of the rootstocks´ relative sensitivity to ApPL. For quantification further research is necessary to find appropriate parameters. Based on the current results an overview will be given on the response of the rootstock clones under study to ApPL, fire blight and woolly apple aphid.

Poster Abstract 110

Effect of Interstock in Breaking Juvenility in Ambri Apple

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Long gestation period (nearly 15-17 years) is a serious problem in ambri apple leading to its extinction from the fruit map of the country. Among different procedures which led to reduction in juvenile phase, interstock of various clonal rootstocks (M-9, MM-106 and MM-111) with different lengths (10, 15 and 20cm) gave promising

results during 2006 and 2007. The greater the length of the interpiece, the narrower the juvenile period. However, as the length of interstock increased, the tree became weaker. Besides reducing juvenile period to 3-4 years, it became possible to establish high density orchards on seedling rootstock under high altitude conditions with water scarcity in contrast to high density orcharding on clonal rootstocks directly under irrigated conditions.

Poster Abstract 111

Evaluation of Different Weed Control Measures in Apple Nursery

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The present investigation was carried out in Apple Nursery Block at Fruit Research Station, Pahnoo, Shopian, J&K, India during 2006 and 2007. The experiment involved nine treatments viz. T1 (atrazine @ 4 kg ha^{-1}), T2 (diuron 4 kg ha^{-1}), T3 (dalapon 5 kg ha^{-1}), T4 (glyphosate 2½ l ha^{-1}), T5 (black polyethene punched), T6 (black polyethene unpunched), T7 (dry Dal weed), T8 (mechanical weeding) and T9 (control). The design of experiment was RCBD with three replications. The study revealed that mulching with unpunched black polyethene resulted in less weed population/m2 and gave maximum per cent weed control. Significant effect was observed on the growth of nursery plants. Maximum incremental height (43.5 cm), incremental girth (0.75 cm), number of feathers (4.36) and length of feathers (27.95 cm) was recorded under black polyethene unpunched followed by black polyethene punched and diuron. Maximum growth of roots in terms of length of primary roots (19.87 cm) and length of secondary roots (13.46 cm), number of primary roots (23.52) and number of secondary roots (9.74) was also recorded in black polyethene unpunched. The same treatment resulted in maximum conservation of soil moisture (19.78%) whereas minimum soil moisture conservation was recorded in mechanical weeding (14.62%). Highest soil temperature (23.43°C) was observed in black polythene unpunched and also maximum available N, P and K content was noted in same treatment. High pH (6.67) was recorded in mechanical weeding whereas a slight decrease in pH was observed in all other treatments. Diuron gave maximum benefit-cost ratio (2.34) followed by 2.25 in glyphosate and atrazine and minimum benefit-cost ratio (1.57) was recorded in mechanical weeding.

Poster Abstract 112

Hybridizing McIntosh Wijcik and Heat-Tolerant Apple Cultivars to Develop Precocious Seedling Trees with Improved Tree Architecture

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This project was initiated in 1991 with an open pollination of McIntosh Wijick by Gala to produce a prototype population of compact seedling trees (Compact Gala Macs or CGMx). The goal of that cross was to incorporate

the precocity of Gala into a short-statured, spur-type tree. Precocious seedlings from the original cross tolerant to late-spring freezes were selected at Keedysville, MD. Field tolerance to fire blight was also evaluated following summer hailstorms at that site. Fruit from these CGMx seedling selections ripens during August and September. Fruits have good flavor and firmness although fruit size on most CGMX seedling trees is inadequate for commercial production. Thirty CGMx trees were dug with a Vermeer tree spade and reset at a 12.3 m by 12.3 m spacing. Seed from open pollinations of CGMx trees was collected two years later. Seedlings were stratified, germinated and grown for two years in the greenhouse. These seedlings were planted at Queenstown, MD. CGMx trees were also used as pollen parents. Trees were hybridized with commercial cultivars adapted to the hot, humid climate of the mid-Atlantic region. This second generation of crosses used Pink Lady, Fuji, Braeburn, GoldRush, Commander York and Red Yorking as seed parents. Seedlings from these crosses were initially germinated and evaluated in the greenhouse and then planted at Keedysville. The open-pollinated CGMx seedlings block was rated for tree architecture. Field evaluations were based on four criteria: internode length, tree vigor, branching angle and top dominance. About ten percent of the trees evaluated exhibited some commercially-desirable tree structures. Wild-type trees and trees with excessive burrknots were removed, leaving about 100 trees for continued trial at Queenstown. Short-internode trees at Keedysville had a greater range of phenotypes and branch angles. Trees in these plots ranged from columnar to mesotonic. Single axis, non-branching trees were also identified. Thirty seven Pink Lady x CGMx trees and 128 Fuji x CGMx trees were selected for tree architecture studies. Despite a late-spring freeze, both populations began fruiting in 2007. Fruit on some Fuji and Pink Lady x CGMx hybrid trees had good size, red color and flavor. In addition to fruiting trees at Keedysville, a block of non-bearing York x CGMx with a similar range in tree types is also being evaluated.

Poster Abstract 113

Interactions of Apple Rootstocks and Budding Height

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In 2002-2007 budding height effect on tree growth and productivity was investigated in the apple orchard. The experiment was carried out with cv. 'Auksis' on four rootstocks (M.26, M.9, P 22 and P 59) budded at the height of 0, 10, 20 and 30 cm. Increased budding height on all rootstocks reduced tree growth. Significant differences for M.26 appeared at the height of 20 cm, for P 22 and P 59 – at 10 cm. Apple trees on M.9 rootstock were reducing their growth gradually. Independently of budding height total fruit yield per tree on P 22 rootstock was the same. Trees on P 59 budded higher then 10 cm gave lower yield. Apple yield increased up to 20 cm and decreased when trees on M.26 were budded higher. Trees on M.9 rootstock gave gradually lower yield when budding height increased. Tree productivity on all rootstocks with the exception of P 59 was increasing up to 20 cm and had a tendency to decrease when trees were budded higher. Mean fruit weight depended on budding height too. Decrement of fruit weight for M.26 and M.9 rootstocks was noticed at 30 cm, for P 59 and P 22 rootstocks already at 10 cm budding height.

Poster Abstract 114

Field Performance of Different Species and Hybrids as Rootstock for Peach

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Within the framework of a national coordinated program supported by the Ministry for Agricultural and Forestry Policy, in the autumn of 2002, a trial was established in Latiun Region (Rome, 41.6N - 12.4E, 20 m a.s.l), on 'Suncrest' trees grafted onto rootstocks of different vigor: Adesoto 101 (clone of *P. insititia*); Cadaman (*P. persica* x *P. davidiana*); Mayor(*P. amygdalus* x *P. persica*); Montclar (*P. persica*); Mr.s2/5 (*P. cerasifera*); GF677 (*P. persica* x *P.amygdalus*), Penta (*P. domestica*); Tetra (*P. domestica*); Fire (*Prunus persica* x Nemared); Sirio (open pollination of GF 655). The trial plot, characterized by a clay loam soil, hosted before, a fifteen year old peach orchard. The experimental design was a randomized complete block with twelve single-tree replicates for each rootstock. The planting distance was 5 x 5 m and the trees were trained as open vase. Management was done according to good local practices; weed control was achieved by mechanical tillage between rows and chemical spray along the row. A drip irrigation system guaranteed a regular water availability. After five years all the tree on Cadaman, resulted healthy while in the other graft combination, tree mortality ranged between 64 and 90%. The most vigorous rootstocks resulted Cadaman (100%) followed in the order by Penta, Tetra, Fire (65-75%); Mayor Gf677, Adesoto, Montclar (40-45%) and two weaker hybrids Sirio (25%) and Mr.s 2/5 (18%). Cadaman and GF677 have the highest accumulated yield (100%) but the lowest crop efficiency. The other rootstocks showed a decreasing yield: Penta and Fire (80%); Mayor, Montclar, Sirio (70%); Tetra and Adesoto (50%); Mr.s2/5(40%). Trees on Cadaman consistently produced the largest individual fruit size(100%), followed by GF 677, Penta, Tetra, Sirio, Mayor, Fire (90~97%); Mr.s 2/5 and Montclar (88%). Fruit weight, as expected, was negatively affected by the crop load, but the relationship between the two variables, was strongly influenced by rootstock.

Poster Abstract 115

Preliminary Report on the Selection of Cold-and-Drought Resistant Dwarfing Apple Rootstocks

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We select dwarfing apple rootstocks from *Malus baccata* L. Borkh. in Northwest-Shanxi, which is a wild Malus rootstock resource. Among the 150 000 mature seedlings of grafting apple varieties, we chose 571 plants, which form flower buds in the same year and can bloom the next year. Among these, 325 plants bear fruit in the same year it is planted, which we named "Y series" temporarily. In addition, we carried out field investigation and synthetic evaluation on blooming, fruiting, the amount of growth, as well as the over-winter performance of these plants. After 6-year hard work, we have preliminarily selected 75 major clones. As the preliminary test shows, Y series of apple stocks have a strong resistance, an outstanding habit of early-blooming and early-fruiting, a good compatibility of varieties after grafting. Some single clones have a distinct trend of dwarfing, which brings it a bright application future.

Poster Abstract 116

INRA-IRTA Pear Rootstock Breeding Program: Aiming for Tolerance to Iron Chlorosis and Low Vigor

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In 1998 a pear rootstock breeding program was initiated, at INRA Angers, to enhance tolerance to iron chlorosis. Crosses were done between the new INRA pear rootstock selection 'Pyriam' and four "Mediterranean" Pyrus species: *Pyrus communis* cordata hybrid, *P. amygdaliformis*, *P. amygdaliformis* persica, and *P. elaeagrifolia*. Up till 2005, following the latter integrating selection process, 71 clones were selected out of 619 individuals. Selected individuals had an average chlorosis rating 42.3% lower than the initial population, vigor 34.3% lower, and registered a trunk section area 75% lower than the 'BA-29'. Compared with the unselected initial population, the selected clones have increased their in vitro chlorophyll content to an average 29.4%..

Poster Abstract 117

Preliminary Evaluation of Supported and Free Standing 'Honeycrisp' Trees on 24 Apple Rootstocks

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Trees of 'HoneyCrisp' apple (*Malus domestica* Borkh.) grafted on 24 rootstocks were planted at 890 trees/ha in 2004 at Bouctouche, NB, Canada (46°26'N) and grown with and without a trellis support system. The rootstocks included two selections from the Budagovski (B) series (B.118, B.490), five from the Cornell-Geneva series (CG008, CG052, CG054, CG090, G.30), five from the East Malling series (M.4, M.7 EMLA, M.26 EMLA, MM.106, MM.111), three from the Kentville series (KSC.6, KSC 7, KSC.28), and three from the Vineland series (V.1, V.4, V.7). In addition, trees were included on Alnarp 2 (A.2), Maruba Kaido, Novole, Ottawa 8 (O.8), Polish 18 (P.18) and Yltöinen Piikkiö (YP.). Flowering was most precocious on G.30, CG008, O.8 and V.7. Trees that have yet to flower in their third leaf include CG090, KSC.6 and YP. The highest yields and yield efficiencies were obtained from trees on G.30, M.26 EMLA, V.7, CG054, CG008 and V.1 rootstocks. For these rootstocks, the trellis support had a positive impact on precocity resulting in a general two-fold increase in their crop load and total yield. High winds in 2007 caused a high level of breakage with most damage occurring to the free-standing trees. This breakage was most prevalent in some rootstocks, notably G.30.

Poster Abstract 118

Evaluation of Resistance to Pathogens Attack in the Rootstocks Breeding Apricot Program

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Introduction into the culture of a new rootstocks is based on several characteristic. Among these, we can mention small fruits and seeds, different vigor, data of blooming and ripening are essential. The combination of these characteristics, with the traits of resistance on specific pathogen attack increase even more the value of the new rootstocks. The apricot rootstocks can be damaged by a wide range of specific pathogens (*Monilinia laxa*, *Stigmina carpophila*, *Cytospora cincta*, etc.) very hazardous, which can destroy both the yield and the trees health or life. Therefore, the study of apricot rootstocks resistance to these pathogens is the major objective of these rootstock species breeding program carried out in Research Station for Fruit Growing Constanta. In order to achieve this goal, the researches were developed in 3 major stages. In the first stage the resistance sources were identified, by recording the frequency and intensity of the specific pathogens on rootstocks, collected in the apricot germplasm fund. In the second stage of the researches, the resistance sources identified were utilized in the breeding work to create new apricot rootstocks. As a result of there researches were registered the high quality and resistant cultivars (Constanta 14, Constanta 16, etc.). Now days in the third stage, there are under the evaluation the hybrid generation represented by many valuable apricot rootstocks selection.

Poster Abstract 119

Reflective Ground Covers Improve Fruit Quality, Yield, and Canopy Source-Sink Relations in Prunus

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Worldwide, tree fruit management systems have become progressively more intensive: higher inputs, higher outputs. Light has a fundamental role in fruit productivity and quality, yet is often overlooked as an input that can be managed. Trials with reflective ground covers in Australia, Chile, New Zealand, and USA have investigated their potential to improve productivity and quality, and manipulate harvest maturity through light management. This presentation will highlight results from reflective fabric trials with Prunus species conducted in commercial orchards in Washington between 2005 and 2008. From a trial on 'Johanna Sweet' peach in 2007 we observed increased fruit size and significant advancement in fruit maturity in trees treated with DaybrightTM reflective fabric between popcorn bloom and harvest. In 2006, five-year-old 'Honey Haven' nectarine trees treated with DaybrightTM between full bloom and harvest yielded more (+ 17%) and larger fruit (+ 19%) compared to untreated control trees. In 2007, trials with the early-maturing sweet cherry 'Chelan' revealed no significant improvements in fruit quality but an advancement of fruit maturity by five to seven days from DaybrightTM-treated trees compared to untreated. Moreover, commercial packout analysis reported a decrease in cullage (-7%) from fruit grown with a full-season application of DaybrightTM vs. those without a reflective ground

cover treatment. In a 'Bing' orchard that had ExtendayTM applied for four consecutive growing seasons (2004 – 2007), fruit weight and soluble solids in 2007 were significantly higher than from untreated trees and fruit maturity was advanced by five days. DaybrightTM and ExtendayTM reflective ground covers improve canopy source-sink relations by increasing illumination of shaded leaves/fruit. Sweet cherry leaf net CO2 exchange rates are ca. 50% greater in the lower canopy tiers of ExtendayTM-treated trees compared to untreated trees. This presentation will describe preliminary economic assessment of utilizing reflective fabric as well as potential management strategies for practical implementation.

Poster Abstract 120

Improving Fruit Quality and Microclimate Under Hailnets in an Apple

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With the increase of hailstorms as a possible result of global warming, fruit crops are increasingly grown under hailnets. This may result in lesser fruit quality in terms of coloration, fruit mass, firmness, starch and taste, i.e. sugar and acid as well as vitamin content under hailnet due to altered microclimate and particularly light deprivation. Hence, reflective mulches (Extenday and Daybright) were spread to improve fruit quality and light utilization under hailnet at Klein-Altendorf Research Station near Bonn, Germany. A monophosphate (Seniphos) was applied twice for the same purpose; untreated apple cv. 'Elstar' trees served as control. Under the translucent 'white' hailnet, humidity was increased by ca. 6%, soil temperature increased by ca. 0.5°C and light reduced by 11-15% resulting in lesser fruit quality of 2.5% less sugar and less taste. The two reflective mulches increased light reflection at 45° and 90° angles by 2.5-6.3-fold. No significant differences in fruit ripening and firmness were observed, but fruit from trees under hailnet with reflective mulch contained up to 2.4 % (from 13.3 to 15.7 %) more sugar than those of the control (uncovered grass alleys). A less negative NDVI (normalized differential vegetation index) of -0.3 on the red compared with -0.5 on the green fruit side indicated more chlorophyll in the outer, sun-exposed red side of the apples relative to the shaded side. Monophosphate-treated fruits maintained the peel chlorophyll with a greener ground color of 92-97°hue and a NDVI of -0.3 as in the grassed control. Fruit in the lower canopy with reflective mulch were darker red (a value 30; 22° hue) relative to the grassed control with a=25 and 43° hue (light red), expressed in a 4-fold increase in NAI (normalized anthocyanin index), but showed enhanced chlorophyll breakdown (NDVI was declined from -0.2 to -0.5); similarly, the monophosphate increased the NAI by up to 2.5-fold. Overall, the effect of both reflective mulches was most pronounced on apple fruit in the lower canopy under hailnet, which synthesized large vitamin C contents and developed a dark red top color relative to the grassed control with enhanced chlorophyll breakdown. Both reflective mulch cloths improved the fruit quality by increasing the percentage of class I fruit with >25 % coloration by 12% (from 82 to 94%) without and under hailnet by 23 % (from 69 to 89 %) relative to the grassed control resulting in financial net gains of up to 1,300 €/ha. We thank Deutscher Akademischer Austauschdienst DAAD for a grant to the first author.

Poster Abstract 121

The Results of the Estonian Apple Rootstocks Breeding Program

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In this paper, the authors review the stages of apple rootstock breeding in Estonia: the parentage, intensity of selection, the changes of the mother plants' reproductive capacity over time, the winter hardiness of roots and the fruit-bearing capacity of different grafting combinations. The Estonian breeding program was initiated in 1954, with the goal of obtaining rootstocks best suited for local soil and climatic conditions. The following parents were used: M2, M4, M11, winter-hardy cultivars 'Anoka', 'Tchulanovka', a seedling of 'Ranetka purpurovaya' and local cultivars of Malus prunifolia. The program resulted in the release of 10 semi-vigorous and vigorous clones, marked with the letter E (for Estonia). A semi-vigorous rootstock E20 and vigorous rootstocks E53 and E56 were selected for production in nurseries. In more recent breeding activity (starting from 1970), E-series rootstocks and MM106 have been used as donors. 267 clones were selected from the resulting seedlings, from which 43 promising clones were taken into orchard trials. Two semi-dwarfing clones (comparable to M26) and three dwarfing clones (comparable to B9) were chosen in the orchard trials. E-series rootstocks are easy to propagate in stoolbeds and their roots tolerate temperatures up to -14 to -16 °C. The rootstocks E53 and E75 are good donors for breeding winter hardy and productive mother plants. Propagation by layers in stoolbeds the rooting capacity of apple rootstock's may decrease in older plants. Potential donors for breeding dwarfing and semi-dwarfing rootstocks in Estonia are the F2 generation from M8 (62-396, Pure1, P59).

Poster Abstract 122

Varietal Difference of Apple Fruit In Response to High Temperature and High Light Stress Evaluated by Chlorophyll Fluorescence

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The sun-exposed peel of detached Cameo, Fuji, Gala, Golden Delicious and Red Delicious fruit was treated at 30, 35, 40, 42, 44, 46 or 48 ºC in the dark or under a photon flux density of 1200 μmol m-2 s-1 for 30 min, and chlorophyll a fluorescence transients were measured after 1-hr dark adaptation. When treated in the dark, maximum PSII efficiency (Fv/Fm) of all the cultivars remained unchanged as the treatment temperature increased from 30 to 40 °C. With further increases in treatment temperature, varietal difference showed up. The Fv/Fm of Cameo peel started to decrease at 42°C, whereas that of Red Delicious didn't decrease until temperature reached 46°C. At any given temperature from 42 to 48 °C, Red Delicious had the highest Fv/Fm (relative to that at 30°C) whereas Cameo had the lowest Fv/Fm (relative to that at 30°C). When treated under 1200 μmol m-2 s-1, Fv/Fm of all the cultivars decreased as the treatment temperature increased. At any given temperature, Red Delicious had the highest Fv/Fm (relative to that at 30 °C) whereas Cameo had the lowest Fv/Fm (relative to that at 30 °C). These data indicate that apple cultivars differ in terms of tolerance to high temperature and high light stress, and chlorophyll fluorescence is an effective tool for testing genotypic differences in tolerance to high temperature and high light stress.

Poster Abstract 123

Millennium Planting Density Trial of Bramley's Seedling Apple (*Malus pumila* Mill) on M9 and M27 Rootstocks – Yield and Economic Returns, Phase 2 (2004-2007)

S. Mac an tSaoir[1], J. Mansfield[1], G.Cross[2] and R.Harun[2]
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As traditional Bramley orchards in Ireland are being replaced with high density orchards; it is imperative that as these new orchards generate much higher yields as they have a much higher capital charge against them. In 2000, a range of different densities was planted : M9's at 672, 961 and 1492 trees per ha and M27's at 1279, 1492 and 1957 trees Ha-1 (imperial spacings were used to suit the local industry). Since the start of the experiment, yield has steadily increased with yields matching costs of production by year 4. By 2007 the most economical planting density was found to be the M9 rootstock at 1492 trees per ha which generated double the national yield. Both the highest M9 planting density (58 tonnes/ha) and the highest M27 planting density (38 tonnes/ha) generated the highest yields respectively suggesting there may be still further potential for increasing planting density.

Poster Abstract 124

Breeding of Stone Fruit Rootstocks Adapted to South African Soil and Climatic Conditions

S. Booi and H. Ham
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The stone fruit industry of South Africa has been challenged during the last decade by changes in climatic, market demand and consumer preferences, both locally and on the export market. For stone fruit cultivars to perform optimally, a combination of correct orchard practices as well as rootstocks is a key factor in competitive and successful farming. Therefore, the stone fruit rootstock breeding program concentrates on the breeding of new resistant rootstocks for stress conditions associated with low chilling (warmer winters), water logging, drought, high salinity soil, lime induced iron chlorosis and nematodes (ring and root knot). Special emphasis is also on assisting second economy producers (emerging farmers) who are often farming under less than optimal site conditions. New rootstocks are bred conventionally and then tested under controlled conditions to determine the level of stress resistance/tolerance. The most promising resistant selections are tested in rooting and horticultural trails to determine their compatibility with commercial cultivars. Exciting new results were obtained during the past season (2006-2007). Eight different screening trials were conducted with rooted cuttings and cross-pollinated seedlings. One of the evaluation trials included inoculation of both ring and root knot nematodes (*M. javanica* and *C. xenoplax*). A number of selections showed resistance/tolerance to both ring and root knot nematodes under experimental conditions. These results will be confirmed in a statistical trial before they can be promoted to Phase 2 for further evaluation trials that will concentrate on the rooting ability and horticultural traits.

Poster Abstract 125

Overview of Plum (*Prunus salicina*) Rootstocks in South Africa

P.J.C. Stassen and E.Y. Reinten
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Over a period of three decades, 20 trials with more than 50 different rootstocks have been conducted. From results, several rootstocks were made available to the plum industry to assist in the huge soil diversity and soil borne pathogen problems. In South Africa, Marianna is used for more than 70 years. This rootstock is immune against root knot nematodes, and adapted with its shallow rootstock to higher clay soil and rising water tables. It is however very sensitive to *Pseudomonas syringae* which is a problem in winter rainfall areas. Maridon, a Marianna progeny selected in South Africa is less affected by *P. syringae*. This rootstock is however not compatible with the plum cultivar Pioneer. There is no real difference in yield, fruit mass and tree size between Marianna and Maridon. The inter specie hybrid SAPO 778 was found to be a rootstock well adapted to a wide range of soil conditions and is currently widely use in the plum industry. GF 667 is recommended for high pH soils but showed signs of incompatibility with the plum cultivar Sapphire. The inter specie crossings Viking and Atlas render high yields and fruit mass to plum scions in higher potential soils, but Atlas is sensitive to wet soil conditions. Viking is adaptable to a range of soil conditions but performs poorly in sandy soils, where GF 667 and Flordaguard perform well. Viking can be used on high pH soil.

Poster Abstract 126

Progress in Developing Armillaria Resistant Rootstocks for Use with Peach

T.G. Beckman
USDA-ARS, 21 Dunbar Road, Byron, Georgia 31008, USA

Guardian™ (BY520-9) peach seedling rootstock was released in 1993 to provide a rootstock with superior resistance to peach tree short life (PTSL) which at the time was the number one cause of premature death of peach trees in the southeastern US production area. Since that time Guardian has become the dominant rootstock in this industry principally due to its exceptional resistance to PTSL. However, Guardian, like most peach seedling rootstocks, is highly susceptibility to Armillaria Root Rot (ARR) which, prior to Guardian's release, was the second most important cause of peach tree death in this industry. Since Guardian's release the rootstock development program at Byron has shifted its focus to the development of peach, plum and plum-peach interspecific hybrid materials with resistance to ARR, here incited principally by *A. tabescens*. In 2007 the USDA, in cooperation with the Univ. of Florida, released 'Sharpe' rootstock for grower trial on Armillaria infested sites. 'Sharpe' is a clonal plum hybrid rootstock with resistance to PTSL, ARR and root-knot nematodes (*Meloidogyne spp*). 'Sharpe' is semi-dwarf; producing trees ca. 60% the size of those budded on Guardian. A number of plum hybrid, and plum x peach interspecific hybrids are nearing release in the Byron program that provide not only superior resistance to PTSL, ARR and root-knot nematodes but also offer a range of vigor from 50% to 110% that of seedling peach with comparable, if not superior, horticultural productivity. An overview of advanced selections nearing release will be presented.

