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6th INTERNATIONAL CONGRESS ON

HAZELNUT

TARRAGONA - REUS, SPAIN
14th - 18th June, 2004

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PROGRAMME
ABSTRACTS BOOK

SIXTH INTERNATIONAL CONGRESS ON HAZELNUT

Organized by:

INSTITUT DE RECERCA I TECNOLOGIA AGROALIMENTÀRIES (IRTA)

INTERNATIONAL SOCIETY FOR HORTICULTURAL SCIENCE (ISHS)

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WELCOME to the VI International Congress on Hazelnut Tarragona-Reus, Spain 14th-18th June, 2004

We have the pleasure in welcoming research participants and Hazelnut industries to the VI International Hazelnut Congress which will be held in Tarragona and Reus. The Congress will be an international forum to meet each other and to exchange experiences related to the latest results concerning agronomic, industrial, health benefits and commercial aspects of hazelnut.

The Spanish nut tree sector represents a remarkable weight in the agricultural final production, our country being the second world producer of almond (55.000 t grain) and the fourth of hazelnut (9.000 t grain). In Spain hazelnut covers some 25.000 ha, concentrating 95 % in Catalonia and, more concretely in Tarragona (18.000 ha), where the hazelnut is, in diverse districts, an important source of income. The hazelnut sector is grouped in six Nut Growers Associations, all of them located in Catalonia. In Spain, hazelnut commercialization is mainly dedicated to the chocolate industry and the elaboration of toasted "snacks."

As you probably know, the 1st Hazelnut Congress was held in Reus in the year 1976. Since then, different cities all over the world have hosted the following: Avellino, Italy (1983); Alba, Italy (1992); Ordu, Turkey (1996) and Corvallis, USA (2000). This spring we have the opportunity to meet again in Tarragona-Reus, twenty-eight years after that event. The organization in charge is the IRTA – Centre Mas Bové, Constantí (Generalitat de Catalunya) in collaboration with the International Society for Horticultural Science (ISHS).

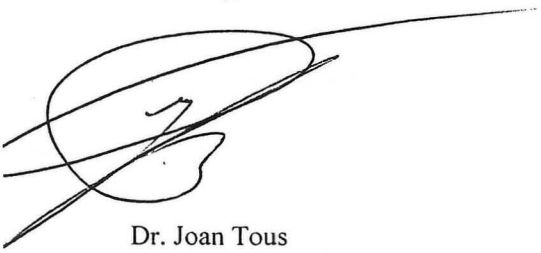
The following pages provide a schedule-index of events for the conference, the abstracts of all presentations and a list of participants' names.

In this Congress there are about 125 participants of several countries, such as Australia, China, France, Italy, New Zealand, Poland, Portugal, Spain, South America, Turkey, Ukraine, USA, etc. The organization of the congress has received financial support from several institutions (Diputació de Tarragona, Ministerio de Ciencia y Tecnología, UE-PORTA, Generalitat de Catalunya, CIHEAM, FAO-CIHEAM Nut Network, Caixa Tarragona, Ajuntaments (town councils) de Tarragona, Reus and Constantí) and private sponsors (Borges, Morella Nuts, Indústries Garriga, DOP Avellana de Reus, Unió Agraria Cooperativa and Coselva). We thank all of them.

We hope you will enjoy your stay with us and that you will have the opportunity to learn about our region and local customs.

Hoping to meet you at the Congress,

Sincerely,



Dr. Joan Tous
Convener of the Congress

Dr. Mercè Rovira
Scientific Secretariat

ACKNOWLEDGEMENTS

The Organising Committee gratefully acknowledges the financial support received from:

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International Society for Horticultural Science (ISHS)
Departament d'Agricultura, Ramaderia i Pesca de la Generalitat de Catalunya (DARP)

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Indústries Garriga, S.L.
Unió Agrària Cooperativa
Coselva
Denominació Origen Protegida Avellana de Reus

SCHEDULE FOR THE CONGRESS

Time	Event	Location
14th June, Monday		
8h-9h	Registration / Poster set up	Hall of Diputació de Tarragona
9h-9.45h	Opening session of the Congress	"Santiago Costa" Hall
9.45h-11h	**Oral Session 1: Germplasm and Genetic Improvement** *Chairman: S. A. Mehlenbacher (U.S.A.)*	
11h-11.30h	Cofee Break	Hall of Diputació de Tarragona
11.30h- 12.30h	**Oral session 1 (continuation)**	"Santiago Costa" hall
12.30h-13.30h	**Oral Session 2: Biology and Physiology** *Chairman: G. Me (Italy)*	
14h-15h	Lunch	Astari Hotel
15.30h-16h	**Oral session 2** (continuation)	"Santiago Costa" Hall
16h-16.30h	Poster set up	Hall of Diputació de Tarragona
16.30h	Departure to Reus	
17h-18.30h	Visit to Borges Nut Industry	Reus
19h-20.30h	Technical Tour: Visit to IRTA-Mas Bové	Constantí
20.30h-23h	Dinner in IRTA-Mas Bové	
23.30h	Arrival to the hotels	Tarragona
15th June, Tuesday		
8.30h-8.45h	**Oral Session 3: Propagation and Rootstocks** *Chairman: A. Tombesi (Italy)*	"Santiago Costa" Hall
8.45h-10.45h	**Oral Session 4: Orchard Management** *Chairman: A. Tombesi (Italy)*	
11h-11.30h	Cofee Break	Hall of Diputació de Tarragona
11.30h-13.30h	**Oral Session 5: Pest and Diseases** *Chairman: A. N. Azarenko (U.S.A.)*	"Santiago Costa" Hall
14h-15h	Lunch	Astari Hotel
15.30h-17h	**Poster Sessions 1, 2, 3**	
17h-18h	Invited Conference. Nucis Fundation: 'Health and nuts'	"Santiago Costa" Hall
18h-20h	Tourist and cultural Tour in Tarragona	Tarragona
20h-21h	Welcome coctail in Tarragona's Town Hall	

16th June, Wednesday	Technical and cultural Tour	
8h.	Departure from Diputació de Tarragona	
8.30h-10h	Hazelnut Orchard "Tros Nou"	La Selva del Camp
10.15h-11.45h	"Coselva" Industry	"
12h-13.15h	Hazelnut Orchard " Mas del Metge"	"
14h-15.30h	Dinner	L'Espluga de Francolí
16h-17.30h	Visit to Poblet Monastery	"
17.30h-18h	Visit to winery of Monastery	
18.15h	Return to Tarragona	
19h	Arrival to the Hotels	Tarragona
17th June, Thursday		
8.30h-9.15h	**Oral Session 6: Post Harvest and Quality** ***Chairman: A. Solar (Slovenia)***	"Santiago Costa" Hall
9.30h-11h	**Oral Session 8: Industry, Marketing and Economics** ***Chairman: C. Tuncer (Turkey)***	
11h-11.30h	Coffee break	Hall of Diputació de Tarragona
11.30h-13.30h	**Oral Session 8** (continuation)	"Santiago Costa" Hall
12h-13.30h	**ISHS hazelnut workshop**	"Santiago Costa Hall"
	Poster Sessions 4, 5, 6, 8	Hall of Diputació de Tarragona
14h-15h	Lunch	Hall of Diputació de Tarragona
15.15h-16h	Poster take away	
16h	Departure to Reus	
16.30h-18.30h	Modernism in Reus: Tourist and Cultural Tour	Reus
19h	Arrival to the hotels	
20.30h-23h	Gala dinner	Tarragona
23.30h	Arrival to the hotels	
18th June, Friday	Open day	Auditori Caixa de Tarragona
9h-9.30h	Welcome to the Workshop	
9.30h-11h	1st Round table: 'World hazelnut situation and perspectives'	
11h-11.30h	Coffee Break	
11.30h-13.30h	2nd Round table: 'Production and commercial aspects on hazelnut	
13.30h-14h	Conclusions and Closure of the Congress	

LIST OF CONTENS

SESSION 2: BIOLOGY AND PHSYSIOLOGY

Chairman: G. Me (Italy)

Oral

Poster

SESSION 3: PROPAGATION AND ROOTSTOCKS

Chairman: A. Tombesi (Italy)

Oral

Poster

SESSION 4: ORCHARD MANAGEMENT

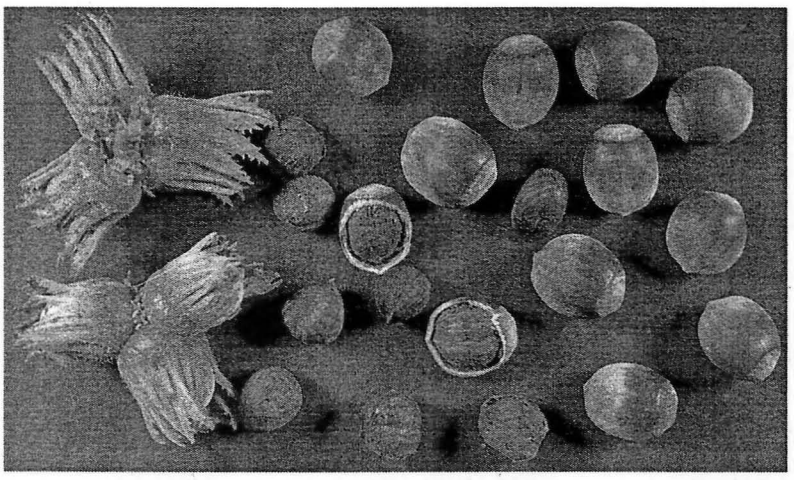
Chairman: A. Tombesi (Italy)

Oral

Poster

Poster

Session 1



Germplasm and Genetic Improvement

AN EVALUATION OF HAZELNUT GENOTYPES IN AUSTRALIA

B. J. Baldwin [1], K. Gilchrist [1], L. Snare [2]
[1]The University of Sydney, Faculty of Rural Management, P.O. Box 883, Orange, NSW 2800, Australia
[2]NSW Agriculture, Orange Agricultural Institute, Forest Road, Orange, NSW 2800, Australia

Five field experiments have been established to evaluate 24 hazelnut genotypes. Planting commenced in 1995. The experiments are on-going. The genotypes include imported cultivars and Australian selections. Two of the field sites are in NSW (Orange and Moss Vale), two in Victoria (Toolangi and Myrtleford) and one in Tasmania (Kettering). Data gathered on average dates of commencement and duration of pollen shed and female bloom, along with dates of leafing out, is presented.

Tree butt circumferences have been measured annually in autumn to assess tree growth. Nut yields have been obtained from 2000 onwards.

Differences in tree growth and nut yields have been found between sites and genotypes. In general the trees at the Myrtleford site have grown best and given the highest yields, with some genotypes producing 5 kg/tree in their seventh year after planting. The genotypes 'Barcelona' 'Tonda di Giffoni' and 'Tokolyi/Brownfield Cosford' (TBC), an Australian selection, have been the highest yielding across all sites. Good yields have also been obtained at some sites for 'Ennis', 'Butler' 'Segorbe' and 'Tonollo', the latter being another Australian selection.

DEVELOPING HAZELNUTS FOR THE EASTERN UNITED STATES

T. J. Molnar, J.C. Goffreda, C.R. Funk
Rutgers University, Cook College, Department of Plant Biology and Pathology, 59 Dudley Road, New Brunswick, NJ 08901, USA

Two major limiting factors, eastern filbert blight (*Anisogramma anomala* [Peck] E. Muller) and the lack of cold hardiness, obstruct the successful culture of European hazelnut (*Corylus avellana* L.) east of the Rocky Mountains. In the early 1900s, hazelnut breeders in the eastern United States made interspecific hybrids between the wild American hazelnut (*C. americana* L.) and the European hazelnut in an attempt to develop hybrids with improved stable resistance to eastern filbert blight and better cold hardiness. While definite progress was made with these hybrids, the lack of genotype diversity used in the controlled crosses and the discontinuation of focused breeding programs left much room for improvement. Recently, exhaustive efforts have been made by the USDA-ARS National Clonal Germplasm Repository and Oregon State University, Corvallis Oregon, to develop and preserve a worldwide collection of *Corylus* genetic resources. Since the discovery of eastern filbert blight in the Pacific Northwest in the early 1970s and its subsequent spread, these collection efforts have been combined with an urgent need to locate and/or develop eastern filbert blight resistant commercial quality cultivars for the hazelnut production region of the United States. This led to the development of successful inoculation and resistance screening techniques and to the identification of resistant genotypes. These new techniques and expanded genetic resources were not available to the early eastern United States hazelnut breeders. At Rutgers University we are using these modern techniques to screen and evaluate hazelnut cultivars and selections for stable high resistance to eastern filbert blight found in the eastern United States. Genotypes being evaluated include selections from earlier and current eastern North American breeding programs and hobbyists, accessions from the USDA-ARS National Clonal Germplasm Repository, breeding material from Oregon State University, and selections from our own germplasm collection and breeding efforts. We are also evaluating these collections for cold hardiness and other agronomic characters with the intent to use the most promising as parents in our hazelnut genetic improvement program. New Jersey's geographic location and climate make it well suited for assessing the limiting factors of hazelnut culture in the eastern United States. The genetic resources exist within the *Corylus* genus to develop hazelnuts for food, soil conservation, and environmental enhancement and beautification anywhere in the temperate world. By using modern breeding procedures and technologies it will be possible to greatly increase the usefulness of hazelnuts in New Jersey, the eastern United States, and any other climatically homologous areas.

PRODUCTIVITY AND YIELD EFFICIENCY OF HAZELNUT (*Corylus avellana* L.) CULTIVARS AT DIFFERENT LOCATIONS IN CHILE

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Instituto de Investigaciones Agropecuarias. Centro Regional de Investigación Quilamapu. Casilla 426, Chillan, Chile

A network of experimental hazelnut orchards has been established in the Mediterranean area of Chile. The purpose of these orchards is to determine the adaptation ability of several commercial cultivars to the growing region. The orchards in the northern territory of Chile were planted in 1999; while those in the southern territory were planted in 2002.
The planting density was 4 x 3 m (833 plants/ha), and the cultivars were: 'Negret', 'Gironell', 'Grifoll', 'Morell', 'Tonda Romana', 'Tonda delle Langhe', 'Barcelona', 'Tonda di Giffoni' and 'Mortarella'. Chilean ecotypes were also planted as pollinizers.
The first results showed that cultivars 'Tonda Romana' and 'Barcelona' provided the highest yields (up to 1 ton/ha in the third year); while the greatest yield efficiency was obtained with 'Tonda Romana', 'Morell', and 'Grifoll'. The lowest yields were found in 'Tonda delle Langhe'.
The paper discusses vigour index and its relation to production and yield efficiency. Based on these results, cultivars show a large range of ability to adapt to the climatic conditions of Chile. The paper also discusses some very unique physiological disorders observed in the early stages of cultivar development.

INTERSPECIFIC HYBRIDIZATION OF HAZELNUT AND PERFORMANCE OF SOME ADVANCED SELECTIONS IN CHINA

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The hazelnut (*Corylus heterophylla* Fish.) has been well known and widely distributed throughout northern China since ancient times, but until recently this kind of hazelnut has been wild. In comparison with the European hazelnut (*C. avellana* L.), the nut weight of *C. heterophylla* is smaller (about 1.0 g), and the yield is poorer (about 300 kg/ha), but it does exhibit very good winter hardiness. A breeding programme involving interspecific hybridization between *C. heterophylla* and *C. avellana* was initiated in 1979 at the Economic Forestry Research Institute of Liaoning Province. The aims of this programme included: good climatic adaptability; high and constant productivity; bigger nut size, good kernel quality; and greater winter hardiness. During 1980-1986, we obtained 2.300 seedlings. Almost 40 were selected during the period 1988-1990, and from 1991 to 1999 advanced selection trials involving hazelnut cultivars were carried in different climatic zones of Liaoning and other provinces. In 1999, 5 new varieties were released: 'Pingdinghuang' - tree height 1.89 m, diameter 1.78 m, nut weight 2.14 g, kernel percentage 41 %, yield 1.77 t/ha.; 'Bokehong' - 2.66 m, 1.78 m, 2.1 g, 41 %, 1.95 t/ha; 'DAWEI' - 2.30 m, 1.58 m, 2.5 g, 41 %, 1.43 t/ha; 'Jinling' - 2.13 m, 1.67 m, 2.0 g, 43 %, 1.13 t/ha; and 'Yuzui' - 2.51 m, 1,66 m, 2,2 g, 40 %, 1.22 t/ha, respectively. New varieties showed good growth and yields in the zone of China between N42° and N32° (average annual temperature 7.5°C – 14°C). In 2001-2002, the back-crosses of F_1 x *C. heterophylla* and *C. heterophylla* x *C. heterophylla* F_1 were made in China. In 2003, F_1 x *C. avellana* and *C. avellana* x F_1 were made in both Italy (Università di Torino) and China.

ADVANCED SELECTION AND CULTIVAR PERFORMANCE OF HAZELNUT TRIALS PLANTED IN 1994 AND 1998 AT OREGON STATE UNIVERSITY

R. L. McCluskey, A.N. Azarenko, S.A. Mehlenbacher, D. Smith
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Hazelnut selections from the Oregon State University breeding program pass through several stages of increasingly stringent evaluations before they advance into replicated yield trials. This is one of the final tests prior to cultivar release. As new material is identified, replicated yield trials containing 16-20 advanced selections plus check varieties have been established every one to two years since 1990. Plantings established in 1994 and 1998 are discussed in this paper.

The 1994 trial contained 10 selections and 'Barcelona', 'Casina', 'Negret', 'Segorbe', and 'Willamette'. Data was collected on tree size, nut yield, and kernel quality from 1996-2000. Three selections, OSU 350.089, 309.074, and 308.056 had cumulative nut and kernel yields greater than 'Willamette', the highest yielding of the named cultivars. Cumulative nut yields ranged from 18.8-9.9 kg/tree, and cumulative kernel yields ranged from 9.6-4.5 kg/tree. Several selections had good kernel quality, however all of the selections were susceptible to eastern filbert blight (EFB), and the planting was removed after the seventh leaf.

The 1998 trial initially included 'Barcelona', 'Lewis', and 10 EFB resistant selections. Four selections continue to be evaluated, and OSU 510.041 was released as the EFB resistant pollinizer 'Delta' in February 2001. Selections in this trial are from the BC_1 generation of crosses made to 'Gasaway'. Kernel size is small and trees appear to be less precocious than selections in previous trials. Four years of yield and defect data are included here.

DINUCLEOTIDE MICROSATELLITES OF THE EUROPEAN HAZELNUT

N. V. Bassil[(1)], R. Botta[(2)], S. A. Mehlenbacher[(3)]
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[(2)] Universita degli Studi di Torino, Dipartimento di Colture Arboree, Via Leonardo da Vinci, 10095 Grugliasco, TO, Italy
[(3)] Oregon State University, Department of Horticulture, Corvallis, OR 97333, USA

The objective of this study was to develop the maximum number of markers possible from three microsatellite-enriched genomic libraries of the European hazelnut, *Corylus avellana* L. Thirteen additional dinucleotide-containing loci were detected. Five contained the CA motif and were isolated from CA-enriched library A, while eight - most of which were obtained from GA-enriched library B - contained the GA motif. One GA-containing microsatellite locus - CAC-C119 - was isolated from GAA-enriched library C. Optimum annealing temperature for each primer pair designed using Primer3 was determined by gradient PCR. Amplification and polymorphism of these 13 primer pairs in 20 cultivars of *C. avellana* were initially determined by electrophoresis using 3% agarose gels. Forward primers were fluorescently labelled and will be used to identify the microsatellite alleles by capillary electrophoresis. The ability of these microsatellite markers to reliably distinguish between European hazelnut cultivars irrespective of their geographical origin will be assessed. We plan to use microsatellite markers to identify suspected duplicate accessions and to fingerprint the core hazelnut genotypes.

