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7th International congress on hazelnut

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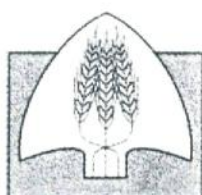
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Monti Cimini

Vignanello (VT)
nociole tonda gentile romana

BOOK OF ABSTRACTS

edited by

Barbara Pancino and Valerio Cristofori

7th International Congress on Hazelnut

Organised by

Centro Studi e Ricerche sul Nocciolo (Hazelnut Research Center)

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International Society for Horticultural Science (ISHS)

WELCOME TO THE 7TH INTERNATIONAL CONGRESS ON HAZELNUT
Viterbo, Italy 23rd-27th June, 2008

We are pleased to welcome all participants to the 7th International Congress on Hazelnut. After 4 years since the last Congress in Tarragona, we meet again to discuss the results of our studies and to share our knowledge and experience about hazelnuts, our common subject of interest and research.

The International Congress on Hazelnut has now a long story. The first two congresses were held in Reus, Spain (1976) and Avellino, Italy (1983); since 1992 a 4-year schedule was established and the congress was hosted in Alba, Italy (1992), Ordu, Turkey (1996), Corvallis, USA (2000), Tarragona-Reus, Spain (2004) and now we are in Viterbo, Italy.

Viterbo, the official site of the 2008 edition of the congress, is located nearby the Monti Cimini, the core of one of the principal hazelnut production areas of the world. In an area of 33,000 ha, there are over 9,000 farms that produce hazelnuts "Tonda Gentile Romana" covering approximately 18,000 ha and giving an average year production of 40,000 tons (about 5% of the world's production). The high productive specialization has contributed to the creation of a very dynamic sector, where several hazelnut farmer associations, as well as firms specialized in assembling specific harvesting machines or in processing and marketing, are present.

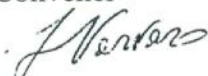
The productive, technical and market context of the hazelnut sector is rapidly changing. This situation suggests the opportunity to establish tighter relations among researchers and experts of the different countries. The 7th Congress on Hazelnut aims to contribute to this purpose. The scientific communications, the technical tours and the round table, focused on innovation and market topics, even with their informal and convivial moments, give an opportunity to discuss about the state of the art and the possible development of the hazelnut sector.

The high number of participants (over 150), coming from about 20 different countries representing all 5 continents, proves the interest and the relevance of this meeting.

The congress is organized by the Hazelnut Research Center together with ISHS, Università della Tuscia and CeFAS and supported by many public institutions, as well as by private local companies. We would like to thank all of them for their contribution to the success of this event.

We hope that all participants will have an exciting congress and will enjoy these days in the old city of Viterbo and in the region of Tuscia Viterbese, which is full of history, culture and attractive landscapes.

Leonardo Varvaro
Convener



Silvio Franco
Scientific Secretariat



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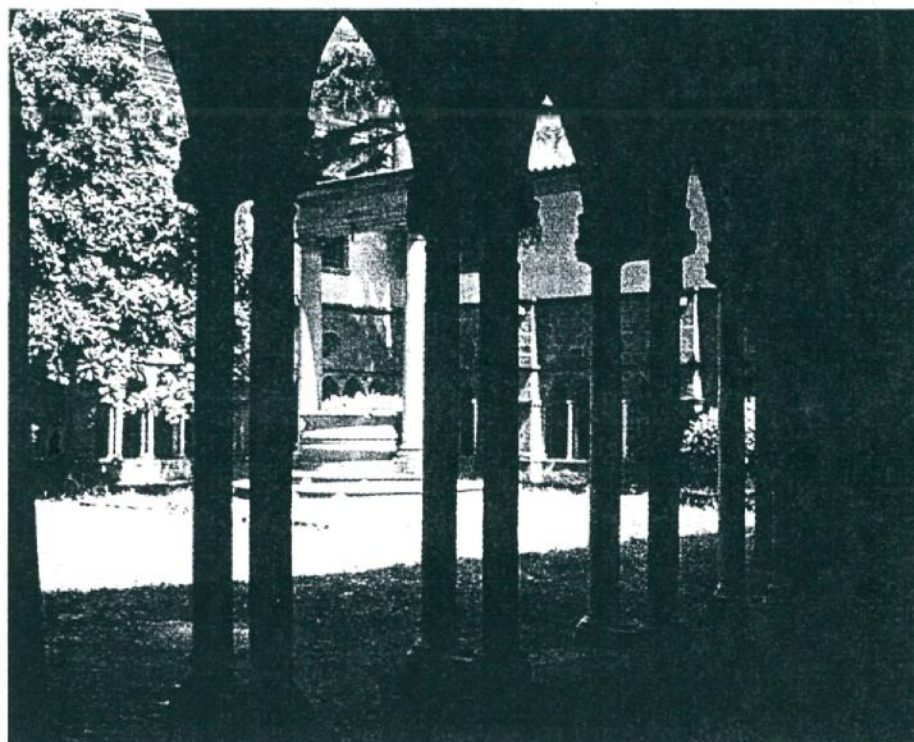
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GENETIC RESOURCES FOR HAZELNUT: STATE OF THE ART AND FUTURE PERSPECTIVES