Poster Abstract 127

Pear Rootstock for Central Zone of Russia

Vadim Girichev
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The main rootstock for a pear in the central zone of Russian horticulture is seedlings of *Pyrus communis*. However, in northern regions the winter hardiness of such rootstock is insufficient. In our Institute along with breeding of pear varieties, the breeding of rootstocks is conducted too. At present time a new seed rootstock for pear 17-47-62 (F_2 from *Pyrus ussuriensiss*) with the high level of winter hardiness (wood is resistant up to 38°C below zero) is received and investigated. Furthermore, this form is characterized by high yielding capacity (62.2 kg per tree) and its seedlings have fibril root system. Alongside with the mentioned characteristic the fruits of this new rootstock have dessert taste.

Poster Abstract 128

Method of Constructing Core Collection for *Malus sieversii* Using Molecular Markers

ZHANG Chun-Yu, CHEN Xue-Sen, ZHANG Yan-Min, LIU Zun-Chun, WANG Yan-Ling
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The method for constructing core collection of *Malus sieversii* based on molecular markers data was proposed. According to 128 SSR allele of 109 *Malus sieversii*, an allele preferred sampling strategy was proposed to construct *M. sieversii* core collection using UPGMA cluster method according to Nei&Li, SM and Jaccard genetic distances by stepwise clustering and compared with the random sampling strategy. The number of lost allele and t-test of Nei's gene diversity and Shannon's Information index were used to evaluate representative of core collections. The results showed that compared with the random sampling strategy, allele preferred sampling could construct more representative core collections. SM, Jaccard and Nei & Li genetic distance had not distinct difference for construction of *M. sieversii* core collection. SRAP data showed that allele preferred sampling strategy was a good sampling strategy for constructing core collection of *M. sieversii*. When 25 *M. sieversii* accessions was selected, allele preferred sampling strategy combined with SM, Jaccard and Nei&Li genetic distances using stepwise clustering was the suitable method for constructing *M. sieversii* core collection.

Poster Abstract 129

Rootstock Effect on Fruit Drop Patterns and Quality of 'Galaxy' and 'Golden Reinders' Apples

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Generally, three main dropping periods are known in apples: i.) drop of the unfertilized flowers; ii.) June drop; and iii.) preharvest fruit drop, the rates of each can be influenced by varietal properties, environmental conditions and technological elements. This study aimed to investigate the effect of different growth inducing rootstocks on fruit drop and quality of the dropped and persisting fruit. A field experiment was conducted at Nagykutas, Western Hungary for 4 consecutive years on 'Galaxy' and 'Golden Reinders' apple trees. Three different growth inducing rootstocks were used for both cultivars: M.9 (dwarf), MM.106 (semi-vigorous) and seedling (vigorous). There were 3 exact fruit shedding periods for 'Galaxy' on M.9 and MM.106 rootstocks, but only 2 on seedling. Since 'Golden Reinders' is known as a cultivar with strong fruit-persisting habit, only 2 dropping waves could be found on all of three rootstocks; first at the end of bloom which can be characterized by the highest rate then a second at the end of June or early July with a very small amount. The rate of fruit drop was closely related to the seed count of the fruit; seed number was the lowest, fruit drop was the highest. The lowest seed number was counted in fruit from both examined cultivars on seedling. Fruit quality evaluations showed that persisting fruits are usually bigger in size with higher rate of red skin color and of dry matter content compared to the dropped ones. Flesh firmness of persisting fruit did not significantly differ from that of dropped ones. Decreasing tendency of fruit quality parameters was measured in the order of M.9, MM.106 and seedling rootstocks, except flesh firmness which was the highest in fruit from trees on seedling. Seasonal changes of leaf/fruit ratio was greatly influenced by shoot growth and the rate of fruit drop.

Poster Abstract 130

Management of Crop Load and Vegetative Growth on Honeycrisp to Optimize Fruit Size, Fruit Quality, Return Bloom and Fruit Set

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Department of Horticulture, Michigan State University, East Lansing, MI. 48824

The variety Honeycrisp is being widely planted by Michigan growers. It has outstanding flavor, crispness, and market demand. It currently is the most profitable variety in the industry. However, uniformity and regulation of fruit size and return bloom can greatly be influenced by crop load and tree vigor. This variety tends to be strongly biennial, which leads to very low crops one year and high crops the next. The objectives of this study were to:(1) conduct a detailed study on the effect of crop load on return bloom in relation to tree and seasonal variability, and (2) on crop quality (fruit firmness, total acidity, soluble solids, color and starch). This was accomplished by establishing 5 or 6 different crop loads (control, low, medium, high) at 4 different sites in two different years (2006, 2007) crop loads were adjusted by hand thinning. We also conducted a survey on several (n=9) different orchards in different locations (n=4) within Michigan. Data recorded were: crop characteristics (size, weight, color, bitter pit) vegetative growth (shoot length or vigor) and return bloom and fruit set, and physiological (zonal chlorosis or leaf photosynthesis). Results indicate the following: 1.There was a direct effect of crop load on current seasons crop quality. 2.Tree age affected this relationship. 3.There was a strong relationship between crop load and next years bloom, however crop load was not as negatively related to next years yield. 4.Bitter pit was not strongly related to crop load, except at the low crop (large fruit) level. 5.Leaf yellowing was related to crop load. 6.Yellowing was positively related to return bloom. 7.Vigorous rootstocks had less yellowing. 8.Photosynthesis was highly related to crop load. 9.Photosynthesis in green areas of low crop load trees had high rates and did not decrease in the afternoon. The information from this study will help producers have a better understanding of the factors that influence flower bud initiation and how they can improve annual cropping.

Poster Abstract 131

Carbon Supply, Demand, and Storage in Relation to Current Seasons Growth and the Following Years Yield

J. A. Flore
Department of Horticulture, Michigan State University, East Lansing, MI. 48824

Crop production and quality are dependent upon the supply and demand for carbon. The leaves are the primary organs responsible for photosynthesis in cherry. The carbon produced is utilized to produce fruit, leaves, stems, roots and buds for the next year. Since leaves are only on the tree about 7 months out of the year, any damage to the leaves will reduce the supply of carbon. Several approaches have been taken to determine the effect of foliage damage on current and next seasons fruit production. Experiments were conducted to determine the effect of leaf damage on both current and next years crop. Two approaches were used to model the supply of carbon. One, the Lakso Apple model of carbon supply and distribution for apple was modified for cherry (now about 70% complete) and two, modification of "Cherry Grower" a model based on Degree Days and past vigor is proposed and being modified to predict if supply and demand for carbon were in balance. However, neither of theses models predict the effect of stored carbohydrate on yield the next year. It was hypothesized that storage starch in the root or shoot could be a good indicator of performance the next year. We did not find a good association between Starch content and return yield or hardiness unless values were extremely low. Based on published and experimental data we developed a set of leaf damage thresholds for "Montmorency" cherry grown under Michigan conditions. On vigorous trees, greater than 20 cm of terminal growth, foliage must be reduced by approximately 50% for the duration of the season before there is a substantial decrease in deep winter hardiness. Reduced vigor (less than 10 cm growth, shading, or foliage damage due to mites) causes the relationship to move to the right, and hardiness begins to decrease at 65-70% foliage. These are estimates but are based on hardiness observation in different experiments in different years.

Poster Abstract 132

The cDNA-AFLP Profiling of Salt-stress Response in Apple

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The cDNA-AFLP (cDNA Amplified Fragment Length Polymorphism) analysis was used to identify genes involved in salt-stress response in Apple. After salt treatment, 68 up-regulated fragments and 28 down-regulated fragments amplified by 64 combinations of primers were recollected from salt resistant rootstock Malus zumi Mats. 17 fragments expressed differencially under salt-stress between Malus zumi Mats and salt sensitive rootstock Malus baccata Brokh were obtained as well. Reverse Northern was applied to confirm the fragments relative with salt-stress, which were sequenced. It provided a draft transcriptional profile of salt-stress responses in apple.

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EVP-2008-0020

ISHS

Cornell University
College of Agriculture and Life Sciences
New York State Agricultural Experiment Station

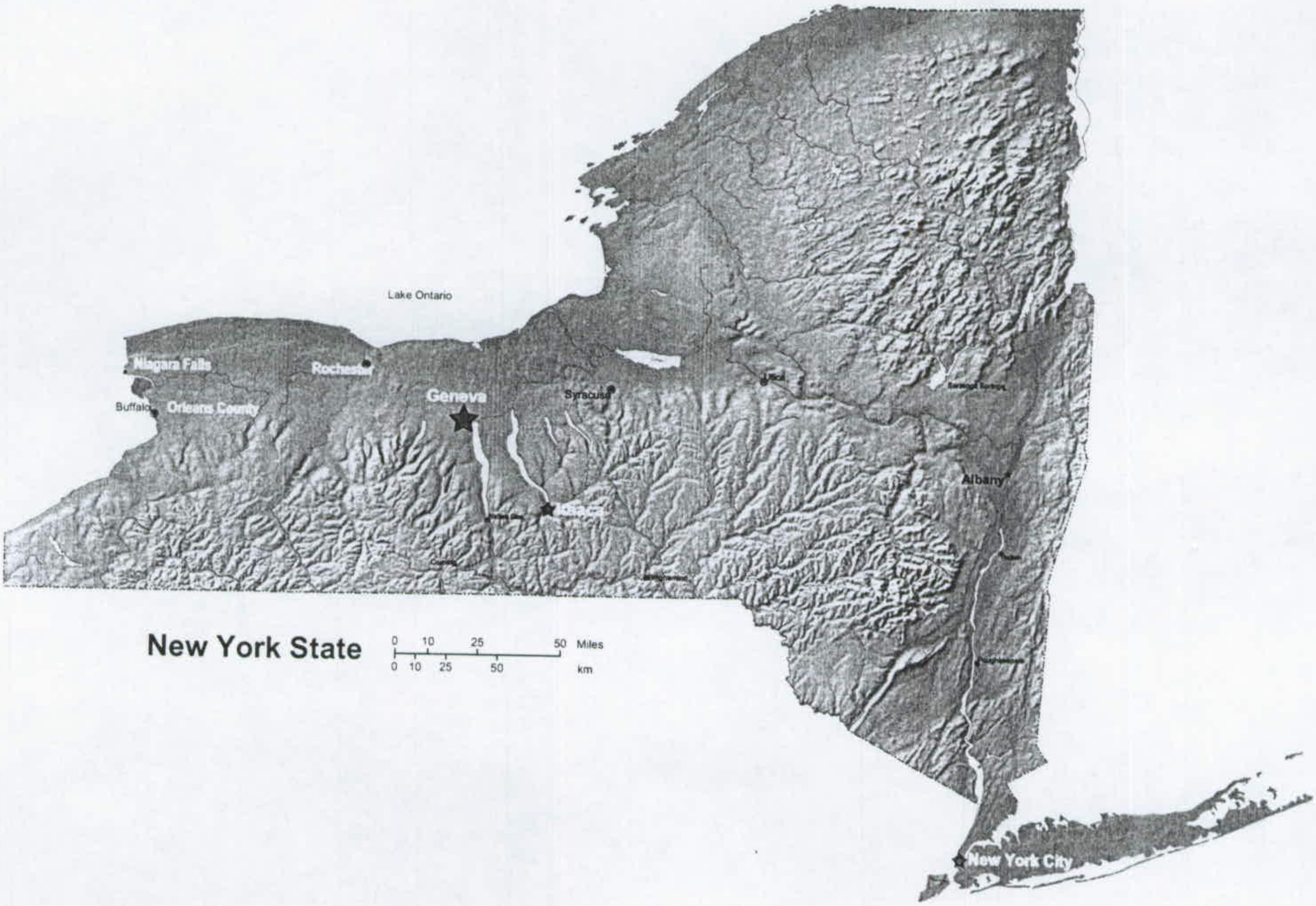
9th International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems

ISHS Tour • Tuesday, August 5, 2008
Cornell University 's New York State Agricultural Experiment Station, Geneva, New York

Tuesday-Tour, August 5, 2008 • New York State Agricultural Experiment Station

Tour Leader: **Terence Robinson**

Time	Topic	Presenter
2:45-3:15	Cherry Rootstocks, Systems and Fruit Size	Steve Hoying, Gabino Reginato, and Tae-Myung Yoon
3:15-3:45	Cornell-Geneva Rootstocks	Gennaro Fazio and Herb Aldwinckle
3:45-4:15	High Density Apple Management and CG Rootstocks	Terence Robinson, Leo Domínguez and Darius Kviklys
4:15-4:45	Whole Tree Photosynthesis and Carbon Model	Alan Lakso
4:45-5:15	Pear Rootstocks and Systems	Terence Robinson
5:15-6:00	High Tunnels for Stone Fruits	Terence Robinson



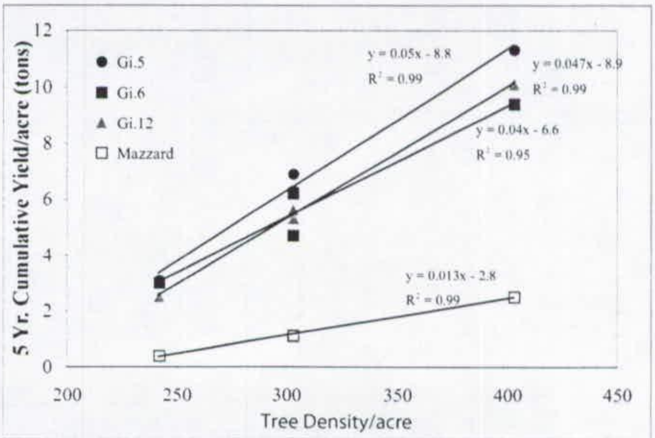
1. The Integrated System of Growing Sweet Cherries in New York

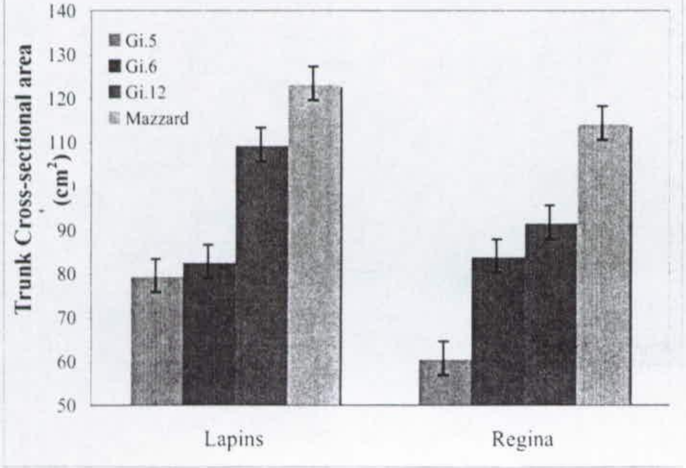
Terence Robinson, and Steve Hoying
With Rafael Parra, Gabino Reginato and Tae-Myung Yoon
Dept. of Horticultural Sciences, Geneva and Highland

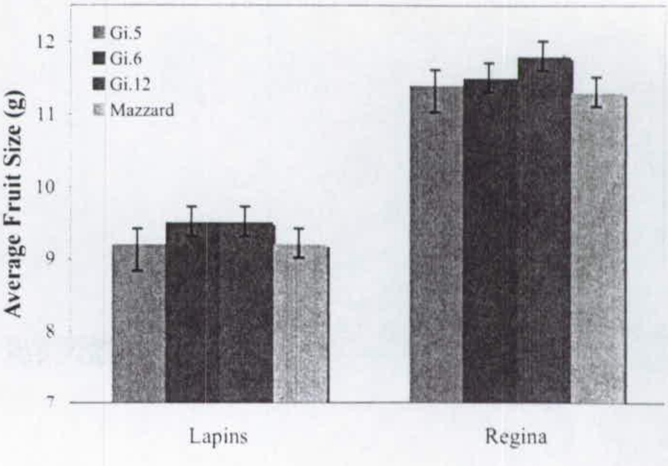
There is a significant opportunity to produce sweet cherries in New York state since there is a large and lucrative market in the Northeast for high quality sweet cherries. The introduction of dwarfing cherry rootstocks and newer varieties has allowed new possibilities for developing high-density cherry orchards that are more precocious and productive. Over the last 10 years a suite of improved management practices have been developed that together form the "Integrated System for Producing High Quality Sweet Cherries in NY". The system includes:

- intensive preplant soil tiling to reduce winter tree damage and reduce summer fruit cracking,
- planting trees on large berms to reduce winter tree damage and reduce summer fruit cracking,
- new varieties that are large and firm such as Regina or are late ripening such as Sweetheart to extend the harvest season.
- Semi-dwarfing rootstocks such as Gisela 6, and 12 for small fruited varieties and dwarfing rootstocks such as Gisela 5 for large fruited varieties.
- high tree planting densities (750-1000 trees/ha with Gisela 6 and 12 and 1200-2000 trees/ha with Gisela 5)
- bud removal to obtain branching without pruning,
- use of the vertical axis training system and minimal pruning for high early production or the modified Spanish Bush system for pedestrian orchards.
- branch bending through the use of clothespins and weights,
- limb renewal pruning using long stubs for limiting canopy size and reduced bacterial canker,
- intensive spring and fall copper spray programs to control bacterial canker,
- trickle irrigation to improve fruit size,
- stubbing back pruning and spur extinction to improve fruit size with Gisela rootstocks.
- a spray of gibberellic acid growth regulator at straw color to delay fruit maturity and to improve fruit firmness,
- rain protection nets or automatic Ca spray systems to control rain cracking,
- bird nets to eliminate bird predation,
- immediate hydro cooling or forced air cooling of the fruit after harvest,
- modified atmosphere bags (MAP bags) to extend shelf life.

Our results from this plot show the value of the precocious Gisela rootstocks and the value of high tree densities for early yields. The combination of Gisela 5 rootstock and Vertical Axis tree training produced a yield of 5.3 tons/acre in the 4th leaf and 8.6 tons/acre in the 5th leaf with Regina. The only draw back of the Vertical Axis system is tree height of 13ft. The Modified Spanish Bush had lower yields but can be picked from the ground



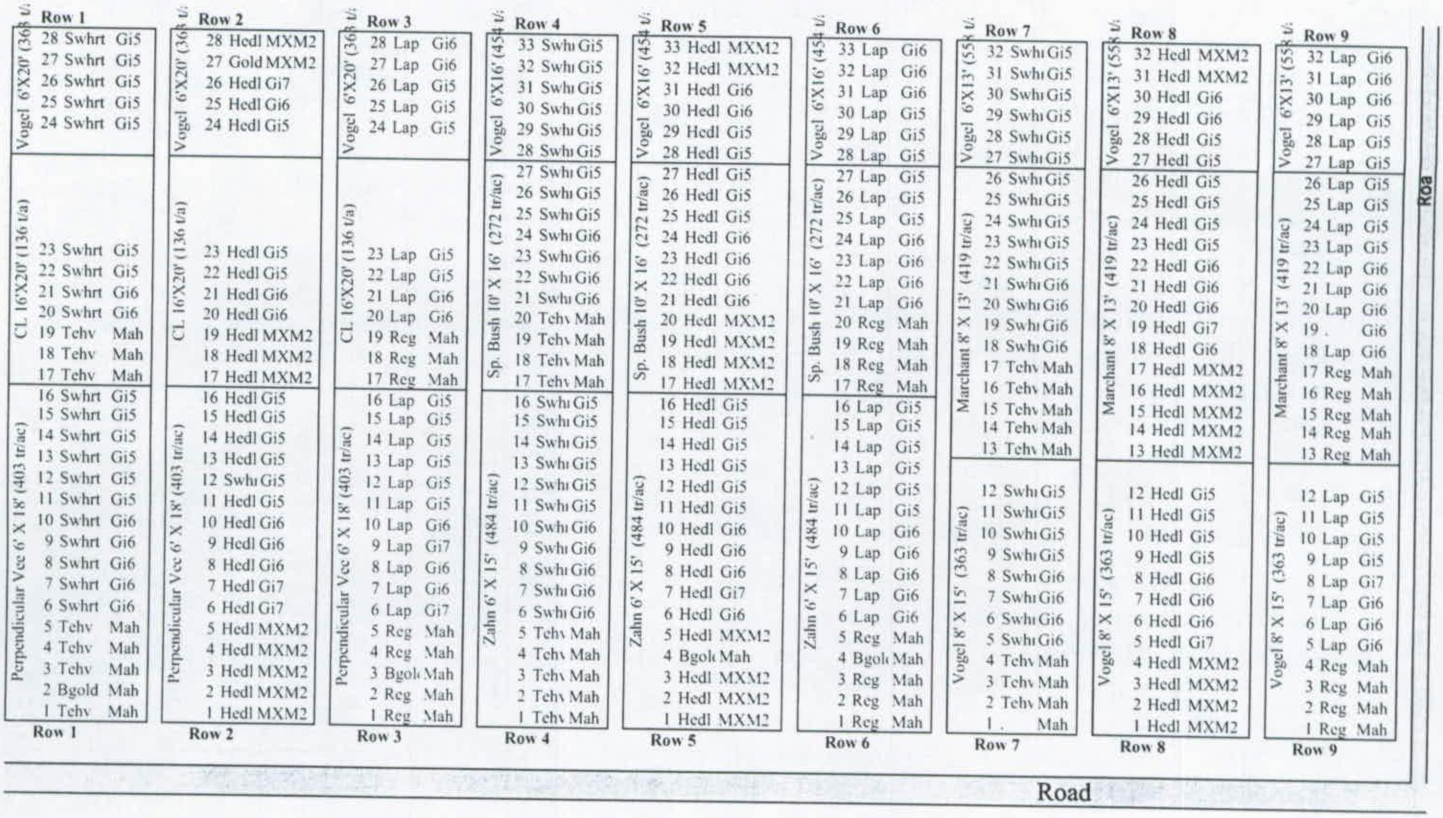




Loomis 1 Cherry Systems Trial

Planted May 1999

Rep 1



Row 1

Vogel 6'X20' (368 t/
28 Swhrt Gi5
27 Swhrt Gi5
26 Swhrt Gi5
25 Swhrt Gi5
24 Swhrt Gi5

CL 16'X20' (136 t/a)
23 Swhrt Gi5
22 Swhrt Gi5
21 Swhrt Gi6
20 Swhrt Gi6
19 Tehv Mah
18 Tehv Mah
17 Tehv Mah

Perpendicular Vee 6' X 18' (403 tr/ac)
16 Swhrt Gi5
15 Swhrt Gi5
14 Swhrt Gi5
13 Swhrt Gi5
12 Swhrt Gi5
11 Swhrt Gi5
10 Swhrt Gi6
9 Swhrt Gi6
8 Swhrt Gi6
7 Swhrt Gi6
6 Swhrt Gi6
5 Tehv Mah
4 Tehv Mah
3 Tehv Mah
2 Bgold Mah
1 Tehv Mah

Row 2

Vogel 6'X20' (368 t/
28 Hedl MXM2
27 Gold MXM2
26 Hedl Gi7
25 Hedl Gi6
24 Hedl Gi5

CL 16'X20' (136 t/a)
23 Hedl Gi5
22 Hedl Gi5
21 Hedl Gi6
20 Hedl Gi6
19 Hedl MXM2
18 Hedl MXM2
17 Hedl MXM2

Perpendicular Vee 6' X 18' (403 tr/ac)
16 Hedl Gi5
15 Hedl Gi5
14 Hedl Gi5
13 Hedl Gi5
12 Swhi Gi5
11 Hedl Gi5
10 Hedl Gi6
9 Hedl Gi6
8 Hedl Gi6
7 Hedl Gi7
6 Hedl Gi7
5 Hedl MXM2
4 Hedl MXM2
3 Hedl MXM2
2 Hedl MXM2
1 Hedl MXM2

Row 3

Vogel 6'X20' (368 t/
28 Lap Gi6
27 Lap Gi6
26 Lap Gi5
25 Lap Gi5
24 Lap Gi5

CL 16'X20' (136 t/a)
23 Lap Gi5
22 Lap Gi5
21 Lap Gi6
20 Lap Gi6
19 Reg Mah
18 Reg Mah
17 Reg Mah

Perpendicular Vee 6' X 18' (403 tr/ac)
16 Lap Gi5
15 Lap Gi5
14 Lap Gi5
13 Lap Gi5
12 Lap Gi5
11 Lap Gi5
10 Lap Gi6
9 Lap Gi7
8 Lap Gi6
7 Lap Gi6
6 Lap Gi7
5 Reg Mah
4 Reg Mah
3 Bgol Mah
2 Reg Mah
1 Reg Mah

Row 4

Vogel 6'X16' (454 t/
33 Swhi Gi5
32 Swhi Gi5
31 Swhi Gi5
30 Swhi Gi5
29 Swhi Gi5
28 Swhi Gi5

Sp. Bush 10' X 16' (272 tr/ac)
27 Swhi Gi5
26 Swhi Gi5
25 Swhi Gi5
24 Swhi Gi6
23 Swhi Gi6
22 Swhi Gi6
21 Swhi Gi6
20 Tehv Mah
19 Tehv Mah
18 Tehv Mah
17 Tehv Mah