DNA-TYPING OF HAZELNUT: A UNIVERSAL METHODOLOGY FOR DESCRIBING CULTIVARS AND EVALUATING GENETIC RELATEDNESS

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Dipartimento di Colture Arboree, Università degli Studi di Torino, Via Leonardo da Vinci 44, 10095 Grugliasco,Torino, Italy

The European hazelnut (*Corylus avellana* L.) has been the source of many commercial nuts and for many centuries the most important cultivars in Europe and Turkey have been selected from local wild populations of the species. Methods for identifying hazelnut cultivars are primarily based on the analysis of morphological traits. However, these are often unreliable or imprecise indicators of plant genotype, as they are influenced by environmental factors. Discriminating between closely related cultivars is therefore often extremely difficult, especially in the nursery and when plants are young and do not yet bear fruit. On the contrary, DNA-typing can provide a convenient and reliable method for accurately identifying hazelnut cultivars. Microsatellite or Simple Sequence Repeat (SSR) markers meet many of the requirements of the ideal molecular marker: abundance in genome, reproducibility, high degree of polymorphism, and co-dominant inheritance. SSR markers have recently been developed and characterized in *C. avellana*. Twelve of the available loci were selected for their high polymorphism and clarity of profile and were used to genetically identify the most important commercial hazelnut cultivars, using a semi-automated technique based on fluorochrome technology. The unique combined genotype of each cultivar was defined by combining the genotypes obtained across the 12 loci; DNA profile data were expressed in a format suitable for constructing a database. Statistical analysis was applied to investigate the informative content and discriminative power of the loci, probability of identity, possible parentage and phylogenetic relationships among cultivars. The methodological approach and perspectives of the technique are discussed with a view to its application at the international level and in the genetic certification of propagated material.

INVESTIGATION OF GENETIC DIVERSITY AMONG EUROPEAN HAZELNUT (*Corylus avellana* L.) CULTIVARS USING SSR MARKERS

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[(2)] USDA-ARS National Clonal Germplasm Repository, 33447 Peoria Road, Corvallis, OR, 97333, USA

We used 10 pairs of simple sequence repeat (SSR) primers to investigate genetic diversity in 274 cultivars of European hazelnut (*Corylus avellana* L.) representing a wide range of geographical regions. 82 of the 274 were suspected duplicate accessions, as they were morphologically identical, but they had been imported from different collections under different names. Preliminary PCR results showed that the SSR primers we used were highly polymorphic. ABI Genescan® and Genotyper® software were used to identify the precise allele size generated from each PCR reaction based on an internal lane standard. MicroSat and Powermarker software was used to generate a genetic similarity matrix based on possible pair-wise combinations of accessions using the "proportion of shared alleles". UPGMA cluster analysis was used to construct a tree from the genetic similarity matrix, using MEGA2 software. The results will be discussed.

CLONAL SELECTION IN *Gevuina avellana* MOL. FOR NUTRITION AND PHYTOTHERAPY

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The importance of clonal selection in Gevuin nut production (Chile Nut) has been stressed in several studies. To evaluate the variability of selected clones, several chemical and physical kernel traits (water, energy, protein, carbohydrate, lipid, fibre, ash, calcium, copper, iron, magnesium, manganese, phosphorus, sodium, zinc, vitamin A and E content, and UV absorbance) were studied during five growing seasons (from 2000 to 2004) in Southern Chile. This article presents preliminary results with respect to the absorbance of UV radiation by seed oil. The chemical traits are also compared with the composition of hazelnut and other nuts. Clear evidence of variability in the chemical and physical traits of different clones allows genetic improvement in *Gevuina*.

HAZELNUT CULTURE TODAY AND THE OUTLOOK FOR ITS DEVELOPMENT IN THE CRIMEA

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The geographical situation of the Crimea, its different topography, the Black Sea and the Azov Sea determine the wide spectrum of ecological factors which influence the growth and productivity of cultivated species.
The Crimea is famous for its hazelnuts. At the end of 1930, half of all plantations were on the South Coast of the Crimea. But now little attention is paid to this culture and there are no commercial hazelnut plantations.
The mild climate of the south coast of the Crimea allows the cultivation of wonderful varieties. In more mountainous regions of the Crimea it is advisable to use more frost-resistant varieties.
The establishment of industrial hazelnut plantations in the Crimea is possible in practically all the regions of the peninsular. Their profitability will be determined by soil-climate conditions and the demands which are presented by hazelnut culture and the correct combination of main varieties and varieties-pollinators.

HAZELNUT IN GEORGIA

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Georgians traditionally consider hazelnut as one of the most significant perennial cultures and of immense economic importance. It is noteworthy that the European market has shown increasing interest in high-quality Georgian hazelnut and hazelnut products.
At present, hazelnut is grown on a total area of 5.800 ha in Georgia, while a state development program foresees extending the area of hazelnut orchards to 50.000 ha during the period 1999-2008. Hazelnut is mainly grown in regions where the sum of active temperatures ranges from 38,00 to 42,50°C, average rainfall reaches 1.500-1.900 mm, relative air humidity is 70-75% and elevation above sea level is between 450 and 650 m, though hazelnut also naturally grows on land up to 1.800 metres above sea level.
Two hazelnut species, *Corylus Pontica* and *Corylus Colchica* which are the ancestors of various endemic hazelnut varieties, have been adapted for specific soil and climate conditions and constitute high-quality cultivars. They have developed as a result of natural selection and hybridization ('Gulshishvela', 'Shveliskura', 'Khachapura', 'Anakliuri', 'Dedoplis Titi', 'Nemsa', 'Saivanobo', etc.) and originate from the eastern and south-eastern Black Sea coast and adjoining regions.
Scientific work in this field is currently focused on the distribution of endemic and introduced hazelnut varieties and the introduction of potential future forms in nurseries and collection orchards. Crop improvement involves optimal selection of cultivars for commercial orchards, schemes for improving the layout of orchards, selecting specific hazelnut varieties according to the dictates of local relief (plains, slopes, terraces, spherical rows), the number of fertile branches per hazelnut tree/shrub, tree-forming, and the introduction and dissemination of up-to-date methods of pest and disease control.

UKRAINIAN HAZELNUTS: CULTIVARS, AGROTECHNICS, PERSPECTIVES

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The hazelnut (*Corylus avellana* L.) is a naturally occurring species that is found throughout the Ukraine. Its cultivars (hazelnuts) have been grown in Crimea for centuries. Systematic science work aimed at breeding new hazelnut cultivars and introducing them into farming production began at the Ukrainian Research Institute of Forestry and Forest Improvement in the late 1930s under Dr. Fedir A. Pavlenko. The main aim was to breed high-yielding nut breeds for improving forest plantations in steppe conditions. To this end, various different crosses were effected between Turkish hazelnuts (*Corylus colurna* L.) and other hazelnuts and filberts. The hybrids obtained were valuable as initial material for further breeding. The "bush-trees" had nut yield capacities as high as 8-18 kg, kernel percentages of 43-50%, and kernel fat contents of 62-65%.
In the 1950s, the main objective of hazelnut breeding was the creation of cultivars that were hardy to winter and drought conditions and that produced highly marketable nuts. These previously bred forms became the forebears of the Ukraine's commercial cultivars. Since 1981, 12 hazelnut cultivars have been included in the Ukraine's State Register of Plant Cultivars: 'Bolgrads'ka novynka', 'Borovs'kyi', 'Dar Pavlenka', 'Klynovydnyi', 'Koronchatyi', 'Lozivs'kyi sharovydnyi', 'Pyrizhok', 'Raketnyi', 'Sriblyastyi', 'Stepovyi 83', 'Shedevr', 'Shokoladnyi'. Plantations of hazelnut have been established in Kharkivs'ka, Donyetska, Kirovograds'ka and other regions of the Ukraine. According to perennial data, the average yield at the Pershotravneva State Cultivar Trial Station (SCTS) was 7-8 centneres per ha (some 2.5 kg nuts per bush), at the Kirovograd SCTS, it was 11 centneres per ha (4 kg nuts per bush), and at the Melitopol' SCTS (Zaporizhzhya region) - under irrigation – it was about 30 centneres per ha.
In the 1970s, the main research priorities were to increase yield capacity by applying agrotechnical measures: appropriate selection and use of varieties, appropriate choice of pollinators, formation and nursing of bushes, fertilizing, irrigation, and protecting nut yields from the nut weevil (*Curculio nucum* L.). At the same time, phenological observations and biological studies of flowering and fruiting, vegetative propagation, and hybridization were also carried out. In recent years valuable hybrids have been selected with the traits of Siberian filbert (*Corylus heterophylla* Fisch. ex Trautv.) and hazelnut fruits; with compact and elongated decorative crowns and with a large number of bunches. Six new forms with a high yield capacity have been created and 5 shortish forms which have provided valuable material for the creation of highly profitable plantations. To provide the population of the Ukraine with its own hazelnut nut resources and cover domestic demand, it is necessary to create over 50.000 hectares of hazelnut plantations. Another way of further increasing the area under hazelnut cultivation would involve promoting low productivity informal plantations in river valleys and also in orchards requiring redevelopment. For these and on flat plots with fertile soils under steppe and forest-steppe conditions, it is only possible to use the rooted outplants of hazelnut cultivars included in the State Register of Plant Cultivars. Experience shows that until hazelnuts begin to fruit on such plots, (5 years), interrows may be used for intertilled cultivation and the production of some other crops. On industrial plantations, the most rational spacing for plants is 6 x 6 m, therefore using the interrows for growing crops is an additional advantage.
On forest parcels with type C_2 growing conditions, it may be possible to combine growing hazelnut for nuts and pine trees for use as Christmas trees. They can also be grown together with a relatively close spacing of pine trees (Ukraine patent N°. 6191 and Russian patent N°. 2025945). The priority certificate on patent application N°. 2003108957 credits A. P. Ryabokon and V. Y. Slyusarchuk with the invention of a "Method for joint growth of pine trees and filbert in a fresh leafy subforest" for obtaining planting material, nuts and wood. The area under filbert plantations may be increased with the planting of greenery on recultivated land and in recreation zones where land could be dedicated to leisure uses for the general public.

EUROPEAN HAZELNUT IN CHINA: PRESENT SITUATION AND FUTURE PERSPECTIVES FOR A EUROPEAN HAZELNUT CULTURE IN CHINA

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The European hazelnut (*Corylus avellana* L.) was first introduced into China and planted in gardens at the end of the 19th century. However, it was not until 1971 that the Economic Forestry Research Institute of Liaoning Province began to study this species in China. Between 1972 and 1975, we introduced 1.210 hazelnut seeds from Italy and other European countries and 203 seedlings were obtained. Field observations began during the 3rd year after the seedlings were planted in the field. The seedlings showed great variation in their growth and fruit characteristics. Twenty-two seedlings were selected in 1983. Between 1985 and 1996 advanced selection trials were carried out in different climatic zones: from 1985 to 1996 in Dalian (Liaoning province, N38°54′, northern temperate zone) and Taian (Shandong province, N36°10′, southern temperate zone); and from 1990 to 1996 in Feixi (Anhui province N31°45′northern subtropical zone) and Yichang (Hubei province, N30°39′ in the middle of a subtropical zone). In Anhui and Hubei provinces, the selections demonstrated better vegetative growth, but gave poorer yields due to deficiencies in the development of male and female flowers. In 1996, 3 new varieties were released: 'Lianfeng' - nut weight 2.71 g, kernel percentage 45 %, yield 2.14 kg/tree (for 8 year-old trees); 'Yifeng' - 3.21 g, 46 %, 2.09 kg/tree; and 'Taifeng' - 3.21 g, 43 %, 2.10 kg/tree (for 8 year-old trees) respectively. Hazelnut showed good growth and yield in the southern temperate zone of China. Between 1996 and 1997, about 40 different varieties of European hazelnut, including 'TDGL', 'Barcelona', and 'Butler', were introduced into China from Italy and the USA. Bearing in mind the fact that China has quite large temperate areas, which are suitable for hazelnut cultivation, and that there is a potentially large market for hazelnut in China, there should be very good scope for hazelnut cultivation in this country.

HAZELNUT PRODUCTION IN SERBIA: CURRENT SITUATION AND FUTURE PROSPECTS

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Hazelnut is one of the major nut species. Fruits have multiple uses and due to their aroma, they are of particular interest in confectionary.
Considering their high yields and excellent nut quality, the lack of attention afforded to this cultivar in Serbia seems particularly unjustifiable. Hazelnut is mainly grown in private gardens, which demonstrates the favourable agroclimatic conditions for its successful cultivation. Until now, production has been so low that it has not even been recorded. It has been estimated to be below 1.000 tons per year, which does not even satisfy 10 % of local needs. Hazelnut has therefore been traditionally imported.
Over the last 10 years, interest in hazelnut has increased. Its annual share of new plots accounts for 50-100 ha, which should duly result in increased production. One of the limiting factors for a more intensive spread of hazelnut is the lack of quality nursery stock. Rooted shoots and stock grafted onto Turkish hazelnut (*Corylus colurna*) have mainly been used. Root shoots can be eliminated by grafting; this also makes mechanized harvesting a possibility.
As to the distribution of hazelnuts, special attention should be afforded to the choice of cultivar and particular to satisfying the requirements of the confectionary industry (cultivars with small, round nuts).

HAZELNUT DIVERSITY IN ASTURIAS (NORTHERN SPAIN)

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The province of Asturias, situated in the north of Spain, is known for its wild hazelnuts which tend to grow spontaneously or be planted in border hedgerows and on river banks. However, regular plantations cannot be found. In the last century hazelnut production in this area was very important and in the 1960s S. Alvarez Requejo from SERIDA carried out studies that specifically focused on commercial varieties. Hazelnut research has been recently reinitiated in order to preserve the genetic diversity of this species and to promote interest in planting it.
In August 2003, new prospecting of native hazelnuts began in collaboration with IRTA-Mas Bové. The first aim was to recover the maximum hazelnut genetic diversity possible and the second was to find individual species that were outstanding on account of their agronomic and commercial characteristics. In this survey a total of 44 trees were examined and a high degree of genetic variability was observed. The specimens were located at 180-600 m above sea level and were generally close to rivers. Two kinds of hazelnut could be clearly distinguished: long oval nuts with thick shells (*bravos* or *monteses* hazelnuts) and more commercially interesting round nuts with thin shells.
Tree (vigour, growth habit) and nut characters (shell attractiveness, size, shape, amount of fibre on the pellicle and blanching) were scored. Data relating to time anthesis, caking abundance, sensibility to *Phytoptus avellanae*, and bud shape were also recorded. Ten individuals ('Aciera-1', 'San Pedro-4', 'Rubiano-3', 'Pola de Allande-3', 'Riocastiello-2', 'Yerbo-2', 'Los Cuetos-1', 'Las Cuevas-1', 'Las Cuevas-2' and 'Tanda-1') were particularly outstanding. In January 2004, this material was propagated with a view to its introduction into two collections (Mas Bové and SERIDA) for preservation and characterisation.
Hazelnut prospecting in Asturias will continue over the next few years.

COLLECTION FUNDS OF THE GENUS *Corylus* L. IN THE NATIONAL DENDROLOGICAL PARK "SOFIYIVKA" AS A VALUABLE BASE FOR FILBERT BREEDING

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The overview of the history of foundation, restoration and conservation of the National dendrological park "Sofiyivka" is given in the abstract. Nowadays National dendrological park "Sofiyivka" is a masterpiece of landscaping architecture where more than two thousand species, forms, sorts and hybrids of trees and grassy plants are collected.
The data about the wide collection of the genus *Corylus* L. which consists of more than 14 species, 15 forms, 111 sorts and hybrids are given in the abstract.
One of the species *Corylus avellana* L. is native from Ukraine and also from Uman and "Sofiyivka" itself, the other species are introducted and some of the species were introduced from their native growing places. All the introduced species of the genus *Corylus* L. have very good growing and development characteristics in conditions of this region, nearly all the representative species reached the age of fruitfulness. An important work was made for the investigation of biological peculiarities of *Corylus colurna* L. and methods of its multiplication were developed. Species, forms, sorts and hybrids of *Corylus* L. which are growing in the National dendrological park "Sofiyivka" are the valuable base for filbert breeding.

VARIATION IN IMPORTANT QUALITY CHARACTERISTICS IN HAZELNUT FOR DIFFERENT YEARS AND CORRELATIONS BETWEEN HUSK NUMBER AND NUT AND KERNEL TRAITS

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This study involved 'Tombul', 'Palaz', 'Kalınkara' and 'Çakıldak' hazelnut cultivars grown at an altitude of 310 m in a flat orchard in Ordu province (Turkey) in 2000 and 2001. The experimental design was completely randomized with three replicates. In this experiment, the stems were 15 years old and the spacing between ocaks was 4 m and 5 m. Stem contour was determined at 50 cm from ground. Nut and kernel traits were as follows: nut weight (g), nut size (mm), shell thickness (mm), kernel weight (g), kernel size (mm), internal cavity (mm), kernel percentage (%), poorly filled nuts (%), shriveled kernels (%), blanks (%), good kernels (%), doubles (%), full pellicle removal (%) and average pellicle removal (%). In this study, it was found that husk numbers and blanks varied between years; nut weight, kernel weight, shriveled kernel and good kernel varied between cultivars; kernel size and full pellicle removal varied between years and cultivars; and nut size, internal cavity, kernel percentage, poorly filled nuts, doubles and average pellicle removal varied significantly between years X cultivars interactions. In addition, a significant positive correlation was observed between husk number and internal cavity, and a significant negative correlation was determined between husk number- full pellicle removal and husk number- average pellicle removal.

EFFECT OF STEM NUMBER ON SOME POMOLOGICAL AND TECHNOLOGICAL TRAITS IN HAZELNUT

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This study was carried out to determine the effects of stem number per ocak (a traditional bush form) on pomological and technological traits for the hazelnut cultivar 'Tombul' grown under ecological conditions at Ordu (Turkey) in 1999 and 2000. In this study, ocak groups having 5, 6, 7, 8, 9 and 10 stems were used. Significant differences between stem groups were observed for nut weight, nut thickness, kernel weight, kernel thickness, kernel percentage and kernel quality. According to the results obtained, 7 or 8 stems per ocak in productive soil, and 5 or 6 stems per ocak in less productive soils would be recommended in order to optimize yield and quality traits.

SELECTION OF HAZELNUTS GROWN IN THE GİRESUN REGION (TURKEY)

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This study was conducted in order to investigate the fruit characteristics of wild hazelnuts grown near Giresun, Turkey. Thirty-three types of hazelnut were evaluated and 9 types were selected. Those selected had nut weights of between 1.41 g and 2.54 g, kernel weights of between 0.76 g and 1.11 g, kernel ratios of between 38.49 % and 56.52 %, shell thicknesses of between 0.72 mm and 1.66 mm, and fruit numbers of between 394 and 709 per kg.

THE EVALUATION OF THE EFFECT OF THE CLIMATE CONDITIONS ON HAZELNUT PRODUCTION IN THE CENTRAL AND EASTERN BLACK SEA REGION

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This research was carried out to determine the effects of climate conditions on hazelnut production and yield in the central and eastern Black Sea region of Turkey. In the study, data from 1993 to 2003 were used. Results were evaluated for air temperature, humidity, wind speed, rainfall, rainy days, foggy days and clear days. In the results, it was determined that humidity, rainfall and foggy days negatively affected hazelnut production; air temperature and wind speed positively affected production. There is a positive correlation between yield and air temperature. The effects of climate data on hazelnut production and yield in Trabzon, Giresun and Ordu provinces were different.

POMOLOGICAL PROPERTIES OF SOME HAZELNUT CULTIVARS UNDER LOCAL CONDITIONS IN ČAČAK

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Research was carried out at the Fruit and Grape Research Centre in Čačak to investigate the benefits of enriching hazelnut assortment and its pomological properties under local agroecological conditions. The hazelnut assortment is very old and changes insignificant. The aim is to introduce cultivars with smaller and rounder nuts, which are of prime interest for confectionary.
This paper presents the pomological properties of hazelnut cvs. 'Uebov' and 'Furfulak" under the agroecological conditions of Čačak. The share of these cultivars is also significant in the assortments of neighbouring countries (Romania and Bulgaria). Under our conditions, the cultivars in question performed excellently with respect to yield and nut quality. Over a long term study, nuts of cv. 'Uebov' averaged 2.7 g with kernel ratio accounting for 44.6 %, whereas the average mass of cv. 'Furfulak' was 2.9 % with a kernel ratio of 46.8 %.

TREE PHENOLOGICAL TRAITS AND FRUIT PROPERTIES OF SEVERAL HAZELNUT CULTIVARS GROWN UNDER DIFFERENT MICROCLIMATES

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Tree phenological traits and fruit physical properties of several hazelnut cultivars grown under four locations in the northern region of Portugal were compared. Experimental sites are located about 50 km away from each other, the elevation varying between 350 and 650 m a.s.l. The youngest experimental trees are 15 years old, the oldest ones are 20. Local conditions are suitable for hazelnut production in the four sites. Full-bearing trees yearly yield ranged from 0.1 to 0.6 $kg.m^{-2}$, according to the cultivar, however, high yielding cultivars in a specific site were systematically low-yield in other sites. Biennial bearing also occured, mainly with high-yield cultivars, in all the sites. The dichogamy level of each cultivar varied among the four sites; often a slightly protandrous cultivar in one site was protogynous in another. In some cases, an 80% overlapping period of male and female flowerings in one place was observed, and no overlapping occurred at all in two other sites. Also, the longer-lasting male flowering in a given site was ephemeral in another site for consecutive years. The major concern in all the places was pollen unavailability in late February. Sprouting occurred during March, 'Tonda di Giffoni' being among the most precocious and 'Longa d'Espanha' one of the latest. Fruit and kernel sizes varied from site to site and significant differences in sampling were found in some years. Blank nuts and percent kernel were the most variable fruit traits. Thus, compatible cultivars must be tested locally so that the best choice can be done for each region.