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Keywords: *Corylus*, filbert, breeding, germplasm characterization

Abstract

World production of the European hazelnut (*Corylus avellana* L.) is based primarily on selections from the wild. Breeding programs are developing new cultivars for the kernel and in-shell markets, but efforts are limited. To date, the hazelnut breeding program at Oregon State University has released six cultivars, eight pollinizers, and two ornamentals. Micropropagation allows routine, rapid multiplication of new cultivars. *C. avellana* is highly polymorphic, and cultivars have been collected and preserved in several genebanks. Collections in Corvallis house more than 900 accessions of *Corylus*, of which 500 are *C. avellana*. Recent introductions include germplasm from Turkey, Georgia, Azerbaijan, Armenia, southern Russia, and Serbia. Of more than 500 known cultivars, only about 15 are worthy of consideration for commercial production. Apple mosaic virus is common in cultivars from some regions, but infected trees often show no symptoms. Very strict plant quarantine regulations designed to prevent the spread of eastern filbert blight also prevent the sharing of improved cultivars. Genetic studies have identified several simply inherited traits. Most economically important traits are quantitative with moderate to high heritabilities. Climatic adaptation is rarely a concern in the major production areas, but expansion of hazelnut plantings into marginal areas will require the development of adapted cultivars from diverse germplasm and identification of suitable pollinizers. Genetic diversity in other species will be useful in breeding efforts for marginal areas. Studies at the DNA level have been useful in clarifying the taxonomy of *Corylus* and related genera. More than 150 microsatellite markers have been developed and placed on the linkage map where they serve as anchor loci, and many also amplify *Betula*. Characterization with microsatellite markers showed that 72 of 270 accessions in the Corvallis collections were duplicates, and assigned most accessions to one of four major geographic groups: Central European, Black Sea, English and Spanish-Italian. Eastern filbert blight caused by *Anisogramma anomala* is a major concern in North America. Several sources with high levels of resistance have been identified and are being used in breeding, with selection facilitated by DNA markers. A bacterial artificial chromosome (BAC) library will allow map-based cloning of important genes, including eastern filbert blight resistance from 'Gasaway' and the S-locus that controls pollen-stigma incompatibility. Public databases now include very few *Corylus* sequences. EST sequences from genera in the Order Fagales may be useful for studies in *Corylus*, as synteny of the genomes is expected. Hazelnut is amenable to *Agrobacterium*-mediated transformation, with regeneration most successful if explants are from germinating seeds or very young seedlings.

WORLD HAZELNUT SITUATION AND PERSPECTIVES

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Keywords: *Corylus*, production, orchard managementAbstract

The official statistics of FAO classify 32 countries as hazelnut producers; ten years ago, in 1997, only 15 countries were listed as hazelnut producers. In the meantime, the total production has increased from 617,000 t to 960,000 t (year 2006). Asia, as a continent, has increased it more than Europe (+ 64.7% and + 40.6% respectively).

In spite of the increasing number of producing countries, the hazelnut crop is still concentrated in two Mediterranean countries: Turkey and Italy, covering together 83.5% of the world production. Other countries of a certain importance are the USA (4.3%), Spain (2.6%) Iran (1.9%), and China (1.5%).

The varieties are very traditional, and have remained unchanged for a long time; therefore, waiting for new improved cultivars, the progress of the industry is related mainly to the orchard management techniques.

One of the problems when growing hazelnut is the suckering, which varies from cultivar to cultivar but needs to be kept under control always, with two negative consequences: increase in costs and increase in the spreading of diseases such as the bacterium *P. avellanae*, which causes serious damage in the Mediterranean countries.

The selection and use of non-suckering rootstocks (*C. colurna*) proved to be a solution in the Balkanian countries.

In order to reduce the initial low cropping of new orchards, the tendency to increase the plant density has been proved to be positive. The multisystem bush is the most common training system; in recent plantings, the open vase and also the hedge row (V-shape hedge) are also adopted.

The mineral fertilization has been the object of a wide research activity; according to the majority of the authors, the leave content of a tree in good conditions at the end of July should be 2.2% of the dry matter for N, 0.18% for P, 0.9% for K and 0.24% for Mg.

The spreading of the industry out of the traditional areas, the necessity to increase the productivity, and the climatic change have increased the irrigation need and the related research. A rainfall of 800 mm/year, well distributed during all seasons, is needed for a good hazelnut growing and production.

In recent years, a lot of work has been done to improve the mechanical harvesting and 3 main systems can be distinguished: a) harvesting by metallic brooms or blower followed by mechanical soil cleaning, which is used in mountain areas of Tarragona (Spain) and Italy, b) harvesting by vacuum machine used in flat areas of Spain and Italy, c) harvesting by sweepers and pickup machine, which is utilized in big orchards in Oregon (USA) and France.

Important progress has been achieved as far as the storage of the nuts is concerned, by combining temperature (<10°C) and CA (oxygen below 2-3%).