Zahn 6' X 15' (484 tr/ac)
16 Swhi Gi5
15 Swhi Gi5
14 Swhi Gi5
13 Swhi Gi5
12 Swhi Gi5
11 Swhi Gi5
10 Swhi Gi6
9 Swhi Gi6
8 Swhi Gi6
7 Swhi Gi6
6 Swhi Gi6
5 Tehv Mah
4 Tehv Mah
3 Tehv Mah
2 Tehv Mah
1 Tehv Mah

Row 5

Vogel 6'X16' (454 t/
33 Hedl MXM2
32 Hedl MXM2
31 Hedl Gi6
30 Hedl Gi6
29 Hedl Gi5
28 Hedl Gi5

Sp. Bush 10' X 16' (272 tr/ac)
27 Hedl Gi5
26 Hedl Gi5
25 Hedl Gi5
24 Hedl Gi6
23 Hedl Gi6
22 Hedl Gi6
21 Hedl Gi6
20 Hedl MXM2
19 Hedl MXM2
18 Hedl MXM2
17 Hedl MXM2

Zahn 6' X 15' (484 tr/ac)
16 Hedl Gi5
15 Hedl Gi5
14 Hedl Gi5
13 Hedl Gi5
12 Hedl Gi5
11 Hedl Gi5
10 Hedl Gi6
9 Hedl Gi6
8 Hedl Gi6
7 Hedl Gi7
6 Hedl Gi6
5 Hedl MXM2
4 Bgol Mah
3 Hedl MXM2
2 Hedl MXM2
1 Hedl MXM2

Row 6

Vogel 6'X16' (454 t/
33 Lap Gi6
32 Lap Gi6
31 Lap Gi6
30 Lap Gi5
29 Lap Gi5
28 Lap Gi5

Sp. Bush 10' X 16' (272 tr/ac)
27 Lap Gi5
26 Lap Gi5
25 Lap Gi5
24 Lap Gi6
23 Lap Gi6
22 Lap Gi6
21 Lap Gi6
20 Reg Mah
19 Reg Mah
18 Reg Mah
17 Reg Mah

Zahn 6' X 15' (484 tr/ac)
16 Lap Gi5
15 Lap Gi5
14 Lap Gi5
13 Lap Gi5
12 Lap Gi5
11 Lap Gi5
10 Lap Gi6
9 Lap Gi6
8 Lap Gi6
7 Lap Gi6
6 Lap Gi6
5 Reg Mah
4 Bgol Mah
3 Reg Mah
2 Reg Mah
1 Reg Mah

Row 7

Vogel 6'X13' (558 t/
32 Swhi Gi5
31 Swhi Gi5
30 Swhi Gi5
29 Swhi Gi5
28 Swhi Gi5
27 Swhi Gi5

Marchant 8' X 13' (419 tr/ac)
26 Swhi Gi5
25 Swhi Gi5
24 Swhi Gi5
23 Swhi Gi5
22 Swhi Gi5
21 Swhi Gi6
20 Swhi Gi6
19 Swhi Gi6
18 Swhi Gi6
17 Tehv Mah
16 Tehv Mah
15 Tehv Mah
14 Tehv Mah
13 Tehv Mah

Vogel 8' X 15' (363 tr/ac)
12 Swhi Gi5
11 Swhi Gi5
10 Swhi Gi5
9 Swhi Gi5
8 Swhi Gi6
7 Swhi Gi6
6 Swhi Gi6
5 Swhi Gi6
4 Tehv Mah
3 Tehv Mah
2 Tehv Mah
1 . Mah

Row 8

Vogel 6'X13' (558 t/
32 Hedl MXM2
31 Hedl MXM2
30 Hedl Gi6
29 Hedl Gi6
28 Hedl Gi5
27 Hedl Gi5

Marchant 8' X 13' (419 tr/ac)
26 Hedl Gi5
25 Hedl Gi5
24 Hedl Gi5
23 Hedl Gi5
22 Hedl Gi6
21 Hedl Gi6
20 Hedl Gi6
19 Hedl Gi7
18 Hedl Gi6
17 Hedl MXM2
16 Hedl MXM2
15 Hedl MXM2
14 Hedl MXM2
13 Hedl MXM2

Vogel 8' X 15' (363 tr/ac)
12 Hedl Gi5
11 Hedl Gi5
10 Hedl Gi5
9 Hedl Gi5
8 Hedl Gi6
7 Hedl Gi6
6 Hedl Gi6
5 Hedl Gi7
4 Hedl MXM2
3 Hedl MXM2
2 Hedl MXM2
1 Hedl MXM2

Row 9

Vogel 6'X13' (558 t/
32 Lap Gi6
31 Lap Gi6
30 Lap Gi6
29 Lap Gi5
28 Lap Gi5
27 Lap Gi5

Marchant 8' X 13' (419 tr/ac)
26 Lap Gi5
25 Lap Gi5
24 Lap Gi5
23 Lap Gi5
22 Lap Gi6
21 Lap Gi6
20 Lap Gi6
19 . Gi6
18 Lap Gi6
17 Reg Mah
16 Reg Mah
15 Reg Mah
14 Reg Mah
13 Reg Mah

Vogel 8' X 15' (363 tr/ac)
12 Lap Gi5
11 Lap Gi5
10 Lap Gi5
9 Lap Gi5
8 Lap Gi7
7 Lap Gi6
6 Lap Gi6
5 Lap Gi6
4 Reg Mah
3 Reg Mah
2 Reg Mah
1 Reg Mah

1ft = 0.3048 m
1 ha = 2.471 acres

Loomis 2 Cherry Systems Trial

Planted June 2002

N

Row 10	Row 11	Row 12	Row 13	Row 14	Row 15	Row 16	Row 17	Row 18
Steep Leader 10' X 18' (242 tr/ac)	Steep Leader 10' X 18' (242 tr/ac)	Spanish Bush 8' X 18' (303 tr/ac)	Spanish Bush 8' X 18' (303 tr/ac)	Zahn 6' X 18' (403 tr/ac)	Zahn 6' X 18' (403 tr/ac)	Zahn 6' X 18' (403 tr/ac)	Vogel 8' X 18' (303 tr/ac)	Vogel 8' X 18' (303 tr/ac)
				27 Hud G5	27 **Hud** G5	27 **Hud** G5		
				26 Hud G5	26 Reg G5	26 Lap G5		
				25 Hud G5	25 Reg G5	25 Lap G5		
				24 Hud G5	24 Reg G5	24 Lap G5		
				23 Hud G5	23 Reg G5	23 Lap G5		
				22 Hud G5	22 Reg G5	22 Lap G5		
		21 **Hud** G5	21 **Hud** G12	21 Hud G5	21 Reg G5	21 Lap G5	21 **Hud** G5	21 **Hud** G5
		20 Reg G5	20 Lap G5	20 Hud G5	20 Reg G12	20 Lap G12	20 Reg G5	20 Lap G5
		19 Reg G5	19 Lap G5	19 Hud G5	19 Reg G12	19 Lap G12	19 Reg G5	19 Lap G5
		18 Reg G5	18 Lap G5	18 Hud G5	18 Reg G12	18 Lap G12	18 Reg G5	18 Lap G5
17 **Hud** G12	17 **Hud** G12	17 Reg G5	17 Lap G5	17 Hud G5	17 Hud G6	17 Lap G12	17 Reg G5	17 Lap G5
16 Reg G5	16 Lap G5	16 Reg G5	16 Lap G5	16 Hud G5	16 Reg G6	16 Lap G12	16 Reg G5	16 Lap G5
15 Reg G5	15 Lap G5	15 Reg G12	15 Lap G12	15 Hud G12	15 Reg G6	15 Lap G6	15 Reg G5	15 Lap G12
14 Reg G5	14 **WG** G5	14 Reg G12	14 Lap G12	14 Hud G12	14 Reg G6	14 Lap G6	14 Reg G12	14 Lap G12
13 Reg G5	13 Lap G5	13 Reg G12	13 Lap G12	13 Hud G12	13 Reg G6	13 Lap G6	13 Reg G12	13 Lap G12
12 Reg G12	12 Lap G12	12 Ske G6	12 Lap G12	12 Hud G12	12 Reg G6	12 Lap G6	12 Reg G12	12 Lap G12
11 Reg G12	11 Lap G12	11 Reg G6	11 Lap G6	11 Hud G6	11 Reg G6	11 Lap G6	11 Reg G6	11 Lap G6
10 Reg G12	10 Lap G12	10 Reg G6	10 Lap G6	10 Hud G6	10 Reg G6	10 Lap G6	10 Reg G6	10 Lap G6
9 Reg G6	9 Lap G6	9 Reg G6	9 Lap G6	9 Hud G6	9 Reg G6	9 Lap G6	9 **Rai** G6	9 Lap G6
8 Reg G6	8 Lap G6	8 Reg G6	8 Lap G6	8 Hud G6	8 Reg Maz	8 Lap Maz	8 Reg G6	8 Lap G6
7 Reg G6	7 Lap G6	7 Reg G6	7 Lap G6	7 Hud G6	7 Reg Maz	7 Lap Maz	7 **Rai** G6	7 Lap G6
6 Reg G6	6 Lap G6	6 Reg Maz	6 Lap Maz	6 Hud Maz	6 Reg Maz	6 Lap Maz	6 Reg Maz	6 Lap Maz
5 Reg Maz	5 Lap Maz	5 Reg Maz	5 Lap Maz	5 Hud Maz	5 Reg Maz	5 Lap Maz	5 Reg Maz	5 Lap Maz
4 Reg Maz	4 Lap Maz	4 Reg Maz	4 Lap Maz	4 Hud Maz	4 Reg Maz	4 Lap Maz	4 Reg Maz	4 Lap Maz
3 Reg Maz	3 Lap Maz	3 Reg Maz	3 Lap Maz	3 Hud Maz	3 Reg Maz	3 Lap Maz	3 Reg Maz	3 Lap Maz
2 Reg Maz	2 Lap Maz	2 Reg Maz	2 Lap Maz	2 Hud Maz	2 Reg Maz	2 Lap Maz	2 Reg Maz	2 Lap Maz
1 **Hud** G6	1 **Hud** G6	1 **Hud** G6	1 **Hud** G6	1 Hud Maz	1 **Hud** G6	1 **Hud** G6	1 **Hud** G6	1 **Hud** G6
Row 10	**Row 11**	**Row 12**	**Row 13**	**Row 14**	**Row 15**	**Row 16**	**Row 17**	**Row 18**

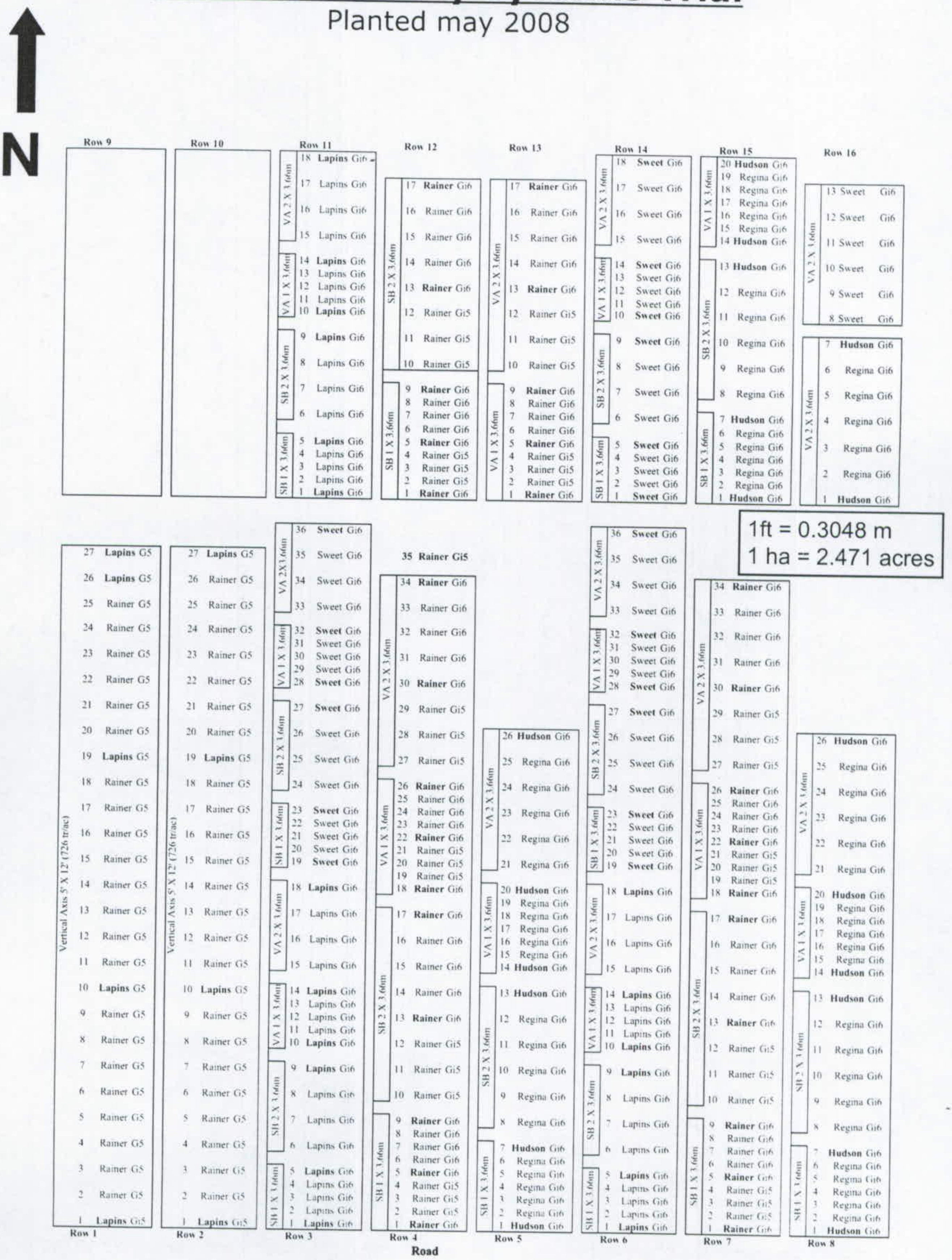
Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8	Row 9
Vogel 8' X 18' (303 tr/ac)	Vogel 8' X 18' (303 tr/ac)	Zahn 6' X 18' (403 tr/ac)	Zahn 6' X 18' (403 tr/ac)	Spanish Bush 8' X 18' (303 tr/ac)	Spanish Bush 8' X 18' (303 tr/ac)	Spanish Bush 8' X 18' (303 tr/ac)	Steep Leader 10' X 18' (242 tr/ac)	Steep Leader 10' X 18' (242 tr/ac)
		27 **Hud** G5	27 Lap G12					
		26 Reg G5	26 Lap G5					
		25 Reg G5	25 Lap G5					
		24 Reg G5	24 Lap G5					
		23 Reg G5	23 Lap G5					
		22 Reg G5	22 Lap G5					
21 **Hud** G5	21 Lap G12	21 Reg G5	21 Lap G5	21 Hud G5	21 **Hud** G5	21 Lap G5		
20 Reg G5	20 Lap G5	20 Reg G5	20 Lap G12	20 Hud G5	20 Reg G5	20 Lap G5		
19 Reg G5	19 Lap G5	19 Reg G5	19 Lap G12	19 Hud G5	19 Reg G5	19 Lap G5		
18 Reg G5	18 Lap G5	18 Reg G12	18 Lap G12	18 Hud G5	18 Reg G5	18 Lap G5		
17 Reg G5	17 Lap G5	17 Reg G12	17 Lap G12	17 Hud G5	17 Reg G5	17 Lap G5	17 **Hud** G5	17 Lap G5
16 Reg G5	16 Lap G5	16 Reg G12	16 Lap G12	16 Hud G5	16 Reg G5	16 Lap G5	16 Reg G5	16 Lap G5
15 Reg G5	15 Lap G12	15 Reg G6	15 **WG** G6	15 Hud G12	15 Reg G5	15 Lap G12	15 Reg G5	15 Lap G5
14 Reg G12	14 Lap G12	14 Reg G6	14 **WG** G6	14 Hud G12	14 Reg G12	14 Lap G12	14 Reg G5	14 Lap G5
13 Reg G12	13 Lap G12	13 Reg G6	13 Lap G6	13 Hud G12	13 Reg G12	13 Lap G12	13 Reg G5	13 Lap G5
12 Reg G12	12 Lap G12	12 Reg G6	12 Lap G6	12 Hud G12	12 Reg G12	12 Lap G12	12 Reg G12	12 Lap G12
11 Reg G6	11 Lap G6	11 Reg G6	11 Lap G6	11 Hud G6	11 Reg G6	11 Lap G6	11 Reg G12	11 Lap G12
10 Reg G6	10 Lap G6	10 **Rai** G6	10 Lap G6	10 Hud G6	10 Reg G6	10 Lap G6	10 Reg G12	10 Lap G12
9 Reg G6	9 Lap G6	9 Reg G6	9 Lap G6	9 Hud G6	9 Reg G6	9 Lap G6	9 Reg G6	9 Lap G6
8 Reg G6	8 Lap G6	8 Reg Maz	8 Lap Maz	8 Hud G6	8 Reg G6	8 Lap G6	8 Reg G6	8 Lap G6
7 Reg G6	7 Lap G6	7 Reg Maz	7 Lap Maz	7 Hud G6	7 Reg G6	7 Lap G6	7 **Rai** G6	7 Lap G6
6 Reg Maz	6 Lap Maz	6 Reg Maz	6 Lap Maz	6 Hud Maz	6 Reg Maz	6 Lap Maz	6 Reg G6	6 Lap G6
5 Reg Maz	5 Lap Maz	5 Reg Maz	5 Lap Maz	5 Hud Maz	5 Reg Maz	5 Lap Maz	5 Reg Maz	5 Lap Maz
4 Reg Maz	4 Lap Maz	4 Reg Maz	4 Lap Maz	4 Hud Maz	4 Reg Maz	4 Lap Maz	4 Reg Maz	4 Lap Maz
3 Reg Maz	3 Lap Maz	3 Reg Maz	3 Lap Maz	3 Hud Maz	3 Reg Maz	3 Lap Maz	3 Reg Maz	3 Lap Maz
2 Reg Maz	2 Lap Maz	2 Reg Maz	2 Lap Maz	2 Hud Maz	2 Reg Maz	2 Lap Maz	2 Reg Maz	2 Lap Maz
1 **Hud** G6	1 Lap Maz	1 **Hud** G6	1 Lap Maz	1 Hud Maz	1 **Hud** G6	1 Lap G6	1 **Hud** G6	1 Lap G6
Row 1	**Row 2**	**Row 3**	**Row 4**	**Row 5**	**Row 6**	**Row 7**	**Row 8**	**Row 9**

Road

1ft = 0.3048 m
1 ha = 2.471 acres

Loomis 3 Cherry Systems Trial

Planted may 2008



1ft = 0.3048 m
1 ha = 2.471 acres

2. Promising New Apple Rootstocks

Terence Robinson, Gennaro Fazio and Herb Aldwinckle
Dept. of Horticultural Sciences and USDA, Geneva

We are evaluating rootstocks from around the world to identify improved apple rootstocks which are dwarfing and highly productive but also have resistance to fire blight and tolerance to the winters in upstate NY. The winter of 2002/2003 in the Champlain Valley has shown that M.26, M.9 and B.9 are susceptible to winter cold when there is no snow cover.

In this plot we are evaluating new rootstocks from Geneva (G and CG series), Japan (JM series), Czech Republic (JTE series), Germany (PiAu series), and Russia (Bud series) using Golden Delicious as the scion. After 4 years the smallest trees were on JTE-G, and B.9. A slightly larger group included M.9T337, G.41, G.16, G.935, M.26, Bud62-396, JM.10 CG.5179, JM.7, and M.9 Pajam2. An intermediate group included CG.4210, PiAu.51-11 JM.4, JM.8 and JTE-H. The largest trees were on JM.5, PiAu.36-2, PiAu 56-83, PiAu51-4and JM.2.

Among CG stocks, G.16 and G.41 were the smallest followed by G.935, CG.5179 and CG.4210. Among the JM stocks JM.10 was the smallest followed by JM.7, JM.1, JM.8, JM.4, JM.2 and JM.5. Among M.9 clones, M.9T337 was smaller than M.9Pajam2. Among Budagovsky stocks B.62-396 was significantly larger than B.9 and similar to M.9Pajam2. Among JTE stocks, JTE-H was much larger than JTE-G which was the most dwarfing stock in the trial. Among PiAu stocks PiAu 51.11 was the most dwarfing followed by PiAu 36-2, PiAu 56-83 and PiAu 51-4. All of the PiAu stocks were relatively vigorous and non-productive.

Cumulative yield was greatest with CG.4210, followed by G.41, JM.8, JM.7 G.935 and JTE-H. The greatest yield efficiency was with G.41 followed by JTE-G, B.9 G.16, G.935, and JM.8.

From this trial we conclude:

- All CG stocks performed very well with G.41 being the best dwarfing stock and G.935 being the best semi-dwarfing stock.
- Among the JM stocks, JM.8 was the best followed by JM.7 and JM.4. Four JM stocks (1, 2, 5, and 10) performed very poorly and should be discarded. JM.4, 7 and 8 warrant further testing.
- Among Budagovsky stocks B.9 was too dwarfing in this replant soil while B.62-396 was significantly larger and similar in size and productivity to M.9Pajam2. It has potential in preplant sites.
- Among JTE stocks, JTE-G was too dwarfing while JTE-H performed similarly to M.9Pajam2.
- None of the PiAu stocks performed well and should all be discarded.

2003 NC-140 Golden Del. Trial (Five years of data)

Stock*	% Survival 2007	TCA Nov 2007	Cum Fruit No	Cum Yld	Cum Yld Eff	Av Fruit Size (g)	Cum Suckers	Tree Height (m)	Canopy Voume (m^3)
JTEG	100	5.6	117.4	15.8	2.85	153.4	0.0	1.74	0.53
Bud9	100	9.3	216.4	26.4	2.82	147.3	1.3	2.09	1.36
M9T337	100	15.4	250.9	32.2	2.14	147.7	0.6	2.44	2.48
CG3041	100	15.9	305.0	42.1	2.69	151.5	0.0	2.49	2.02
G16	88	16.3	264.1	30.2	1.89	139.4	0.4	2.25	1.58
CG5935	100	18.6	363.3	40.8	2.22	133.2	1.1	2.65	2.78
BUD62396	100	18.7	270.9	38.0	2.03	153.8	0.4	2.54	2.09
M26EMLA	100	19.7	308.8	37.3	1.91	143.3	1.6	2.66	2.80
CG5179	88	20.0	383.6	38.1	1.93	122.7	2.5	2.92	3.49
JM7	100	20.4	321.6	44.0	2.17	160.1	0.0	2.53	2.77
M9Pajam	100	20.9	321.0	39.9	1.97	151.1	0.4	2.56	2.63
JM10	100	22.1	174.8	22.4	1.02	144.1	0.3	2.80	2.26
JTEH	100	23.8	329.1	43.3	1.85	156.6	0.5	2.61	3.69
JM8	100	24.8	288.2	41.0	1.96	162.7	0.3	2.67	4.67
JM1	100	26.2	120.8	15.3	0.77	130.9	0.7	2.72	1.89
PiAu511	100	29.4	257.6	33.3	1.16	154.1	0.8	2.94	3.02
JM4	100	30.1	217.0	29.7	1.00	154.4	0.0	2.92	2.59
CG4210	100	30.3	553.3	63.2	2.10	140.7	0.4	3.01	4.15
PiAu5683	100	40.5	237.6	30.9	0.77	148.2	0.3	3.31	4.89
PiAu514	100	41.5	312.0	42.6	1.04	149.0	0.6	3.32	4.51
PiAu362	100	41.8	347.0	49.9	1.20	170.7	0.0	3.33	5.37
JM2	100	45.8	111.9	15.5	0.34	145.2	0.1	3.24	2.91
JM5	100	46.5	225.2	31.2	0.68	150.7	1.4	3.26	3.89
LSD $p \leq 0.05$	**12**	**6.2**	**97.1**	**10.0**	**0.51**	**17.6**	**2.1**	**0.34**	**1.53**

*Rootstocks ranked by Trunk Cross-Sectional Area

Hansen 16 2003 NC-140 Rootstock Trial

Spacing 2.5 X 4.5m, planted April 2003

↑ N

Tree #	Row 5	Row 4	Row 3	Row 2
52	Guard	Guard	Guard	Guard
51	M.9T337	G.16	M.26EMLA	M.26EMLA
50	G.16	M.26EMLA	G.16	G.16
49	M.26EMLA	M.9T337	M.9T337	M.9T337
48	M.9T337	M.26EMLA	G.16	M.26EMLA
47	G.16	G.16	M.26EMLA	M.9T337
46	M.26EMLA	M.26EMLA	M.9T337	G.16
45	G.16	M.9T337	Guard	Guard
44	M.9T337	G.16	PiAu5.11	M.26EMLA
43	M.26EMLA	Guard	CG.5935	J.TE.H
42	M.9T337	M.9Pajam	JM.8	PiAu.51.4
41	Guard	CG.4210	JM.7	M.9T337
40	J.TE.H	J.TE.G	PiAu.51.4	CG.5935
39	JM.7	PiAu.56.83	PiAu.56.83	JM.2
38	BUD.62.396	M.26EMLA	JM.1	G.16
37	M.9Pajam	CG.5935	BUD.62.396	CG.4210
36	G.16	CG.5935	CG.5179	M.9Pajam
35	PiAu.56.83	PiAu5.11	CG.3041	G.16
34	J.TE.H	JM.4	CG.4210	JM.5
33	CG.3041	G.16	PiAu.56.83	J.TE.G
32	M.26EMLA	CG.3041	JM.4	J.TE.H
31	J.TE.G	BUD.62.396	JM.7	CG.3041
30	JM.8	JM.1	BUD.62.396	M.26EMLA
29	JM.10	PiAu.51.4	M.9Pajam	JM.4
28	CG.5179	Bud.9	M.9T337	J.TE.G
27	M.9T337	PiAu5.11	Bud.9	PiAu5.11
26	M.9T337	JM.2	JM.10	JM.2
25	Bud.9	CG.5179	CG.5179	Bud.9
24	JM.5	Guard	Guard	Guard
23	Guard	CG.3041	JM.2	CG.5935
22	M.26EMLA	CG.5179	CG.4210	CG.3041
21	CG.3041	J.TE.H	JM.4	M.9T337
20	Bud.9	J.TE.G	PiAu5.11	J.TE.G
19	BUD.62.396	G.16	G.16	M.9T337
18	M.9T337	M.9Pajam	J.TE.H	CG.3041
17	PiAu.51.4	CG.5935	CG.5935	CG.4210
16	CG.5935	JM.2	G.16	PiAu.51.4
15	J.TE.G	PiAu.56.83	JM.5	M.9Pajam
14	JM.4	Bud.9	J.TE.H	M.9Pajam
13	M.9T337	CG.5179	CG.5179	PiAu5.11
12	JM.8	JM.2	JM.8	JM.8
11	PiAu.36.2	JM.7	PiAu.36.2	JM.5
10	PiAu.56.83	JM.1	JM.1	M.26EMLA
9	M.9Pajam	PiAu.51.4	J.TE.G	CG.5179
8	G.16	JM.4	M.26EMLA	PiAu.56.83
7	CG.4210	JM.5	Bud.9	JM.7
6	PiAu5.11	BUD.62.396	JM.4	PiAu.51.4
5	JM.1	JM.8	PiAu.56.83	JM.10
4	J.TE.H	JM.7	BUD.62.396	JM.2
3	JM.10	M.26EMLA	Bud.9	BUD.62.396
2	CG.4210	PiAu5.11	JM.7	JM.1
1	Guard	Guard	Guard	Guard

3. Apple Physiology

Alan N. Lakso

Department of Horticultural Sciences, Geneva

Several techniques used in our apple physiology will be demonstrated. These include whole canopy gas exchange with an automated datalogging system, sap flow gauges (used with calibration by canopy gas exchange), minirhizotron root observation system, laser canopy analyzer, and fruit growth sensors. Examples of results will be provided.