SELECTION AND BREEDING OF HAZELNUT CULTIVARS SUITABLE FOR ORGANIC CULTIVATION IN THE NETHERLANDS

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Although hazelnuts are endemic in The Netherlands, the acreage of hazelnut orchards has always been very limited. Foreign cultivars have been evaluated in experiments and are grown on a small scale, but sub-optimal yields and quality, and susceptibility to disease have prevented a further increase in acreage. In order to overcome these difficulties, many hazelnuts growing in hedges and other green areas in The Netherlands were selected and evaluated for their characteristics. This produced at least three cultivars ('Emoa 1', 'Emoa 2' and 'Emoa 3') with excellent yield potentials and other good quality characteristics (size, shape, taste, pellicle removal). Since the cultivars have a low susceptibility to disease, they are particularly suitable for organic cultivation. The acreage of 'Emoa 1', 'Emoa 2' and 'Emoa 3' is still limited, but first yield and quality results are very promising. Orchards are generally planted with hazelnuts alone ('Emoa 1', 'Emoa 2' and 'Emoa 3' together with pollinators) but in one orchard hazelnuts were grown together (intercropping) with walnuts and Sea Buckthorn (*Hippophaë rhamnoides*).

25 YEARS OF ACHIEVEMENTS AND PERSPECTIVES IN HAZELNUT BREEDING IN ROMANIA

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The specific ecological conditions of Romania and its social needs led to the establishment of a hazelnut breeding program, which was launched 25 years ago. S.C.D.P. Valcea was chosen in order to make the program viable and obtain good results. This research station is located south of the Carpathian mountains, in the Oltenia region, at latitude 45° N. It is in an area where the average annual temperature is 10.2°C and average annual rainfall is 715 mm. A collection of 6 *Corylus* species, 45 cultivars of different origins and 19 biotypes, was established at the station. The breeding program was initially based on clonal selection from 'Imperiale de Trapezund', 'T.G.D.L.', 'Red Lambert' and 'Cosford' cultivars, and later also on intraspecific and interspecific crosses. Genetic variability was considerably improved as a result of obtaining 5.500 hybrids, 60 clonal selections and 25 bud variation selections. The breeding program gave rise to the first Romanian hazelnut cultivars: 'Valcea 22', 'Cozia', 'Romavel' and 'Uriase de Valcea'. Three of these cultivars are for table use and the other ('Romavel') has two uses (table and industry). The cultivars are productive and are better adapted to Romanian environmental conditions.

'URIASE DE VALCEA': A NEW VALUABLE HAZELNUT CULTIVAR

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The cultivar 'Uriase de Valcea' ('Ennis' x 'Purple Filbert') was obtained at S.C.D.P. Valcea and named in 2002. Its fruits are for table consumption. The tree has medium vigor and a semi-erect habit. The blooming of both of its flowers is late. The cultivar is well adapted to the environmental conditions of Romania, is tolerant to diseases, and produces high fruit yields. Its fruits are large (size index of 23.3 mm) have an ovoid shape, average fruit weight of 5.0 g, roundness index of 0.88, exocarp thickness of 1.1 mm, and good uniformity. The kernel represents 49.1 % of total fruit weight. Fruit ripening takes place at the beginning of September. The cultivar is only propagated through grafting, because when layering is used, a red-leaf plant (of chimeral origin) may be obtained which is different from the cultivar.

STUDIES ON HAZELNUT CULTIVAR IMPROVEMENT IN CHINA

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China is one of the original sources of hazelnut and a large number of wild *Corylus heterophylla* Fisch. plants can be found in the northern part of the country. It is not, however, cultivated artificially as its nuts are too small and its yields too low. *Corylus avellana* L., which is originally from Italy, is not cold resistant and does not survive the hard winters of northern China. In 1980 a breeding programme involving *Corylus heterophylla* Fisch x *Corylus avellana* L. was initiated with the aim of obtaining hazelnut cultivars adapted to the conditions in China.
In line with the breeding aims, the most interesting *Corylus heterophylla* Fisch. were chosen as female parents and the best *Corylus avellana* L. as pollen parents in order to hybridise according to a common method. Branches were isolated using white paper bags and during the full bloom period pollination was carried out using mixed pollen. Hybrid seedlings were then planted. Primary and secondary selections were made, and comparison and adaptation experiments were carried out.
After a 20 year breeding programme (1980 to 1999), the best 110 lines of primary selection and the best 60 lines of secondary selection were gathered from 2000 F1 plants. In parallel, 10 of the most interesting cultivars were selected from comparison and adaptation experiments, with a view to planting them widely. The most cold-resistant cultivars (up to –33°C during the dormant period) were: 'Da wei', 'Ping ou No.110', 'Ping ou No. 21' and 'Ping ou No. 226'. The best cold-resistant cultivars (up to –30°C during the dormant period) were: 'Ping ou No. 1', 'Ping ou No. 3' and 'Ping ou No. 33'. The following cultivars resisted temperatures of up to –25°C during their dormant period: 'Ping ou No. 69', 'Ping ou No. 545' and 'Ping ou No. 349'. The main characteristics of the above cultivars are: (1) big nuts: the average nut weight was 2.3 - 3.6 g, which is 1.73 - 2.70 times bigger than that of *Corylus heterophylla* Fisch. nuts, (2) full nuts with bright clean kernels; kernel percentage was 40-48 %, which is 1.14 - 1.36 times higher than for *Corylus heterophylla* Fisch., (3) early bearing age and good crop yields: nut bearing began after 2 - 3 years. After 5 years, nut crop yields ranged from 550 to 770 kg/hm², from 1.660 to 2.200 kg/hm² after 7 years, and from 2.200 to 3.000 kg/hm² after more than 10 years: this represents 2.4 - 3.3 times more than for *Corylus heterophylla* Fisch. nuts, (4) high cold resistance and adaptability: the crop enduried temperatures as low as from –25°C to –33°C during the dormant period, and tolerated soils with PHs ranging from 5.5 - 8.0. This effectively established culturing limits between latitudes 36° N and 42° N.
In China, hazelnut cultivation has progressed from wild gathering to horticultural production through the successful breeding of the hybrid *Corylus heterophylla* Fisch. x *Corylus avellana* L. During the last 5-6 years, 330 hm² of hybrid hazelnuts have been planted, with 400.000 trees in northern China, and they have been widely accepted by the local peasant farmers.
We can conclude that hazelnut hybrids have a high cultivation value as they combine the cold resisting genes and adaptability of *Corylus heterophylla* Fisch. with the big nuts and good crop yields of *Corylus avellana* L. In China, the success of this hybrid breeding programme has been promoting the cultivation of hazelnuts, from wild gathering to horticultural production.

IDENTIFICATION AND DISCRIMINATION OF THE SELECTED HAZELNUT CLONES BY RAPD

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Selected hazelnut types ('Tombul', 'Palaz' and 'Kalınkara') were used in this research which investigated genetic resemblance using RAPD. Explained step by step, the RAPD technique involves: hazelnut sample collection, sterilization, DNA isolation, phenol extraction, sunk to bottom of ethanol, agarose gel electroforez, determination of DNA quantity, RAPD-PCR, and evaluation of results. Genetic resemblance between cultivars was presented as in the form of a resemblance index and in a dendograme. The highest degree of similarity was observed in 'Palaz' cv. Pomological aspects of the types were similar to the genetic resemblance

MOLECULAR CHARACTERIZATION BY RAPDS MARKERS AND MICROPROPAGATION OF ITALIAN HAZELNUT CULTIVARS

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The use of both the molecular method and phenotypic observations in fruit certification could accelerate the identification process. The availability of micropropagation techniques allows the development of healthy plant materials. In this work a molecular analysis of hazelnut genotypes (*Corylus avellana* L.) was undertaken in order to obtain fingerprinting for typical Italian cultivars. Results were compared with analyses of nut morphological traits. We evaluated a collection of 24 genotypes. DNA was extracted by the Doyle & Doyle method (1990) and analysis was conducted by RAPDs using arbitrarily chosen oligonucleotide primers. The results were used to produce a similarity matrix applying the coefficient of Nei and Li (1979) and phylogenetic analysis. A characteristic electrophoretic pattern was obtained for each of the following cultivars: 'Tonda delle Langhe', 'Tonda Romana', 'Tonda Rossa', 'Tonda Bianca', and 'Tonda di Giffoni'. Phylogenetic analysis using the UPGMA method revealed the presence of a cluster grouping the cultivars 'Tonda Romana', 'Tonda Rossa', 'Tonda Giffoni', and 'Tonda delle Langhe'. The cultivar 'Nocchione' from Lazio proved related to certain genotypes from Sicily and Campania. Morphological analysis revealed significant variability in nut characteristics. Shoot cultures were initiated using single buds and nodal shoot segments from greenhouse-grown plants. ½ Ms medium was used, which was supplemented with IBA (0.05 mg/l) GA3 (0.4 mg/l) and increased BAP concentrations (from 0 to 5.0 mg/l) or zeatin (1 mg/l). Explants from 'Tonda Romana', 'Tonda di Giffoni' and 'Ghirarà' developed shoots with good growth habits in both the medium with BAP (0.5 mg/l) and zeatin (1 mg/l) and in that with 3 % glucose or lactose.

DNA FINGERPRINTING OF *Corylus avellana* L. ACCESSIONS REVEALED BY AFLP MOLECULAR MARKERS

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In recent years several PCR based approaches have been designed to develop molecular markers for many plant systems comprised of fruit crop species. AFLP (Amplified Fragment Length Polymorphism) is one of these approaches, and has the advantage of providing a high (30-100 "loci") 'multiplex ratio' per primer pair. It has therefore become a popular approach for identifying molecular markers for varietal fingerprinting. In *Corylus avellana* L. varietal fingerprinting has so far been performed using low 'multiplex ratio' PCR-based techniques (RAPD and SSR). Here we present the first application of AFLP for fingerprinting 59 hazelnut accessions of different Italian and foreign origins.

The quality of the DNA template is an important factor in determining the success of the AFLP technique, so we developed a simple, quick and efficient protocol for extracting high quality DNA from young leaves using a modified CTAB protocol.

Genomic DNA was digested with MseI and EcoRI restriction enzymes and, after the ligation of specific oligonuleotide adaptors, the fragments obtained were preamplified using a EcoRI/MseI primer pair with a single selective nucleotide. Selective amplification was carried out using a fluorescent–labelled EcoRI +3 bases primer in combination with 8 different MseI + 3 selective bases primers.

The AFLP fragments were separated using an automated capillary DNA sequencer (AB 310). The electropherograms obtained were analysed with the Gel Compar II ver.3.0 software and UPGMA cluster analysis and PCA were carried out. The high level of polymorphism detected (73% of the fragments occurred in most 90% of the accessions) suggests that AFLP is an efficient marker-discovery method for varietal fingerprinting in hazelnut germplasm.

CHARACTERIZATION OF HAZELNUT (*Corylus avellana* L.) CULTIVARS USING MICROSATELLITE MARKERS

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Leaves of twenty three hazelnut accessions were sampled from a collection field at the Horticultural Research Station of SPII at Kamal-Abad, Karaj, Iran. The accessions included sixteen cultivars of the Iranian germplasm and seven internationally known cultivars.
DNA was extracted and samples were analysed at nine highly polymorphic microsatellite loci. DNA was amplified using dye fluorescent labelled primers and polymorphism detected on polyacrylamide sequencing gel using a semi automated ABI PRISM377 apparatus. Allele number of loci ranged from 6 to 12, and heterozygosity level varied between 0.59 and 0.85.
Genetic distance between genotypes was computed as (1- proportion of shared alleles). Cluster analysis was performed using the UPGMA method and resulted in a dendrogram that divided the genotypes into three main sub-clusters. The first sub-cluster grouped together nine cultivars including 'Gerdoie', 'Anbouh', 'Paizeh', 'Tabestaneh' and 'Longue d'Espagne', that showed identical genetic profile. While the four Iranian cultivars are very likely synonymous varieties, the individual sampled as 'Longue d'Espagne' was mislabeled, as demonstrated by comparing its genetic profile with the genotype of accessions of the same cultivar sampled in Italian and USA collection fields. The second sub-cluster grouped four Iranian cultivars. The third sub-cluster included the six foreign cultivars and three Iranian accessions; the two Iranian cultivars 'Tabari Rood' and 'Khandan' shared the same genotype.
Finally the cultivar 'Dobooseh' was set apart from the other genotypes in the dendrogram and carried several unique alleles.
Results showed a good genetic variability within the Iranian germplasm but also indicated the possible presence of synonymy cases that should be further investigated.

A LINKAGE MAP FOR HAZELNUT

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A linkage map for European hazelnut (*Corylus avellana* L., 2n = 2x = 22) was constructed using a population of 144 seedlings from a cross of OSU 252.146 x OSU 414.062. The male parent was heterozygous for a dominant gene that confers resistance to eastern filbert blight caused by *Anisogramma anomala*, and about 50 % of the seedlings were resistant. A total of 1400 decamer primers were screened using template DNA of 8 genotypes: resistant parent OSU 414.062, susceptible parent OSU 252.146, three resistant seedlings, and three susceptible seedlings. Primers that generated easily-scored polymorphic bands that appeared to segregate in a 1:1 ratio were identified and used to amplify the DNA of all seedlings in the population. The map for the resistant parent consists of 245 loci placed in 9 groups and spans a total of 583 cM. The map for the susceptible parent consists of 189 loci placed in 11 groups and spans a total of 599 cM. Many individual markers and small groups have not yet been assigned to a linkage group. As additional loci are scored and added to the map, we expect them to merge with the larger linkage groups and form 11 groups per parent. An additional 120 markers that segregate 3:1 were scored but have not yet been placed on the map.These will make it possible to identify the corresponding linkage groups in the two parents.

Session 2

Biology and Physiology

FLORAL PHENOLOGY OF COMMERCIAL CULTIVARS AND CHILEAN POLLINIZER ECOTYPES OF HAZELNUT (*Corylus avellana* L.) IN CHILE

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Time of flowering and dichogamy of ten introduced hazelnut cultivars and three Chilean ecotype pollinizers, growing in the INIA Quilamapu Research Center (latitude: 36° 31` 34`` S., longitude: 71° 54` 40`` W., Chillán, Chile), were evaluated for seven consecutive years (1996-2002).

Most commercial cultivars and all of the Chilean pollinizers, regardless of gender, started flowering between the dates of 15th May to 15th June; while 'Morell' and 'Daviana' flowered later. The type of dichogamy varied remarkably from one year to another among cultivars. On average, 62% of the cultivars evaluated were protandrous, while the rest were protogynous. In 'Tonda Gentile delle Langhe', protandry was associated with the warm season (temperatures above 12°C, before pollen shedding).

Pollen shedding was earliest in 'Naranjo' pollinizer, and latest in 'Amarillo' and 'Verde'. In the 'Naranjo' ecotype, the duration of pollen shed ranged from 43 days, when the mean temperature was 13°C, to 80 days, when the mean temperature did not exceed 9°C.

The results of this research suggest that dichogamy and time of flowering in Chilean hazelnut ecotypes and commercial cultivars are strongly influenced by local thermal conditions. Therefore, it is strongly recommended to compile phenological data for local thermal conditions before orchard plantation, as this information will assist in selecting viable cultivars and pollinizers.

THE EFFECTS OF SEASONAL VARIATION ON NUT FALL IN AUSTRALIA

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Hazelnuts were picked up from the ground at two field sites in the summers of 2000, 2001 and 2002 on a weekly basis. The field sites were at Orange in NSW and at Myrtleford in Victoria. Nut numbers and weights were recorded at each pick up time. At the Myrtleford site, the samples collected were also cracked to assess how kernel quality was influenced by time of nut fall. Data were collected for several genotypes. Periods of peak fall were noted for each genotype. The number of heat units accumulated to peak nut fall was determined from temperature data obtained from the automatic weather stations at each site. Daily heat units were calculated from mean daily temperature, subtracting 10°C.
Regression analysis was carried out on the time of peak nut fall and accumulated daily heat units from 1st December each year. It was found that heat units had a significant (P=0.05) influence on the time of peak nut fall. On average, 927 accumulated heat units were recorded to nut fall for the cultivar 'Barcelona' and 102 days from the beginning of December.
The significance and implications of this finding are discussed.

PHENOLOGICAL TRAITS OF IMPORTANT HAZELNUT CULTIVARS IN ORDU, TURKEY

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This project was carried out to determine the phenological characteristics of 'Tombul', 'Palaz', 'Kalınkara' and 'Çakıldak'. These hazelnut cultivars were grown at Ordu in coastal (0-250 m altitude), middle (250-500 m altitude) and high zones (500-750 m altitude) from 1999 to 2002. This study recorded the following information: the appearance of female and male flowers, time of fruit cluster formation, time of ripening, and time of leaf bud burst. These occurred earliest in the coastal zone and latest in the high zone. The earliest ripening times were associated with 'Tombul', 'Palaz', 'Kalınkara' and 'Çakıldak' cvs., respectively. The 'Tombul' cultivar was homogamous, 'Çakıldak' cv. was protandrous and excluded from homogamous in period 1999 to 2000 and 'Palaz' and 'Kalınkara' cvs. were dichogamous at the coastal zone. Average flowering periods for male flowers varied from 81.67 ('Palaz') to 48.33 ('Çakıldak') days, and average receptive periods varied from 61.67 ('Kalınkara') to 28.33 ('Çakıldak'). This period varied according to year and altitude, and decreased from the coast to the higher area. The vegetation period lasted between 162 ('Palaz') and 174 ('Çakıldak') days. For our cultivars, the recommended pollinizers were: 'Tombul' and 'Palaz' for 'Çakıldak'; 'Palaz' and 'Kalınkara' for 'Tombul'; 'Tombul' and 'Kalınkara' for 'Palaz'; and 'Palaz' and 'Tombul' for 'Kalınkara' cv.

PRELIMINARY RESULTS OF INCOMPATIBILITY ALLELES EXPRESSED IN POLLEN FROM SOME TURKISH HAZELNUT CULTIVARS

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Knowledge of incompatibility (S) alleles in hazelnut cultivars would greatly facilitate the selection of parental combinations for breeding studies and choosing pollinizers for orchards. In this study, incompatibility alleles expressed in the pollen of 14 hazelnut cultivars were identified and studied. The cultivars and tester plants were located at the Hazelnut Research Institute in Giresun and at the Department of Horticulture in the Faculty of Agriculture of Ankara University, Turkey. Two to five tyvek bags were placed on tester plants for each cultivar in December. Catkins were brought to the lab, laid on papers in the afternoon, and left to elongate. Pollen was collected the following morning and stored in glass vials with cotton stoppers at -20°C until used. Collected females were pollinated, placed on moist paper in petri dishes and incubated for 18-20h at room temperature. The stigmatic styles were squashed in aniline blue and pollen tubes and were observed under a fluorescence microscope. Compatible crosses produced masses of long tubes, while incompatible crosses produced very short tubes which often curved or ended in pronounced bulbs. The incompatibility alleles of S_2, S_5, S_8, S_{10}, S_{12} and S_{21} were identified in the pollen of Turkish cultivars.

RELATIONSHIP BETWEEN THE ABOVE AND UNDERGROUND PARTS OF THE HAZELNUT VARIETY 'TONDA DI GIFFONI'

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The bibliography on the relationship between the above and underground parts of hazelnut varieties in natural conditions is very limited. In 2000, a project took place concerning, the improvement of hazelnut productivity in Portugal, and for this reason we performed an experimental study in the field to observe the influence of irrigation drip on hazelnut yield. As we did not know how the root system grew in the soil and where the most important thinner roots were, we decided to study these subjects. We therefore applied a classical method to study root systems called "Dry Excavation" which is the most accurate method but which requires people and time. We excavated 6,5m² around two trees of hazelnut variety 'Tonda Di Giffoni' which were collected and its components were studied including leaf area.
Our objective was to discover where most thin and absorptive roots grew, and then, try to irrigate without water loss and relate the root length density to the total leaf area of the two trees studied.
The trees were trained in Romisondo's oblique system (double pairs) and we selected them because it is one of the best varieties in the region of Entre Douro e Minho (Northwest of Portugal). The trees were twelve years old and we defined a 5 x 2 m rectangular area with a thin line based on the row and interrow space. We divided the 5 x 2 m rectangle into four smaller 2,5 x 1,0 m rectangles. We decided to divide each small rectangle again with the aim of separating the area near the trees from the outer area. We divided the root samples into three classes of diameter: $\varnothing < 2,0$ mm, $2,0 < \varnothing \leq 5,0$ mm and $\varnothing > 5,0$ mm. The length of each root diameter class was estimated multiplying its dry weight by a coefficient that relate the length and the dry weight.
We found the greatest thin roots in the upper layers as a consequence of the bulk soil density. We think that it is possible in the future to develop the fine root system in the deep layers applying appropriate soil management techniques as it is advised by some technicians. We also verified a relation between the leaf area and the root length density.