ORAL SESSION N.1

Germplasm and Genetic Improvement



Chairman: *Pablo Grau*

FIRST RESULTS OF 'SAFENUT': A EUROPEAN PROJECT FOR THE PRESERVATION AND UTILIZATION OF HAZELNUT LOCAL GENETIC RESOURCES

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Keywords: *Corylus avellana* L., germplasm, endangered genotypes, traditional knowledge

Abstract

Within the Council Regulation (EC) N. 870/2004 AGRI GEN RES, which established a Community programme on the conservation, characterisation and utilization of genetic resources in agriculture, the project 'SAFENUT', that stands for: 'Safeguard of almond and hazelnut genetic resources from traditional uses to modern agroindustrial opportunities', represents an example of a resourceful strategy for re-organizing and sharing in a more efficient manner the genetic resources, upgrading the knowledge on their value and uses. One of the main objective of the project is the centralization of available hazelnut germplasm, harmonizing the standard descriptors for a common characterization of cultivars. By addressing genetic resources collected in typical areas of cultivation, less known local varieties, or underutilized genotypes present in marginal areas, this project could represent an important step towards the characterization, documentation and management of *Corylus avellana* genetic resources in the Mediterranean Basin. This includes the creation of a core collection and gene banks. In order to share and spread all the related information, the final goal is to set up a European virtual inventory linked to the main other important databases. The gathered information will also be used to promote a wider application of traditional knowledge, agricultural practices, as well as to raise stakeholder awareness on the values of biodiversity components from the biological, economical and socio-cultural perspective. The project benefits from the participation of 11 partners from 6 European Countries including the ONGs Lega Ambiente and Farmer's Association. The present work summarizes the main actions and the first-year-results which focused on the centralization and harmonization of hazelnut germplasm with the establishment of the specific morphological descriptors. A survey was performed in different areas of traditional cultivation and novel ecotypes were pre-selected. In the frame of the biochemical evaluation, 60 varieties were analysed for oil, tocopherol, phenolic and mineral content of the kernel. These results showed great health and technological interest in defining the use of nuts. SSR markers were used for characterized germplasm and find mistakes and synonymus/homonimys cases in the collections. Concerning traditional knowledge a review on the existing hazelnut exhibitions were carried out and questionnaires were designed with the aim to recover historical memories from students and to compare agricultural techniques and importance of crops in landscape among the Partner Countries.

CLONAL SELECTION OF PALAZ HAZELNUT CULTIVAR
IN THE UNYE DISTRICT OF ORDU PROVINCE

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Keywords: hazelnut, Palaz, clonal selection, pomology

Abstract

This research was conducted to select Palaz clones which carried out select on the highest character clones of the Palaz hazelnut cultivar grown in villages of the Unye district of the Ordu province in 2005-2006. In this research, 56 and 46 Palaz hazelnut clones were investigated in 2005 and 2006, respectively. The 18 clones from the first year were also investigated during the second year. Totally, 84 clones were investigated. The results of the study were evaluated with the 'Weight Ranked Method'.

At the end of the evaluation 52Ü05, 52Ü55, 52Ü17, 52Ü82, 52Ü81, 52Ü43, 52Ü44 and 52Ü61 hazelnut genotypes were selected and measured according to nut weight: 2.13, 2.14, 2.20, 2.22, 2.27, 2.16, 2.13g and 2.17; kernel weight: 1.15, 1.17, 1.18, 1.18, 1.21, 1.18, 1.14 and 1.18g; kernel percentage: 53.98, 54.38, 52.10, 52.63, 53.23, 53.25, 53.12 and 54.37%; shell thickness 1.06, 1.02, 1.10, 0.99, 1.03, 0.98, 1.04 and 1.12mm; nut size: 17.44, 17.33, 17.70, 17.77, 17.73, 17.35, 17.29 and 17.44mm; marketable kernel: 79.59, 83.51, 82.70, 86.52, 92.56, 80.40, 84.15 and 86.55%; pellicle removal: 80.11, 85.74, 94.96, 50.25, 92.63, 77.11, 80.25 and 80.00%, respectively. The least fibrous were taken from 52Ü43 and 52Ü55 clones.

INVESTIGATION OF THE POMOLOGICAL CHARACTERISTICS OF SELECTED TOMBUL
HAZELNUT CLONES IN THE BULANCAK AREA OF THE PROVINCE OF GİRESUN

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Keywords: hazelnut, Tombul, selection, pomology, clone

Abstract

This study was carried out to determine some nut and kernel characteristics of clones of Tombul hazelnut cultivars grown in villages of Bulançak in the province of Giresun in the year 2005-2006. The clones had nut weight between 1.76-2.40g, kernel weight between 0.95-1.16g, shell thickness between 0.67-1.20mm, nut number per cluster between 3.08-4.15 number/cluster, nut size between 16.34-18.57mm, kernel size between 12.86-13.62mm, and kernel cavity between 1.54-2.69mm. The study found that nut number per cluster increased as nut size and shell thickness decreased but kernel percentage increased. In connection with the decrease of nut number per cluster, nut size and shell thickness increased but kernel percentage decreased.