4. Return Bloom With Honeycrisp

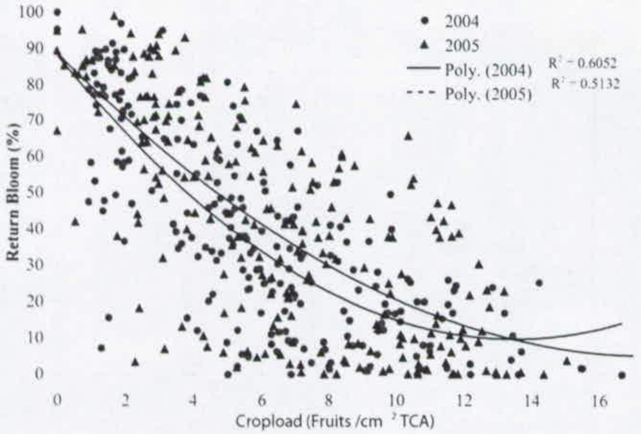
Terence Robinson and Steve Hoying

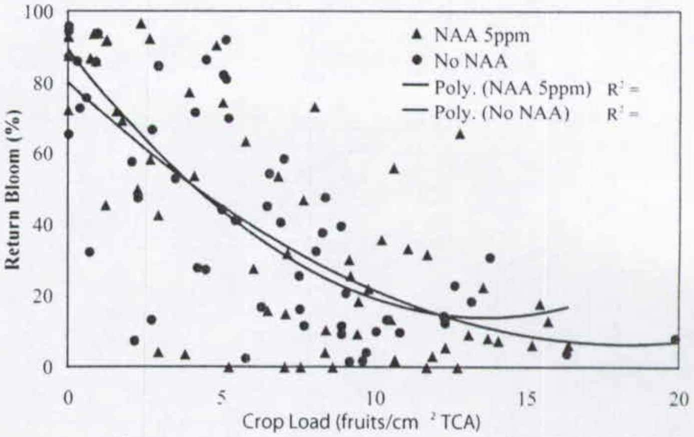
Department of Horticultural Sciences, Geneva and Highland

Honeycrisp apple has shown extreme biennial bearing in NY State. Our studies in this plot have shown that cropload exceeds 5 fruits/cm^2 TCA fruit size return bloom the next year was almost nonexistent. In our current study we are studying the interaction of cropload and mineral nutrient content. Efforts to reduce bienniality by either high nitrogen, high potassium or foliar N,B,Zn,Mg or Ca have not been successful. More successful has been the application of summer sprays of either 2oz NAA/100 gallons or 0.5 pt Ethrel/100 gallons. Our trials have shown that 4 weekly sprays starting in late June are better than 2 or 1 spray. We have also shown that 4 sprays of Ethrel led to increase pre-harvest drop and advanced maturity. It is likely that the last sprays in the 3rd week of July were too close to harvest and affected fruit ripening.

Despite many growers utilizing summer NAA sprays in 2005 there was widespread lack of bloom across the state in 2006 followed by snowball bloom in 2007. In an effort to solve this problem we are conducting 3 trials in 2007 (Geneva, Highland and Champlain) to determine the proper timing of NAA or Ethrel sprays and if the rate of NAA can be increased for better response. We are also studying the effect of different croploads on the return bloom response to summer NAA sprays.

To manage biennial bearing we currently recommend a multi-spray thinning program beginning with a petal fall application of 2oz NAA + 1pt Sevin XLR followed by a spray of 3oz NAA/100 gallons + 2pt Sevin XLR/100 gallons at 12 mm fruit size. This should be followed by a summer NAA program of 4 weekly sprays of 3oz NAA/100 gallons beginning on June 21.





Hansen 14E, Nutrition/Cropload Study

Honeycrisp/M.9, 4x1m, planted May 2002

↑ N

Tree #	Row 5	Trt	Row 4	Trt	Row 3	Trt	Row 2	Trt	Row 1	Trt
59	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
58	**Zestar**	.	HCrisp	.	HCrisp	.	HCrisp	5	HCrisp	5
57	HCrisp	.	HCrisp	.	HCrisp	.	HCrisp	5	HCrisp	5
56	HCrisp	.	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
55	**Zestar**	.	HCrisp	2	HCrisp	3	HCrisp	12	HCrisp	4
54	HCrisp	14	HCrisp	2	HCrisp	3	HCrisp	12	HCrisp	4
53	HCrisp	14	HCrisp	2	HCrisp	3	HCrisp	12	HCrisp	4
52	HCrisp	14	HCrisp	2	HCrisp	3	HCrisp	12	HCrisp	4
51	HCrisp	14	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
50	**Zestar**	.	HCrisp	13	HCrisp	8	HCrisp	1	HCrisp	11
49	HCrisp	6	HCrisp	13	HCrisp	8	HCrisp	1	HCrisp	11
48	HCrisp	6	HCrisp	13	HCrisp	8	HCrisp	1	HCrisp	11
47	HCrisp	6	HCrisp	13	HCrisp	8	HCrisp	1	HCrisp	11
46	HCrisp	6	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
45	HCrisp	9	HCrisp	7	HCrisp	10	HCrisp	7	HCrisp	6
44	HCrisp	9	HCrisp	7	HCrisp	10	HCrisp	7	HCrisp	6
43	HCrisp	9	HCrisp	7	HCrisp	10	HCrisp	7	HCrisp	6
42	HCrisp	9	HCrisp	7	HCrisp	10	HCrisp	7	HCrisp	6
41	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
40	HCrisp	11	HCrisp	12	HCrisp	9	HCrisp	5	HCrisp	8
39	HCrisp	11	HCrisp	12	HCrisp	9	HCrisp	5	HCrisp	8
38	HCrisp	11	HCrisp	12	HCrisp	9	HCrisp	5	HCrisp	8
37	HCrisp	11	HCrisp	12	HCrisp	9	HCrisp	5	HCrisp	8
36	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
35	HCrisp	3	HCrisp	1	HCrisp	13	HCrisp	10	HCrisp	14
34	HCrisp	3	HCrisp	1	HCrisp	13	HCrisp	10	HCrisp	14
33	HCrisp	3	HCrisp	1	HCrisp	13	HCrisp	10	HCrisp	14
32	HCrisp	3	HCrisp	1	HCrisp	13	HCrisp	10	HCrisp	14
31	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
30	HCrisp	2	HCrisp	4	HCrisp	6	HCrisp	9	HCrisp	7
29	HCrisp	2	HCrisp	4	HCrisp	6	HCrisp	9	HCrisp	7
28	HCrisp	2	HCrisp	4	HCrisp	6	HCrisp	9	HCrisp	7
27	HCrisp	2	HCrisp	4	HCrisp	6	HCrisp	9	HCrisp	7
26	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
25	HCrisp	1	HCrisp	14	HCrisp	11	HCrisp	13	HCrisp	3
24	HCrisp	1	HCrisp	14	HCrisp	11	HCrisp	13	HCrisp	3
23	HCrisp	1	HCrisp	14	HCrisp	11	HCrisp	13	HCrisp	3
22	HCrisp	1	HCrisp	14	HCrisp	11	HCrisp	13	HCrisp	3
21	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
20	HCrisp	10	HCrisp	8	HCrisp	12	HCrisp	4	HCrisp	2
19	HCrisp	10	HCrisp	8	HCrisp	12	HCrisp	4	HCrisp	2
18	HCrisp	10	HCrisp	8	HCrisp	12	HCrisp	4	HCrisp	2
17	**Zestar**	.	HCrisp	8	HCrisp	12	HCrisp	4	HCrisp	2
16	HCrisp	5	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
15	HCrisp	5	HCrisp	9	HCrisp	14	HCrisp	11	HCrisp	10
14	HCrisp	5	HCrisp	9	HCrisp	14	HCrisp	11	HCrisp	10
13	HCrisp	5	HCrisp	9	HCrisp	14	HCrisp	11	HCrisp	10
12	HCrisp	5	HCrisp	9	HCrisp	14	HCrisp	11	HCrisp	10
11	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
10	HCrisp	4	HCrisp	13	HCrisp	5	HCrisp	2	HCrisp	1
9	HCrisp	4	HCrisp	13	HCrisp	5	HCrisp	2	HCrisp	1
8	HCrisp	4	HCrisp	13	HCrisp	5	HCrisp	2	HCrisp	1
7	HCrisp	4	HCrisp	13	HCrisp	5	HCrisp	2	HCrisp	1
6	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
5	HCrisp	6	HCrisp	7	HCrisp	3	HCrisp	12	HCrisp	8
4	HCrisp	6	HCrisp	7	HCrisp	3	HCrisp	12	HCrisp	8
3	HCrisp	6	HCrisp	7	HCrisp	3	HCrisp	12	HCrisp	8
2	HCrisp	6	HCrisp	7	HCrisp	3	HCrisp	12	HCrisp	8
1	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.	**Zestar**	.
Tree #	**Row 5**	Trt	**Row 4**	Trt	**Row 3**	Trt	**Row 2**	Trt	**Row 1**	Trt

Trt 1+2=Unfertilized Control
Trt 3+4=100Kg N = 258g CaNO3/tree
Trt 5+6=200Kg K20 = 133g KCl/tree
Trt 7+8=100Kg N +200 Kg K20 = 258g CaNO3/tree + 133g KCl/tree
Trt 9+10=50Kg N + 100 Kg K20 = 60.6g NH4NO3/tree + 66.7g KCl/tree
Trt 11+12=50Kg N + 100 Kg K20 + Foliar NBZNMG = 60.6g NH4NO3/tree + 66.7g KCl/tree
Trt 13+14=50Kg N + 100 Kg K20 + Foliar NBZNMG+ Foliar Ca = 60.6g NH4NO3/tree + 66.7g KCl/tree

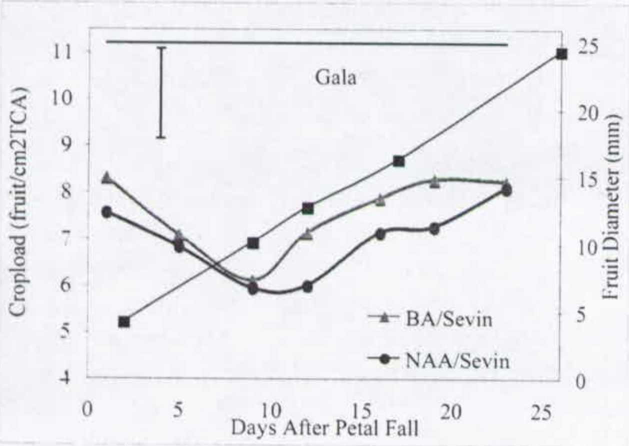
5. CHEMICAL THINNING OF APPLE

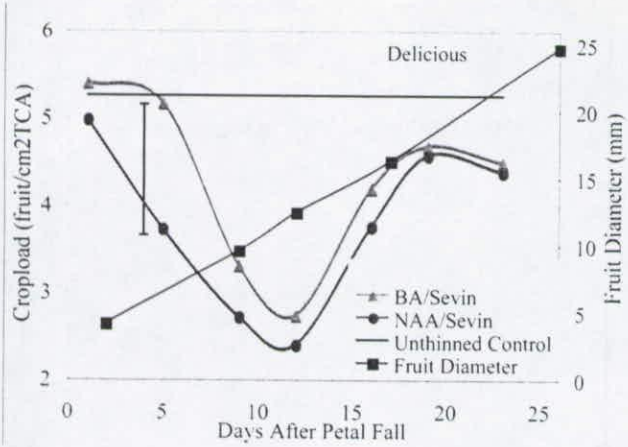
Terence Robinson and Alan Lakso
With Rafael Parra, Gabino Reginato, Tae-Myung Yoon and Darius Kviklys
Department of Horticultural Sciences, Geneva

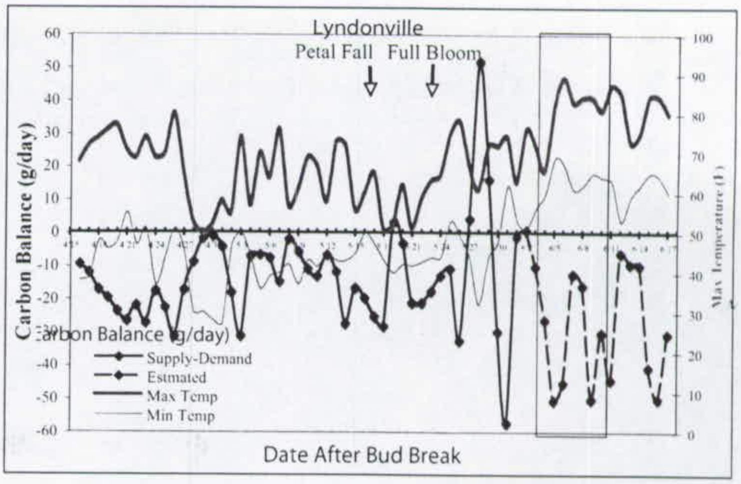
This trial compares the timing of application of 75ppm Maxcel+Sevin or 7.5ppm NAA+Sevin to either Gala, McIntosh or Delicious. In 2008 there was good thinning temperatures (70-85°F) from petal fall to 21 days after petal fall. The best thinning was achieved between 7 and 11 days after petal fall. By 21 days after petal fall fruits were 20mm in size and neither NAA or Maxcel gave appreciable thinning with Gala. However with McIntosh and Delicious even the later timings gave reasonable thinning. A single application of either Maxeel or NAA did not adequately thin Gala regardless of timing. Much of the problem with Gala is due to bloom on one year wood on thin weak shoots. These do not respond to thinners while more vigorous shoots do.

Chemical thinning studies at Geneva over the last 8 years have shown that:

1. The optimum timing of thinning can be estimated from temperature and sunlight data using a carbon balance model developed by Alan Lakso. On cool years the optimum timing is when fruit size is 13-15mm. In warm year the optimum timing is when fruit size is 10mm.
2. The best thinning of Gala and other hard to thin varieties is achieved with a multiple thinning program. For Gala a 3 spray program consisting of a full bloom spray of 2% ATS followed by a petal fall spray of 1200ppm Sevin XLR followed by a 12mm spray of 100ppm BA + 600ppm Sevin XLR has been the most successful. This will in most years give Gala fruit sizes peaking on 88's.
3. An economic analysis of Gala thinning has shown that aggressive thinning to produce 80-88 count Gala has not produced the greatest grower returns but rather a less aggressive thinning program which produces 100 count fruits coupled with a high yield has resulted in greater grower returns. The production of 80-88 count fruit size is possible in NY state but requires an excessive reduction in yield with a lower total crop value.
4. Thinning of Honeycrisp is best accomplished with a 2 spray thinning program beginning with a petal fall application of 10ppm NAA + 600ppm Sevin XLR followed by a spray of 7.5ppm NAA + 600ppm Sevin XLR at 12 mm fruit size.







6. The Tall Spindle Apple Orchard System

Terence Robinson and Stephen Hoying and Gabino Reginato
Dept. of Horticultural Sciences, Geneva and Highland

Our most recent economic studies indicate than an optimum tree density for NY state is 2,500-3200 trees/ha unless fruit price was very high. This tree density led to the development of a training system we call the Tall Spindle.

It is an amalgamation of the slender spindle, the vertical axis and the super spindle systems The system utilizes the concept of high tree densities from the slender spindle system but utilizes lower planting densities than the Super Spindle. The system uses tall trees similar to the Vertical Axis but very narrow canopies like the Super Spindle. A key component is the use of highly feathered trees (10-15 feathers) and pendant limb angles to induce cropping and reduce branch growth and vigor. The system also utilizes minimal pruning at planting and during the first 3 years. Without pruning of the leader at planting and with feathers starting at 30 in above the soil, the tall spindle tree can be allowed to crop in the second year which gives natural bending of lateral branches which keeps them weak. At maturity, the Tall Spindle canopy has a dominant central trunk and no permanent scaffold branches. Limb renewal pruning is utilized to remove and renew branches as they get too large (>2cm diameter).

Tree density with Tall Spindle orchards can vary from a high of 3700 trees/ha (90cm X 3m) to a low of 2,300 trees/ha (1.2m X 3.6m). The proper density considers the vigor of the variety, vigor of the rootstock, and soil strength. For weak and moderate growing cultivars such as Honeycrisp, Delicious, Braeburn, Empire, Jonamac, Macoun, Idared, Gala, NY674, and Golden Delicious we suggest an in-row spacing of 90cm. For vigorous varieties such as McIntosh, Spartan, Fuji, Jonagold, Mutsu, etc, and tip bearing varieties such as, Cortland, Rome Beauty, Granny Smith and Gingergold we suggest an in-row spacing of 1.2m. Between-row spacing should be 3m on level ground and 3.6m on slopes.

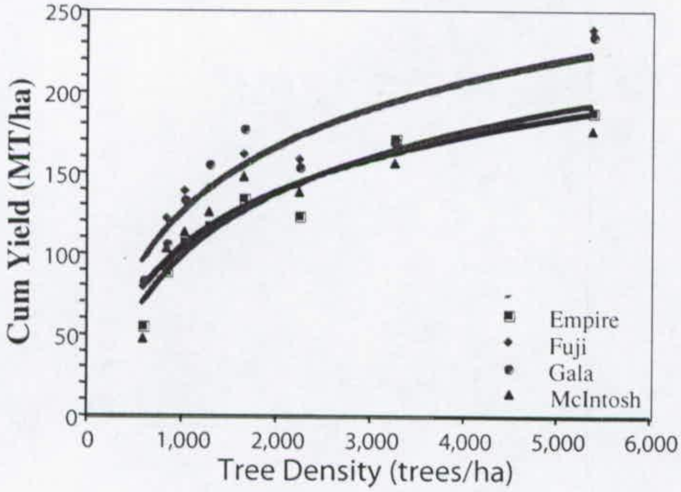
Dwarfing rootstocks such as M.9, B.9 or the new fire blight resistant dwarf rootstocks from Geneva® (G.16, G.11, G.41 and G.935) have been used successfully in Tall Spindle plantings. The weaker stocks such as M.9T337, B.9, G.11 and G.41, are especially useful with vigorous scion varieties on virgin soil. The more vigorous stocks such as M.9Pajam 2, M.9Nic29, G.16 and G.935 are much better when on replanted soil or when weak scion cultivars are used.

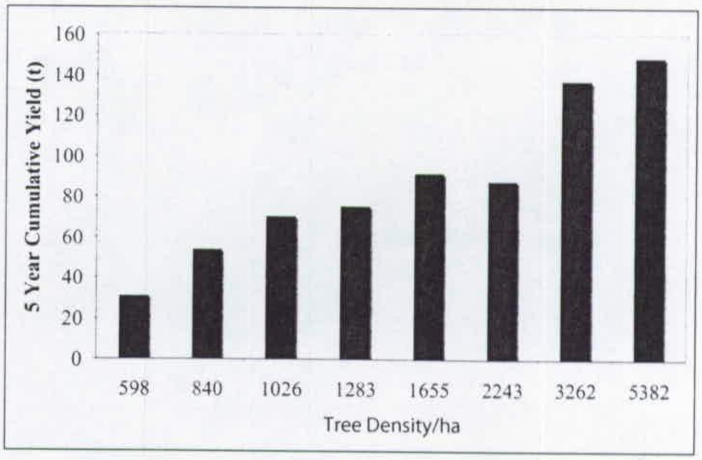
An essential component of the Tall Spindle system is a high branched (feathered) nursery trees. We recommend that the caliper of trees used in tall spindle plantings be a minimum of 1.6 cm and that they have 10-15 well positioned feathers with a maximum length of 30cm and starting at a minimum height to 75cm on the tree. Generally nursery trees in North America have 3-5 long feathers instead of 10 short feathers. The tree with fewer long feathers requires more branch management than the tree with more short feathers. If trees have long feathers they should be tied or weighted below the horizontal at planting to induce cropping and to prevent them from developing into substantial lower scaffolds. This simple change in feather management allows for long-term cropping of many feathers and little invasive pruning for the first 5-8 years at the very close spacing of the Tall Spindle system.

The Tall Spindle has no permanent lower tier of branches. As lower branches become too large they are removed back to the trunk with a bevel cut and replacement shoots are produced. This renewal pruning strategy is used on the upper part of the tree as the trees age to remove larger limbs and maintain a conic tree shape.

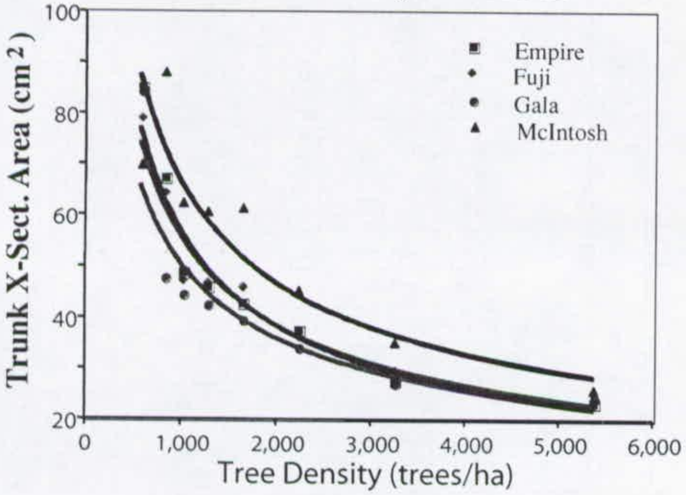
In summary, the tall spindle system uses higher tree densities than most NY growers plant, but the adoption of this system by NY growers will increase lifetime profits of new orchards and help improve the competitive position of the NY fruit industry.