THE ARCHITECTURAL ANALYSIS OF A FRUITING BRANCH IN TWO HAZELNUT (*Corylus avellana* L.) CULTIVARS

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The two hazelnut cultivars 'Istrska dolgoplodna leska' (ID) and 'Pauetet', with different vigour and growth habits, were researched in the tree architectural analysis in order to quantitatively explain genotypic differences in shoot morphology, including shoot dimensions and geometry. A fruiting branch constructed from the five-year-old bearer plus corresponding four-, three-, two-, and one-year-old shoots was used as a structural unit. In both cultivars the branching pattern is proleptic. The fruiting shoots are one year old with a few exceptions in cv. 'ID', in which fruits grow on green shoots. In cv. 'ID', annual shoots very often grow on the older (three, four and five years of age) shoots, while in cv. 'Pauetet' time succession of shoot development is much more uniform, i.e. young shoots are almost always inserted onto the one-year-older bearing shoot. Basitony is better expressed in cv. 'ID'. In this cultivar the branching density is significantly higher than in the cv. 'Pauetet'. A five-year-old fruiting branch is constructed from 28.8 shoots of different ages in cv. 'ID', and from 24.5 shoots in cv. 'Pauetet'. In cv. 'ID', which exhibits the spreading growth habit, the angles of young shoots (one- and two- year-old shoots) are significantly larger than in cv. 'Pauetet' which has a semi-erect to erect growth habit. In contrast, the older wood (three, four and five years of age), has wider angles in cv. 'Pauetet' than in cv. 'ID'. Both genotypes significantly differ in the shoot diameter. Cv. 'ID' has thicker shoots of all ages except the five-year-old bearer. One-, two- and three-year-old shoots on the two-, three- and four-year-old bearer are longer in cv. 'ID', while the older shoots are longer in cv. 'Pauetet'. Cv. 'ID' develops significantly more fruits per one-year-old flowering shoot than the cv. 'Pauetet' does.

EFFECT OF SHADE ON FLOWERING AND YIELD FOR TWO DIFFERENT HAZELNUT TRAINING SYSTEMS

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A method for measuring sunlight intensity at different points within the canopy of a hazelnut tree was used to determine its light environment and to compare two different training systems (free vase and double hedge). Canopy light infiltration was measured over a period of three years, using a portable solar bar. The bar was horizontally inserted at heights of 1, 2 and 3 m above the soil surface and oriented towards the four cardinal points. Measurements were taken for three replicate plants for each training system in the central hours of the day in mid-June. The area and stomata densities of leaves sampled from the lower and the upper parts of the canopy were recorded at the same time and also compared. To evaluate the influence of light penetration on yield, the number of female inflorescences was counted on four branches orientated towards the four cardinal points in late February. Fruit set on the same branches was determined in mid-June and at the beginning of August. In both training systems, light interception was greater on the exterior part than the interior one of the canopy. The free vase system permits to have a better light interception in the exterior part of the canopy especially at greater heights from the soil surface. In the case of double hedge, the higher vegetative growth due to short distance between the two plants caused reciprocal shade, especially in the case of internal leaves. Female inflorescence density did not reveal any significant differences between the two training systems, but fruit set was significantly higher in the case of vase (+ 34% in June, + 48% in August). Both area per leaf and stomata density were also higher with vase, especially in the upper part of the canopy.

EFFECT OF IRRIGATION ON PHYSIOLOGICAL AND BIOCHEMICAL TRAITS OF HAZELNUTS (*Corylus avellana* L.)

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Leaf gas-exchange parameters (A, gs, Ci and A/gs), leaf water potential (□leaf), photon flux density intercepted by the canopy (Sh) and metabolites (photosynthetic pigments, soluble sugars, starch and total phenols) were measured in cv. 'Grada de Viseu' (a traditional portuguese hazelnut cultivar) under four different irrigation treatments based on ETC levels (100, 75, 50 and 0%), in 2003. There were significant differences between the four irrigation treatments in terms of Sh, chlorophyll a (Chla), chlorophyll b (Chlb), total chlorophyll and carotenoids ($P < 0.001$), in gs, Ci, and soluble sugars ($P < 0.01$), and in starch and total sugar content ($P < 0.05$). At ETC 100 and ETC 75, cv. 'Grada' showed the highest levels of A, gs, and Ci. Levels of metabolites (Chla, Chlb, Chltotal and carotenoids) were also consistently higher in these treatments. The best irrigation treatment appeared to be ETC 75, however, data for several more years and/or different irrigation treatments are required before any firm conclusions can be drawn on these issues.
Finally, our evaluation indicates that irrigation conditions during hazelnut growth may have a profound influence on physiological parameters and probably also on fruit quality.

STUDIES ON THE EFFECT OF TEMPERATURE ON THE TIME OF POLLEN SHED AND FEMALE BLOOM

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The dates of pollen shed, female bloom and leafing out were recorded for a range of genotypes grown at five localities in Australia over several seasons. Onset of flowering and leafing out tended to occur in the same order for each genotype and year. Early flowering and leafing out was in general agreement with the relative chill hour requirements estimated by Mehlenbacher (1991). Automatic weather stations at the field sites were used to monitor temperatures and record chill hours in the range 0-7°C. The recorded chill hours in the 0-7°C range to the onset of flowering varied considerably between sites and seasons and did not prove a reliable predictor for anticipating the onset of flowering or leafing out. At two sites with very different temperature patterns, Orange (continental) and Kettering (maritime), temperature was recorded on an hourly basis. These data were then used to calculate chill hours for the cultivars 'Barcelona' and 'Ennis' based on the Richardson model (Richardson *et al*, 1974). The relative value of this model is discussed.

GROWTH ANALYSIS AND NITROGEN DYNAMICS IN HAZELNUTS

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Leaf area development and dry matter accumulation were measured in 'Tonda Gentile Romana' hazelnut plants. The measurements were carried out on irrigated and non-irrigated young plants and non-irrigated adult orchards. Nitrogen concentration in leaves, shoots and nuts was periodically examined during the growing season.
Biomass partitioning in the above ground parts of the plants was affected by age and irrigation. In young plants, 60% of the dry matter was due to leaves. The contribution of fruit and pruning weight was about 15% and 11% respectively. In the adult orchard, nuts represented 46% of the biomass.
The highest concentration of nitrogen in the leaves was in spring, decreasing during the growing season. Nitrogen content in the shoots was higher in irrigated plants. Shoots showed the highest content on the first date of measurement (end of April). In adult plants, the concentration decreased to a minimum level in August and then recovered higher values in September. In young plants, nitrogen increased in the shoots from July. These differences are related to the different crop load and sink strength and to water availability in the soil. In the adult orchard, nitrogen accumulation was low and started only after harvest.

SEASONAL CHANGES IN FRUCTOSE, GLUCOSE AND SUCROSE CONTENT OF BARK TISSUES IN HAZELNUT GROWN IN THE BLACK SEA REGION

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Seasonal changes in total carbohydrates, fructose, glucose and sucrose in the bark tissues of 'Tombul', 'Palaz', 'Kalınkara', 'Çakıldak' and 'Sivri' cvs. grown in eastern (Giresun) and western Black Sea regions (Düzce) were determined by HPLC. As in other fruit species, fructose, glucose and sucrose levels decreased from the end of spring to summer. There were steady changes with lower values in summer, followed by increases from mid-fall until winter. Despite the general tendency of declining values during spring, the soluble sugar content of 'Sivri' increased in April in the Düzce region. Annual changes in fructose, glucose and sucrose for the two regions and cultivars did not show any significant differences. The differences between the regions and cultivars were most prominent in fall and winter. Sucrose levels were highest in December and January in Düzce, which has lower winter temperatures than Giresun. But in December, the opposite results were obtained for sugar content, except for glucose in 'Kalınkara'. Differences between regions during the winter period were mostly associated with 'Palaz', 'Çakıldak' and 'Sivri' cultivars. Sucrose levels were also higher in these cultivars than in the others in January.

MICROSPOROGENESIS IN HAZELNUT

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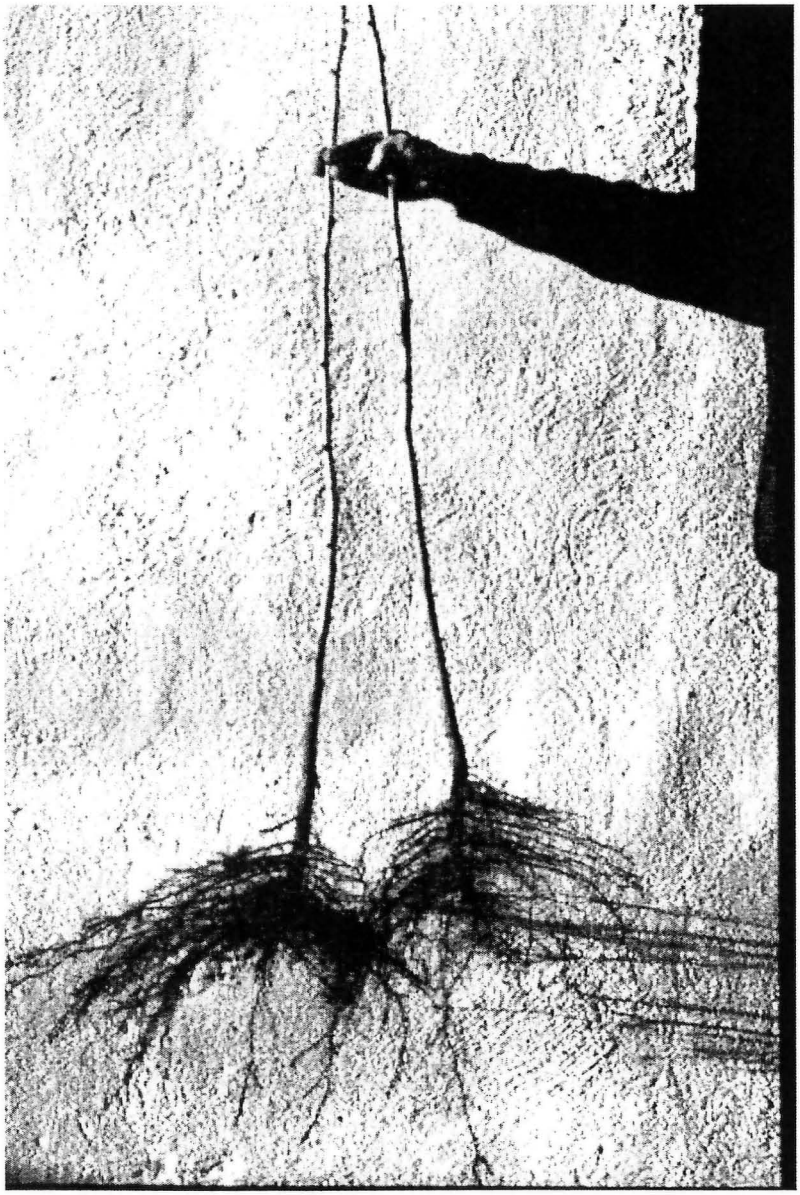
Microsporogenesis is an important process in male flower development and the timing of its occurrence may contribute to the time of pollen shed in hazelnuts. Nine varieties from the National Clonal Germplasm Repository in Corvallis, OR, were studied. These represented early to late blooming cultivars, including 'Tonda Gentile delle Langhe', 'Tonda di Giffoni', 'Barcelona', 'Hall's Giant', 'Cresswell', 'Brixnut', 'Gem', 'Gasaway' and 'Contorta'. Three catkins from a single tree of each variety were randomly selected once per week from the beginning of August to the end of November 2002. The catkins were fixed in FAA solution, embedded using the Technovit 7100 kit, stained with toluidine blue, and examined by light microscopy. On 4th August, different varieties were at varying stages of microsporogenesis. Later blooming varieties contained archesporial cells while early blooming varieties had microspore mother cells present. Pollen mother cells were present in all varieties by 22nd August. Young pollen grains were seen at the end of September, when hazelnut catkin dormancy is purported to begin. This study contributes to a better understanding of pollen development. This is important for increasing precision in matching hazelnut microsporogenesis with bloom phenology.



Session 3

Propagation and Rootstocks

MICROPROPAGATION OF HAZELNUTS

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In vitro propagation is a widely used technique. It allows us to obtain thousands of explants from few apices in a short time. Many studies have shown the problems relating to the *in vitro* propagation of the hazelnut (*Corylus avellana* L.); the difficulties are linked to sterilization, to the establishment of the material and to the artificial conditions that lead to a low multiplication rate. Moreover, the developing buds often do not show the juvenile morphology. The aim of this study was to improve the protocol for hazelnut micropropagation.
Axillary buds of the cv. 'Tonda Romana' and cv. 'Montebello' were used. The procedure adopted was based on the sterilization of explants with NaOCl (0.8% free chlorine) for 20' followed by a second sterilization with Na-merthiolate ($C_9H_9HgNaO_2S$) 0.05% for 20'. The buds, after washing with sterile water, were transferred to a solid multiplication medium containing macro and microelements (Perèz-Tornero et al., 2000), vitamins DKW (Driver and Kuniyuki, 1984) and the following hormones: 0.5 mg/l BAP, 0.04 mg/l IBA, 0.05 mg/l GA3: after 1 or 2 sub cultures the explants were transferred to a DKW medium containing a modified dosage of macro and microelements, vitamins DKW and the following hormones: 1.5 mgl-1 BAP, 0.01 mgl-1 IBA and 0.1 mgl-1 GA3. The multiplication rate was x3 in the cv. 'Tonda Romana' and x5 in the cv. 'Montebello'. The plantlets were rooted with macro, microelements and vitamins at 1/3 of full concentration and the following hormonal combination: 2 mgl-1 IBA for cv. 'Montebello' and 2 mgl-1 IAA for cv. 'Tonda Romana'. The percentage of rooting was 80% in the cv. 'Montebello' and almost 100% in the cv. 'Tonda Romana'.
The plantlets did not show necrotic or vitrified apices, their general appearance was excellent and they were transferred to the soil successfully.

INVESTIGATIONS INTO THE ANATOMICAL AND HISTOLOGICAL DEVELOPMENT OF THE GRAFT UNION OF 'TOMBUL' ON 'KUŞ', 'PALAZ' AND 'KARA' CULTIVARS

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In this research, 'Tombul' hazelnut was grafted onto 'Kuş', 'Palaz' and 'Kara' hazelnut cultivars and the graft union was studied both anatomically and histologically. A chip-budding graft technique was used and samples were taken 14, 23, 30, 45, 60 and 90 days after grafting. In comparison with the other varieties, earlier callus and vascular tissue formation was observed in 'Kuş' and 'Palaz' with a marked increase in callus formation. The 'Kara' hazelnut produced the heaviest necrosis after grafting, while 'Kuş' produced the least necrosis of all the varieties. Although the graft union was perfectly completed in 90 days after grafting in all combinations, 'Tombul'/'Kuş' and 'Tombul'/'Palaz' combinations were found to be more advantageous than the 'Tombul'/'Kara' combination.

ADVENTITIOUS ROOT FORMATION COURSE IN HAZELNUT HARDWOOD CUTTINGS AS A CONSEQUENCE OF FORCING TREATMENTS

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The study of the evolution of rooting formation of hazelnut is important for optimising the practice of cutting propagation. Furthermore, the use of several portions of suckers permits an increase in rooted plants obtainable by means of traditional multiplication.
Cuttings taken from 1-year-old suckers of cv. 'Tonda Gentile delle Langhe' were used, divided into lower, middle and upper portions. Each portion was treated with different formulations or solutions of IBA (water solution of K salt, hydroalchoholic solution and dispersion in cyclodestrine), all at concentrations of 2.500 ppm and placed in rooting bedding, unheated or with bottom heating at 21° or 27°C. The best percentage of rooting was obtained with the lower and middle portions of the suckers, at 27°C and treated with IBAK (over 70% rooting) and IBA cyclo (over 60% rooting). Furthermore, for each trial, a sample of rooting hardwood cuttings was taken at weekly intervals to monitor root formation progress. The results were interpolated by a logistic model curve featuring coefficients which revealed interesting relationships with the experimental variables.

MORPHO-ANATOMICAL ASPECTS OF HAZELNUT CUTTINGS FORCED TO ROOT

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Propagation of hazelnuts by hardwood cutting is still to be encouraged, given the widespread habit of using rooted suckers and the limited extent of experience in the use of micropropagated plants.
In order to study in depth the chain of events involved in root formation and to determine the possible effect of forcing techniques on rooting formation, as well as bottom heating and basal hormonal treatments, microscope observation of hardwood cuttings was carried out, taken every week for 12 weeks after their placing in rooting bedding. The observations covered: callus formation and an estimation of cambium activity, lenticel proliferation activity, the quantification of rooting response as hyperplastic cellular mass and complete root emission. More specifically, root genesis was related to the distance from the treated area and from any vegetative buds and to cutting diameter.
The results revealed a high potential for stimulation of cellular proliferation in winter hardwood cuttings regardless of heat and hormone treatment. However, this does not always lead to the formation of adventitious roots. The formation of the latter seems to be favoured by medium-sized cuttings, and especially by heat treatment.

PROPAGATION OF HAZELNUT CULTIVARS FROM HARDWOOD CUTTINGS

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Rooting of hardwood hazelnut cuttings (*Corylus avellana* L.) was studied over two years. Ten cultivars were used in the trial. Cuttings 10-12 cm in length were prepared during December. The basal part, 2 cm in length, was vertically watered from two sides and treated with IBA (1.000 ppm). Prepared cuttings were placed in moderately moist polyethylene bags and stored in the cold room at 4°C until transfer to the beds for rooting. Beds had basal heating (electrical blankets) and were located in the tunnel covered with plastic foil. Three temperature regimes, i.e. 18, 22 and 26°C, were used. Cuttings were set up 5 x 5 cm from each other in two substrates of ZEOLIT. The granulations varied by 1 to 2 mm. Cuttings were also set in the mixture of peat and perlite, stock medium (Klassman). The leaf moisture was maintained under the MIST system. The control was conducted in June and rooting degree was noted. Rooted cuttings were transplanted into containers, acclimatized and later cared for. Callused cuttings without the roots were returned to the substrate. In September, rooting degree was checked again.
In terms of rooting degree, a significant difference between the substrates was not recorded. Temperature regime substantially affected the rooting. Significant differences in rooting were registered among the cultivars. Thus, cvs. 'Istarski', 'Sivri Yagly' and 'Ludolf' had the highest percentage of rooted cuttings.

INFLUENCE OF ROOTSTOCK ON YIELD, TREE SIZE AND YIELD EFFICIENCY FOR THREE HAZELNUT CULTIVARS IN OREGON

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A trial was established in 1996 to evaluate the influence of self-rooted and two non-suckering rootstocks, 'Dundee' and 'Newberg', on hazelnut yield, tree size and percent kernel. Three cultivars were selected to represent different classes of tree vigor: 'Barcelona' (high), 'Lewis' (intermediate), and 'Clark' (low). In addition, 'Barcelona' and 'Clark' have distinct biennial bearing habits, whereas 'Lewis' has less year to year variation. Four replications of each scion-rootstock combination, including self grafted onto own root, were planted in March 1996, and trees were evaluated from 1999 to 2002. Every other tree was harvested in 2001 and 2002 as alternate trees were being pruned back in preparation for tree removal. Self-rooted trees had a smaller trunk cross-sectional area (TCSA) than either 'Dundee' or 'Newberg' in all years, and trees grafted onto 'Dundee' were consistently larger for all years with the exception of 'Barcelona' in 2001. All three cultivars on self-rooted trees had higher yield efficiencies in 1999 (p-value=0.01-0.06). In 2001, a high crop year, percent kernel was highest in 'Barcelona' and 'Lewis' trees grafted onto 'Newberg', and lowest for self-rooted trees (p-value= 0.02). 'Lewis' trees on 'Dundee' were 25% larger, had 10-30% higher yields, and exhibited less biennial bearing than self-rooted trees of 'Lewis' in both 2001 and 2002.