ADVANCED SELECTION AND NEW CULTIVAR PERFORMANCE IN HAZELNUT TRIALS PLANTED IN 1998 AND 2000 AT OREGON STATE UNIVERSITY

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Keywords: *Corylus avellana* L., filbert, nut breeding, "Santiam"

Abstract

Oregon State University has an ongoing program of testing advanced breeding selections that are resistant to eastern filbert blight (EFB) in replicated yield trials. The objective is to develop new disease resistant cultivars that have improved yield and kernel quality compared to what is now being grown. 'Barcelona' accounts for 67% of all trees in production in Oregon, and it is susceptible to EFB. 'Lewis' has moderate quantitative resistance and accounts for 6% of all trees.

Two cultivars with complete resistance to EFB, 'Santiam' and 'Yamhill', were released by Oregon State University (OSU) in February 2005 and January 2008, respectively. They were tested in separate trials planted in 1998 and 2000, and results are reported in this paper.

- * 'Santiam', tested as OSU 509.064, was planted in the 1998 advanced selections trial and is the first kernel variety developed in Oregon to have complete resistance to EFB conferred by a single dominant gene from 'Gasaway'. 'Santiam' nuts are small, 1.8-2.2g, trees are 50-70% smaller than 'Barcelona', and the cumulative marketable kernel yield is similar to 'Barcelona' and 'Delta', but less than 'Lewis'. Kernel mold is normally less than 5%, but in 2004 it was 10-25%. Nuts mature two weeks before 'Barcelona'.
- * 'Yamhill', tested as OSU 542.102, was included in the 2000 trial and also released as a kernel variety with complete resistance to EFB inherited from 'Gasaway'. Trees are 50% smaller than 'Barcelona', but are precocious and cumulative marketable kernel yield was 25% greater than 'Barcelona' and comparable to 'Lewis'. Nuts are small 1.7-2.4g and total defects are less than 5% in most years. Nuts fall free of the husk 7-10 days ahead of 'Barcelona'.

> rendimento, % c/p

RESPONSE OF HAZELNUT PROGENIES FROM KNOWN RESISTANT PARENTS
TO ANISOGRAMMA ANOMALA IN NEW JERSEY, U.S.A.

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Keywords: *Corylus avellana* L., *Corylus americana*, genetic improvement, disease resistance

Abstract

Great progress is being made at Oregon State University (OSU) to identify and characterize hazelnut genotypes resistant to the disease Eastern Filbert Blight (EFB), caused by *Anisogramma anomala*. However, little is known on how these sources of resistance, especially when incorporated into advanced generation progeny, will respond to EFB in regions outside of the Pacific Northwest. To examine this question, controlled hybridizations were made in 2000 at OSU between genotypes identified as highly resistant to EFB and genotypes susceptible to the disease. Sources of resistance evaluated were derived from 'Zimmerman', 'Ratoli', 'Grand Traverse', and 'Yoder #5'. Progeny of three additional crosses, designed to yield progeny expressing moderate to high levels of quantitative resistance, were also examined. Seeds from the crosses were germinated at Rutgers in spring 2002 and the resulting seedlings were field planted that fall. Plants were exposed to EFB in 2003-2007 and were evaluated for their response in January 2008. They were rated on a scale of 0 to 5, in which 0 represents no sign of EFB and 5 represents all branches exhibiting cankers. Progeny derived from 'Zimmerman' and 'Ratoli' segregated according to previous reports (3 resistant : 1 susceptible and 1 resistant : 1 susceptible, respectively). Interestingly, progeny of 'Yoder #5', a cultivar believed to have obtained its resistance from *Corylus americana*, segregated in a pattern that closely fit a ratio of 1 resistant : 1 susceptible. 'Grand Traverse' transmitted a high level of resistance to 25 percent of its progeny. Nearly all seedlings of the progenies designed to express quantitative resistance were highly susceptible to EFB. This study suggests 'Zimmerman', 'Ratoli', 'Grand Traverse', and 'Yoder #5' can be useful in breeding resistant plants for locations where EFB is endemic, but high levels of quantitative resistance may be difficult to obtain without recurrent selection.

THE EFFECTS OF SITE AND SEASONAL CONDITIONS ON NUT YIELD AND KERNEL QUALITY OF HAZELNUT GENOTYPES GROWN IN AUSTRALIA

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Keywords: nut yields, kernel quality, hazelnut genotypes, climate, soil type

Abstract

The productivity and kernel quality of a range of hazelnut genotypes was measured at five sites in Australia over several seasons to assess interactions between genotypes and environmental conditions. At Myrtleford in north-east Victoria, "Barcelona" consistently gave the highest nut yields whilst at Moss Vale in the Southern Highlands of NSW, "Tonda di Giffoni" and the Australian selection "Tokolyi/Brownfield Cosford" (TBC) were the highest yielding genotypes.

In contrast, at Kettering in southern Tasmania, "TBC" yielded well, whilst the genotypes "Barcelona" and "Ennis" performed poorly.