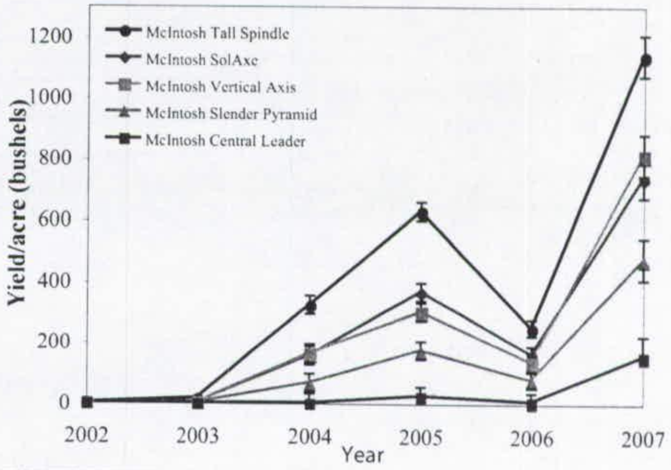
Effect of Tree Density on 7 Yr. Cumulative Yield

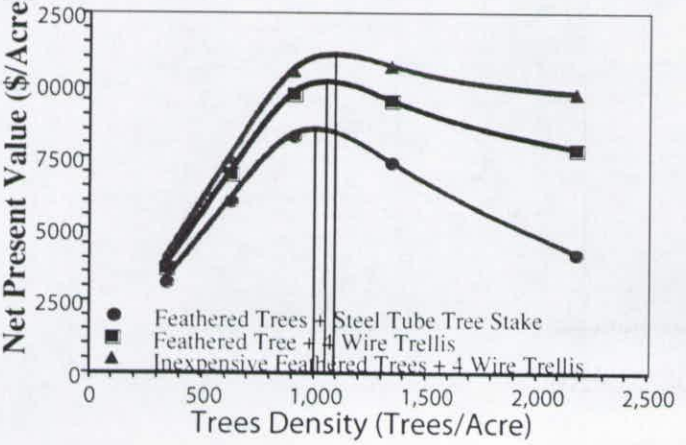


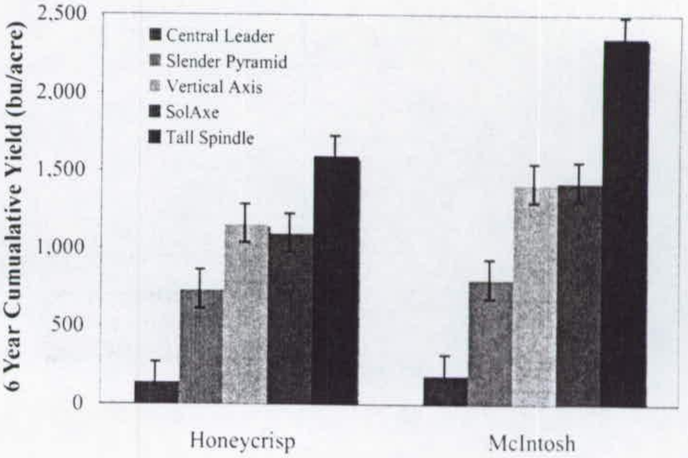


Effect of Tree Density on Tree Size









Hansen 10, Orchard Systems Trial

Planted April 1997

N →

Rep. 2

R34	1 2 3 4 5 6	Gala/M.7 10' X 18'	7 8 9 10 11 12	Fuji/M.7 10' X 18'	R34
R33	1 2 3 4 5 6	Empire/M.7 10' X 18'	7 8 9 10 11 12	Mac/M.7 10' X 18'	R33
R32	1 2 3 4 5 6	Gala/M.7 10' X 18'	7 8 9 10 11 12	Fuji/M.7 10' X 18'	R32
R31	1 2 3 4 5 6 7	Empire/M.26 8' X 16'	8 9 10 11 12 13 14	Mac/M.26 8' X 16'	R31
R30	1 2 3 4 5 6 7	Gala/M.26 8' X 16'	8 9 10 11 12 13 14	Fuji/M.26 8' X 16'	R30
R29	1 2 3 4 5 6 7 8	Empire/M.9 7' X 15'	9 10 11 12 13 14 15	Mac/M.9 7' X 15'	R29
R28	1 2 3 4 5 6 7 8	Gala/M.9 7' X 15'	9 10 11 12 13 14 15	Fuji/M.9 7' X 15'	R28
R27	1 2 3 4 5 6 7 8 9	Empire/M.9 6' X 14'	10 11 12 13 14 15 16 17	Mac/M.9 6' X 14'	R27
R26	1 2 3 4 5 6 7 8 9	Gala/M.9 6' X 14'	10 11 12 13 14 15 16 17	Fuji/M.9 6' X 14'	R26
R25	1 2 3 4 5 6 7 8 9 10	Empire/M.9 5' X 13'	11 12 13 14 15 16 17 18	Mac/M.9 5' X 13'	R25
R24	1 2 3 4 5 6 7 8 9	Gala/M.9 5' X 13'	10 11 12 13 14 15 16 17 18	Fuji/M.9 5' X 13'	R24
R23	1 2 3 4 5 6 7 8 10	Empire/M.9 4' X 12'	11 12 13 14 15 16 17 18 19 20 21	Mac/M.9 4' X 12'	R23
R22	1 2 3 4 5 6 7 8 10 11	Gala/M.9 4' X 12'	12 13 14 15 16 17 18 19 20 21	Fuji/M.9 4' X 12'	R22
R21	1 2 3 4 5 6 7 8 9 10 11 12 13	Empire/M.9 3' X 11'	14 15 16 17 18 19 20 21 22 23 24 25 26 27	Mac/M.9 3' X 11'	R21
R20	1 2 3 4 5 6 7 8 9 10 11 12 13	Gala/M.9 3' X 11'	14 15 16 17 18 19 20 21 22 23 24 25 26 27	Fuji/M.9 3' X 11'	R20
R19	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	Empire/M.9 2' X 10'	19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36	Mac/M.9 2' X 10'	R19
R18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	Gala/M.9 2' X 10'	19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36	Fuji/M.9 2' X 10'	R18

1ft = 0.3048 m
1 ha = 2.471 acres

7. High Density Pear Training Systems and Rootstocks

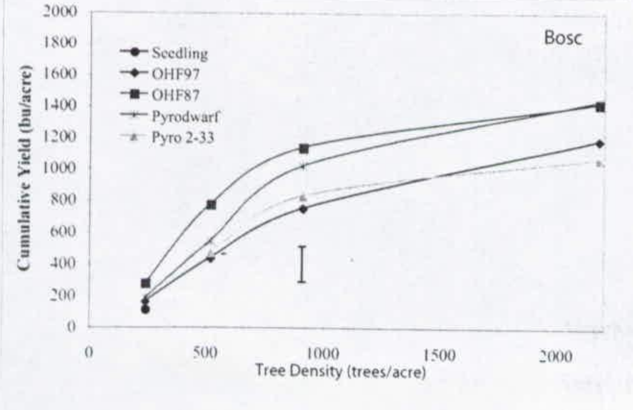
Terence L. Robinson
Department of Horticultural Sciences, Geneva

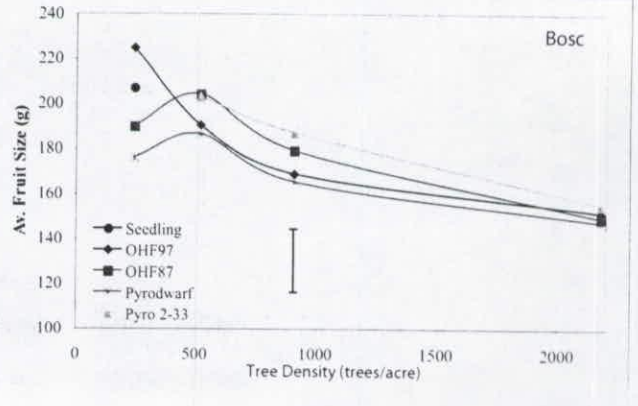
Pear production in the Eastern USA is characterized by low density orchards (150 trees/acre) on seedling rootstocks which have low early production and low mature yields. Recently several new semi-dwarfing rootstocks have become available which could be used in high density pear orchards that could be managed similarly to high density apple orchards. In addition several new high-quality fire blight resistant pear varieties offer the potential for pears to be an attractive alternative fruit crop for NY growers.

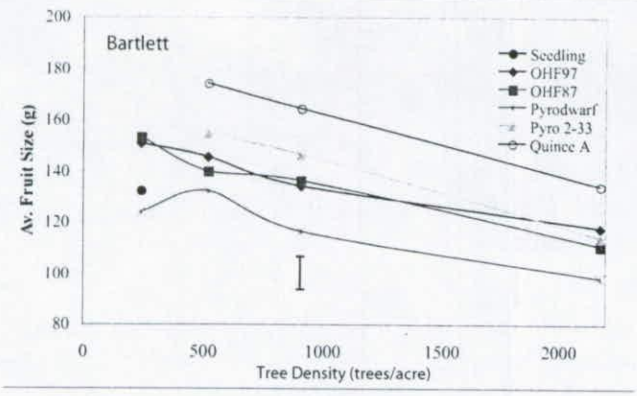
In this field trial at Geneva, we are comparing four training systems: Central Leader (242 trees/acre), Vertical Axis (518 trees/acre), Tall Spindle (908 trees/acre) and Super Spindle (2178 trees/acre) on 6 rootstocks (seedling, OHF97, OHF87, Pyrodwarf, Pyro 2-33 and Quince A) with 3 varieties (Bartlett, Bosc and Taylor's Gold Comice). The significant results to date are:

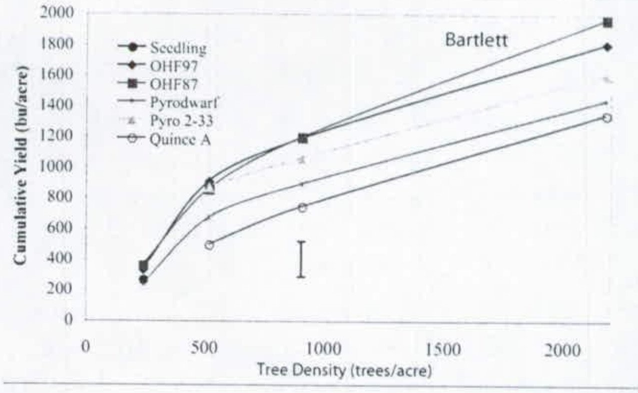
1. Increasing tree density had a significant negative effect on tree size as measured by trunk cross-sectional area for each rootstock with trees at the highest planting density being only 55% the size of the trees in the lowest planting density.
2. With Bartlett, the largest trees were on OHF97 followed by OHF87, Pyro 2-33, Pyrodwarf and the smallest trees were on Quince A. However, with Bosc and Taylor's Gold the largest trees were on OHF87 followed by OHF97, Pyro 2-33 and Pyrodwarf. Trees of Taylor's Gold on OHF97 and on seedling were damaged in the winter of 2004/05 with 37% of the scions killed. The damage was greatest in the central leader system which had the most vigorous trees. None of the other rootstocks were damaged.
3. Tree density had a large positive effect on yield in the third and fourth years with Bartlett on OHF87 or Bosc on Pyrodwarf achieving 24 t/acre (1,100 bu/acre) in the fourth year. In contrast, the lowest density system (central leader) had only 10% of the yield of the highest density system. OHF87 being the best rootstock for Bartlett but Pyrodwarf performed best with Bosc and Taylor's Gold.
4. Fruit size was negatively related to planting density with the super spindle system producing significantly smaller fruit size than either the vertical axis or the central leader. Part of the effect was due to greater crop loads on the super spindle system. However, when fruit size was adjusted for crop load there was still a negative effect of planting density on fruit size of Bartlett.
5. With Bartlett, Quince A produced the largest fruit size while Pyrodwarf and seedling had significantly smaller size. OHF97, OHF87 and Pyro 2-33 had intermediate fruit size. With Bosc and Taylor's Gold, there was no difference in fruit size between the rootstocks.

The results of this study show that there is great potential to improve the early yield of pears with increased tree planting density and new rootstocks. The extremely high planting density of the Super Spindle achieved a yield of 1,100 bu/acre in the fourth years but the long term manageability of such high planting densities without the use of fully dwarfing rootstocks is questionable. The more moderate planting densities of the Tall Spindle (908 trees/acre) may have greater long-term manageability.



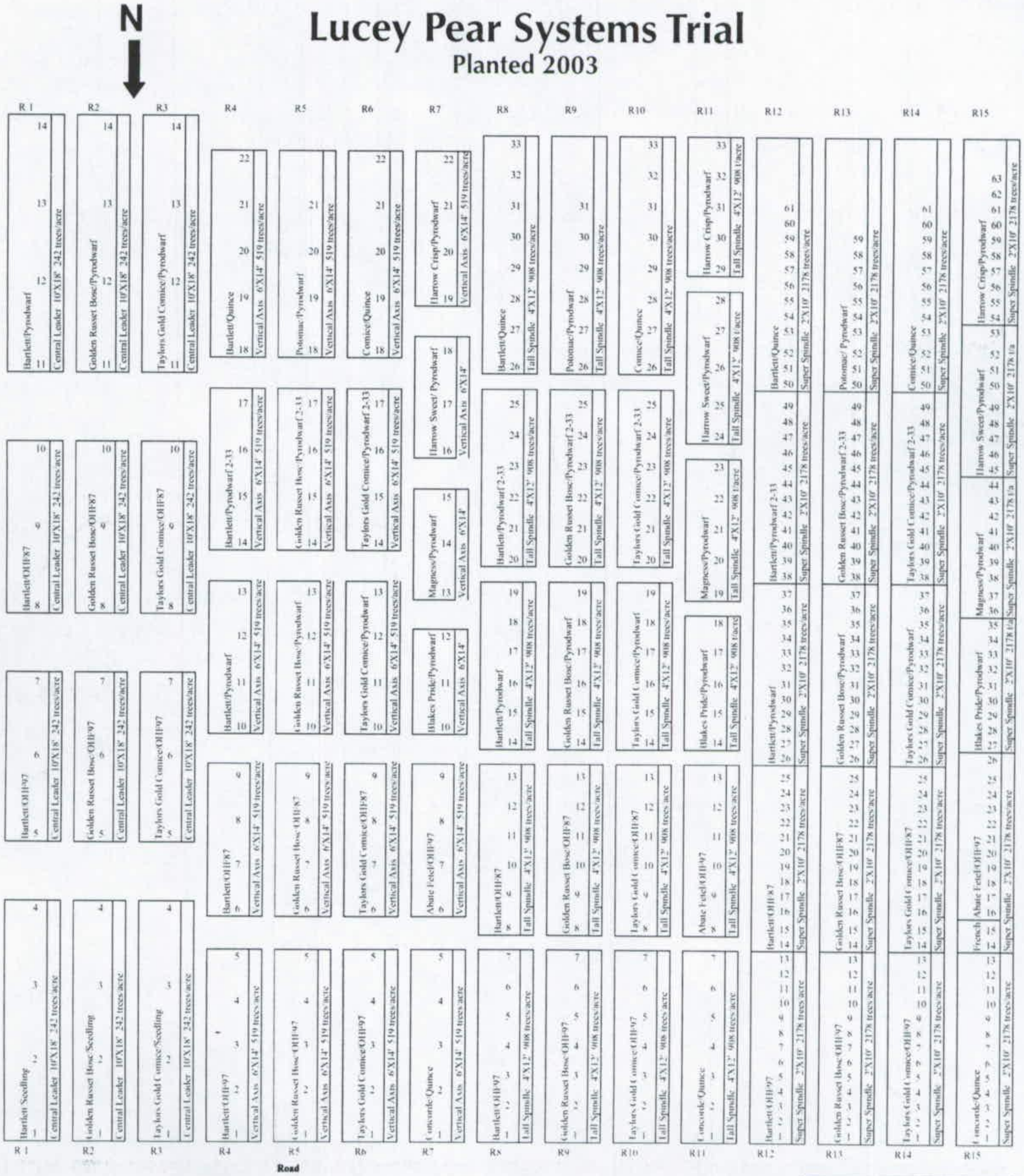






Lucey Pear Systems Trial

Planted 2003



1ft = 0.3048 m
1 ha = 2.471 acres

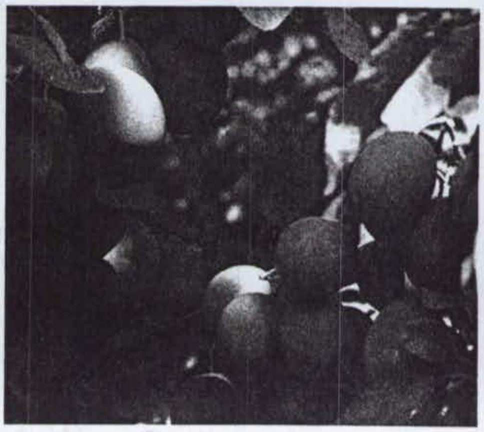
ISHS

EVP_2008_0020

9th International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems

Cornell University
College of Agriculture and Life Sciences
New York State Agricultural Experiment Station

ISHS Post-Tour, Saturday-Sunday, August 9-10, 2008
Western New York Fruit Industry and Niagara Falls



Post-Tour
Western NY and Niagara Falls

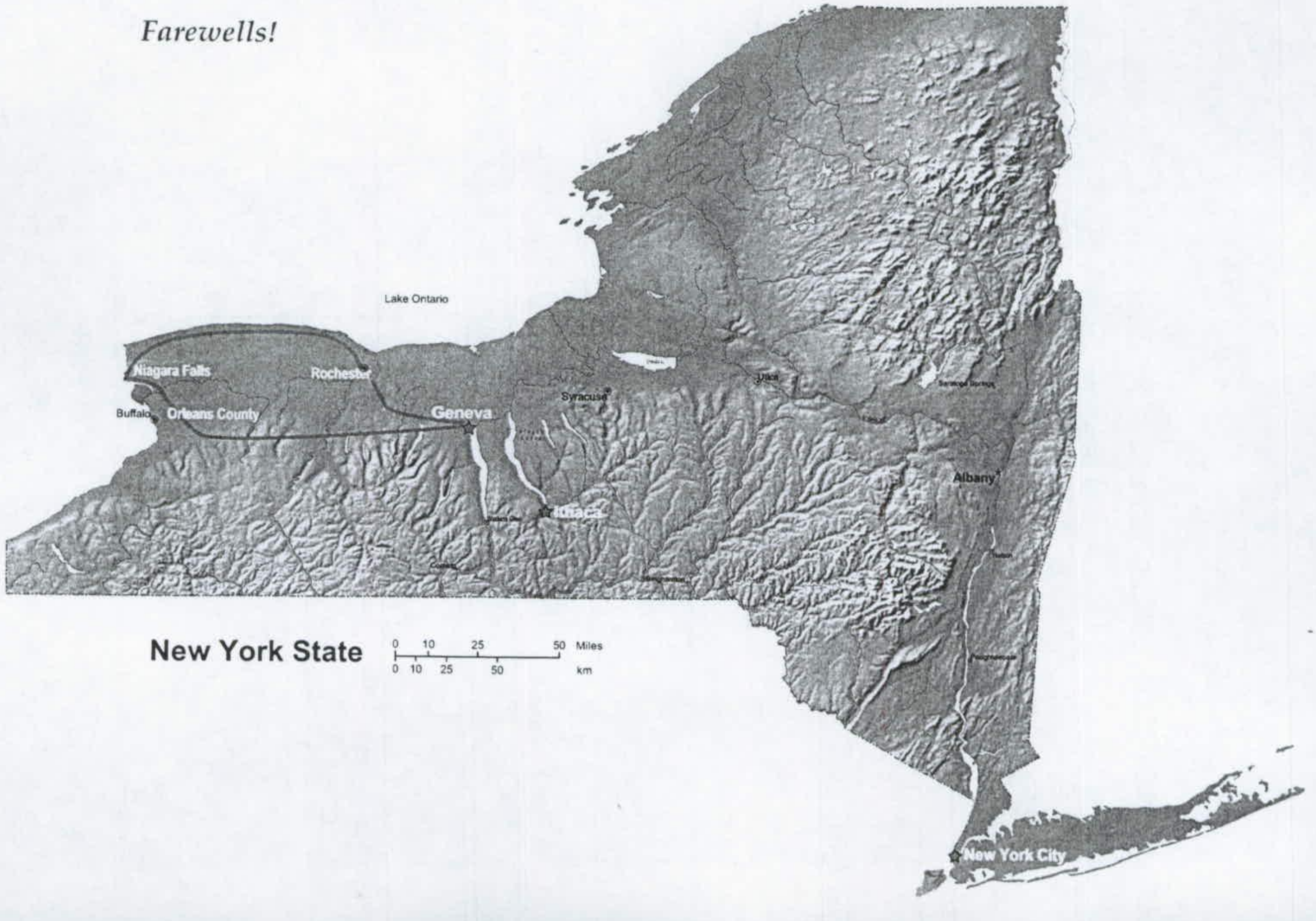
Saturday August 9, 2008

8:30am	Leave Geneva
9:30am	Arrive Burch Orchards – *CG Rootstock Plot Honeycrisp apples*
10:15am	Arrive Zingler Orchards - *Apple Planting Systems and Tree Quality*
11:30am	Orchard Dale - *Agri-tourism WNY Style Market, U-Pick berries, Apples, 1992 Apple Planting System Trial Gala, Cortland, Red Delicious, Empire*
12:30pm	Lunch at "The Berry Patch"
1:45pm	Stillwater Lamont Farms - *Super Spindle Apple Plantings*
3:15pm	LynOaken Farms - *Peaches, Equipment, Cider and juice production, winery*
6:00pm	Days Inn, Niagara Falls *Evening on your own. Suggestions: Casino, Falls at Night, Travel to Canada Gardens and night life (be sure to have proper papers (Passport and VISA if necessary depending on your residence) for reentry into the USA*

Sunday August 10, 2008

8:30am	Leave Days Inn Hotel, Niagara Falls, NY. *Be sure to have checked out, prepared luggage for loading onto the bus and have had breakfast.*
9:00am	Cave of the Winds Tour – *Walking tour behind the Falls*
11:00am	Maid of the Mist Tour – *Boat Tour to the base of Niagara Falls*
12:00 noon	Lunch – MarJim Manor
1:00pm	Marjim Winery Tour and Singer Farms – *Winery and Stonefruit*
2:45pm	Peach Planting systems trial Niagara Orchards – *Planted 1999*
3:45pm	New Royal Sweet Cherry Plantings – *Various ages Sweet Cherries on an excellent site*
6:00pm	Arrive Rochester Airport Holiday Inn - *Overnight*

Farewells!



Farm Descriptions

Frank & Hale Burch Farms, Inc.

Operators: John & Jim Burch
Total Farm Size: 260 acres
# of farm Units: 3
Full-time Employees: 5
Crops: Apples, Peaches, Cherries, Strawberries, Raspberries, Blueberries, Currants, and Gooseberries
Marketing Strategies: Apples 50% processing, 50% fresh (3/4 through two packing houses ¼ retail at our own farm.) All other fruit sold retail at our farm either on a roadside stand or pick your own
Infrastructure: Owned and operated by family with seasonal help as needed
Planting Systems: Central leader (7,26,9/111,106,111) Verical Axis(rootstock trial) 3-wire vertical Trellis (9)
Varieties (Apples): 20+ varieties. Empire, Golden & Red Delicious, Gala, Fuji, Idared, Crispen Honeycrisp, McIntosh, Cortland, Austin and others
Advantages: Weather, Good sites, abundant markets
Challenges: Costs of operating in NY
Future Trends: Plant high value varieties on higher density planting systems
Research Cooperation: Rootstock trial, fire blight trial with biological control

R.M. Zingler Jr. Farms

Operators: Mike Zingler
Total Farm Size: 590 acres (490 owned, 100 rented)
# of farm Units: 8, but mainly contiguous in Kendall area
Full-time Employees: 11-12
Crops: Apple, pears, peaches, nectarines, apricots, sweet cherries, plums, strawberries, raspberries
Marketing Strategies: Wholesale (apples, pears), Farm markets, some direct-marketing to stores (most other crops)
Infrastructure: Partner in Lake Ontario Fruit, Inc. (Packing and Storage)
Planting Systems: Standard (free-standing/central leader) on older plantings to variation on tall-spindle (5X13) on new plantings (M9 mainly, along with some M26, B9)
Varieties (Apples): 20+ apples cultivars grown- newer club/managed varieties such as Honeycrisp, MN-1914, and Pinata; along with significant acreage of Empire, Gala, Cameo, Fuji, and McIntosh
Advantages: Diversified tree fruit and berry crops, different marketing strategies, using Smart Sprayers exclusively for over 10 years
Challenges: Labor, cost of replanting, and what to plant
Future Trends: Phasing out processing acreage that was inherited and pointing towards nearly all fresh. Predicting and planting high-value varieties using the most profitable planting systems
Research Cooperation: Apple Thinning Trials, Growth Regulator Trials with Steve Hoying

Orchard Dale Fruit Farm & Brown's Berry Patch

Operators: Robert, Deborah, Eric and Bobby Brown
Total Farm Size: 200 acres
# of farm Units: 1
Full-time Employees: 8
Crops: Apple, sweet cherry, peach, strawberry, raspberry, blueberry, quince
Marketing Strategies: Wholesale (packed, processed, store-to-door), Retail (PYO, farm market, agri-entertainment)
Infrastructure: Vertically integrated with nursery, orchards, storage, packing and retail
Planting Systems: Standard to super spindle (M9 for past twenty years)
Varieties (Apples): 15+ including Empire, McIntosh largest percentage
Advantages: Next generation involved, diverse marketing, good employees
Challenges: Labor costs, meeting market demands
Future Trends: Planting profitable varieties (including managed varieties)
Research Cooperation: Planting systems trials, various crop protectant trials

Lamont Fruit Farm Inc.