Session 4

Orchard Management

DOES CANOPY MANAGEMENT ALLEVIATE BIENNIAL BEARING IN 'ENNIS' AND 'MOTEBELLO' HAZELNUT TREES?

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Biennial bearing in 'Ennis' is pronounced in young trees and can have an influence on nut quality as well as yield. A 0.6 ha block of 'Ennis' trees planted in 1983 on 3.05m x 6.10m spacing was used from 1993 to 2002. Three pruning treatments were applied: no pruning except removal of dead wood, selective scaffold removal (SSR), and removal of alternate trees. Alternate trees were heavily pruned in 1994 and 1995 prior to their removal. There has been less variation in yield in the pruned and unpruned trees over the past four years than in the tree removal treatment. When expressed on a yield per acre basis, there is little difference between the three treatments, even though there are half the number of trees in the removal treatment. Pruned trees (SSR) have had more giant/jumbo nuts than either unpruned or tree removal treatments in heavy crop years, but there has been no difference in nut size distribution in low crop years.

In 1999, a heavy crop year, three pruning treatments were applied to three replicates of 39 trees, each of 'Montebello', which were planted in 1985 on 5.5m x 5.5m spacing. Trees were either hand-pruned or vertically hedged to remove 20-30% of canopy, or pruned lightly to remove dead wood and low hanging branches only. Mechanically hedged trees tended to have higher yields, fewer defects and larger nuts.

THE INFLUENCE OF DIFFERENT IRRIGATION STRATEGIES AND THE PERCENTAGE OF WET SOIL VOLUME ON THE PRODUCTIVE AND VEGETATIVE BEHAVIOUR OF THE HAZELNUT TREE (*Corylus avellana* L.)

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Hazelnut is a traditional crop in some areas of the "Camp de Tarragona", Catalonia, and also in others including "Priorat" and "Conca de Barberà". The main limiting factors for hazelnut production are low rainfall and limited water availability. Drip irrigation is the main system used in most orchards to supply water. This system has two main limitations: a) Unsuitable water supply (the irrigation period does not match the physiological process) and b) Deficient management (very limited wet soil volume). In an attempt to deal with these two main limitations, two field experiments were carried out on two plots with different soils: loamy-soil at "Alcover" and sandy soil at "La Selva del Camp". Both plots are commercial orchards in full production with 'Pauetet' as the main cultivar and 'Gironell' as the pollinator at "Alcover" and 'Negret' at "La Selva del Camp".
The effects of the different irrigation strategies applied (**E-1**=Irrigation from April to September; **E-2**: Irrigation from June to September; **ECDI-1**: Irrigation from April to September with a 30% water supply reduction in summer; **ECDI-2**: Irrigation from April to September with a 60% water supply reduction in summer) on crop production and harvest quality are given. The productive and vegetative responses of hazelnut trees after being irrigated with different wet soil volumes (WSV), 6%, 13%, 25% and 57%, are also presented.
1.- Results obtained under these agroclimatic conditions showed that strategy **E-1** (Irrigation from April to September) which supplied water throughout the hazelnut's annual physiological cycle (vegetative, reproductive cycle) provided the best productive response (kg kernel/ha) and, quite significantly, also the best kernel quality (kg kernel/ha > Ø 12 mm).
2.- Strategy **E-2** affected the physiological phases and significantly reduced kernel quality (kg kernel/ha > Ø 12 mm).
3.- Dose irrigation reduction during summer (**ECDI-2**) caused a significant fall in production (kg kernel/ha) and also in quality (kg kernel/ha > Ø 12 mm).
4.- The best productive response (kg kernel/ha) and vegetative growth (mm/year) obtained was around 25% (WSV) with respect to total potential soil explored by roots.
5.- The **E2** and **ECDI-1** strategies produced similar levels of water saving (15%) in relation to **E1**. However the highest levels of efficiency were obtained when **ECDI-1** was applied.

FURTHER EXPERIMENTS ON CONTROL OF SUCKER GROWTH IN HAZELNUTS (*Corylus avellana* L.) WITH NEW ESTERS OF 1-NAPHTHYLACETIC ACID

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The well known plant growth regulator 1-naphthylacetic acid (NAA) has been employed for sucker control in many tree fruit species. Esters of NAA are also active in sucker control. In the hazelnut (*Corylus avellana* L.), which is known to have a strong suckering tendency, the elimination of suckers is performed either mechanically (at a high cost) or with chemical herbicides. Following previous research in which new esters of 1-naphthylacetic acid were used, six other new esters, derived from NAA and primary linear alcohols with 6-11 carbon atoms, were suspended in deionized water with the wetting agent Tween 20 (1 % w/w) and sprayed at concentrations of 0.25 %, 0.5 % and 1.0 % (w/w) till runoff. Three replicates were arranged in a randomized block design and treatments applied to 0.1-0.2 m long herbaceous suckers of 'Tonda Gentile delle Langhe' trees. Sucker control was evaluated 4, 11 and 30 days after treatment using a wilting index. After 4 days at the doses of 0.25 and 0.5 % undecyl 1-naphthylacetate produced a significantly lower effect than hexyl and octyl derivatives. At 1% no differences were detected. After 11 days at 0.25 and 0.5 % there were no significant differences between the tested esters, while at 1 % the decyl derivative had a lower effect than heptyl. After 30 days, no differences were detected between the compounds; all produced complete wilting. The compounds with a shorter chain produced a quicker action. Although the six compounds at the same concentration (by weight) showed similar effectiveness, it must be stressed that the undecyl derivative has a number of moles/L lower than the hexyl derivative of 21 %. None of the compounds caused phytotoxic effects on the plants or changed nut quality or the yield of the trees.

THE EFFECTS OF HAZELNUT HUSK AND THE OTHER ORGANIC MATERIALS ON PROPERTIES OF HAZELNUT CULTIVATED SOILS AND YIELD QUALITY

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The effects of hazelnut husk compost, peat, farmyard manure and chicken manure on hazelnut cultivated soil properties and yield quality were investigated. A trial orchard displayed the general orchard properties of hazelnut cultivated soils in the Central and Eastern Black Sea region and it was established with the 'Tombul' type of hazelnut which is more extensively grown in the region. Organic matters were applied on a dry weight basis in the first year and then the residual effects of materials in the second year were determined. In order to designate the changes in soil properties and yield quality for two years, soil samples and nut samples were analysed and the yields of the 'Tombul' hazelnut were determined.

The effects of organic material applications on physical and chemical soil properties were clearer in the first year than the second year. While chicken manure and farmyard manure had more effect on chemical soil properties, generally husk compost and peat had more effect on physical soil properties. The yield of 'Tombul' hazelnut was 4.130 kg/ocak in the first year and increased to 4.880 kg/ocak in the second year. Higher 'Tombul' hazelnut yields were found in chicken manure and farmyard manure. After application of organic materials on the hazelnut orchard, some quality properties were determined, such as 100 nut weight, kernel percentage, oil content, protein, hazelnut ashes, shell thickness, nut size, kernel size, cracked shell, total good nuts, etc. Shell thickness increase with chicken manure applications. The greatest decrease in the amount of wrinkled nuts of 'Tombul' hazelnut was determined in peat applications depending on water retention capacity of the material. Empty nut ratio decreased in the second year, and the highest effect was determined in farmyard manure depending on potassium content.

USAGE OF HAZELNUT HUSK COMPOST AS GROWING MEDIA

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The use of composted hazelnut husk (CHH) as a plant growth medium was investigated. The mediums were prepared using different fractions of CHH mixed, in different ratios, with clay loam soil. Firstly, the aggregate size distribution of CHH was performed so that different fractions were determined. 0-2 mm, 2-4 mm and 4-6.35 mm were found. Secondly, these fractions of CHH were mixed with soil at 2 %, 4 % and 8 % ratios. Some physical and chemical properties of the growing medium were determined.
Physical and chemical properties of the growing medium were then determined. The mixture of 4 mm aggregate size and 8 % ratio CHH was found to be more suitable based on ideal growing media properties.

EFFECT ON YIELD AND NUT QUALITY OF OCAK AND SINGLE TRUNK TRAINING SYSTEMS

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This study was carried out in Hazelnut Research Institute (Giresun-Turkey) in 2001-2003. Training garden was established in 1992 with 'Tombul' cultivar.
In the experimental design, nine trees or nine ocak (four trees per ocak) were used in each tree treatment. In the result of study, statistical differences between training systems were not shown. But single stem training system was higher than ocak in yield and some nut characteristics.
In the present, the yield and nut characteristics will be shown in detail.

INNOVATIONS IN HARVESTING MACHINES

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In the last 20 years, the development of hazelnut cultivation in Italy has been related to the introduction of harvesting machines, which have completely replaced manual harvesting. During this time, the performance of the harvesters has led to a considerable increase from about 100 kg/h to more than 1.000 kg/h. In this period, their innovations have been concerned not only with technical and economic performance (such as a reduction of operating time and costs) but also with the operator's safety and health and, in general, the quality of the working environment and the control of some ergonomic aspects (dust, noise, posture). After a description of the main technical aspects of harvesters (with particular reference to the self-propelled harvesters), the authors discuss the results of experimental tests carried out in the last three years.
The tests show remarkable harvesting performances for the different types of harvesters (pulled vacuum harvesters, with and without side-picker and trailer, self-propelled aspirating or picking harvesters with trailer), which vary from about 0,2-0,4 ha/h for pulled machines to 0,35-0,75 ha/h for self-propelled ones. The variability depends on factors like work conditions, row length, orchard production and also on the organization of the harvesting yard.

HARVESTING, CALIBRATION AND SHELLING OF HAZELNUTS

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Manual harvesting is the most limitative operational handicap for the expansion of hazelnut cropping in Portugal, yet the importing of equipments is not a realistic alternative option because it is very expensive and is not adapted to Portuguese hazelnut orchards.
In an attempt to overcome this shortcoming, a small-size and low-cost equipment is being developed for mechanical harvesting and two others are being prepared for calibration and shelling, all within the scope of an AGRO 162 project called "Yield increase on hazelnut crops in Portugal".
Basically, the equipment for hazelnut harvesting is composed of a hopper, a four-stroke engine, a ventilator, two flexible tubes for conveying the draw in material and a wheelbarrow required to drive the assemblage. The calibrator is built with three iron sieves mounted in a slope position to allow for the rolling of the hazelnuts; the sieve with the shortest distance between the separator's grill is positioned at the lowest level. The shelling equipment is made essentially of a metallic roll driven by an electrical engine, with two rulers positioned in accordance with the generating roll that compress the hazelnuts against a wooden ruler. The distance between the roll and the wooden ruler can be adjusted.
The trials on hazelnut harvesting allowed us to obtain works rate from 20 to 40 h/ha, depending on the conditions of the test (e.g. stripped or non-stripped material, ground conditions, etc). The calibrator was designed to obtain lots < 14 mm, 14 - 16 mm, 16 - 18 mm and > 18 mm. The shelling equipment performances depend greatly on the size of the lot: for lot < 14 mm the best results were 10 % of intact hazelnuts, 65 % of unbroken kernel and 25 % of broken kernel; for lot 14 - 16 mm the best results were 15, 70 and 15 %; for lot 16 - 18 mm were 5, 80 and 15 %; and for lot > 18 mm were 10, 85 and 5 %. The shelling performance of the smallest lot can be improved if the fruit shell is shelled again using a shorter shrink distance.
In conclusion, it can be stated that the harvesting equipment is a reasonable solution for short acreage orchards where a low work rate is allowed since it has a low price. The shelling equipment provides a good percentage of shelling hazelnuts in the upper lots, but in the lower ones it is necessary to do more than one shelling operation; this limitation can be reduced if we have more sieves to get more lots of small hazelnuts.

THE EFFECT OF "ORMIN-K" FERTILIZER ON SOME POMOLOGICAL AND TECHNOLOGICAL TRAITS IN THE 'TOMBUL' HAZELNUT CULTIVAR

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This study was carried out to determine the effects of doses of Ormin-K fertilizer (potassium compounds 57 %; N, P_2O_5, SO_4, CaO, MgO, Fe, Mn, Zn, Cu and Mo compounds 33 %, organic matter 8 %, moisture 2 %) and application methods (broadcasting and banding) on nut and kernel quality characteristics in the 'Tombul' hazelnut cultivar in 2001 and 2002 in Ordu (Turkey) ecological conditions. As a result of this study, it was determined that there were significant differences in years and doses regarding nut weight, kernel weight, percent kernel and good kernel, and there were no significant differences in application methods regarding the nut and kernel traits.

COMPARISON OF TWO PRUNING TRAINING SYSTEMS ON 'NEGRET' AND 'GIRONELL' HAZELNUT CULTIVARS

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In modern hazelnut orchards, trees are frequently grown on free vase with only one trained stem and a variable trunk height. This pruning training system usually varies within the producing areas, mainly according to the ecological conditions, variety vigour, plant quality and harvesting system used. In Oregon and France, with vigorous cultivars ('Barcelona' or 'Fertile de Coutard'), selected stems and orchards designed for mechanical harvesting, pruning of young trees is performed during the first years, leaving 3 to 4 scaffold branches and a trunk height superior to 80 cm. Meanwhile, in Spain and Italy, with less vigorous varieties ('Negret', 'Tonda Gentile delle Langhe', 'Tonda Romana', 'Tonda Giffoni', etc.), lower crown heights are used (10-40 cm) in order to favour crop bearing and to improve adaptation to adverse crop conditions.
The influence of two trunk heights (40 and 80 cm from the ground) in vase training on two hazelnut cultivars with different vigour ('Negret' and 'Gironell') was studied in a trial for 12 years (1991-2002). Early bearing, productivity and the vegetative development of the trees were assessed.
The results show that shorter trunks (40 cm) increase tree vigour and improve early bearing. Although sucker emission is bigger for higher trunks (80 cm), it should be considered that with vigorous varieties ('Gironell'), sucker control and crop mechanization are much easier. Significant differences in yields and nut quality were not observed between the two pruning training systems assayed. This means that the best system to carry out all the cultural practices in the hazelnut orchard can be choosen within the range of 40 to 80 cm.

INFLUENCE OF CANOPY DENSITY ON FRUIT GROWTH AND FLOWERING FORMATION

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A study was carried out to assess if some degree of pruning might improve the productivity of the hazelnut trees in 'Tonda di Giffoni' and 'Tonda Romana' cultivars in central Italy. The taking away by pruning of increasing quantities of wood and shoots reduced the leaf area index (LAI) and the leaf area per tree. As regards reducing canopy density, LAI ranged from 9.5 to 5.5 in 'Tonda di Giffoni' and from 7.6 to 4.8 in 'Tonda Romana'; the incident photosynthetic photon flux adsorbed by leaves and recorded at the base of the canopy ranged from 92 % to 87 % in 'Tonda di Giffoni' and from 91 % to 89 % in 'Tonda Romana'. Canopy reduction affected yield per tree slightly in 'Tonda di Giffoni' and more in 'Tonda Romana'. Nut size increased in the trees where the canopy was less dense. Female and male inflorescence densities were highest in the trees with the largest leaf area in both cultivars. The sucker number increased in the most pruned trees of 'Tonda Romana'. Hazelnut trees take advantage of canopy with LAI ranges around 7 because this density might form a high leaf area per tree with an incident photosynthetic photon flux adsorption of about 90 – 91 %, which can improve productivity and flower formation.

PRELIMINARY OBSERVATIONS ON THE EFFECTS OF RENEWAL PRUNING IN HAZELNUT ORCHARDS

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50% of hazelnut production in the Langhe area of Piedmont is based on the cultivation of old plants, the majority grown as bushes or even bushed vase. Pruning of hazelnuts in this area is not carried out regularly and often the orchards become overgrown, with plants yielding only in the most favourably exposed parts of the canopy. In two hazelnut orchards in the Langhe, rejuvenation pruning was carried out annually from 2001 on lots of 12-24 bushes 20 years old, bushed vase trained with 4-5 branches. Pruning involved cutting away all the branches 1.5-2 m above the ground in early spring. The following were evaluated over the two years following the pruning: crown volume, yield, and the commercial and technological characteristics of the nuts.
These surveys revealed that there is some recovery in production from the second year, and that quality always improves in the case of pruning. These results also showed that the species requires optimal exposure of the crown to light, and that new bearing branches are positive, at least in terms of qualitative characteristics, as required by the hazelnut processing industry.

EFFECT OF HIGH DENSITY AND DYNAMIC TREE SPACING ON YIELD AND QUALITY OF HAZELNUT

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Training systems and plant density in Lazio (central Italy) are based on bushes at a density of 400-500 plants per hectare. High-density systems have received little attention. In an adult orchard of 'Tonda Gentile Romana', with single-stem plants spaced 2.5 x 4 m, plant density was reduced from 1.000 to 500 plants per hectare in 2000 and 2001, seventeen and eighteen years after planting. Vegetative growth, yield and nut quality were measured from 2000 to 2003 in order to verify the plant response to tree spacing of a medium- vigour cultivar. The results indicate good productivity and quality after eighteen years of high density and the beginning of competition among plants. When the distance between plants on the line increased from 2.5 to 5 m, vegetative growth improved and the trunk cross-sectional area and canopy volume increased. Yield was affected by spacing, year and the interaction year * spacing. Yield per hectare decreased in the first year after plant removal, but plant production improved. In the following years, yield per hectare was variable, as a consequence of difficulties in achieving equilibrium between vegetative and productive activity. Plant density had only a slight effect on nut quality, as revealed by nut traits and defects and seed chemical composition. The oil content was lower in the high-density thesis. The effect of the year on sugar and oil accumulation was evident, with higher concentrations in 2002, when the summer was cooler and rainy.

EFFECT OF NITROGEN, BORON AND IRON FERTILIZATION ON YIELD AND NUT QUALITY OF 'NEGRET' HAZELNUT TREES

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In a mature hazelnut orchard cv. 'Negret', established in La Selva del Camp, Tarragona (north-east Spain), a field experiment was set up in order to study the effect of N, B and Fe on yield and nut quality. Two fertilizer trials were conducted in the spring of five consecutive years (1999-2003) for N and three years (2001-2003) for B and Fe. These involved four N treatments (200, 150, 100 and 50 kg/ha, as a control) and four B treatments (soil, 50 g/tree and 25 g/tree in March the first and second year of the trial respectively; two foliar sprays of 500 ppm in May and June; two foliar sprays of 500 ppm and soil iron chelates in May, 30 g/tree; and an untreated control) with five replications.
The greater amount of N resulted in significantly lower production and kernel yield from hazelnut trees, whereas a B foliar and Fe chelate treatment increased production with respect to the other three treatments. Boron treatments increased kernel yield and kernel size in comparison with the untreated control. Results also suggested that current N recommendation guidelines (100 kg/ha) might be too high to obtain good yields and nut quality. It was concluded that applying 50 kg N/ha when the leaf N level was about 2.4 % of the dry mass in July and two B foliar sprays with soil Fe chelates in spring was the optimum way of obtaining higher production and better nut quality.

CORRELATIONS BETWEEN LEAF MINERAL CONTENT AND PRODUCTION AND QUALITY PARAMETERS, IN AN EXPERIMENTAL ORCHARD OF 'NEGRET' HAZELNUT (*Corylus avellana* L.)

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A field experiment was set up in a mature cv. 'Negret' hazelnut orchard in La Selva del Camp, Tarragona (North-East Spain), in order to study the effects of several different treatments on yield and nut quality.
The experiment was conducted over six years (1998-2003). The field experiment was conducted applying the following quantities of general fertiliser: 50 kg N/ha, 70 kg P_2O_5/ha, and 110 kg K_2O/ha and irrigating according to local custom, which served as the reference treatment. Nitrogen treatments: 50, 100, 150 and 200 kg N/ha. Boron treatments: a foliar spray treatment of 2.5 l/tree with a solution of 500 mg B/l and another applied to the soil at 50 g B/tree. A Boron foliar spray treatment was combined with an iron treatment applied to the soil at 30 g Fe/tree in chelate form (EDDHA) and containing 6.5 % Fe. There were a further four irrigation treatments, two of which involved regulated deficit irrigation.
Correlations between leaf mineral content, between them, were studied and valuable information was obtained.

VARIATIONS IN THE IMPORTANT PHYSICAL AND CHEMICAL TRAITS OF NUTS AND THE SOIL NUTRITION COMPOSITION IN THE 'TOMBUL' HAZELNUT CULTIVAR AT DIFFERENT ELEVATIONS

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This study was conducted on the 'Tombul' hazelnut cultivar growing at eight elevations (50 m, 150 m, 250 m, 350 m, 450 m, 550 m, 650 m and 750 m) in the Ordu-Ulubey province in 1998. Twenty traits (nut weight, nut size, kernel weight, kernel size, kernel percentage, internal cavity, shell thickness, shriveled kernels, good kernels; fat, protein and ash content; organic matter, potassium, phosphorus and pH in soil; nitrogen, phosphorus and potassium in leaf) were examined at each elevation.