Tree growth was best on those soils with lighter textured, well drained subsoils, such as the alluvial, sandy loam at Myrtleford, compared with the heavier textured clays in the B horizon (subsoil) at Orange, Moss Vale and Kettering.

Dry seasonal conditions, particularly during kernel development resulted in a higher proportion of poorly filled or shrivelled kernels. Ennis was the most affected with 15-23% poor fill or shrivelled kernels, compared with 10-16% for Barcelona and 8-12% for TBC over four seasons and three research sites. In some seasons there was a correlation between kernel weight and the proportion of poorly filled or shrivelled kernels.

STUDIES ON HAZELNUT HYBRIDIZATION BREEDING OF *C. HETEROPHYLLA* X *C. AVELLANA* IN CHINA

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Keywords: hazelnut, breeding, interspecific hybrid, cultivar, characteristic

Abstract

China is one of the originations of *Corylus* L.. *C.heterophylla* Fisch is spread naturally across a very large area of northern China, which bears very small nuts and presents low yields. Collecting wild nuts was a common habit until the culture appeared at the end of the last century. In order to obtain hazelnut cultivars to grow in China, the crossing breeding of inter-species between *C.heterophylla* Fisch. x *C.avellana* L. was initiated in the 1980s in China.

According to the breeding objectives, we took a selection of *C.heterophylla* Fisch. as the mother part and mixed pollen of *C.avellana* L. as the father part to conduce the interspecific hybrid. The flower bud shoots were bagged with paper bags before the flowering to avoid the pollen pollution, and artificial pollination was conducted during the blossom stage. The seeds obtained went into the breeding procedure which consists of hybrid seedlings cultivation, selecting for fine lines, trials for advanced lines and cultivars, and adaptability test to different climatic zones.

The first group of cultivars, or advanced lines, was released after nearly 20 years of research work (1980-1999). In the procedure of breeding, 110 lines were screened among 2000 hybrid seedlings of the F1 generation, and 60 advanced lines were obtained. Variety and advanced lines trials were conducted in different climatic zones in the northern part of China. Of these advanced lines, the hardiest cultivars and advanced lines (resistant to the low temperature of -35°C at the dormancy stage) are Dawei, Pingou226, Pingou110. The hardier advanced lines (resistant to the low temperature of -30°C at the dormancy stage) are Pingou33, Pingou237. The hardy advanced lines (resistant to the low temperature of -25°C at the dormancy stage) are Pingou48, Pingou349. The common characteristics of these cultivars include (1) larger size of nut, nut weight of 2.6-3g; (2) kernel is glabrous and full filling, kernel percentage varies between 38.9-47.5%, oil content is 45.9-63.8%, crude protein content is 18.3-25.3%, it is multivitamin and rich with minerals; (3) very precocious and high yield, these cultivars begin their bearing 2-3 years after establishment. The yield in the 5th, 7th and 10th year after establishment is 660-1110 kg/ha, 2220-2553 kg/ha and 2325-3000 kg/ha respectively; (4) very hardy, resisting the low temperatures of -25°C/-35°C at the dormancy stage. Good adaptability to soil and possible good growth in the soil of pH value 5.5-8.0. The successes of the hazelnut breeding program in China changed the hazelnut growing from the collection of wild nuts to modern horticulture. In the past 10 years, 1.5 million hazelnut trees, about 1200 hectares, were planted in northern China. The cultures of hybrid hazelnuts are warmly welcomed by the farmers, and the trade of growing hazelnut in China has a very expansive foreground.

PERFORMANCE OF 'NEGRET' HAZELNUT CULTIVAR GRAFTED ON 4 ROOTSTOCKS IN CATALONIA (SPAIN)

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Keywords: clonal rootstocks, vigour, yield, suckers emission, kernel quality, 'Negret'

Abstract

'Negret' is the most widely grown cultivar in Tarragona's hazelnut orchards. In this area, trees tend to develop low vigor, iron chlorosis and high sucker emission. IRTA's hazelnut rootstock selection started in the early 1990s in Catalonia (Spain), in order to resolve these agronomic problems. 'Negret-N-9' grafted onto four clonal rootstocks ('Dundee', 'Newberg', 'Tonda Bianca' and 'IRTA-MB-69' selection) was compared to an own-rooted 'Negret-N-9' clone. This trial was planted in 2000, trained in to vase, and it was spaced 6.5 x 3.5 m (440 trees/ha) with drip irrigation. The statistical design was a randomized complete block with ten replications, and one tree per replication and treatment.

Preliminary results showed that some rootstocks have a strong influence on 'N-9' scion vigor and yield during the first five years after budding (period 2003-2007). 'Dundee' and 'MB-69' rootstocks showed the best vegetative growth and yield performance, and the lowest sucker emission of the 'Negret-N-9' scion. In contrast, the own-rooted 'Negret-N-9' (control) showed the highest sucker emission, and the poorest growth and yield, but it gave the best kernel quality (high weight and big kernel size, oil richer in oleic acid).