Operators: Rod Farrow and George Lamont
Total Farm Size: 420 acres apples
# of farm Units: 5
Full-time Employees: 10
Crops: Apples (400,000bu)
Marketing Strategies: 75% Fresh wholesale, mostly through Lake Ontario Fruit in which we are partners with 6 other entities. 25% Processing. Partner in NBT cooperative for Managed Varieties
Infrastructure: Vertically integrated, nursery, fruit production, storage and packing
Planting Systems: New plantings Super spindle (11'x 2' - 2000trees/acre B9), Vertical Axis (14'x5' - 520 trees/acre EMLA 9) Central Leader (16-18'x10-12' 200-272 trees/acre M26, MM106)
Major Varieties (Apples): Empire, Honeycrisp, Acey Mac, Gala
Others: Red Del, Mac, Gingergold, Macoun, Jonagold, Red Cort, Crispin
Advantages: Good sites with irrigation water, strong variety mix, great group of employees and pickers (H2A). Strong demand for east coast apples (food miles). Price of fuel!
Challenges: Immigration, global warming? (hail), new site availability
Future Trends: Improve fruit quality with better practices, varieties and storage. Excellent opportunity to grow
Research Cooperation: Variety trials, Lime Trials, Foliar Nutrient trials, Mating disruption

LynOaken Farms

Operators: Darryl Oakes, Linda Oakes, Jeff Oakes, Wendy Wilson

Total Farm Size: 350 acres

# of farm Units: 6

Full-time Employees: 12

Crops: Apples, Sweet Cherries, Tart Cherries, Peaches, Wine Grapes

Marketing Strategies: 2 wholesale distributors, own store and delivery program, own farm market, winery, and cider mill

Infrastructure: Cold storage, CA, and small packing line.

Planting Systems: Mainly vertical axis (500-600 trees/acre), new planting tall spindle (1,200 trees/acre) mainly on M9.

Varieties (Apples): A new variety collection of over 400 cultivars, markets about 20 varieties, major ones: Ginger Gold, Gala, McIntosh, Empire, Cortland, Honeycrisp, Jonagold, Crispin, Red Delicious, Idared, and Fuji.

Advantages: Great soil, a good climate, diverse crops and diverse marketing strategies

Challenges: Labor

Future Trends: An increase in direct marketing, and fresh-market peach acreage, investing in managed apple varieties

Research Cooperation: Multiple trials with the departments of Entomology and Horticulture with Cornell University. 25 plus years of cooperative research

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Singer Farms

Operators: Owned by Tom Singer and Jim Bittner

Total Farm Size: About 500 acres of tree fruit

# of farm Units: 1

Full-time Employees: 7

Crops: Fresh sweet cherries, processing sweet cherries, tart cherries, apricots, plums, fresh peaches, processing peaches, apples and 10 ac of certified organic apples. Planted blueberries in 2008

Marketing Strategies: Produce what the costumer wants.

Infrastructure: On farm cold and CA storage.

Varieties (Apples): Red Del, Empire, Spartan, Gala. No apples planted in 10 years

Advantages: Biggest assets are well drained soils along the lake

Challenges: Controlling labor costs.

Future Trends: Packing stone fruit for supermarkets

Research Cooperation: Sweet cherry variety and rootstock trials

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Niagara Orchards, Inc.

Operators: Dan and Debra Sievert

Total Farm Size: 2100 acres

# of farm Units: Several

Full-time Employees: 15-18

Crops: Apples, Peaches, Tart Cherries

Marketing Strategies: Apples all wholesale to 1 packinghouse, peaches all fresh market, mainly wholesale to a large supermarket chain, Tart cherries, part owner in a Co-Op

(Niagara Orchards, Inc. , continued)

Infrastructure: Fully integrated orchards

Planting Systems: Apples – older plantings on M26 or M9/MM106 interstems (12X20 spacing), central leader, newer on M9, closer spacing (4X14)

Varieties (Apples): More than 20 varieties, Main varieties – Empire, Red Delicious, McIntosh

Advantages: Diverse crops and marketing strategies, largest tart cherry producer in NY state, produce over 20% of tarts in the state

Challenges: Labor, large farm size, increased costs of all inputs

Future Trends: downsizing a bit due to labor (Apple production)

Research Cooperation: Peach orchard planting systems trial with Terence Robinson & Steve Hoying

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NewRoyal Orchards

Operators: Allan, Dennis, and Timothy Buhr

Total Farm Size: 370 acres planted

# of farm Units: 5 within 5 mile radius

Full-time Employees: 10

Crops: Apples (300 acres), Pears (Bartlett, Bosc, Asian-40 acres), Sweet Cherries (30 acres).

Marketing Strategies: Wholesale, mostly fresh fruit. 50% market own fruit and broker some other growers, 50% market through Sun Orchards & Niagara Fresh

Infrastructure: Cold storage (20,000 bu.), CA (25,000 bu.)

Planting Systems: Apples – central leader mainly with interstems, some M7, MM106, some vertical axis M9 on single wire, some 4 wire trellis on M9

Varieties (Apples): 20+ cultivars grown-Major varieties Golden Delicious, Empire, Red Delicious, McIntosh, Ginger Gold

Varieties (Sweet Cherries): Marketed primarily wholesale to those who can freeze them. Over 30 acres grown. 8 acres on Mazzard planted early 1980's- Hedelfingen, Emperor Francis, Rainier, Cavalier, Hardy Giant, Royalton, Hartland, and Van. 5 acres on Gisela, planted 1995-6. Royalton, Hartland, Somerset, Kristen, Summit, Emperor. Francis, Hudson, Black Gold, Hedelfingen. 15 acres on Gisela, planted 1999, 2000, and 2004. Hartland, Emperor Francis, Hedelfingen, Black Gold, Royalton, Summit, White Gold, Gold, Ulster, Tieton, Blushing Gold. 7 acres on Gisela #6 and #12 planted 2007 and 2008. Hudson, Tieton, Regina, Chelan, Gold

Advantages: Close to markets in Pennsylvania, Ohio, and New York.

Challenges: Labor, weather (hail-damaged fruit)

Future Trends: Involving next generation

Research Cooperation: Markets sweet cherries from NYSAES Geneva, and Allan serves on NYARD program. Fumigation trials, Apple variety trials

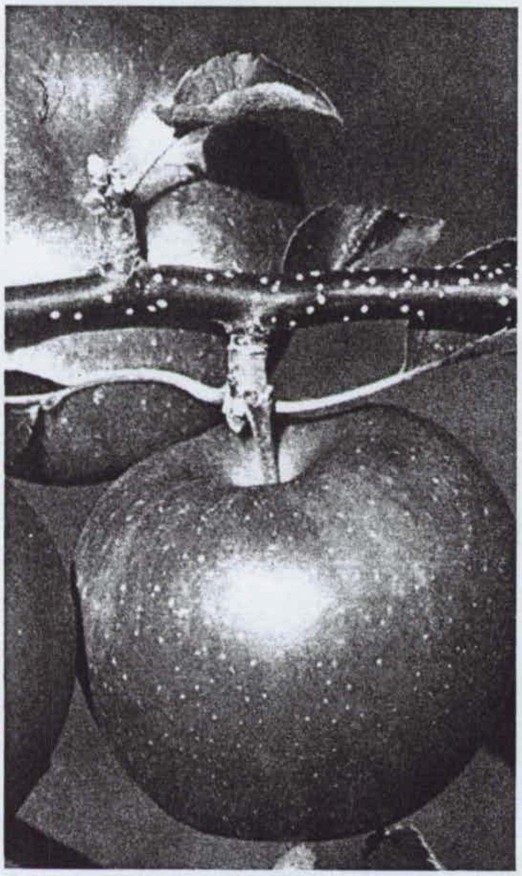
ISHS

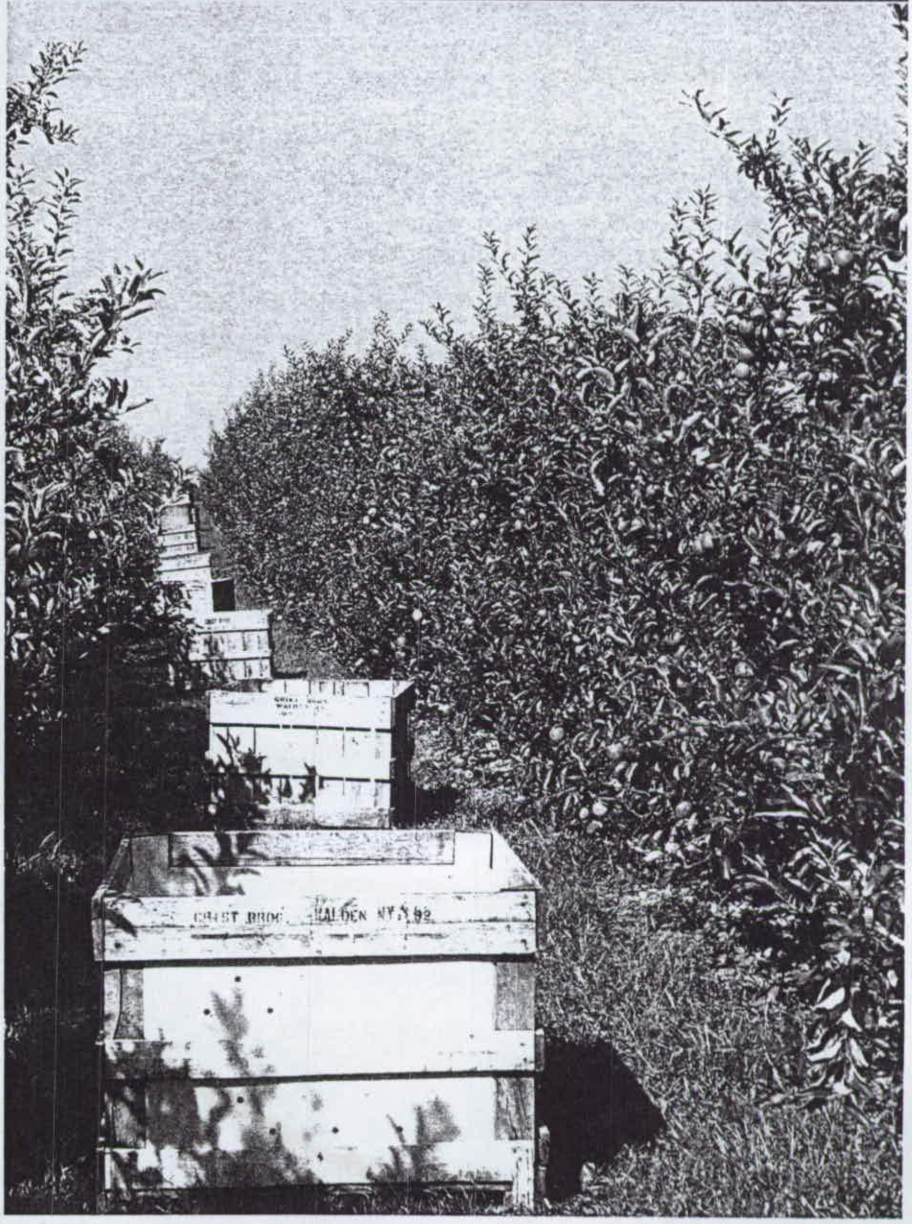
EVP- 2008-0020

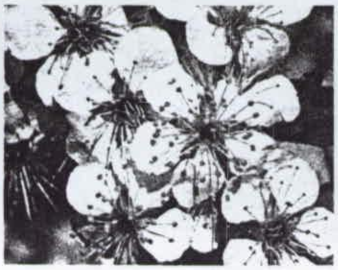
9th International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems

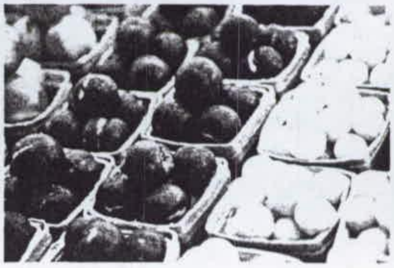
Cornell University
College of Agriculture and Life Sciences
New York State Agricultural Experiment Station

ISHS Tour, Wednesday, August 6, 2008
Wayne County





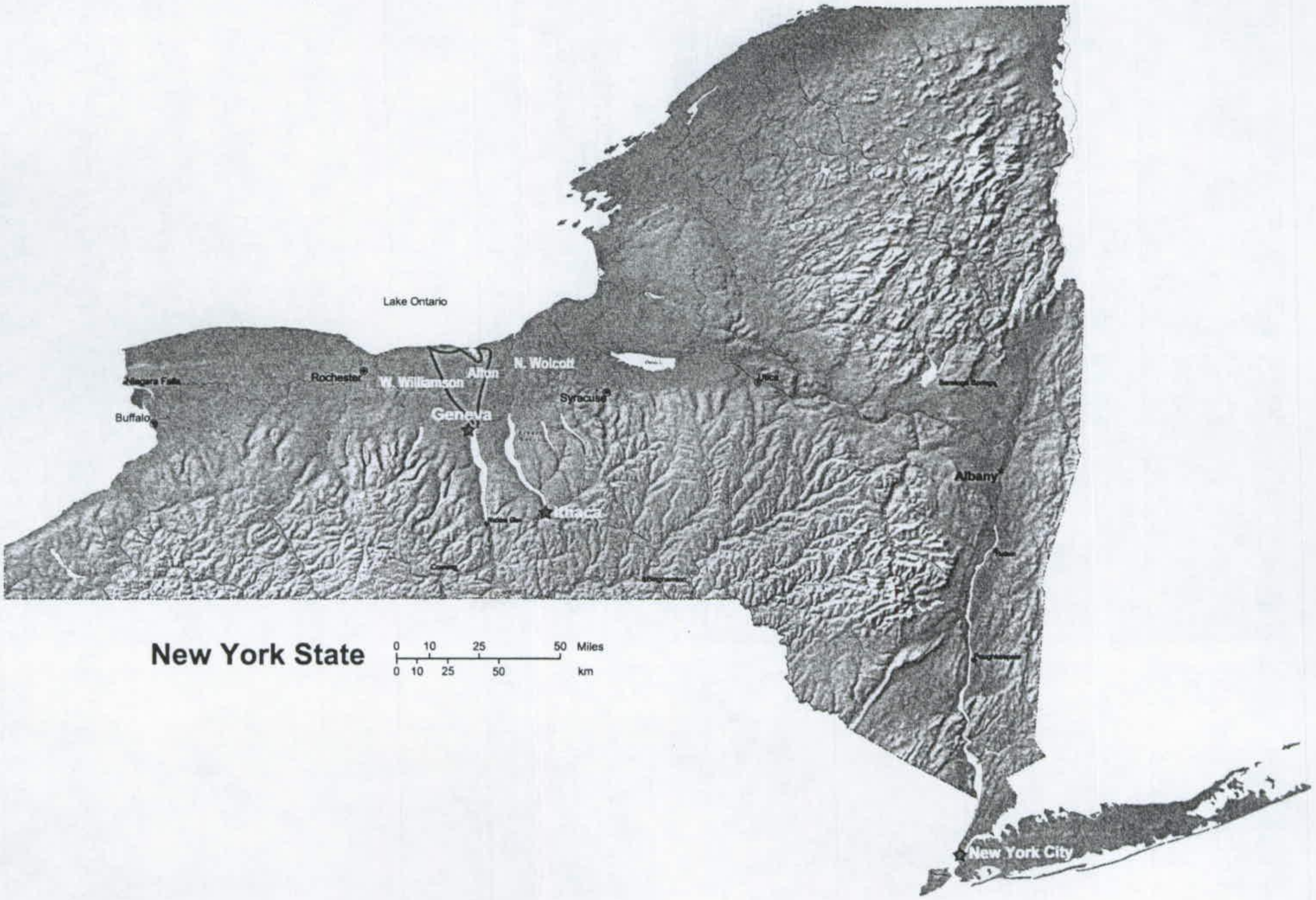




Wednesday-Tour, August 6, 2008 • Wayne County

Tour Leader: Steve Hoying

Time	Topic	Presenter
8:00-9:00am	Overview of the NY Fruit Industry	Steve Hoying and Alison DeMarree
9:00-12:00 noon	Nursery Production at Waflers Nursery	Paul Wafler and Bill Pitts
	Tall Spindle System at Waflers	Terence Robinson and Paul Wafler
	Super Spindle System at Fowler Farms	JD Fowler and Steve Hoying
	CG Rootstocks at Cahoon Farms	Gennaro Fazio
12:00-1:30pm	Sodus Bay Restaurant	Alison DeMarree
1:30-4:00pm	Pruning Gala for Improved Fruit Size at Vanderwalle's	Scott Vanderwalle and Steve Hoying
	Apple Orchard Systems and Rootstock Trial	Terence Robinson
	V-system and Mechanical Thinning of Peach at Furber Farms	Alison DeMarree and Todd Furber
	Organic Apple Production in Humid Climates at Knapp Farms	Steve Knapp and Steve Hoying
4:00-5:00pm	Club Varieties at DeMarree Fruit Farm	Tom DeMarree and Alison DeMarree
	Retail Fruit Marketing	Ed and Jan Burnap Mike and Kendra Maloney
5:00-6:00om	Bus Trip to Geneva	Steve Hoying and Alison DeMarree



August 6th Tour of Wayne County Fruit Farms

Wafler Farms & Nursery

Wafler Nurseries has been operating for 46 years in Wayne County. Its owner, Fritz Wafler, came to the United States in 1952 from Switzerland and after working across the country as a migrant worker bought this farm in 1958. Nowadays his son Paul Wafler has become the operator and manager of the farm.

The farm currently consists of 350 acres planted with apples for fresh market. Wafler family members are very innovative farmers, always adopting new technologies such as the trend for newer blocks being planted at 3.5 feet between the trees and 13 feet between the rows in Tall Spindle system.

Approximately 200,000 trees (mostly apple and a few tart cherries) are produced annually in Wafler Nursery. Trees are commonly shipped to Michigan, Ohio, North Carolina and the northeastern United States. About 60% of the trees are produced for Wayne County apple growers. Common rootstocks are: B.9, M.9 and Cornell Geneva rootstocks. The most popular varieties include: Honeycrisp, Gala, Linda and Ruby Mac and Royal Empire.

As many of the soils along the Lake Ontario are heavy with good water holding capacity and a summer characterized by frequent rains, the nursery plots are irrigated only during drought years. Trees produced here do not have the caliper of trees produced in warmer areas but usually have a better root system.

Bill Pitts is in charge of sales and nursery management, Susan Wafler (Paul's wife) is the office manager and Joyce LeRoy is the office assistant. Contacts: Phone: 315-594-2399, fax: 315-594-8829, e-mail: info@waflernursery.com

Van De Walle Fruit Farm

Van De Walle Fruit Farm started with fruit production in 1983, being a first generation involved in fruit business. Van De Walle Fruit Farm and Wayne County Fruit Sales is owned and operated by Scott (Orchard), Marshall (Packinghouse) and their parents Ken and Donna Van De Walle. The fruit farm operation consists on approximately 320 acres of apples for fresh market. Recent plantings are being planted to 2.5 x 12 feet spacing supported by black locust poles and wires. Varieties recently planted include: Honeycrisp , Gala, MN 1914 and McIntosh. Fruit grown on the farm is either packed in their own facilities or at Hess Brothers in Pennsylvania.

Knapp Orchards

Knapp Orchards started its fruit operation as a first generation 11 years ago. Steve Knapp, the owner and operator farms 400 acres of both process (70%) and fresh market apples. Steve has been growing organic apples on approximately 60 acres for six years. The latest orchard planted has two spacings: 3 x 13 feet on B.9 in its third leaf and 6 x 14 ft on G.30 rootstock in its 2nd leaf. The two main varieties are scab-resistant Liberty and Florina. There are also planted approximately 10 disease resistant Geneva numbered varieties from Cornell's Apple Breeding Program produced at the Agricultural Experiment Station at Geneva under Dr. Susan Brown direction.

Cahoon Farms

Cahoon Farms is owned by third generation farmers. The family, four brothers, a sister and their children operates over 1,500 acres and a process fruit business. They produce both fresh market and process apples, which are either processed into fresh or frozen slices or dices or dried, and tart cherries that are frozen as IQF or 5+1 (sugar and fruit ratio). Their Dry House Fruit division infuses and dries apples, cranberries, blueberries and cherries for bakeries and as snack foods.

Bob Cahoon is in charge of the orchards. Check their website at: www.dryhousefruits.com or orchards sales at: rcahoon@cahoonfarms.com

Cherry Lawn Farms

Todd, Ted and Ron Furber (father) are the owners and operators of Cherry Lawn Farms. They operate over 300 acres of fresh market and process apples, process peaches and tart cherries. Fresh apples are the main crop.

About 50 acres of peaches are grown, mainly trained as a Three Leader (8 ft x 18 ft) and Perpendicular Vee (6 ft x 18 ft). Peach varieties include Babygold 5, Virgil, Venture and Catherina. Peaches are first thinned mechanically, then by hand (plastic bat) with workers standing on a worker platform pulled by a tractor.

Fowler Farms

John and Bob Fowler are the 5th generation of Fowlers as farmers. John's son, J.D., is in charge of the orchard operation and Bob's son, Austin, of the storage and packinghouse facilities, making them the 6th generation involved in the operation of Fowler Farms. Over 2,500 acres of fruit, mostly apples (over 21 varieties) with some sweet cherries are under production.

All the new orchards planted by Fowler Farms have been planted to 1 ½ - 2 ft x 10 ft spacing to be trained as Super Spindle. The support system consists on black locust posts that are locally grown. The leader of each tree is supported by a vertical wire fastened to a high tensile steel wire at 18 inches off the ground and to another wire at approximately 7 1/2 - 8 feet height. Drip irrigation tubing is fastened to the low wire to keep it off the ground and prevent the tubing from being kicked into the path of an orchard mower.

Check their website: www.fowlerfarms.com

Burnap Fruit Farms & Farm Market

Burnap Fruit Farms is owned by second generation farmers being the farm started by Ed Burnap in 1970 and expanded in 1976, 1980 and 1998. The farm is now organized as an LLC (Limited liability corporation) owned and operated by Ed's son-in-law Mike Maloney (farm) and daughter Kendra (farm market) and Jan and Ed. The farm market was started in 1980. Nowadays, approximately 180 acres are currently in production; 150 apples (60% for fresh market), 25 acres of peaches (1.5 acres for fresh market), 3.5 acres of strawberries, raspberries and blackberries, 1 acre of sweet cherries, 1 acre of asparagus and 4 acres of sweet corn.

In 1984, they planted Y-trellis developed at Geneva. Current apple plantings are trained as Vertical Axe with 2 wires. All plantings are 15 feet between the rows and 3.5 (Honeycrisp) to 5 feet (Empire) between the trees. New plantings are for both fresh market (Empire, Cameo, Macoun, Honeycrsip, Gala, Fuji, Jonagold, Royal Court, and Ginger Gold) and process (Idared, Rome Beauty) markets.

Donald DeMarree Fruit Farm, Inc.

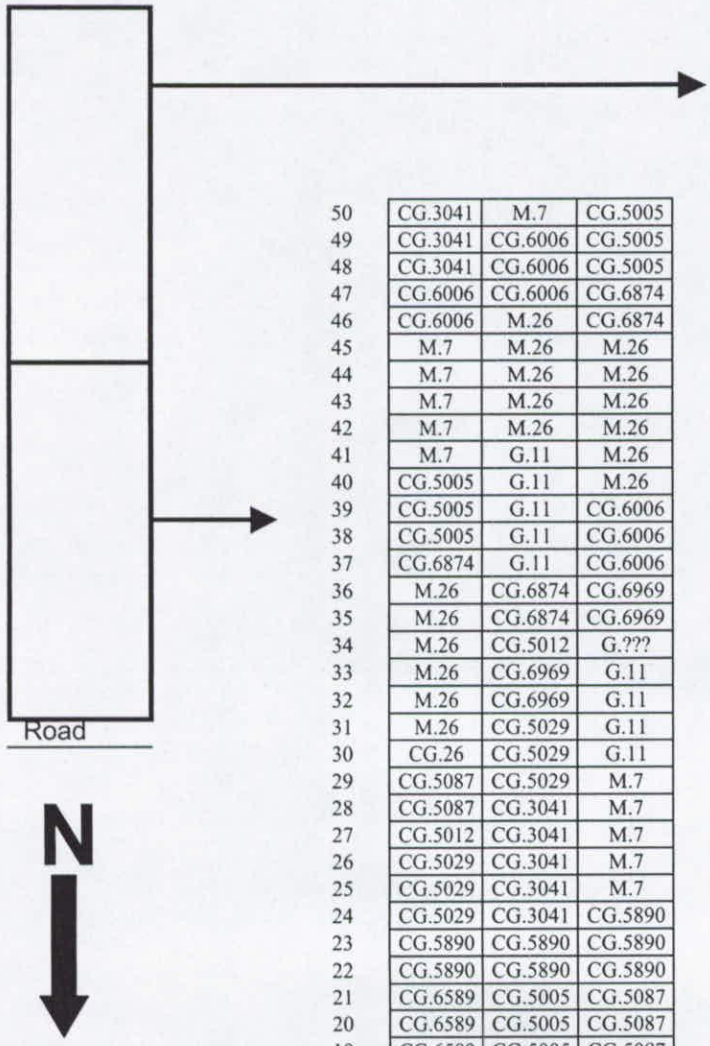
Tom DeMarree is a second generation fruit grower. Tom's father, Don, started the farm in the early 1960's and he and Tom increased their acreage in 1985. Tom took over management of the farm in 1989 and added acreage in the spring of 2005. Fresh market and process apples (over 24 varieties) and process peaches are the main fruit crops produced by the farm on approximately 160 acres with over half of that acreage under trickle irrigation.