LEAF ANALYSIS AS A TOOL FOR EVALUATING NUTRITIONAL STATUS OF HAZELNUT ORCHARDS IN CENTRAL ITALY

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Leaf analysis is a well accepted tool for diagnosing the nutritional status of nearly all crops. It allows optimisation of fertiliser applications with the aim of obtaining high yields of good quality fruits and reducing any possible negative impact on the environment. Results are usually interpreted using reference values, which must be determined for each species, cultivar, soil and set of climate conditions.
Hazelnut is one of the major crops in Viterbo Province (Lazio Region, Central Italy), where about 20,000 ha of orchards are cultivated. Even so, there is relatively little available experimental data concerning reference values for leaf analysis interpretation relating to the most widespread cultivar in this area (mainly 'Tonda gentile romana').
The objectives of this work were to study the dynamics of macro and micronutritive elements contained in leaves during the vegetative cycle of hazelnut and to determine provisional standards for foliar analysis interpretation.
The study was performed as part of a three year field survey involving 28 orchards located on the eastern side of the Cimini mountains (Viterbo Province).
At the beginning of the study, chemical and physical soil properties were determined and, throughout the three years of the survey, information concerning orchard management (i.e. fertilisation, irrigation, and pest control) was collected and recorded.
According to a specific sampling protocol, leaf sampling was carried out three times per year in the following phases: (i) start of the vegetative season (April); (ii) beginning of fruit widening (June) and (iii) before the differentiation of masculine flowers (October). Each sample of leaves was analysed for total N, P, K, Ca, Mg, Fe and B.
Results were elaborated using the GLM Repeated Measures procedure where the within - subject factors were the years and sampling times. Even taking into consideration the variability in the content of nutritive elements in leaves due to the different climatic conditions over the three years of the survey, preliminary results showed systematic differences between the phases for some of the considered parameters.

FURTHER INVESTIGATIONS INTO THE MINERAL UPTAKE OF HAZELNUT ORCHARDS

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Mineral uptakes by the hazelnut have rarely been studied. In order to determine the quantity of mineral nutrients to be applied to the hazelnut orchard per year, we need to know the quantity of mineral nutrients the bushes consume over this period. With this goal in mind, investigation aimed at determining mineral consumption by hazelnuts was conducted in order to give a direction to future technical indications as to the quantity of fertiliser to be applied, possibly under a regime of integrated production.
In two hazelnut orchards in the specialised district of production in Piedmont (the Langhe) consisting of 15-year-old plants grown in bushed vase, the following were recorded for each plant over two years: total yield, pruned wood, leaf mass and leaf involucre which fell to the ground. For each of these, the content percentage of N, K, P, Ca, Mg, Fe, Mn, Cu, Zn and B were determined and then calculated as a proportion of dried mass per bush.
The data reveal some differences as to mineral uptake, related to the year and the site of the plantation. They also reveal the 'frugal' nature of the species, which takes up limited quantities of N and K, and even less P. Of the micronutrients, the highest uptake was for Fe and B.
If Sucz's algorithm is applied to the final results, it is possible to calculate the quantity of fertiliser to be applied to the bushes, which diverges from that usually applied in this area.

THE EFFECTS OF "ORMIN-K" AND "TSP" FERTILIZERS ON VEGETATIVE GROWTH

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One-year-old 'Tombul' hazelnut saplings were cut at a length of 25-30 cm and root pruning was carried out; saplings were then placed in plastic cups and forest soil. 5 weeks after planting into plastic cups, the different doses of Ormin-K and TSP were applied. In a study carried out between 2001 and 2004, the longest sapling was obtained by 100 g Ormin-K and the shortest sapling was measured by 200 g Ormin-K+25 g TSP; the thickest trunk was obtained by Ormin-K+50 g TSP and the thinnest stem was measured by 200 g Ormin-K.

A NATIONAL PROJECT ON ORGANIC HAZELNUT PRODUCTION IN ITALY

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The Italian Ministry of Agriculture and Forestry (MiPAF) is going to finance a national project on the development of organic hazelnut production in Italy which is currently extended to limited areas. The project "Studies on hazelnuts aimed at obtaining high-quality organic production" involves eight partners belonging to the University, the National Research Council and MiPAF Research Institutes. The objectives of the project are to promote environmental-friendly techniques focused on agronomic practices, fruit quality, tree physiology and the detection and control of main insects and pathogens. The economic analysis of the organic production will also be thoroughly evaluated. The investigations will be performed in hazelnut orchards, experimental fields and laboratories located in Piedmont (i.e. the Langhe district and Torino), Latium (i.e. the provinces of Viterbo and Rome) and Sardinia (i.e. the provinces of Nuoro and Sassari). Many private co-operatives and laboratories as well as the regional agriculture services will be actively involved in the project, which will last until 2007.

HAZELNUT PLANT PROTECTION GROUPS IN CATALONIA. CULTURAL PRACTICES IMPROVEMENT AND NEW MANAGEMENT IN HAZELNUT PRODUCTION

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Plant Protection Groups (called ADV in Catalonia) are producers associations with the aim of improving their productions by means of more effective cultural practices.
Technicians study the evolution of pests and diseases in the orchards and decide the best moments and methods to control them. Cultural and biological methods are preferred. Chemical controls are only recommended when tolerance levels are surpassed. In these cases, chemicals must be accepted by laws and machinery must ensure a right and safe application.
Irrigation and fertilization plans are decided taking in consideration foliar and soil analysis, in order to reduce costs and to ensure "sustainability".
It must be considered that ADV implies an important change in agricultural practices, based on "sustainability" and on the Integrated Pest Management system. Production uses control and certified methods in order to ensure "tracing" of the products and food and environmental safety.

INFLUENCE OF SOIL COVER CROP ON MECHANICAL HARVESTER EFFICIENCY AND KERNEL QUALITY OF HAZELNUTS IN PIEDMONT

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Green soil cover is one of the most eco-compatible choices for ground management and is therefore also to be favoured in hazelnut cultivation. However, although on the one hand this practice is to be favoured for controlling surface erosion, of particular importance due to the soil position of typical hazelnut orchards in the Langhe, on the other hand it can cause problems for the mechanical harvesting of this species.
In a hazelnut orchard which was 10 years old at the start of the trials, made up of the cv. 'Tonda Gentile delle Langhe' grown as bushes, spaced at 5m x 5m, with no irrigation, 4 artificial soil greening types were created, using 2 different weed mixtures in 2 periods of seeding and compared with natural green cover of the soil and traditional chemical weeding usual for this area. Over a 3-year period from the start of the trial, the following characteristics were monitored: the efficiency and evolution of the weed soil coverage, the efficiency of mechanical harvesting using 3 different types of harvesters; the quality of the product harvested, the soil chemico-physical composition and the mineral leaf composition.
These 3-year results evidence the compatibility of artificial soil greening and mechanical harvesting, as regards both the satisfactory functioning of the harvesters tested and the quality of the product, even if mechanical harvesting sometimes severely damages the weed coverage. Nevertheless, improvements in soil chemical fertility and nutritional status, tested by means of chemical analysis, suggest the soil greening in alternation with chemical weeding.

GENERAL PROPERTIES OF SOILS, CONDITIONS FOR USING FERTILIZERS AND SOIL PRODUCTS IN THE 'TOMBUL' HAZELNUT ORCHARDS OF GIRESUN

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This research was carried out making a 'Tombul' hazelnut orchard in Giresun from 2000 to 2003. Soil properties of 2.600 hazelnut orchards and leaf sample properties of 775 orchards were studied for four years. These orchards determined general soil properties, soil products and conditions for using fertilizers.
Some physical and chemical properties of these soils were determined. 57.35 % of clay loam was found in these soils and was approximately very strongly acid and acid in 95.00 %. For an increase in soil products of orchards, first of all, lime requirements of soils was determined. Salinity was not found in any of these soils according to climate conditions in the region. It was shown that approximately one half of these soils were necessary for the organic matter and application to organic matter was useful. Otherwise, research orchards were found to be very most nutrient element deficient. The greater increase in hazelnut yield was determinated according to true fertilizer methods.

THE MECHANIZED MANAGEMENT OF ORCHARDS IN CENTRAL ITALY

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The present research aims to make a detailed analysis of the cultivation of hazelnuts in the province of Viterbo in central Italy, paying attention to both agronomic issues and the attained level of mechanization. In the province of Viterbo, hazelnut cultivation represents an agricultural and economic reality of great importance. Blooming of this cultivation began in the 1950s and a remarkable increase has been recorded since then, rising from 2.000 ha to 20.000 ha at present. This expansion has involved 17 communes in the province and the cultivation represents the only agricultural activity for many of them. In Italy, the province of Viterbo is at the first place for hazelnut production (30.000 – 40.000 tons/year). This great development can be attributed to the particular characteristics (climate and soil) of the Monti Cimini area: land with reaction close to neutrality, tendentially sandy, a sub-Mediterranean climate with the correct combination of not too many hard winters and an annual average rainfall higher than 1.000 millimetres.
A particular contribute to this delovepment has been given by local constructors, which have realized innovative machines for both tillage and crop operations.
The research illustrates the soil management technique actually used, the implications for cultivation and manuring, pruning, irrigation systems, the phytosanitary defence, and the specific machines used in each operation.

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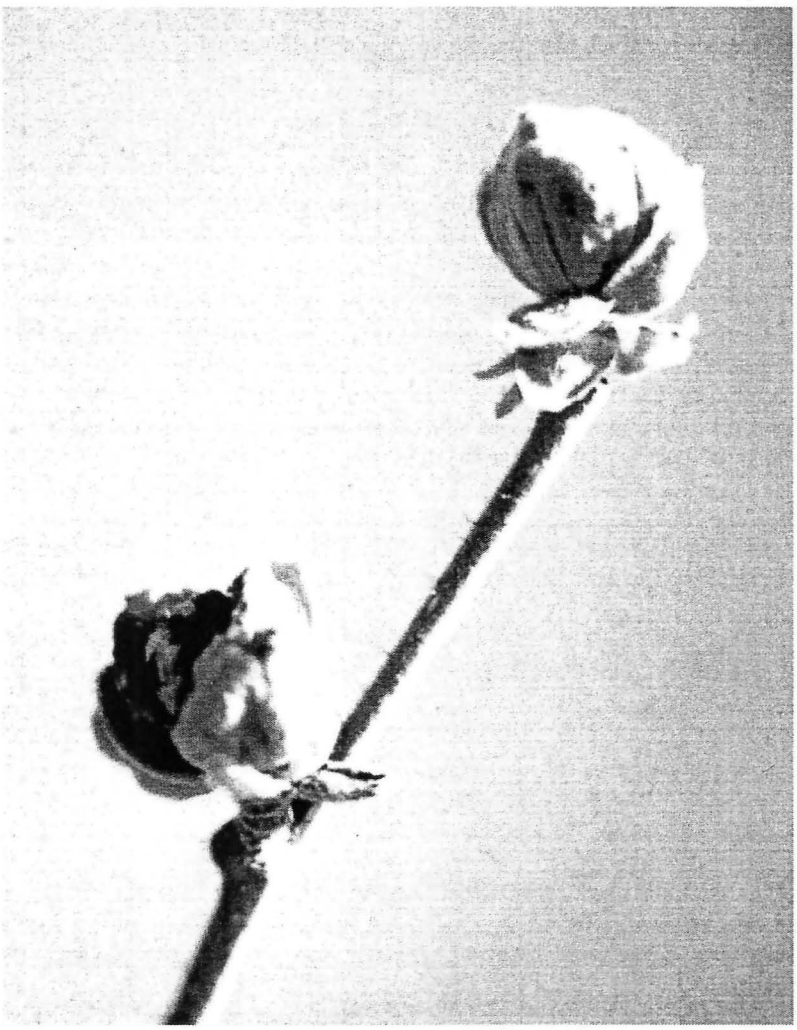

Pest and Diseases

THE INSECT PEST PROBLEM AFFECTING HAZELNUT KERNEL QUALITY IN TURKEY

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There are a lot of insects and mite pests in hazelnut orchards in Turkey. Most pests affect hazelnut production by direct or indirect injury. But a few of them influence kernel quality by feeding on nuts in addition to yield. In the last few years, hazelnut exporters have begun to complain about this kind of damage decreasing kernel quality because they have difficulties exporting.
It was established that there were more than 15 bug species which may affect kernel quality (*Heteroptera*: *Pentatomidae*, *Coreidae* and *Acanthosomatidae*) in Turkish hazelnut orchards.
In this study, the population fluctuations of these bugs were determined in six hazelnut orchards and on three main varieties. *Palomena prasina* and *Gonocerus acuteangulatus* were found to be the main species. The population level was above the economic damage threshold. In a cage experiment with *P. prasina,* three types of injury were determined on hazelnuts. In addition to field and cage experiments, quite significant data from hazelnut factories were examined for kernel injury by bugs. Dependence on variety, locality and kernel sample damage reached around 10%.

SUSCEPTIBILITY OF LARGE-FRUITED HAZEL VARIETIES CULTIVATED IN POLAND TO MAJOR PESTS AND THEIR CROP PRODUCTIVITY

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In Poland, the cultivation of hazelnuts does not have a long tradition, but since the 1990s the production area has constantly increased and now hazelnuts are grown over 1000 ha, mostly in south-east Poland. The hazelnut cultivars grown in that region are old, mostly from the 19th century, characterized by large and oval nuts, useless to the confectionery industry, but willingly bought directly by consumers. It should be mentioned that weather conditions in Poland are rather unfavourable for cultivating hazelnuts in comparison with warmer countries. However, according to chemical analysis results, nuts obtained in these conditions contain considerably less saturated fatty acids unfavourable to the human diet and more unsaturated fatty acids. Similarly, as in some other countries, insect and mite pests are major detriments to hazelnut production in Poland and are the major concern for many hazelnut growers. Nevertheless, there are hundreds of pest species but only a few of them are common and cause economic damage. Among them, in Polish conditions, the most important are: nut weevil (*Curculio nucum*), big bud mite (*Phytoptus avellanae*), filbert aphid (*Myzocallis coryli*) and scale insect (*Parthenolecanium corni*). In the course of several years' research, the different susceptibility of chosen cultivars of large-fruited hazelnut to these pests was confirmed. The establishment of resistant varieties and their putting into practice may lead to a reduction in the application of heavy pesticides and the preparation of a hazelnut IPM program in our country. Moreover, the resistance of hazelnut cultivars to major pests in comparison with their crop productivity is discussed in this paper.

PHYTOSANITARY PROBLEMS IN THE EVOLUTION OF HAZELNUT TREES IN TARRAGONA

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Hazelnut weevil (*Curculio nucum*) is the most widespread pest in Tarragona (north-east of Spain). Since the introduction of organic insecticides, the uncontrolled and indiscriminate fight with chemicals has led to the appearance of new pests, both insects and mites. Some of them have become widespread pests (aphids, yellow spider, bud mite) and some of them have become more localized (tortrix moth, scale, leopard moth). In recent years, the Integrated Pest Management System (IPM) has managed to keep most of these pests under control. Nevertheless, new problems are appearing (rotting and a white spot on the fruits) which make new studies necessary.

INNOVATIVE STRATEGIES IN EPIDEMIOLOGICAL STUDIES OF HAZELNUT DIEBACK BY USING G.P.S./G.I.S. AND A.Sp.I.S TECHNOLOGY

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Since the 1980s, in the province of Viterbo (north of Latium), a dieback of the hazelnut tree has caused progressive decay of the plants. Physiological, biochemical and molecular tests on bacterial strains, obtained from symptomatic samples of hazelnut branches, have shown some bacterial strains of the *Erwinia amylovora* group or *Pseudomonas avellanae* Janse *et al.* involved in the etiology.
In order to analyze the spatial distribution of the disease which affects hazelnut fields in this area and the relationships between different territorial compartments, a Global Positioning System (GPS) has been set up to record the diseased plants, in association with the Geographic Information System (GIS) spatial databases based on Mapinfo® software. The hazelnut areas mainly affected by dieback disease began to be monitored from 2003 onwards and they have been correlated with historical data on the incidence of dieback over the last 5 years. Furthermore, data acquired in the ground activity have been compared with the multiple layers of data supplied by the Latium Region and local Farmer's Associations (meteorological, geological, chemical, hydrographical and agronomical data, land use) and analyzed by GIS software; digital maps have then been drawn. Results show a certain correlation between the incidence of the disease and the environmental conditions (relative humidity and temperature), exposure, the elevation of fields and soil characteristics. The infrared foliage emission was measured during the main phenological phases of the culture, using a portable spectroradiometer GER 3700 in the field, on both healthy plants and diseased ones, then by flight with an Advanced Spectroscopic Imaging System (A.Sp.I.S) assembled on an airplane. The site monitoring will continue, in association with aerial photos taken over the whole territory.

EFFICIENCY OF PESTICIDES AGAINST BIG BUD MITES [*Phytoptus avellanae* NAL. AND *Cecidophyopsis vermiformis* NAL. (ACARINA: ERIOPHYOIDEA)] ON HAZELNUT

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Big bud mites, including *Phytoptus avellanae* Nal. and *Cecidophyopsis vermifomis* Nal., are important pests in hazelnut (*Corylus avellana* L.) orchards, causing significant yield loss. Two of the most important aspects of management of these mites are the determination of effective pesticides and the proper timing of their application. Both these aspects were studied in the Samsun province of the Black Sea region of Turkey. Two field trials were conducted using randomised complete block design experiments over the 3-year period of 1994-97. The migration period of the mites (April-May), which is the most important period for spreading of infestation, was covered each year. In experiment 1, from 1994-1996, nine pesticides (Sulphur WP, Azinphos-methyl EC, Azinphos-methyl WP, Dimethoate EC, Bromopropylate EC, Amitraz EC, Quinomethionate WP, Carbosulfan EC and Methidathion EC) were evaluated at their registered application rates for their effectiveness as alternatives to the standard pesticide Endosulfan EC, for control of both big bud mites. Experiment 2 was undertaken during 1997, when the most appropriate time of application was determined for both Sulphur WP - the most effective pesticide evaluated during experiment 1 - and the standard pesticide Endosulfan EC, with a control included. The criterion for assessment in both experiments was comparison of the number of big buds before and after treatment. Data obtained from both experiments were analysed using the Henderson-Tilton formula. Results from the first experiment indicated that Sulphur 80 % WP was as effective for the control of big bud mites (83.25% at 400g/100L) as the standard pesticide, Endosulfan 35 % EC (83.35% at 250cc/100L). The second experiment demonstrated that a single application of Sulphur or Endosulfan at the end of April or beginning of May, before the peak period of migration of the mites from infested buds to new auxillary buds, was very effective in keeping the mite and big bud numbers low.

Balaninus nucum: ECONOMIC ASPECTS RELATING TO THIS PEST AND OPTIONS FOR BIOLOGICAL CONTROL

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In recent times, *Balaninus nucum* has become the most important pest associated with hazelnut production. This paper reviews its economic impact at several different levels, ranging from field production to the food processing industry.
The conventional method for controlling this pest involves the use of chemical insecticides, but this entails substantial environmental and safety problems. Other control systems involve the use of alternative techniques: the selection of resistant trees; the use of genetically modified plants; the use of semi-chemicals, including mass trapping and sex confusion and that of micro-organisms and enthomopathogenic nematodes. Each of the mentioned techniques was evaluated in term of its potential success. All of the foreseeable strategies require the use of decision support devices capable of capturing environmental, agronomical and biological data that can be incorporated into computerised models. For such systems to be effective and economic, producers need to establish contacts with research organisations on a regional level, especially where research organisations and/or extension/plant protection services and other producer-related services are concerned.

BIOLOGICAL CONTROL OF HAZELNUT WEEVIL (*Cucurlio nucum* L., COLEOPTERA, CURCULIONIDAE) WITH THE ENTOMOPATHOGEN FUNGUS *Beauveria bassiana* (BALSAMO) VUILL. (DEUTEROMYCOTINA, HYPHOMYCETES)

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The need for biological control of the phytophagous insect has led researchers to the possibility of using microorganisms in open fields for the management of insect pests by taking advantage of their natural abilities to control pests. On the basis of these considerations, we decided to test, in cages on the field, the effectiveness of a commercial product made of *Beauveria bassiana* (Bals.) against the key hazelnut pest *Curculio nucum* L. Trials were carried out in a hazelnut orchard in the province of Viterbo (Italy). Three untreated control cages and three cages treated with the entomopathogens fungus were used during the tests. The cages were placed under the canopy of the hazelnut and buried up to half of their height. 200 mature *C. nucum* larvae were placed in each cage and allowed to bury themselves naturally. After burying, treatment with a commercial product was carried out on the three treated cages. Mortality was monitored during the following spring. The treated cages showed 99.5 % of *C. nucum* mortality in comparison with 64.0 % for the untreated cages. The data show the high effectiveness of the biological control of *B. bassiana* on the key insect pests on hazelnut trees in central Italy.