SSR FINGERPRINTING PANEL VERIFIES IDENTITIES OF CLONES IN BACKUP
HAZELNUT COLLECTION OF USDA GENE BANK

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Keywords: filbert, microsatellite

Abstract

The USDA Agricultural Research Service maintains a genebank representing world hazelnut (*Corylus* L.) diversity in Corvallis, Oregon. More than 630 clones are preserved as growing trees in a two-hectare field planting, with a single tree per accession. In the early 1990s, prior to the spread of eastern filbert blight caused by *Anisogramma anomala* to within 75 kilometers of Corvallis, a backup collection was established at the USDA National Arid Land Plant Genetic Resources Unit in Parlier, California. A core collection of 170 genotypes representing the wide taxonomic, geographic and phenotypic diversity of *Corylus* was selected for this second planting. Two trees of each 'core' genotype were grafted onto seedling rootstocks over a period of five years and an orchard was established in Parlier. The mother trees in Corvallis are self-rooted, but the grafted trees in Parlier are at risk of identity problems due to suckers arising from below the graft union. In May 2007, young leaf samples were collected from 29 Parlier trees that exhibited uncharacteristic morphological phenotypes. A set of 12 simple sequence repeats (SSRs) was used to fingerprint trees in the backup collection, and the results were compared to the fingerprints of the same accessions in the Corvallis collection. Based on the results, three misidentified accessions will be eliminated and the fingerprinting panel will be refined further.

HIGHLY INFORMATIVE SIMPLE SEQUENCE REPEAT (SSR) MARKERS FOR FINGERPRINTING HAZELNUT

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Keywords: hazelnut, filbert, fingerprinting, microsatellite, polymorphic information content

Abstract

Simple sequence repeat (SSR) or microsatellite markers have many applications in breeding and genetic studies of plants, including fingerprinting of cultivars and investigations of genetic diversity, and therefore provide information for better management of germplasm collections. They are repeatable, co-dominant, highly polymorphic, and technically simple to use. We developed more than 150 SSR markers for hazelnut, and characterized them using a diverse set of 50 accessions. Some hazelnut SSR loci amplify other genera in the Betulaceae. The number of alleles per locus ranged from 2-26. Polymorphic information content (PIC) values ranged from 0.21 to 0.91. Most loci segregated 1:1, 1:2:1 or 1:1:1:1 in our mapping population allowing us to assign them to one of the 11 linkage groups. In this study we identify two sets of a dozen markers each that are useful for fingerprinting hazelnut accessions. Loci for fingerprinting will be chosen based on high heterozygosity, PIC values, low frequency of null alleles, coverage of the hazelnut genome, and ease of scoring.

ALLELE SEGREGATION AT SSR LOCI AND ALLELE TRACEABILITY OF HAZELNUT ACCESSIONS (*CORYLUS AVELLANA* L.) FROM LANDRACES GROWN IN THE LATIUM REGION (ITALY)

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Keywords: molecular markers, parentage analysis, DNA fingerprinting, self-incompatibility

Abstract

Allele differences at six SSR loci (CaT-B107, CaT-C504, CaC-B028, CaC-B005, CaC-A102 and CaT-B502) among accessions of hazelnut tree landraces cultivated in the Latium region in Italy ("Tonda Gentile Romana", "Tonda di Giffoni", "Nocchione") were determined using: (a) full-sib (FS) progenies from either controlled pairwise or open pollinations of those accessions, (b) DNA purification, PCR and agarose gel (4%) electrophoresis of the amplicons of about 30 seeds of each offspring, (c) segregation analysis of the amplicons after PCR with the primer-pair assigned at each SSR locus, and (d) allele annotation to the segregating amplicon database. Five alleles per locus, in average, were identified after an electrophoresis of SSR-PCR amplicons. Except in one case, the FS parental accessions were heterozygous at each of the six SSR loci and showed independent allele segregation for any pairwise loci combination in their FS offspring.

The polymorphic PCR fragments amplified at each SSR locus favored parentage analysis, DNA fingerprinting of the parental accessions, traceability of hazelnut seed products, detection of associations to economically important seed traits, and inference on genetic systems affecting pollen tube growth. The combination of primers to detect allelic variation at the CaC-B028 and CaT-B107 loci was found to be adequate for the clear differentiation among genotypes of the tested parental accessions. The alleles at the CaT-B107, CaT-B502, CaT-C504 and CaC-B028 generated unique SSR-PCR amplicon combination for "Tonda Gentile Romana", allowing its differentiation among other hazelnut landraces and, in some instances, the identification of pollination events by the pollen of wild hazelnut plants. The expected four genotypes at the six loci in the FS offspring were identified in all cases except in the FS offspring from "Tonda Gentile Romana" mated to "Nocchione" as male parent. In that progeny, an unexpected segregation at the locus CaT-B107 showed that only one of the SSR paternal alleles was transmitted to the progeny, indicating putative linkage of the not-transmitted SSR allele with either a gametophytic factor or an allele causing the unilateral incompatibility when "Nocchione" was used as the pollen donor. This evidence suggests the necessity of more research to ascertain the efficacy of "Nocchione" as pollenizer of "Tonda Gentile Romana".