Fresh market apple plantings are currently planted at 1,200 trees per acre (3ft x12ft). Row width in past years ranged from 13–14 ft with 3.5 – 6 ft between the trees. Recent plantings are on a 3–4 wire trellis using 12 feet lodgepole or red pine poles every 35 – 40 feet. DeMaree Fruit Farm has been characterized for being very innovative incorporating newer varieties, and plantings in recent years include; Honeycrisp, NY 674, Pinova, Brookfield Gala, Topaz, Cameo, Eve Braeburn, Ambrosia, Macoun, Fuji, Snapp Stayman and MN1914 planted on Bud.9, EMLA.9, M.9 and CG.16.

15 acres of process peaches have been planted at 16-18 feet between the rows and 5 – 6 feet between the trees to be trained as Perpendicular V system. Varieties include: Venture, Catherina, Virgil and Vinegold.

Cahoon CG Rootstock Trial -Dutch Street

cv. Golden, planted May 2001



Tree #	Row 27	Row 26	Row 25
86		CG.5087	CG.6874
85		CG.6874	CG.6874
84		CG.6006	CG.6589
83		CG.6006	CG.6589
82		CG.6589	CG.6589
81		CG.6589	CG.6589
80		CG.6589	CG.6589
79		CG.6589	CG.6589
78		CG.6589	CG.5890
77		CG.6969	CG.5890
76		CG.6969	M.26
75		CG.4214	M.26
74		CG.5890	M.26
73		CG.5890	M.26
72		CG.5012	M.26
71		CG.5029	M.26
70		CG.5029	M.7
69		CG.5029	M.7
68		CG.3041	M.7
67		CG.3041	M.7
66		CG.3041	M.7
65		CG.3041	CG.4214
64		CG.3041	CG.5029
63		G.11	CG.5029
62		G.11	CG.5029
61		G.11	G.11
60		G.11	G.11
59		G.11	G.11
58		CG.5087	G.11
57	Stock	CG.5087	G.11
56	CG.6969	CG.5087	CG.6006
55	G.11	CG.5087	CG.6006
54	G.11	M.7	CG.6006
53	G.11	M.7	CG.5005
52	G.11	M.7	CG.5005
51	CG.3041	M.7	CG.5005

Tree #	Row 27	Row 26	Row 25
50	CG.3041	M.7	CG.5005
49	CG.3041	CG.6006	CG.5005
48	CG.3041	CG.6006	CG.5005
47	CG.6006	CG.6006	CG.6874
46	CG.6006	M.26	CG.6874
45	M.7	M.26	M.26
44	M.7	M.26	M.26
43	M.7	M.26	M.26
42	M.7	M.26	M.26
41	M.7	G.11	M.26
40	CG.5005	G.11	M.26
39	CG.5005	G.11	CG.6006
38	CG.5005	G.11	CG.6006
37	CG.6874	G.11	CG.6006
36	M.26	CG.6874	CG.6969
35	M.26	CG.6874	CG.6969
34	M.26	CG.5012	G.???
33	M.26	CG.6969	G.11
32	M.26	CG.6969	G.11
31	M.26	CG.5029	G.11
30	CG.26	CG.5029	G.11
29	CG.5087	CG.5029	M.7
28	CG.5087	CG.3041	M.7
27	CG.5012	CG.3041	M.7
26	CG.5029	CG.3041	M.7
25	CG.5029	CG.3041	M.7
24	CG.5029	CG.3041	CG.5890
23	CG.5890	CG.5890	CG.5890
22	CG.5890	CG.5890	CG.5890
21	CG.6589	CG.5005	CG.5087
20	CG.6589	CG.5005	CG.5087
19	CG.6589	CG.5005	CG.5087
18	CG.6589	CG.6589	CG.5087
17	CG.6589	CG.6589	CG.3041
16	CG.4214	CG.6589	CG.3041
15	CG.5005	CG.6589	CG.3041
14	CG.5005	CG.6589	CG.3041
13	CG.5005	CG.4214	CG.3041
12	M.26	CG.5087	CG.4214
11	M.26	CG.5087	CG.6589
10	M.26	CG.5087	CG.6589
9	M.26	CG.5087	CG.6589
8	M.7	CG.5012	CG.6589
7	M.7	CG.3041	CG.6589
6	M.7	CG.3041	CG.6589
5	M.7	CG.3041	CG.5029
4	M.7	CG.3041	CG.5029
3	CG.5087	CG.6969	CG.5029
2	CG.5087	CG.6969	CG.5029
1	CG.5087	CG.6969	CG.5012

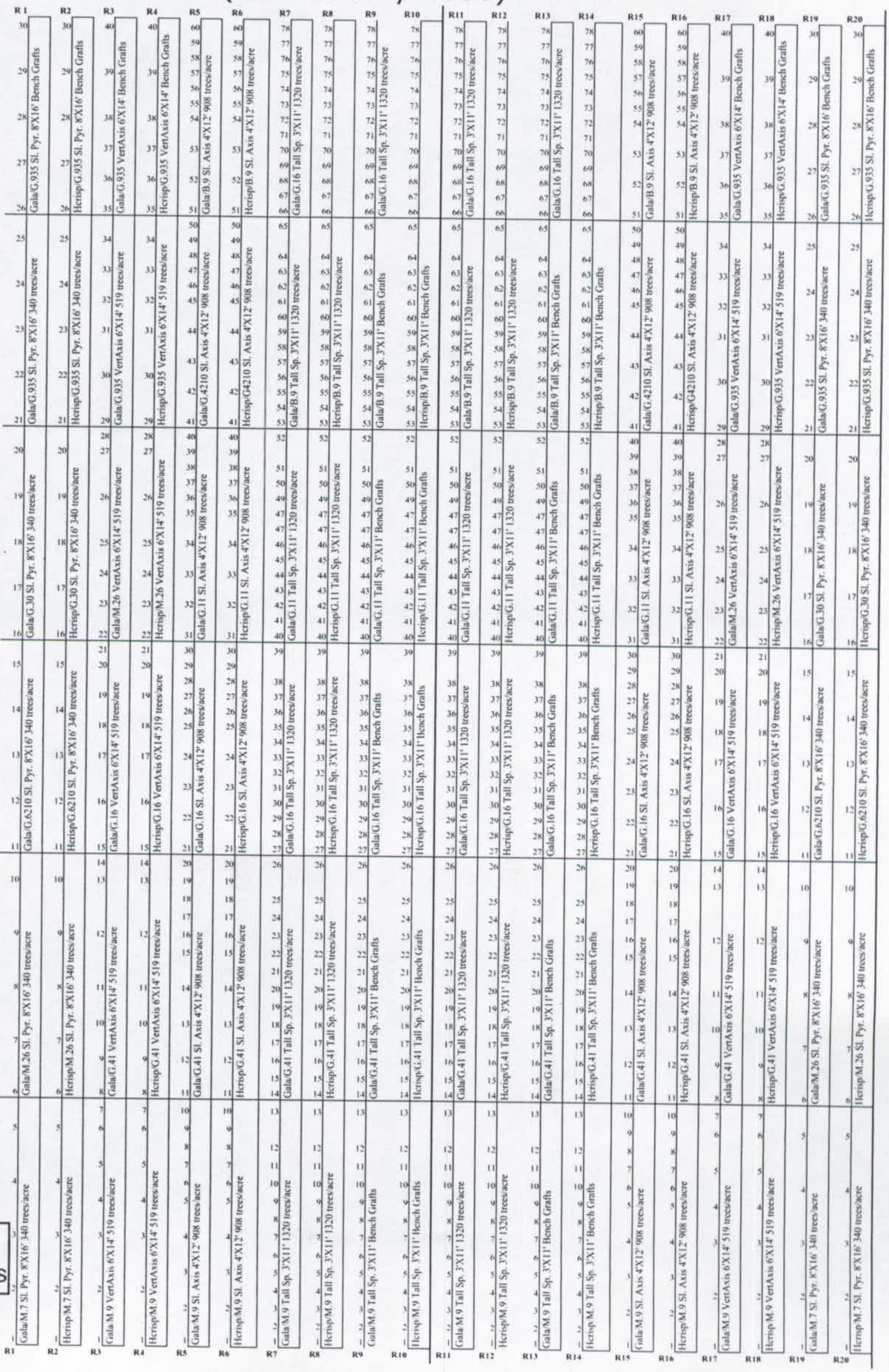
Cahoon CG Rootstock Trial
Planted May 2001

Stock	**Tree Survival (%)**	**Trunk X-sectional area 2007 (cm²)**	**Cum. Fruit (#/ tree)**	**Cum. Yield (kg/tree)**	**Av. Fruit Size (g)**	**Cum. Root Suckers (#/tree)**	**Cum Yield Effiency (kg/cm² TCA)**	**Rank of Cum. Yield Efficiency**
G.11	100	21.0	692	85.0	139	0.1	4.1	7
CG.5029	100	23.7	649	78.1	143	2.4	3.3	11
M.26	100	25.5	578	69.7	147	0.3	2.8	12
G.41	92	25.8	860	115.5	150	0.7	4.5	3
CG.4214	100	26.6	1033	100.4	134	2.0	3.9	8
CG.6006	92	26.7	985	111.4	134	0.0	4.2	6
CG.5005	87	27.3	979	122.2	150	0.9	4.5	2
CG.5087	100	27.4	1065	115.5	132	0.2	4.4	5
CG.5012	100	28.6	1048	128.6	145	0.0	4.5	4
CG.6874	78	29.0	1066	141.0	152	1.7	4.9	1
M.7	100	31.8	522	62.8	152	9.5	2.1	13
CG.6969	100	32.6	930	119.2	147	0.2	3.7	10
CG.5890	100	40.0	1070	152.6	153	0.5	3.8	9
CG.6589	93	71.2	914	121.7	147	0.5	1.7	14
LSD $P \leq 0.05$	**20**	**7.2**	**201**	**28.3**	**12**	**3.4**	**0.8**	

*Rootstocks ranked by increasing trunk x-sectional area

Vanderwall Apple Systems Trial

(Planted May 2006)



1ft = 0.3048 m
1 ha = 2.471 acres

Vanderwalle Systems Trial
Planted May 2006

Variety	Training System	Tree Density (trees/ha)	Rootstock	Tree Type	Fruit Number 2007	Yield 2007 (t/ha)	Fruit Size 2007 (g)	Crop Value 2007 ($/ha)	Yield Efficiency 2007 (kg/cm^2 TCA)	Pruning time 2007 (min/ha)	Trunk X-sectional area 2007 (cm^2)
Gala	Tall Spindle	3262	B9	Feathered	26	8.6	107	125	0.44	20	4.6
Gala	Tall Spindle	3262	G11	Feathered	34	10.8	100	64	0.41	23	6.1
Gala	Tall Spindle	3262	G16	Feathered	37	12.0	95	97	0.34	24	7.6
Gala	Tall Spindle	3262	G41	Feathered	14	5.7	120	409	0.31	15	4.3
Gala	Tall Spindle	3262	M9	Feathered	29	10.8	108	374	0.40	139	6.6
Gala	Slender Axis	2244	B9	Feathered	11	3.1	124	218	0.30	16	4.2
Gala	Slender Axis	2244	G11	Feathered	22	6.1	120	377	0.48	23	4.7
Gala	Slender Axis	2244	G16	Feathered	39	9.4	101	162	0.48	32	6.8
Gala	Slender Axis	2244	G41	Feathered	8	2.3	132	219	0.22	19	3.8
Gala	Slender Axis	2244	G4210	Feathered	10	2.6	114	118	0.21	20	4.9
Gala	Slender Axis	2244	M9	Feathered	37	10.3	118	635	0.47	22	8.3
Gala	Vertical Axis	1283	G16	Feathered	35	4.9	104	132	0.39	12	7.7
Gala	Vertical Axis	1283	G41	Feathered	8	1.5	161	189	0.13	9	5.9
Gala	Vertical Axis	1283	G935	Feathered	6	0.9	119	61	0.09	10	5.8
Gala	Vertical Axis	1283	M26	Feathered	17	2.2	101	41	0.16	10	7.9
Gala	Vertical Axis	1283	M9	Feathered	18	2.8	124	150	0.18	9	7.4
Gala	Slender Pyramid	840	G30	Feathered	27	2.6	107	85	0.22	12	10.4
Gala	Slender Pyramid	840	G6210	Feathered	21	2.3	141	198	0.18	12	9.5
Gala	Slender Pyramid	840	G935	Feathered	5	0.8	150	168	0.12	10	5.4
Gala	Slender Pyramid	840	M26	Feathered	25	2.8	138	265	0.31	10	7.9
Gala	Slender Pyramid	840	M7	Feathered	16	1.5	118	60	0.10	18	13.5
Gala	Tall Spindle	3262	B9	Bench Graft	0	0.0	.	0	0.00	7	3.0
Gala	Tall Spindle	3262	G11	Bench Graft	0	0.0	.	0	0.00	6	2.8
Gala	Tall Spindle	3262	G16	Bench Graft	0	0.0	.	0	0.00	8	4.4
Gala	Tall Spindle	3262	G41	Bench Graft	0	0.0	.	0	0.00	8	2.5
Gala	Tall Spindle	3262	M9	Bench Graft	0	0.0	.	0	0.00	8	3.1
Gala	Vertical Axis	2244	G935	Bench Graft	0	0.0	.	0	0.00	3	2.8
Gala	Slender Pyramid	840	G935	Bench Graft	0	0.0	.	0	0.00	5	2.7

Vanderwalle Systems Trial
Planted May 2006

Variety	Training System	Tree Density (trees/ha)	Rootstock	Tree Type	Fruit Number 2007	Yield 2007 (t/ha)	Fruit Size 2007 (g)	Crop Value 2007 ($/ha)	Yield Efficiency 2007 (kg/cm² TCA)	Pruning time 2007 (min/ha)	Trunk X-sectional area 2007 (cm²)
Honeycrisp	Tall Spindle	3262	B9	Feathered	14	7.0	148	915	0.30'	17	4.8
Honeycrisp	Tall Spindle	3262	G11	Feathered	24	8.7	111	333	0.43	26	4.9
Honeycrisp	Tall Spindle	3262	G16	Feathered	19	10.2	156	1597	0.39	30	6.0
Honeycrisp	Tall Spindle	3262	G41	Feathered	0	0.1	96	0	0.00	9	2.8
Honeycrisp	Tall Spindle	3262	M9	Feathered	18	9.7	160	1637	0.39	25	5.8
Honeycrisp	Slender Axis	2244	B9	Feathered	3	0.8	143	36	0.08	9	3.5
Honeycrisp	Slender Axis	2244	G11	Feathered	17	6.0	153	873	0.37	16	5.4
Honeycrisp	Slender Axis	2244	G16	Feathered	17	7.4	185	1558	0.37	16	5.9
Honeycrisp	Slender Axis	2244	G41	Feathered	1	0.2	213	58	0.00	8	2.0
Honeycrisp	Slender Axis	2244	G4210	Feathered	0	0.0	.	0	0.00	9	3.9
Honeycrisp	Slender Axis	2244	M9	Feathered	15	6.6	184	1403	0.34	13	5.5
Honeycrisp	Vertical Axis	1283	G16	Feathered	9	2.4	192	528	0.16	18	6.5
Honeycrisp	Vertical Axis	1283	G41	Feathered	0	0.1	380	21	0.00	8	3.7
Honeycrisp	Vertical Axis	1283	G935	Feathered	0	0.0	.	0	0.00	13	4.5
Honeycrisp	Vertical Axis	1283	M26	Feathered	15	4.2	227	994	0.22	16	6.8
Honeycrisp	Vertical Axis	1283	M9	Feathered	11	2.9	201	694	0.17	13	6.5
Honeycrisp	Slender Pyramid	840	G30	Feathered	6	1.2	214	297	0.07	13	7.9
Honeycrisp	Slender Pyramid	840	G6210	Feathered	4	1.4	395	396	0.09	12	8.1
Honeycrisp	Slender Pyramid	840	G935	Feathered	1	0.2	350	70	0.00	9	5.0
Honeycrisp	Slender Pyramid	840	M26	Feathered	14	2.6	217	653	0.25	12	7.4
Honeycrisp	Slender Pyramid	840	M7	Feathered	6	1.1	230	288	0.06	15	10.6
Honeycrisp	Tall Spindle	3262	B9	Bench Graft	0	0.0	.	0	0.00	5	2.3
Honeycrisp	Tall Spindle	3262	G11	Bench Graft	0	0.0	.	0	0.00	5	2.0
Honeycrisp	Tall Spindle	3262	G16	Bench Graft	0	0.0	.	0	0.00	5	2.8
Honeycrisp	Tall Spindle	3262	G41	Bench Graft	0	0.0	.	0	0.00	5	2.0
Honeycrisp	Tall Spindle	3262	M9	Bench Graft	0	0.0	.	0	0.00	5	2.5
Honeycrisp	Vertical Axis	2244	G935	Bench Graft	0	0.0	.	0	0.00	4	1.8
Honeycrisp	Slender Pyramid	840	G935	Bench Graft	0	0.0	.	0	0.00	3	2.2
				LSD $P \leq 0.05$	**11**	**2.6**	**54**	**583**	**0.15**	**51**	**1.6**

Fruit Production in New York

Stephen A. Hoying
Mike Fargione
Terence Robinson

Cornell University

ISHS Symposium • August 4-8, 2008
NYSAES, Geneva, NY

Cornell University, Cooperative Extension, and the Regional Fruit Programs in NY

New York's tree fruit crops include apples, pears, sweet and tart cherries, peaches, nectarines, apricots, and plums. Apples predominate with 89% of the acreage and peaches and sour cherries each comprise 3.5% of the acreage.

New York ranks second in the United States in the production of apples behind Washington State recently averaging 25 million bushels (525,000 tons). About 30 million bushels can be produced in good seasons and average production has been increasing in recent years with renovation of orchards and the establishment of more efficient planting systems (Table 1).

According to 2007 USDA-NASS release New York currently has 81,662 acres (33,048 ha) of tree fruit and grapes. Apples account for 42,360 acres (17,142 ha), grapes 33,692 acres (13,373ha), stone fruit 4,392 acres (1,777ha). Fruit crops are produced on approximately 700 family farms. Forty-three percent of these farms are less than 10 acres and many are leased to larger operators. At the other end of the scale, 8 percent of fruit farms are over 200 acres (81 hectares). Table 2 shows the distribution of these farms by apple acres per farm.

NY Fruit Production Regions

Most of NY's commercial fruit is grown in 3 production regions (Figure 1), Western New York on the south shore of Lake Ontario, the Hudson Valley in Southeastern NY bordering the Hudson River within 100 miles of New York City, and the Champlain Valley bordering Lake Champlain and Vermont in Northeastern NY. Each region has its own strengths and caters to different but overlapping markets.

The Western New York or Lake Ontario region is the largest with 28,800 acres or 71% of the acreage. This region produces about a 50:50 mix of fresh and processing apples, processing tart cherries, and a smattering of sweet cherries, pears and peaches.

The Hudson Valley with 8350 acres or 22 % of the acreage is more diversified with a wide variety of stone fruit and berries and is focused on fresh market production for NYC and local markets. In this region, pears and stone fruit are a larger part of the mix since a greater proportion of growers have direct relationships with customers by servicing green markets and operating farm stands.

A shorter growing season and the harsher winters in the Champlain Valley limit the varieties of apples that can be grown. This region has 3151acres or 7% of the state's total. This region has built their reputation on the finest quality McIntosh grown in the US and lately have been very successful with the cold-adapted Honeycrisp variety developed at the University of Minnesota. Most of this regions production is marketed nationally and internationally.

Climate

The climate of New York State is broadly representative of the humid continental type, which prevails in the northeastern United States, but its diversity is not usually encountered within an area of comparable size. Differences in latitude, character of the topography, and proximity to large bodies of water have pronounced effects on the climate. Masses of cold, dry air frequently arrive from the northern interior of the continent. Prevailing winds from the south and southwest transport warm, humid air, which has been conditioned by the Gulf of Mexico and adjacent subtropical waters. These two air masses provide

Table 1. Rankings of apple production by US state.
Total Apple Production: Selected States and United States 4/

	Production					
	Million pounds			1,000 42-pound equivalents		
State	2005	2006	2007	2005	2006	2007
New York	1,045.0	1,250.0	1,260.0	24,881	29,762	30,000
California 1/	355.0	355.0	340.0	8,452	8,452	8,095
Michigan	760.0	850.0	780.0	18,095	20,238	18,571
New England 1/ 2/	130.6	139.5	159.5	3,110	3,321	3,798
Ohio 1/	99.0	102.0	55.0	2,357	2,429	1,310
Pennsylvania	500.0	470.0	455.0	11,905	11,190	10,833
Virginia	250.0	220.0	210.0	5,952	5,238	5,000
Washington	5,700.0	5,650.0	5,400.0	135,714	134,524	128,571
United States 3/	9,704.9	9,931.7	9,254.7	231,069	236,469	220,350

1/ Estimates for current year carried forward from earlier forecast.
2/ Includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont.
3/ National total includes amounts for other states not listed.
4/ In orchards of 100 or more bearing age trees.

Table 2. Apples: Number of farms and acres, by size, 2001 and 2006

	2001				2006			
	Farms		Acres		Farms		Acres	
Size Group	Number	Percent	Number	Percent	Number	Percent	Number	Percent
(apple acres per farm)								
<10	257	37	1,022	2	299	43	786	2
10-19.9	95	14	1,478	3	88	13	1,216	3
20-49.9	137	20	5,364	12	110	16	3,312	8
50-99.9	106	15	8,540	19	88	13	6,410	15
100-199.9	58	8	9,917	23	56	8	7,352	17
200+	42	6	18,242	41	56	8	23,284	55
Total 1/	695	100	44,563	100	697	100	42,360	100

1/ Totals may not add due to rounding.

the dominant continental characteristics of the climate. The third great air mass flows inland from the North Atlantic Ocean and produces cool, cloudy, and damp weather conditions. This maritime influence is important to New York's climatic regime, especially in the southeastern portion of the state, but it is secondary to that of the more prevalent air mass flow from the continent.

Nearly all storm and frontal systems moving eastward across the continent pass through or in close proximity to New York State. Storm systems often move northward along the Atlantic coast and have an important influence on the weather and climate of Long Island and the lower Hudson Valley. Frequently, areas deep in the interior of the state feel the effects of such coastal storms. Cold winter temperatures prevail over New York whenever Arctic air masses flow southward from central Canada or from Hudson Bay. High-pressure systems often move just off the Atlantic coast, become more or less stagnant for several days, and then a persistent airflow from the southwest or south affects the state. This circulation brings the very warm, often humid weather of the summer season and the mild, more pleasant temperatures during the fall, winter, and spring seasons.

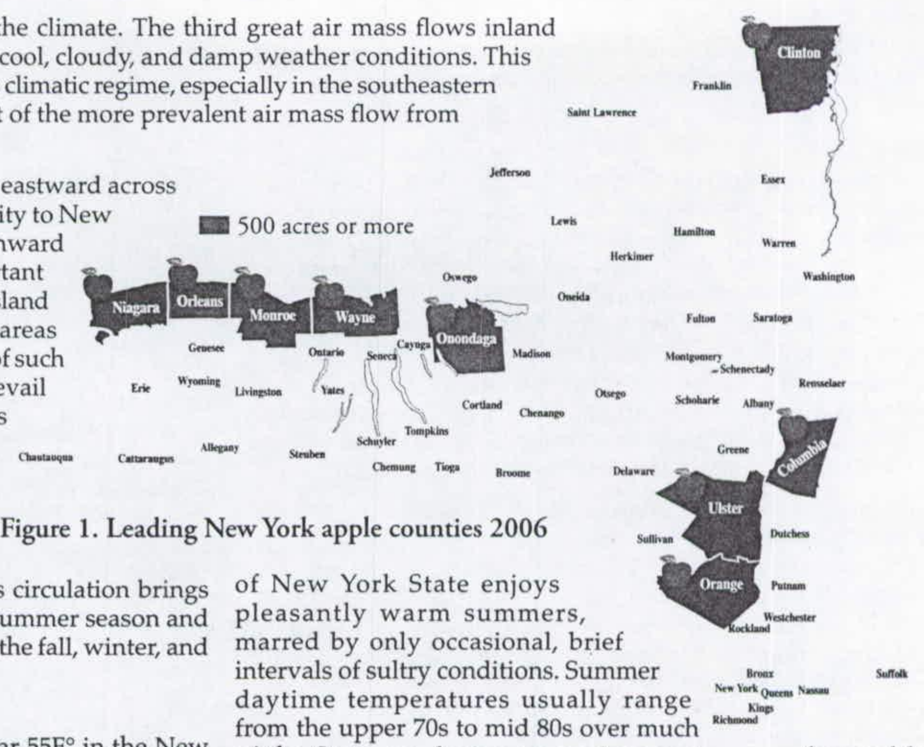


Figure 1. Leading New York apple counties 2006

Temperature
The average annual mean temperature is near 55F° in the New York City area. In January, is about 26° along Lake Erie and in the lower Hudson Valley and to 31° on Long Island. The highest temperature on record in New York State is 108F° near Troy, NY on July 22, 1926. Temperatures of 107F° have been observed at Lewiston, Elmira, Poughkeepsie, and New York City. The record coldest temperature in NY is -52° on February 18, 1979.