BIOLOGICAL AND MORPHOLOGICAL STUDIES ON NUT WEEVIL (*Curculio nucum* L. COL., CURCULIONIDAE)

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Nut weevil (*C. nucum*) is the main pest in Turkish hazelnut orchards as in most other countries. This insect seriously affects nut production as a direct pest. In this research, some biological and morphological characteristics of insects and damage were investigated in three provinces in 2000 and 2001. Biological features such as adult longevity, preovipositional period, oviposition behaviour, damage types, distribution of biological stages, density and population fluctuations were determined in addition to some morphological characteristics of different biological stages and sex. It was observed that adults fed on leaves, female flowers and developing fruits in the early season. Damage to leaves was not serious but significant injury due to feeding on flowers and immature nuts was observed. Dropping of flowers and immature nuts dependent on insect feeding was determined. This kind of damage was as important as that made at a larval stage.

ALYCINA AND EUPODINA MITES IN HAZELNUT ORCHARDS IN TURKEY

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Between 1991 and 1999, mites were surveyed in hazelnut orchards throughout the growing areas in the Black Sea region of Turkey, focusing on the coastal plain. Plant samples, with a minimum of five shoots per orchard, were collected and examined, including the upper and lower leaf surfaces, petioles, buds, shoots, flowers and big buds. The mites found were preserved in ethyl alcohol, mounted in Hoyer's medium and identified. Samples of leaf litter were also collected from the orchards and beneath surrounding hedge plants during the winter. Mites were extracted from these samples with Berlese funnels. Fourteen mite species from 5 families and 2 cohorts, namely *Bimichaelia grandis* Berlese, *Lorryia livshitzi* (Kuznetzov, 1974), *Lorryia obnoxia* (Kuznetzov et Zapletina), *Lorryia paraobliqua* Panou et Emmanouel, *Tydeus kochi* Oudemans, *Tydeus linarocatus* (Schiess), *Microtydeus beltrani* Baker, *Homeopronematus staerki* (Schruft), *Triophtydeus immanis* Kuznetzov, *Triophtydeus triophthalmus* (Oudemans), *Cyta grandjeani* Gomelauri, *Biscirus silvaticus* (Kramer), *Cunaxoides biscutum* Baker et Hoffman, *Cunaxoides parvus* (Ewing) were found in this study.

MICROLEPIDOPTERAN HAZELNUT PESTS IN POLAND

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The list of insects and mites associated with hazelnut shrubs is extremely long but only a few of them are harmful, the remaining ones being either beneficial or incidental. The pest incidence and importance has changed in time as well as the cultural practices used in the orchards. Some of the pest problems are primarily induced by the use of insecticides. In orchards where no chemical treatments and horticulture techniques are applied some pests like microlepidopteran species can have economic significance. The aim of this research was to establish the species composition of microlepidopteran occurring in two ecosystems formed by man to various degrees. Data were gathered in ten-day intervals during three growing seasons (1998-2000) in two ecosystems: a protected hazelnut orchard and an unprotected one. Six microlepidopteran species were found: *Stigmella microtheriella* and *S. floslactella* from the Nepticulidae family, Parornix avellanella, *Phyllonorycter coryli* and *P. nicelli* from the Gracillaridae family and Coleophora seratella from the *Coleophoridae* family. The main factor affecting the occurrence of microlepidopteran species feeding on hazelnuts with respect only to quantitative composition was the type of environment with different chemical treatments. The differences in species composition of microlepidopteran between two studied orchards were not confirmedaffirmed. Species from *Phyllonorycter* genus were dominant in both orchards, whereas *S. floslactella* and *C. seratella* occurred in the smallest number. Giving up suitable chemical pest control and horticultural techniques resulted in an increase in the number of microlepidopteran species. Their maximum numberwas observed in September, which probably had no influence on hazelnut yield.

SEXUAL DISRUPTION AS A METHOD OF FIGHTING AGAINST THE LEOPARD MOTH (*Zeuzera pyrina*) IN HAZELNUT TREES

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Fighting the hazelnut leopard moth by means of sexual disruption was assayed in Tarragona in 2002 by technicians from both the Health Vegetables Service from the Generalitat of Catalonia and from several Plant Protection Groups. Trials were carried out in a central 5 ha hazelnut orchard which belongs to a larger 10 ha farm in Vilallonga del Camp (Tarragona). The efficacy of sexual disruption was evaluated by comparing the percentage of trees with active galleries, before placing the diffusers one year later. The results were very interesting and active galleries dropped from 11.12 % to 0.95 % when sexual disruption was used. A new trial in a larger 40 ha orchard began in 2003 in order to confirm the viability of this method.

USE OF "AKACID" IN HAZELNUT PLANTATIONS

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"Akacid" is a modern biocide and disinfectant, produced in Austria, which is already established in numerous applications. It is a macromolecular, cationic polymer, which is produced in a special patented and highly developed polymerisation process. "Akacid" is not toxic in any kind of higher life forms (mankind and mammalians).
As it has a very good effect against all kind of bacteria, viruses and fungi it is used in the disinfection of clinic areas.
Due to this effect the idea was born to test this substance as a plantprotectant, especially for hazelnuts.
The company "VitroPlant" started series of different tests with "Akacid" concerning plant compatibility, the fungicidal, antibacterial and insecticidal effects of this agent.
Greenhouse-tests with different agricultural and ornamental plants showed up a good plant compatibility.
Tests in the lab showed good results against bacteria and fungi like *Pseudomonas*, *Aspergillus*, *Rhizoctonia solani*, *Botrytis cinerea*, *Sclerotinia sclerotiorum* or *Fusarium oxysporum*.
An insecticidal effect against *Tyrophagus*-mites and spider mites was demonstrated in the lab and in greenhouses.
Currently field tests with hazelnuts are done, where "Akacid" is used as a preventive against bacteria and fungi.
As "Akacid" showed very good results against *Mycosphaerella fijiensis*, it might be possible, that it also has an effect on Eastern Filbert blight, which is similar in its development.
Due to these results cooperation with colleagues from the U.S.A. seems to be very interesting.

BIO-ETHOLOGY OF *anisandrus dispar* F. AND ITS POSSIBLE INVOLVEMENT IN DIEBACK (MORIA) DISEASES OF HAZELNUT (*corylus avellana* l.) PLANTS IN CENTRAL ITALY.

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Hazelnut is one of the most important orchards in central Italy (province of Viterbo) for its quality and production. More than eighty phytophagous insect pests are dangerous in hazelnut orchards, but only few of them, as *Anisandrus dispar* F. (Coleoptera, Scolytidae), can induce severe damages. Moreover, a bacterial disease (called moria) is one of the main phytopathological problems of hazelnut plants in central Italy. Two years ago, a Regional (Latium) financial support allowed to develop a research on the bio-ethology of *A. dispar* and its possible involvement on spreading of the moria disease on hazelnut plants in the province of Viterbo. In the seasons of 2003 and 2004 two experimental hazelnut areas were selected in Capranica and Caprarola districts (Viterbo), where eighteen chemio-chromotrophic traps were installed to study weekly the dynamic population of *A. dispar* females and to catch live Scolytidae females. Representative samples of live *A. dispar* females from each sampling were used to isolate and to identify the bacterial populations present outside and inside the insects. After two years 4.537 *A. dispar* females were caught. April and May resulted to be the months with the capture peaks of the adult Scolytidae. From more than 1.400 live *A. dispar* females, 10 % were submitted to microbiological analyses. Bacterial populations isolated from *A. dispar* were purified and identified by morphological, physiological, biochemical and molecular techniques. The populations of the micro-organisms mainly associated (outside and inside) with the phytophagous were identified as *Erwina billingae*, *Brenneria quercina*, *Pantoea cedenensis* and *Pseudomonas* spp. Studies are in progress to: ***i)*** clarify the biological cycle of *A. dispar*; ***ii)*** point out the role (direct and/or indirect) of the insect respect to the epidemiology of moria disease; ***iii)*** carry on pathogenicity tests on bacterial isolates to prove their involvement in the bacteriosis; ***iv)*** develop specific primers to identify the presence of these bacteria when associated with the insect and with asymptomatic hazelnut plants; ***v)*** verify the influence of environmental parameters on the biology of the insect and on the disease.

GRAY NECROSIS OF HAZELNUT

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In the early summer of 2000, a severe fruit drop was observed in several hazelnut (*Corylus avellana* L.) orchards located near Viterbo (Latium region, Italy), resulting in yield loss often exceeding 30 %. Dropped fruit showed a brown-greyish spot at the base of the nut which progressed into the fruit with discoloration of the pericarp and embryo tissues, also involving bracts. The severity of the fruit drop and the type of symptoms suggested more thorough research to understand the ethiology and epidemiology of the disease named gray necrosis (GN) on the basis of the symptoms. Moreover, the symptomatology of the GN differed from those currently reported on hazelnut fruit. The results of three-year investigations based on isolation from flowers and fruit and artificial inoculations led to a definition of the first picture of the fungal genera associated with the disease, which can be considered a disease complex. Fungal genera consistently isolated from the edge of GN lesions were *Alternaria* spp., *Colletotrichum* sp. *Fusarium* spp. and *Phomopsis* sp. Among *Fusarium* species, *F. lateritium* Nees was the most frequently isolated from both fruit and cankers on young shoots, whose occurrence seems to be closely associated to GN. Pathogenicity tests confirmed *F. lateritium* as the causal agent of "L" shaped cankers on twigs and shoots. There is some evidence that *F. lateritium* could be the primary agent of the disease. In addition, it is important to clarify the role of small-spored catenulate *Alternaria* taxa related to *A. alternata* (*A. alternata*, *A. arborescens*, *A. tenuissima*), as the pathogenic attitude, confirmed with artificial inoculations, could reveal new aspects of the ethiology and epidemiology of GN. The role and timing of the different fungi in causing GN is still a question under investigation.

CHARACTERIZATION OF BACTERIAL STRAINS ISOLATED FROM CANKERS AND EXUDATES ON HAZELNUT IN SARDINIA

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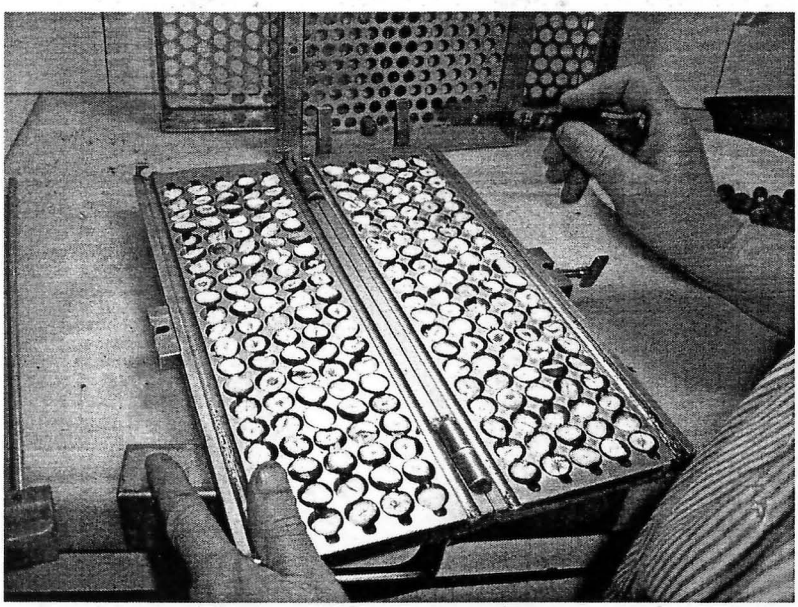
In the last three years several bacterial isolates have been obtained from cankers and exudates observed on 'Tonda Gentile delle Langhe' and 'Tonda Gentile Romana' hazelnut cultivars (*Corylus avellana* L.) cultivated in Sardinia (Italy). Ten representative isolates with fluorescent pigments on the medium B of King et al. (1954), hypersensitive reaction on tobacco leaves and variable levan production, were chosen for pathogenicity tests and serological and molecular characterization. All the isolates were pathogenic to hazelnut, bean, pepper, tomato and pear seedlings, albeit to differing extents. Eight out of ten caused watersoaking on bean pods, while they were weakly pathogenic on lemon fruits and young apricot, peach and walnut plants. No symptoms were observed on lilac and apple. All ten isolates were tested in ELISA. Six isolates reacted positively to an antiserum (NCPPB 381) against a *Pseudomonas syringae* type strain, while only five isolates reacted to an antiserum against *P. savastanoi pv. phaseolicola.* Repetitive PCR with ERIC and BOX primer sets showed that the isolates were different from *Pseudomonas avellanae*, *P. syringae pv. syringae* and *P. savastanoi pv. phaseolicola.* Biochemical and pathogenicity tests, molecular characterization and other comparative studies, showed the 10 isolates obtained in Sardinia belong to a new pathovar whose complete characterization is currently under way.

Session 6



Post Harvest and Quality

EFFECT OF CULTIVAR AND YEAR ON THE QUALITY OF HAZELNUT FRUITS (*Corylus avellana* L.)

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Several studies have shown that hazelnut consumption may play an important role in reducing human diseases, based on the levels of antioxidant compounds. Since cultivar and year are likely to influence nut composition, a study was designed to evaluate both the effect of the year (2001 and 2002) and the cultivar ('Ennis', 'Butler', 'Grossal', 'Segorbe', 'Merveille de Bollwiller' and 'Fertile de Coutard') on trees from an orchard located in Vila Real, in the north of Portugal. Nuts were evaluated for free α-amino acids, protein, total lipid, starch and fiber. Fruit, kernel and shell weight, blank occurrence, production and productivity were also determined. Free α-amino acids were quantified by HPLC. Crude protein (N x 6.25; CP) and crude fat (CF) were determined according to the procedures of AOAC (1990), neutral detergent fibre (NDF) was measured by the procedures of Van Soest et al (1992) and starch was measured by the Salomonsson et al. (1984) method.

Both cultivars and years induced significant differences ($P < 0.001$) in the content of the total aminoacids and in most of the individual aminoacids identified. Cv. 'Fertile de Coutard' showed the highest levels (4.60 mmol/100g DW) of total aminoacid whilst cv. 'Ennis' and 'Grossal' showed the lowest (1.99 and 2.04 mmol/100g DW, respectively). The levels of total aminoacids were consistently higher in 2001 than in 2002. Alanine was the major aminoacid identified on the six cultivars (70% of total) whilst methionine was the lowest (1.5% of total). There were significant differences ($P < 0.001$) in protein, total lipid, starch and fiber between cultivars but not between years. The highest value of protein was identified in cv. 'Merveille de Bollwiller' (17% DW) which showed the lowest fibre content (24% DW). The highest value of starch (2.4% DW) was presented by cv. 'Butler', the cv. 'Ennis' showed a highest amount of fiber (36% DW) and cv. 'Fertile de Coutard' the highest total of lipids (51% DW).

In relation to the physical parameters, cultivar and year had a significant influence on weight of fruit, kernel and shell ($P < 0.001$). Cv. 'Ennis' showed the highest values whilst cv. 'Grossal' showed the lowest. There were significant differences ($P < 0.001$) between the six cultivars and years in blank fruits production.

EFFECTS ON QUALITY AND SHELF LIFE OF HAZELNUTS BY DRYING THEM IN AN ELECTRICAL EQUIPMENT COFFERS SYSTEM

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This research was carried out at the Hazelnut Research Institute. The 'Tombul' hazelnut type, our standard hazelnut, which grows densely in the Black Sea region and has an important place in our country's economy, was used as material. In the case of storage, the hazelnut moisture ratio was to be 25-30 % in harvesting which was necessary for a 6 % decrease in hazelnut kernel moisture.

The results of drying with unnatural methods of hazelnut and storage for one year showed changes in yield. Drying was made at 30°C, 35°C and 40°C in hot weather in a drying machine. Drying hazelnuts in natural conditions was used for control. The drying machine was designed with a horizontal roller with 90 revolutions/hours. During the drying periods moisture percentage and electrical consumption were determined. One hour after removal from the yield the moisture ratio was 0.26 %, 0.35 % and 0.30 % at 30°C, 35°C and 40°C, electric consumption at 2.39 kW/hour, 3.33 kW/hour and 4.02 kW/hour.

Moisture samples were taken from the yield for three different periods in one year. In samples from the yield the amounts of oil content, free oil acids and hazelnut ashes were determined. No Aflatoxin B1 was found in the samples. Total aflatoxin (B1+B2+G1+G2) was to be found at more 0.4 ppb, this value was more decreased in determination limits.

VARIABILITY OF TOTAL FAT AND FATTY ACIDS IN NUT OIL OF *Gevuina avellana* CLONES

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The genetic and production improvement research programme of *Gevuina avellana* (Gevuin) , a native tree of Chile, has developed high productive and quality clones of edible nuts with interesting results in nut characteristics, yield, nutrition and phytotherapy purposes. The total fat and fatty acids, especially the monoinsaturated fatty acids, are very important in the antioxidant complex. During 2001 and 2002, nuts of nine selected clones were analyzed to know the lipid composition and variability among clones. After oil Soxhlet extraction, fatty acid methyl esters (FAME) were prepared by reacting the oil in n-hexane with a methanolic solution. FAME were determinated in a Hewlett Packard 5890 (II) with a flame ionization detector. Kernel oil significative differences among clones were found in total fat, total saturated fatty acids and unsaturated/saturated ratio. The major mean isomer amount was oleic fatty acid (C 18:1 Δ^9 = 35.32%). The hexadecenoic fatty acid (C 16:1) content was the only monounsaturated with significant differences among clones, with values ranging between 21.73 to 23.72 %. The highest clonal value of C 16:1 in 2001 was 24,38 %, with the following isomer proportion: Δ^{11} (23,83 %)· Δ^9 (0.50 %) and a third indeterminated (0.05 %). The total fat in the pericarp (shell) was much lower (0.91 %) than in cotyledons (46.67 %), with the fatty acids in different proportions than in kernel. Results were affected by water stress in the last two months of summer nut development (January - February), with important effects on total fat and total monounsaturated fatty acids, without variation in C 16:1 content. These results show the importance of clonal selection in Gevuin because there is evidence of genetic variation among clones in relation to content and quality of total fat and fatty acids in kernel oil.

KERNEL QUALITY AND COMPOSITION OF HAZELNUT (*Corylus avellana* L.) CULTIVARS

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Nut quality is the most important target for hazelnut growers. About 90 % of production is processed by the food industry. Nut quality is still identified in some morphological, physical and chemical traits requested by the industry. Recently, attention has shifted to the chemical composition and to its effect on taste, nutritional and health properties and the storability of nut and processed products. Research into kernel composition and the perceptional capacity of sensory attributes by consumers are therefore important for characterising the determinants of nut quality. Lipid content and profile affect the expression of organoleptic properties in roasted seeds and the resistance to oxidative processes. Minor components, such as polyphenols, sugars and organic acids, are thought to affect sensory attributes perceived by the consumer and to exert positive effects on human health. Nevertheless, their content and composition have not been thoroughly investigated. In order to characterize the influence of nut composition on quality, seventeen cultivars grown in Viterbo were analysed in 2000-01. Quantitative and qualitative determination of sugars, organic acids, lipids and vitamins was carried out. Total polyphenols in the pellicle and the seed were measured. The sensory profile of six cultivars ('Tonda Gentile delle Langhe', 'Tonda di Giffoni', 'Tonda Gentile Romana', 'Mortarella', 'Nocchione' and 'Tombul') was examined. Fatty acid composition and the level of tocopherolic and non-tocopherolic antioxidants confirmed the nutritional and dietetic value of the nuts. Polyphenols were mainly concentrated in the perisperm. Sensory analysis was able to reveal varietal differences for attributes related to taste and flavour. A positive relationship between sweetness scores and sugar concentration was observed.