HAZELNUT CANDIDATE GENES FOR PATHOGEN PERCEPTION

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Keywords: resistance genes, PAMP receptors, pathogen perception, NBS-ARC domain, kinase domain

Abstract

Pathogen perception is a phenomenon by which plants sense the beginning of an infection process instigated by a pathogen. Effective pathogen perception leads to a rapid signal transduction and an induction of an array of defence genes whose products delay or halt the pathogen progress. As a result the plant survives although with a degree of damage (different degrees of resistance) or with minimum damage (high resistance). Generally, the genes that control pathogen perception are grouped into two major classes: 1) resistance genes (R genes), whose products can recognize hypervariable pathogen effector gene products, which are usually involved in pathogenicity or virulence. Therefore, in most cases R genes are effective against specific strains of the pathogen species and can confer high resistance phenotypes; 2) Receptors of the Pathogen Associated Molecular Patterns (PAMPs). PAMPs are necessary for the viability of the pathogen and are conserved among different microbial taxa. These receptors therefore operate as specific recognition and trigger non-host resistance and basal resistance. Both types of genes are important for an effective resistance response.

A number of pathogens can seriously damage the cultivation of hazelnuts worldwide. Some compromise the viability of the trees. The gene classes cited above thus need to be characterized in order to manage genetic selection procedures effectively.

We used a PCR-based gene candidate approach to isolate gene candidates for pathogen perception (PPGCs) from *Corylus avellana* L. Primers were designed from the conserved domains of PPGCs, particularly NBS-ARC and kinase domains. The isolation of gene fragments was based on PCRs performed under low stringent conditions, cloning of the expected-sized amplicons, and sequencing. Sequences were compared with GenBank accessions for the selection of PPGCs. Phylogenetic analysis grouped the hazelnut genes into pathogen perception gene classes defined by well-known genes from model plant species. Hundreds of gene fragments homologous to known R genes or to P(M)AMP receptors were isolated from *C. avellana* cv Tonda Rossa and from wild hazelnuts.

NEW SOURCES OF RESISTANCE TO EASTERN FILBERT BLIGHT AND LINKED MARKERS

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Keywords: *Corylus*, hazelnut, disease resistance, RAPD markers

Abstract

The hundred-year history of the hazelnut industry in the Pacific Northwest (USA) is threatened by eastern filbert blight caused by the fungus *Anisogramma anomala* (Peck) E. Müller. Marker-assisted selection has been extensively used for 'Gasaway' resistance in the hazelnut breeding program at Oregon State University, USA. Concern over the possible breakdown of this single dominant resistance gene provides an incentive to look for new sources of resistance. Three genotypes (OSU 408.040 from Minnesota, 'Ratoli' from Spain, and OSU 759.010 from the Republic of Georgia) have shown no signs or symptoms of the disease following a series of greenhouse inoculations or exposure of potted trees under structures topped with diseased wood. All three were crossed with susceptible selections, and segregation ratios in the progeny indicate simple inheritance. PCR-based DNA markers linked to resistance have been identified for all three sources and will be useful for marker-assisted selection. More than 100 simple sequence repeat (SSR) loci have been developed and assigned to linkage groups. Co-segregation of disease response and SSR alleles allowed us to assign the resistance loci to linkage groups. Resistance from 'Gasaway' and the three new sources are independent, as the loci map to four different linkage groups. These new sources of resistance will be used in hazelnut breeding either singly or through pyramiding of resistance genes, for which the identified markers will play a prominent role in marker-assisted selection.

ORAL SESSION N.2

Biology and Physiology



Chairman: *Ana Paula Silva*

THE PROPAGATION OF HAZELNUT NODAL EXPLANTS

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Keywords: micro-propagation, growth regulators, culture media

Abstract

The traditional vegetative propagation and rooting of hazelnut are rather problematical. The commercial production of certified plant materials requires the application of contemporary techniques. In our research, we used Azerbaijan varieties of hazelnut. One of the main tasks of clone propagation in vitro is to increase the multiplication rate. Most of hazelnut varieties have a low rate of multiplication. We developed a three-step protocol for efficient micro-propagation. The use of TDZ allowed us to improve axillary bud formation.

Shoot explants from greenhouses were surface-sterilized with NaOCl and Hg(NO₃)₂. Hazelnut buds proliferated on B5 media supplied with 3-5 mg l⁻¹ BA, 0-0.5 mg l⁻¹ IAA and 0.1-0.5 mg l⁻¹ GA. We used the same media with 0.1-2.0 mg l⁻¹ TDZ to induce axillary buds on explants. On the third step, shoots elongated on the DKW and B5 media.

The rooting was performed on half-MS, B5 and DKW media supplemented with 0.1-1.0 mg l⁻¹ IBA, IAA. The best rooting of shoots occurred after shoots elongated on DKW media.

This protocol allowed us to produce high quality hazelnut plants.

EFFECT OF SOME PRETREATMENTS ON SEED GERMINATION
OF TURKISH HAZEL (*CORYLUS COLURNA* L.)