The winters are long and cold and in the majority of winter seasons, temperatures from -15 to -25F° can be expected inland. The Adirondack region records from 35 to 45 days with below zero temperatures in normal to severe winters, with a somewhat fewer number of such days occurring near Lake Champlain and the St. Lawrence River. In the upper Hudson Valley, below zero minimums are observed on about 15 days in most winters and on more than 25 days in notably cold seasons.

Winter temperatures are moderated considerably in the Great Lakes Plain of western New York. The moderating influence of Lakes Erie and Ontario is comparable to that produced by the Atlantic Ocean in the southern portion of the Hudson Valley. In both regions, the coldest temperature in most winters will range between 0° and -10F°. Long Island and New York City experience below zero minimums in 2 or 3 winters out of 10, with the low temperature generally near -5F°.

The moderating effect of lakes Erie and Ontario on temperatures assumes practical importance during the spring and fall seasons. The lake waters warm slowly in the spring, the effect of which is to reduce the warming of the atmosphere over adjacent land areas. Plant growth is thereby retarded, allowing a great variety of freeze-sensitive crops, especially tree and vine fruits, to reach critical early stages of development when the risk of freeze injury is minimized or greatly reduced. In the fall season, the lake waters cool more slowly than the land areas and thus serve as a heat source. The cooling of the atmosphere at night is moderated or reduced, the occurrence of freezing temperatures is delayed, and the growing season is lengthened for freeze-sensitive crops and vegetables.

The summer climate in the lower Hudson Valley is warm with some periods of high, uncomfortable humidity. The remainder of New York State enjoys pleasantly warm summers, marred by only occasional, brief intervals of sultry conditions. Summer daytime temperatures usually range from the upper 70s to mid 80s over much of the State, producing an environment favorable to the production of pome and stone fruit as well as many other outdoor activities.

Temperatures of 90°or higher occur from late May to mid-September in most of the Hudson Valley which records an average of 18 to 25 days with such temperatures during the warm season. In western NY this normal quota usually does not exceed 2 or 3 days. Temperatures of 100F° are rare. Minimum nighttime, temperatures regularly drop to the 40's and 50's

The average length of the freeze-free season in New York State varies from 100-120 days in the Adirondacks to 180-200 days on Long Island. The important fruit areas in Western NY and the Hudson Valley enjoy a frost-free growing season of from 150 - 180 days in duration. The Lake Champlain regions have an average duration of 120 - 150 days between the last spring and first fall freezes.

Precipitation
Average annual precipitation is 30-50 inches per year. Areas of least rainfall occur near Lake Ontario in the extreme western counties and in the vicinity of Lake Champlain.

New York State has a fairly uniform distribution of precipitation during the year. Almost any calendar month has the potential of having the smallest, or largest monthly accumulation of precipitation within a calendar year at a given location. There are no distinctly dry or wet seasons. Minimum precipitation occurs in the winter season, with an average monthly accumulation ranging from about 3.5 inches on Long Island to 2.2 inches in the Finger Lakes and Lake Champlain regions. Maximum amounts are noted in the summer season throughout the state except along the Great Lakes where slight peaks of similar magnitude occur in both the spring and fall seasons. Average monthly amounts in the summer vary from 3 inches south of Lake Ontario and 4.0 inches in the Hudson Valley.

The amount and distribution of precipitation are normally sufficient for fruit production although trees are generally at water deficit during July and August most years. Severe droughts are rare, but deficiencies of precipitation may occur from time to time, which cause at least temporary concern over declining water supplies and moisture stress in crops and other vegetation.

Snowfall

The climate of New York State is marked by abundant snowfall. The state receives an average seasonal accumulation of 40 inches or more with the average snowfall greater than 70 inches over some 60 percent of New York's area. The moderating influence of the Atlantic Ocean reduces the snow accumulation to 25 to 35 inches in Hudson Valley region. Topography, elevation, and proximity to large bodies of water result in a great variation of snowfall in the state's interior, even within relatively short distances. Seasonal snowfall of 40 to 50 inches occurs upstate in WNY near the south shore of Lake Ontario, In northern New York, about 60 inches in the vicinity of Lake Champlain.

Lake effect snow produced in the lee of Lakes Erie and Ontario is a prominent and very important aspect of New York's climate. As cold air crosses the unfrozen lake waters, it is warmed in the lower layers, picks up moisture, and reaches the land in an unstable condition. Precipitation in the form of snow is released and heavy snow squalls frequently occur, generating from 1 to 2 feet of snow and occasionally 4 feet or more. Areas near Lake Ontario, especially those to the southeast and east, are exposed to severe snow squalls well into February because the Lake generally retains considerable open water throughout the winter months.

A durable snow cover generally begins to develop with a continuous snow cover from about mid-December to mid-March, with maximum depths usually occurring in February. Bare ground frequently occurs briefly in these regions during most winters.

History of Fruit Growing in New York

Apples and other fruit came to the Americas with the first settlers. The pilgrims brought apples with them in 1629 to the Massachusetts Bay Company. According to written records, Governor Peter Stuyvesant planted an apple tree from Holland in 1647 on the corner of Third Avenue and 13th Street in New York City. In Eastern New York, apples were introduced to the Hudson Valley by the Dutch while the English planted apples on Long Island. Fruit rapidly spread across the state with some of the earliest orchards in Western New York were established near Niagara Fall by 1700 by French missionaries. Jesuit missionaries were believed to have introduced apples into central New York at about the same time. Indians including the Iroquois, Cayuga, and Seneca acquired seeds from these missionaries and established seedling orchards near their campgrounds. One of these campgrounds was located near the present site of the NYS Experiment Station at Geneva.

The first commercial nursery (Prince Nurseries, Flushing, LI) was established on Long Island by the Huguenot's in 1730. Through the years, settlers continued to bring seeds and trees from Europe for establishment in their new homes. New varieties were recognized, such as 'Jonathan" discovered in 1800 by Jonathan Hasbrouck near Woodstock NY, as seedlings were cultivated or naturally sown. "The Apples of New York", published as a 2 volume set in 1905 by Beach, described over 1000 varieties of apples existing at that time.

During the time of the Revolutionary War, settlers continued to plant fruit trees throughout NY. Almost all early settlers planted apple trees as they established themselves. To these pioneers, the planting of apple trees provided proof of their intentions to stay. One Ohio land company required that settlers plant 50 apple trees and 20 peach trees within the first three years of settlement in order to lay claim to a 100 acre site.

Perhaps the most famous disseminator of apples was John Chapman known as "Johnny Appleseed". He participated in the introduction of apples to Western Pennsylvania, Ohio, and Indiana, but not New York State.

Apples were an important part of the diet of these early settlers. They attempted to grow enough apples to consume fresh from the fall through the winter. Primitive storage was accomplished by storing the apples in insulated pits. However, perhaps the larger portion of the crop was consumed as juice and (fermented) cider. An established farmer might put up from 20 to 50 barrels of cider each fall for his own enjoyment and for his guests.

The first commercial orchard in eastern NY was planted between 1820-1825 in Ulster County at Esopus by Robert Pell. The 20 acre farm grew Newton Pippin apples that were packed in wooden barrels and exported to England by sailing schooner. Most fruit from early commercial orchards in the Hudson Valley were transported by horse-drawn wagon to the Hudson River for transportation to New York City by boat and later by rail. Delivery of fruit by truck to large city commission merchants or stores began in the 1930's. By the 1940's, much Hudson Valley fruit was being sold at the storage or packing house F.O.B.

1850 to 1900 saw rapid changes in the Western NY fruit industry. An increased volume of fruit moved on the Erie Barge Canal. The railroads allowed more rapid shipment of fruits to eastern markets and made commercial production possible at sites located further from the canal. The possibilities of growing apples for sale to distant markets changed the apple industry from one of several crops grown on subsistence farms into a commercial enterprise. As a result, apple production expanded greatly during this period and New York emerged as the leading apple producing state in the country. That position was held until the 1920's when New York was eventually surpassed in production by Washington State.

The New York census of 1875 counted 18,278,636 apple trees. It's been calculated that if these trees were planted at an average spacing of 27 feet apart, that the land area represented by this number of trees would equal approximately one percent of the total area of New York State.

This widespread expansion of an introduced plant species almost caused the apple industry to nearly collapsed between 1870 and 1880 when insect and disease pressure built up to almost unmanageable levels. This development was one of the key events that lead to the establishment of the New York Agricultural Experiment Station in Geneva, New York in 1870. Research carried out in the 1880's restored the industry by providing chemical pesticides with which to combat the principal apple pests, Codling Moth and Apple Scab. The Horticulture department at this station has made many contributions to the apple industry worldwide including the testing and development of many important apple varieties including Jonagold, Empire, Cortland, and Macoun.

In 1896, New York State reached its record production of 54,178,000 bushels. The per capita supply of apples averaged nearly 100 pounds per person near the turn of the century and exceeded 150 pounds during several years. The volume of apples dried increased throughout the late 1800' s and peaked during World War 1 when over 37 million pounds of dried apples were produced in New York. The entire production from some farms were dried. Canning of fruit in NY increased at the turn of the century coinciding with the beginning of mass production of tin cans in Fairport, NY.

County associations of the Cooperative Extension Service were formed soon after the passage of the Smith Lever Act of 1914. The mission of the Extension Service then, as now, was to disseminate the information developed at the land grant colleges and the experiment stations. Communicating information on pest control was one of its earliest functions. Prior to the use of radio, telephone relays among growers were used to advise growers when to spray.

The New York State Fruit Testing Association was formed in 1918 for the purpose of aiding in the dissemination and industry trial of the varieties released by the New York fruit breeding program. The most notable apple releases from the breeding program since its formation are Cortland, Macoun, Empire, and Jonagold.

The dominant apple varieties in the early 1900's were Baldwin representing over 30 % of the apples packed in Western New York, and Rhode Island Greening which accounted for approximately 25 % of the crop. McIntosh was the thirteenth ranking variety and amounted to only about 1 % of the packed crop.

During the 1930's, the New York State Rootstock Cooperative played an important role in the development of clonal roostocks in North America. The Rootstock Cooperative was housed at the Geneva Experiment Station like the Fruit Testing Association. In the late 1920's, the U S government prohibited the import of rootstocks from Europe to prevent the introduction of foreign pests. Just prior to the embargo, the Rootstock Cooperative under the direction of H. B. Tukey and Karl Brase acquired the Malling series of rootstocks. During the 1930's, the association provided the source of these stocks for other researchers in North America. Over 190,000 stocks and 16,000 trees were eventually distributed to 238 individuals and experiment stations in 36 states and Canada. Most of the tests of rootstock performance conducted on this side of the Atlantic during the thirties and forties resulted from materials supplied either directly or indirectly by the Rootstock Association.

The first cold storages using ice cut from local ponds were established prior to 1900. K. M. Davis storage in Williamson began in 1902 and continues in operation today. Electric power refrigeration units were used as early as 1919 in the Hudson Valley. A survey conducted for the New York Central Railroad in 1926 counted 55 apple storages in Western New York with a combined capacity of two million barrels (6 mil bu).

The use of controlled atmosphere (CA) storage began in New York State in the early 1940's. Cornell University's Dr. Robert Smock became convinced of the commercial potential for CA storage based upon his own work and experiments performed in England and California. The first successful commercial CA storage room was built in the Hudson Valley in 1941 by M.G. Hurd of Clintondale. At the time of its early development, CA storage was designed primarily to lengthen the storage season for McIntosh while reducing the risk of the variety developing storage disorders associated with chilling injury.

By 1955, the US CA storage capacity had reached one million bushels. During that era, approximately 70 % of the national CA holdings were McIntosh. In the 1960's, Washington State began a rapid expansion in the construction of CA storage and the average holdings of Red Delicious in CA surpassed McIntosh. Today, the US CA capacity is over 70 million bushels. There are approximately three million bushels capacity in Western New York and approximately 4.5 million bushels capacity in Eastern New York.

The average grower was just beginning to learn about the Malling rootstocks for high density plantings in the 60's. These statements were made by William Blackburn at the Western NY Horticulture Show in 1965. He said, "successful new plantings must have smaller tree units and greater per acre potential production", and ".... a row of M.9's planted 7 feet apart are very interesting and lead to a lot of speculation. Vast production is certainly possible if the maximum number of this size tree were planted on an acre."

Interestingly, Malling 9 was one of the first clonal rootstocks to find its way into commercial orchards in Western New York. It was first planted in 1958 at 16 X 25 ft spacing by John B. Henry in a block on North Geneva Road in Sodus. And despite the spacing mistake made a big impression on him. This block began to bear just 3 years after planting. Eventually, interplants were made in this block which changed the spacing to a tolerable 8 X 12.5 ft. This block was eventually removed in 2001 after 45 years.

Mr. Richard L. Norton, Area Extension Specialist with Cornell Cooperative Extension's Lake Ontario Fruit Program made his first experimental plantings of full dwarf M.9 rootstocks on commercial operations in 1962-65. Although he was convinced shortly after this that this was the best rootstock for the future, he conceded to the majority of growers desire to have self-supporting trees and he began to research and promote the combinations of the Malling 9/106 and 9/111 interstems. By the mid 1960's many growers were able to obtain appropriate varieties on dwarfing rootstocks. The most popular originally were MM.106 and M.7. Subsequently, MM.111 was used in place of MM.106 when this rootstock's susceptibility to collar rot/wet feet (*Phytothphora cactorum*) was discovered.

Mr. Norton's early demonstrations with M.9 were successful and convincing, and between 1975 and 1979 over 20% of the trees planted in Western NY were on this rootstock. In addition, Norton's promotion of the combinations M.9/MM.111 and M.9/MM.106 and his dogged determination to instruct the grower on their culture succeeded in making interstem combinations the most widely planted stocks in Western New York during the 1980's. These stocks were planted at an average spacing of 10 X 18 feet or 242 trees per acre.

On-farm research and demonstration trials carried out throughout New York State by Dr. Terence Robinson, Steve Hoying, Warren Smith, Mike Fargione and Kevin Iungerman from 1988-2008 continued to gather information and instruct growers of the culture and benefits of high density planting systems. Field workshops, In-depth High Density Planting Systems Schools, Fruit School talks, and demonstration trials on grower farms combined to convince growers to rapidly adopt apple planting densities nearing 1000 trees per acre. Currently, forms of the Vertical Axis system and the Tall Spindle Systems are being planted most widely in New York.

The preceding account illustrates the rich history of apple production in New York. This discussion is by no means complete. However, the future importance of the fruit industry in New York is assured by its desirable climate, good soils, progressive growers and marketers, and the support of research and extension programs.

Farm Structure
Fruit farms in New York are primarily family-owned and operated as small businesses. Growers and their families live on the same property as their orchards. There are typically many farm buildings in the complex including barns and equipment storage, fruit storage, shop for mechanical work, and sometimes packing sheds. Typically 2 or more generations live and work on the farm.

According to the 2006 NY Fruit Tree and Vineyard Survey, the average holding is 60 acres of apples, 12 acres of tart cherries, 6.5 acres of peaches, 4.8 acres of pears, and 3.5 acres of sweet cherries. However, there are large differences in the fruit composition and orchard size by region. For example, in Western NY according to the 2006 Lake Ontario Region Fruit Farm Business Summary, the average number of acres of fruit of the 17 participants in the study approaches is 267 acres. Many of these growers operate several rental orchards as part of their holdings.

Many of the larger operations have geographically separated orchards to take advantage of the best soils and sites and to reduce the risk of frost and hail damage.

Planting and Pruning Systems
There has been a steady transition of planting system types since the establishment of fruit production in New York. There has been a steady increase in density and the evolution of pruning techniques. The typical grower now plants new orchards at 500-650 trees per acre depending on variety. Recently the increase in tree density has accelerated with the many progressive growers now planting orchards with nearly 1000 trees/acre and as high as 2,500 trees per acre. One thousand trees per acre appear to be the most profitable apple orchard density for the future using the Tall Spindle system. Single rows are preferred.

Most fruit farms have a wide range of orchard ages, sizes, and spacings. The oldest orchards in the state (which are 75 years or older) are dedicated to the production of fruit for processing products such as apple sauce or juice. These orchards are on seedling rootstocks and have 35-50 trees per acre. They are most commonly found in the eastern part of the Lake Ontario region. Mid-sized central leader orchards typically on M.26 and M.7 date from the 1970's are found across the state. Individually staked interstem orchards (9/106 and 9/111) with densities of 250-350 trees are common in Western New York. Most new orchards are planted using fully dwarf trees with various clones of M.9 and B.9 at 600-700 trees/acre (5-6 X 12). Most recently growers are trying orchards approaching 1000 or even 2500 trees/acre. These orchards can be found in Western New York and the Hudson Valley.

The information required to establish higher density plantings has come from Cornell University, the International Dwarf Fruit Tree Association meetings tours, and from fruit grower's personal observations from private trips and tours to other fruit production areas around the world. A short list of plantation systems currently in use in NY would include, free form, Güttingen V, 3, 4, and 5-wire vertical trellis, Open Center, Modified Open Center, MIA, many forms of Slender Spindle, SolAxe, Super Spindle, Tall Spindle, Tatura types, V-Super Spindle, Vertical Axe, Geneva Y-Trellis.

Varieties
NY has approximately 30 varieties in commercial production as well as numbers of new varieties constantly under test. This is a very high number compared to other production regions in the United States. Listed in the latest NY Fruit Tree and Vineyard Survey are 22 varieties. Other varieties of importance that are not listed but increasing in importance include Cameo, Fuji, and Braeburn. The New York Apple Association lists 20 varieties that seasonally can be easily found. These apple varieties have originated from all over the world including significant varieties developed in New York. Table 3 lists the most important varieties and acreage of each.

Table 3. Significant apple varieties produced in New York.

Variety	Acres
McIntosh	7,365
Empire	4,989
Rome	3,466
Red Delicious	3,455
Cortland	3,068
Idared	2,676
Golden Delicious	2,278
Gala	1,809
Crispin	1,570
Jonagold	1,344
Macoun	1,286
Gingergold	1,053
Honeycrisp	890
Others	9,111

Tart and sweet cherries are harvested in July, apricots, peaches, nectarines, and plums in August and apples in September and October.

Rootstocks
The Malling and Malling Merton series of apple rootstocks are the most common in use in New York. These include MM.111, MM.106, M.7, M.26, and M.9. There are several clones of M.9 that are important including M.9 EMLA, NAKB 337, Nicolai 29, and Pajam 2. All of these clones have shown high yield efficiency, and with the range in vigor they express, it is possible for a grower to fine tune the choice of M.9 to match his particular soil and the variety he will plant.

Other apple stocks currently being propagated for sale to NY include B.9, B.118, G.30, G.11, and G.16. The NC-140 Regional Rootstock Testing Group, whose main objective is to evaluate the field performance of pome and stone-fruit rootstocks in various environments and under different management systems, have many other candidate rootstocks from around the world under test in the NY and the United States.

Sweet cherry rootstocks used on farm include Mazzard and Mahaleb and Gisela 5, 6, 7 and 12.

Peach, nectarine and plum rootstocks are the seedling Lovell and Bailey for peach, and Myrobalan for plums.

Marketing
NY markets it fruit in many different ways. The majority of apples are distributed nationally and internationally through sales agencies and commercial packing facilities which package fruit in many different ways. The most common package is a 40 pound cardboard bushel carton. Fruit are categorized by count size or the number of apples per bushel. Common counts are 64, 88, 100, 120. Preferred sizes depend on the market with supermarkets and fruit stands preferring the larger sizes. Fruit is also packed in 3, 5, and 10 pound plastic bags, and in paper totes with handles.

Local distribution from farm to store is practiced in each region with delivery arrangements made between individual store manager and the grower. The more perishable crops such as stone fruit and berries are handled this way.

Grower-owned farm markets and fruit stands are common and popular. Growers store and sell their own fruit along with other seasonal produce, baked goods, processed foods, gifts, and other items. These markets are often managed by family members. Often U-pick opportunities for seasonal fruit are offered in conjunction with a farm store.

Fruit is also sold through organized community "farmers markets" held in public areas on a regular basis. One of the most important is the "Greenmarket" in New York City which includes 44 separate market locations. Its function is to promote regional agriculture and ensures a continuing supply of fresh, local produce for New Yorkers. Greenmarket has organized and managed open-air farmers markets in NYC since 1976. Greenmarket supports farmers and preserves farmland for the future by providing regional small family farmers with opportunities to sell their fruits, vegetables and other farm products to New Yorkers. Generally, growers rent space and set up tables in these public places to sell their produce right out of the truck. These markets provide a wide range of in-season produce depending on what is currently available at the participating farms. Fruit, vegetables, wine, and other farm products are generally available.

Cost and Earnings

New York regularly publishes a "Fruit Farm Business Summary" that outlines the economic health of a subsample of the fruit industry. Please refer to this bulletin for more information on the economic situation in New York.

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9) Fruit Farm Business summary - Lake Ontario Region 2006 GB White, AM DeMarree, and J Neyhard Bulletin E.B. 2007-15.

Appendix:

Conversion Table – English vs. Metric[1]

To convert Column 1 into Column 2, multiply by:	Column 1	Column 2	To convert Column 2 into Column 1 multiply by:
	Length		
.621	kilometer, km	mile	1.609
1.094	meter, m	yard	.914
3.281	meter, m	foot, ft	.3048
39.4	meter, m	inch	.0254
.03281	centimeter, cm	foot, ft	30.47
.394	centimeter, cm	inch	2.54
.0394	millimeters, mm	inches	25.40

metric: 1 km = 1000 m; 1 meter = 100 cm; 1 meter = 1000 mm
English: 1 mile = 5280 ft; 1 mile = 1760 yards; 1 yard = 3 ft; 1 ft = 12 inches

To convert Column 1 into Column 2, multiply by:	Column 1	Column 2	To convert Column 2 into Column 1 multiply by:
	Area		
247.1	kilometers^2, km^2	acre	.004047
2.471	hectare, ha	acre	.4047
.4047	trees/hectare	trees/acre	2.471

metric: 1 ha = 10,000 m^2 = .01 km^2
English: 1 acre = 43,560 ft^2

To convert Column 1 into Column 2, multiply by:	Column 1	Column 2	To convert Column 2 into Column 1 multiply by:
	Volume		
1.057	liter	quart (US)	.946

English: 1 US gallon = 4 quarts

To convert Column 1 into Column 2, multiply by:	Column 1	Column 2	To convert Column 2 into Column 1 multiply by:
	Mass—Weight		
1.102	ton (metric), MT	ton (English)	.9072
2.205	kilogram (kg)	pound, lb	.454
52.5	ton (metric) of apples	apple packed box, *carton	.01905

metric: 1 metric ton = 1000 kg
English: 1 ton = 2000 lb; 1 packed box or carton* of apples = 42 lb

To convert Column 1 into Column 2, multiply by:	Column 1	Column 2	To convert Column 2 into Column 1 multiply by:
	Yield or Rate		
0.446	ton (metric)/hectare, MT/ha	ton (English)/acre	2.242
.892	kilogram/hectare, kg/ha	pound/acre	1.121
.991	ton (metric) of apples/hectare, MT/ha	bins* of apples/acre	1.009
.4047	trees/hectare	trees/acre	2.471
0.107	liter/hectare	gallon (US)/acre	9.354

metric: 1 metric ton = 1000 kg; 1 hectare = 10,000 m^2
English: 1 ton = 2000 lb; apple bin* = 900 lb; 1 acre = 43,560 ft^2

To convert Column 1 into Column 2, multiply by:	Column 1	Column 2	To convert Column 2 into Column 1 multiply by:
	Temperature		
1.8 C + 32	Celsius, C	Fahrenheit, F	.555 (F-32)

**Commercial cartons (packed boxes) of fruit and field/storage bins of fruit do not have universal weights. The weight of fruit in a packed box or carton varies around the world and with the type of fruit, but is here taken for apples as 42 lbs (19.05 kg); the weight of fruit in a bin also varies but is here taken for apples as 900 lbs (408.2 kg).*

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1. Reproduced from the Compact Fruit Tree, IDFTA Journal