NUTRITIONAL VALUE AND FATTY ACID COMPOSITION OF HAZELNUT VARIETIES HARVESTED IN PORTUGAL

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Nuts are an important part of the Mediterranean diet, which is regarded as healthy. There is a growing interest in evaluating the nut's role in a heart-healthy diet and several studies have been carried out supporting a role for nuts in reducing coronary heart disease risk. In fact, although total fat intake is certainly related to health risks, there is general agreement that the most important issue is the type of fatty acids which are consumed.
Hazelnuts are consumed as a fruit, as an ingredient in confectionery products and as raw materials for the pastry and chocolate industry. Nineteen hazelnut cultivars from the same orchard in Vila Real, Portugal, were studied. Chemical composition, including moisture, total oil content, crude protein, ash and carbohydrates and nutritional value were evaluated. Fatty acid composition was determined by gas-liquid chromatography coupled to a flame ionization detector. Total oil content ranged from 59.3 % in cv. 'Merveille de Bollwiller' and 69.0 % in cv. 'Negret'. Seventeen different fatty acids were identified and quantified. Mono-unsaturated fatty acids were the predominant group, with oleic acid being the major fatty acid in all cultivars, ranging from 76.71 % in cv. 'Gunslbert' to 82.81 % in cv. 'Campanica'. Hazelnuts present a favourable lipid profile that may possibly explain the attributed health benefits.

CHARACTERIZATION OF HAZELNUT VARIETIES BY TEXTURE ANALYSIS

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With the aim of identifying new parameters for the exploitation and protection of hazelnut products, a study was carried out on four varieties of hazelnut used for table consumption ('Barcelona', 'Ennis', 'Tonda Bianca' and 'Tonda Giffoni') and on five selections (B6, B59, C10, L35 and L39). To evaluate suitability for table use, the taste and aroma of the kernel are important but easy shell breaking could also be regarded as a good characteristic. Texture analysis was used to measure shell resistance to breakage using a TA.XT2i® Texture Analyser. A sample of 30 nuts of each variety was analysed on the three fruit dimensions (length, width and thickness). The following parameters were measured: hardness (force required to break shell) and hardness of work done (energy required to break shell), 1st fracture deformation (probe distance travelled to reach breaking force), 1st fracture % deformation (deformation divided by original sample height) and modulus of deformability (gradient curve between 20 and 80 % deformation prior to sample fracture). On the same fruits, shell thickness, nut and kernel weight and dimensions were also measured. Texture parameters can be successfully used to discriminate hazelnut varieties; in fact, the differences found among varieties are numerous and significant. Each variety showed the maximum value of hardness and work for one of the considered dimensions. For instance, as regards length dimension, hardness values vary from 769 N necessary to break 'Ennis' to 352 N to break L35, while the hardness of work done varies from 0.543 J of 'Tonda Bianca' to 0.263 J of L35. 1st fracture deformation and modulus of deformability gave interesting information about shell rigidity and fracturability. Among the morphological characteristics, shell thickness and shape index are related to texture parameters.

USE OF NIR TECHNIQUE TO MEASURE THE ACIDITY AND THE WATER CONTENT OF HAZELNUTS

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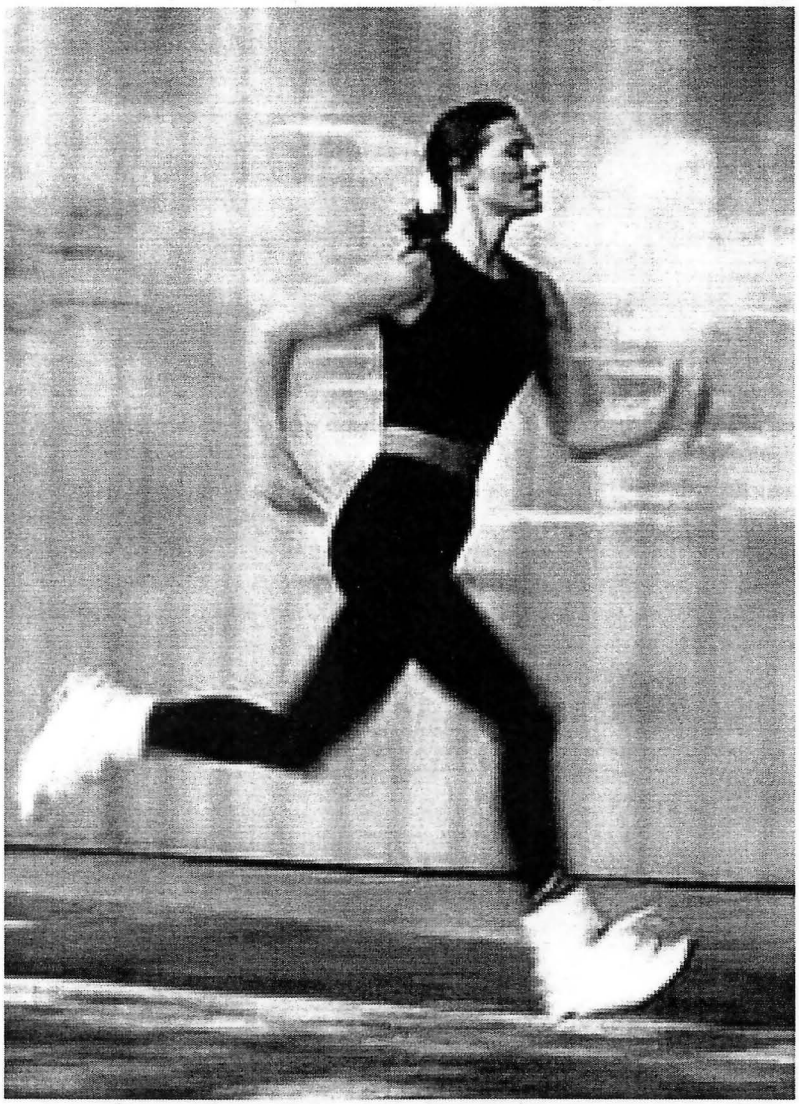
The sensorial and commercial quality of hazelnuts is affected by two main parameters: acidity and water content. NIR technology combined with appropriate chemiometric methodology is widely used for quality feature detection in several fruit species. No paper has been published on the application of this technology on hazelnuts. In this paper we present the data of experimental work carried out on hazelnuts with different proveniences ('Romana', 'Ackakoca', 'Mortarella', 'Azerbaijan') with the aim of applying this technique to measuring water content and acidity using efficient regression models. Hazelnuts were sorted on the basis of their geographic provenience, variety, size, water content, acidity and peroxides number. After this classification, the unshelled hazelnuts were used whole or ground to obtain the typical flour. Successively, the hazelnuts or flour were screened under different NIR. Spectral data and chemical data were used for the PLS regression model. For the hazelnut flour, a $R^2 = 0.901$ and 0.904 were obtained for water content and acidity respectively. For whole hazelnuts, the values were lower: $R^2 = 0.895$ and 0.880. Further development with the discriminant analysis (PLS-DA) permitted efficient discrimination (98 % of the initial classification) of the hazelnuts according to geographic provenience or variety.

Session 7



Health Benefits

HEALTH AND TREE NUTS

Fundació Nucis (Salut i Fruits Secs)
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As well as several observational studies, various dietetic intervention studies have been undertaken with tree nuts and demonstrate that the incorporation of tree nuts into the diet produces a reduction in cardiovascular risk factors such as cholesterol levels.
The beneficial effect that nuts have on cardiovascular health seems to be demonstrated: they reduce total cholesterol and LDL cholesterol levels, therefore very probably contributing to a reduction in the incidence and mortality of cardiovascular disease.
The protective mechanisms that nuts seem to have on cardiovascular health derive from their peculiar nutritive composition. Thus, their lipids profile, rich in mono and polyunsaturated fatty acids and poor in saturated fatty acids, is the main cause of the reduction in total cholesterol and LDL cholesterol levels produced by eating them and therefore in the reduction of the risk of coronary disease.
However, in the majority of studies, this reduction in risk goes further than expected, so that it seems evident that there are also other nutritive components in nuts which would have an effect on the level of the reduction of risk. Thus for example, their antioxidant content would protect the LDL particles from the oxidation which would be produced by the atherogenic process; arginine, by the production of nitric oxide, would be capable of reducing the adhesion and aggregation of the platelets; the omega 3 fatty acids would also reduce platelet aggregation; the dietetic fibre would contribute to the reduction in the levels of LDL cholesterol; and the folic acid content would favour good levels of homocisteine which also plays a preventive role in cardiovascular disease.

Session 8

Industry, Marketing and Economics

THE METHODS AND RESULTS OF THE OREGON AGRICULTURAL STATISTICS SERVICE. ANNUAL OBJECTIVE YIELD SURVEY OF OREGON HAZELNUT PRODUCTION

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According to an industry-wide tree survey conducted in 2000-2001, the hazelnut industry in Oregon currently has 29,140 acres (11,793 hectares) in production on 681 operations. The largest crop in the history of the industry was in 2001 at 49.500 tons (54,563 metric tons). Each year the Hazelnut Marketing Board (HMB) funds the Oregon field office of the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) to conduct an early season objective yield survey which is used to inform HMB marketing efforts. The results of the survey are released in the third week of August, and have an influence on the Hazelnut Growers Bargaining Association's negotiations of a minimum grower field price for the year. An objective yield survey consists of actual counts and measurements of tree characteristics in sample orchards by trained enumerators and laboratory analysis of picked green nuts. A sample of 180 randomly selected orchards is used in the survey, with two randomly selected trees per orchard. Half of each year's sample trees come from trees that were sampled the previous year. In April, before nut set, two primary scaffold branches per tree are marked for sampling. In the first week of August, all nuts from the sample scaffold branches are picked from the tree and sent to the laboratory for analysis. The husks are peeled and the nuts are cleaned and sorted into eight size groups. All of the sample nuts are cracked and weighed, with defective nuts being identified. The principle formula used to produce a total yield for the industry in Oregon is: production per tree X the total number of trees in production. The production per tree is the product of nuts picked per tree, average nut size and dry weight per good nut. The two major types of data expansions used to set the forecast number are direct expansion and linear regression expansion. A ratio expansion of the current year's direct expansion with those of the previous year for the same sample is also used. Over the years, the performance of the NASS objective yield survey has been remarkably accurate, with an average difference of only 6.3 % between predicted and actual yields. NASS releases the official production forecast for the Oregon hazelnut crop in August, with revisions, if necessary, issued the following June. The Hazelnut Marketing Board's final production totals are available in the spring following the harvest.

AN ECONOMETRIC MODEL FOR EVALUATING THE INTERNATIONAL HAZELNUT MARKET

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This work describes the results obtained when applying an econometric model containing simultaneous equations that describes the world market for hazelnuts and pays particular attention to the respective contributions of Turkish and Italian producers. The model includes three equations. The first equation describes Turkish hazelnut exports, while the second describes the influence of these exports on the international price of hazelnuts.
This first section of the model was developed dedicating particular attention to the role played by the system of public subsidies introduced by the Turkish Government in the last 20 years. In this proposal, particular attention was afforded to the role of market interventions by the organization Fiskobirlik. These appear to have exerted a considerable influence upon the price of Turkish hazelnuts and consequently also on international prices.
The third equation describes the impact of changes in international hazelnut prices on the market price for this product in Italy. This last relationship was particularly modelled to investigate the variables influencing the price of 'Tonda Gentile Romana'; the most widespread hazelnut cultivar in the Viterbo production region.
The model was also used for forecasting purposes. It made it possible to estimate the possible impact of different scenarios upon prices and exports. One of the scenarios was based on the hypothesis that Turkish policy for reducing the area of hazelnut cultivation would prove successful.

FARMERS' ATTITUDES TOWARDS THE LIMITATION OF HAZELNUT AREAS IN TURKEY

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The price support policy for hazelnut production resulted in over-production in Turkey. The government therefore passed a regulation (No: 2844 in 1983) to limit the total plantation area. Briefly stated, the regulation offered financial compensation (2000 USD per hectare) for uprooting hazelnut orchards on flat areas and provided support to growers for planting alternative crops. However, the regulation was not effective throughout the country due to the lack of participation by farmers. A review of the relevant literature shows that no previous research was conducted to predict the reaction of the hazelnut growers to the limitations placed on the hazelnut growing areas. The main focus of this study was to identify farmers' reactions towards the limitation of hazelnut growing areas in Turkey. Farmers' awareness of and reasons for the policy for limiting hazelnut growing areas and their perception of alternative crops to hazelnut were both examined. The study revealed that most growers received insufficient information about the policy and its application. They were also unable to fully comprehend the reasons for limiting hazelnut areas. This was mainly due to deficiencies in the campaign for announcing the policy to growers. The main obstacle to growers uprooting their orchards was the low level of compensation offered to them. The effects of previous price support policies, farmers' established habits and their expectations were other barriers that effectively limited the applicability of the policy. The findings of this study could be used by policy makers, extension services and farmers' organisations to improve the development and implementation of hazelnut growing policy in Turkey.

TOTAL INFORMATION SYSTEM AND NETWORKS OF ORGANIC AND CONVENTIONAL HAZELNUT GROWERS IN TURKEY

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This paper examines the structure and functions of agricultural information systems for organic and conventional hazelnut growers in Turkey. These were analysed and compared in order to identify the problems affecting the systems and to improve their performance. The information systems examined were complex and involved both personal and institutional sources. Although most of the sources were common to both kinds of producer, organic growers had exclusive information sources (i.e. the organic marketing company's project manager, the merchant and the certification inspector). The information systems used by the professional staff who support both groups of hazelnut growers were subsequently examined. The information systems of the professional staff were then combined with those of organic and conventional hazelnut growers in order to constitute a total information system and show its communication networks. The main function of the total system was the generation and dissemination of hazelnut-related information. The results of the study showed that the system mainly served for buying organic hazelnuts from organic growers and for exporting them, rather than for developing an organic industry as a serious alternative to conventional production in Turkey.

REFORM OF HAZELNUT POLICY IN TURKEY

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Turkey is the largest hazelnut producer and exporter in the world. The hazelnut policy applied by Turkey therefore has a major influence upon the world hazelnut market. The price support policy resulted in increases in plantation areas and production, but hazelnut consumption and exports did not increase in line with production. Turkey therefore generated a production surplus of about 100.000 tons of hazelnut (in-shell) per year. "Law 2844" of 1983 was issued in order to decrease the surplus of hazelnut in the market. The aims of the law were to limit the cultivation of hazelnuts in particular areas and to adapt the volume of supply to market requirements. The Turkish Government has recently provided once off compensation of US $ 2.000 per hectare to farmers who voluntarily uproot their hazelnut orchards in the regulated (mainly flat) areas. The Government has also stopped giving financial support to the Union of Hazelnut Sales Cooperatives (FISKOBIRLIK) since 2000. Thus, the effects of FISKOBIRLIK in the domestic market has limited. This will also have an effect on the world hazelnut market. This paper will present these reforms, their effects and possible recommendations about Turkish hazelnut policy.

THE PRODUCTION AND MARKETING OF ORGANIC HAZELNUTS: THE CASE OF 'TONDA GENTILE ROMANA'

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Organic farming can no longer be considered a niche of the agrifood sector. Organic production has now gained widespread attention and acceptance. In the last ten years the number of organic farms and the organically cultivated land have dramatically increased and the market share of organic products has shown a similar trend.
In Europe this growth has had two main causes: economic support via the Common Agricultural Policy and the "premium price" paid for the superior quality and health-related properties of organic foods. Hazelnuts are fully experiencing this situation and interest in organic hazelnuts is rapidly increasing amongst producers, processing firms and consumers.
Italy is a country in which the organic farming has a large diffusion. In 2000, there were about 50,000 organic farms in Italy (2% of the total) with a cultivated land of 850,000 ha (almost 5% of the total). A similar situation was observed for hazelnut cultivation at both the national level and in individual producing areas.
An analysis of the organic hazelnut sector was carried out which particularly focused on the Monti Cimini area (the main area of cultivation for 'Tonda gentile Romana'). In this area, which accounts for about 4-5% of world hazelnut production, the share of organically cultivated land is close to 7%.
The analysis focused on several different factors: technical and economic questions at the farm level; the evolution of prices; the state and future perspectives of the market. The results of the study, which will be presented in the paper, have increased our knowledge of the organic hazelnut sector not only at the local level but also within the international framework.

THE IMPACT OF THE MEDIUM TERM REFORM (MTR) ON HAZELNUT FARM INCOME AND PROFITABILITY IN AN IMPORTANT CULTIVATION AREA IN ITALY

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The paper focuses on the possible impact of the MTR on the most representative farm typologies of hazelnut cultivation in the Viterbo province; one of the main hazelnut producing areas in Italy. The structural and technical characteristics of these typologies were defined using field survey data, information extracted from the latest agricultural census and structural data about farms forming part of the Associations of Producers.
Budget and profitability analyses were then conducted for these representative farm typologies. This task was performed considering input and output prices and the support system of the Common Agricultural Policy (CAP) for the hazelnut sector in the most recent production campaign.
Simulations were then carried out changing the CAP support system for the hazelnut sector, according to what was considered in the MTR. The impact on income level and on net return indexes was then estimated for the representative farms. Simulations were also conducted considering several alternative scenarios characterized by different levels of hazelnut price and the application of certain regional taxes. This made it possible to estimate the impact of the MTR on different farm typologies and to identify cases capable of enduring the greater effects resulting from the reform of the old CAP hazelnut support system.

HOW CULTIVAR CHOICE AFFECTS SPANISH CONSUMERS' ACCEPTANCE OF CHOCOLATES, BONBONS AND HARD TURRON MADE WITH HAZELNUTS

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The aim of this work was to evaluate consumer acceptance of several industrial products made with commercial hazelnut cultivars ('Negret', 'Pauetet', 'Tonda di Giffoni' and 'Tomboul'). Five different products were tested between 1999 and 2001: chocolates (dark, brown and white chocolate blended with toasted kernels), bonbons (toasted kernels enrobed with burnt sugar and coated with dark chocolate) and hard turrons (toasted kernels blended with sugar and honey). Samples were coded and submitted to 650 consumers around Catalonia (NE Spain), who valued them according to a structured scale ranging from 1 (do not like at all) to 7 (very good).
Results showed that each cultivar adapted in a different way to a particular industrial product, according to its physical and chemical characteristics. Consumers also preferred different cultivars for different products. Chocolates made with 'Negret' and 'Pauetet' were better accepted than those made with 'Tonda Giffoni', although no significant differences in consumers' acceptance were observed between varieties when toasted kernels were enrobed with burnt sugar and coated with dark chocolate to make bonbons. Hard turrons made with 'Negret' and 'Tomboul' were better accepted than those made with 'Pauetet'. These results confirm the great importance of hazelnut cultivar choice when making certain specific industrial products that are well accepted by consumers. It also demonstrates the overall good acceptance of the native variety 'Negret' for many industrial specialties.

HAZELNUT PRODUCTIVITY IN NORTHERN PORTUGAL: AN ECONOMETRIC APPROACH

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Several commercial hazelnut cultivars located in northern Portugal were evaluated for growth and nut production from 1980 onwards. In a multistemmed trial containing eleven cultivars, fruit production only became significant in the 6th year, when trees produced about 1.59 t/ha. Plant growth was very varied: the smallest bushes were 'Daviana' and 'Longue d'Espagne', which can be cultivated at 6 x 4 m under local conditions. The most vigorous cultivars were 'Segorbe' and 'Fertile de Coutard' which require larger spacings of around 8 x 6 m. In this paper, we apply the Hodrick-Prescott filter to decompose the annual production of the eleven cultivars into their respective trend (long-run yield) and cycle (fluctuations around the trend) components for the 1985-2001 period. The results suggest that the eleven cultivars could be classified into four groups: a 1st group that clusters the 6 most productive cultivars: 'Butler', 'Fertile de Coutard', 'Morell', 'Segorbe' 'Gunslebert' and 'Ronde du Piemont'; a 2nd that groups the medium-productive 'Grossal', 'Longue d'Espagne' and 'Merveille de Bollwiller'; a 3rd represented by the cultivar 'Ennis', evidencing a precocious decline in production, which may be a sign of a lack of adaptation to local conditions; and a 4th, occupied by the pollinizer 'Daviana', which demonstrates a low rate of production and a marked cyclicity. The cyclical variation may have been due to variations in climatic conditions during the pollination periods, which may also have caused different rates of blanks.

METAL ION UPTAKE FROM AQUEUS SOLUTIONS BY HAZELNUT SHELL AND KERNEL PELLICLE

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Shell and pellicle are waste products associated with shelling and pellicle removal in hazelnut production: they are mainly used as a solid fuel. Due to their metal ion adsorbing capacity, these abundant agricultural by-products could serve as cheap sorbents for removing heavy metals from industrial wastewaters and effective substitutes for traditional chemical treatments: using them in this way would help to reduce the manufacturing costs of the hazelnut industry. This work reports on laboratory tests carried out in order to evaluate both the adsorption of selected metal ions by hazelnut shell and pellicle and the recovery of the adsorbed ions.

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