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Keywords: Turkish hazel, seed germination, GA₃, scarification, stratification

Abstract

Seeds of Turkish hazel take a long time to germinate under natural conditions. However, fast and uniform germination is desirable especially in breeding studies. In this study, the seeds were either directly planted in field or treatments of 0, 25, 50, 75, 100, 200 and 400 ppm Gibberellic acid (GA₃), scarification with acid for 2 h, shell splitting and stratification in moist peat at 4°C for 100, 110 and 120 days were applied to the seeds to improve germination. Three replications were used for each treatment. Acid scarification, shell splitting, and 100 and 110 days of stratification did not result in any germination. The field planting and 120 days of stratification resulted in 64% and 14.2% germination, respectively. All of the GA₃ treatments yielded in higher germination than the control (0 ppm). Germination increased as GA₃ concentration increased but higher concentrations had negative effect on germination; 0, 25, 50, 75, 100, 200 and 400 ppm GA₃ resulted in 41.3%, 67.6%, 92.1%, 100.0%, 84.7%, 56.0% and 61.6% germination, respectively. Germinated seeds were transplanted into peat moss in plastic bags. Transplantation success was the highest (70.6%) in 25 ppm GA₃ treatment followed by 75 ppm (64.0%).

PHENOLOGICAL TRAITS OF IMPORTANT HAZELNUT CULTIVARS IN ORDU, TURKEY

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Keywords: phenology, hazelnut, Turkey

Abstract

This project was carried out to determine the phenological characteristics of 'Tombul', 'Palaz', 'Kalinkara' and 'Çakıldak'. These hazelnut cultivars were grown in Ordu in coastal (altitude of 0-250 m), middle (altitude of 250 -500 m) and high zones (altitude of 500-750 m) 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. In the coastal zone, the appearance of female and male flowers, fruit cluster formation, ripening, and leaf bud burst were earlier than the high zone. The earliest ripening times were associated with 'Tombul', 'Palaz', 'Kalinkara' and 'Çakıldak' cvs., respectively. The 'Tombul' cultivar was homogamous, 'Çakıldak' cv. was protandrous expect of 1999-2000 period, and 'Palaz' and 'Kalinkara' cvs. were dichogamous in 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 ('Kalinkara') 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 'Kalinkara' for 'Tombul'; 'Tombul' and 'Kalinkara' for 'Palaz'; and 'Palaz' and 'Tombul' for 'Kalinkara' cv.

FIELD AND CONTROLLED TEMPERATURE STUDIES ON THE FLOWERING OF HAZELNUTS IN AUSTRALIA

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Keywords, Pollen shed, bloom, hazelnut genotypes, temperatures

Abstract

Observations on the date of commencement and the period of pollen shed and female bloom were recorded for a range of hazelnut genotypes at five field sites over an eight year period. Date of commencement of both pollen shed and female bloom varied between seasons and sites but the order of pollen shed or female bloom showed very little variation. The earlier the genotypes came into pollen shed, the longer the period that pollen was shed. All genotypes were protandrous.

Three studies were undertaken using temperature controlled cabinets. Material from a range of genotypes was cut weekly and placed in cabinets where temperatures were maintained at 5°C, 10°C and 15°C. Pollen shed was observed to occur in the cabinets up to six weeks earlier than it occurred for the same genotype in the field but female bloom did not occur any earlier in the cabinets than in the field.

It is hypothesised there are two physiological processes affecting catkin extension; chilling which causes a decline in a plant regulating substance preventing catkin extension and warmth causing the production of a substance which stimulates catkin extension. Once the balance tilts in favour of the stimulating substance, catkin extension occurs. In the female flower, the principle factor is considered to be a decline in the retarding substance due to chilling. Once this is at sufficiently low levels, flowering occurs.

There is concern that with global warming, pollen shed will occur earlier, relative to female bloom resulting in poor pollination for later blooming varieties.

EFFECT OF FULL FLOWERING CLIMATE ON CROP YIELD
OF *GEVUINA AVELLANA* MOL.

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Keywords: *Gevuina avellana*, flowering climate, crop yield.

Abstract

Gevuina avellana Mol. is a native tree from Chile characterized by a high interannual variability in nut yield. The effect of climate during the full flowering period (FFP, February), in respect to the annual fruit yield variability, was studied from 1999 to 2008 in several clonal selections. Clone average yield was 23.5 ± 8.2 kg per year, and annual yield variability was significantly and highly correlated with medium temperature, accumulated precipitation and wind speed. As *Gevuina* is a self-infertile species which needs cross pollination made mainly by bees to form fruits, the climate during the FFP is likely to have firstly an effect over the intensity of pollination and therefore over the following yield. Thus, despite a presumably compensation between the crop load and nut weight, there is an overall effect from FFP climate on final NIS yield. This in turn broadly defines the total kernel and oil yield, being the last a main commercial objective due to its nutritional and phytotherapy properties. The climate during the FFP can exert a great influence on annual nut yield variability. These results are important in understand the productive behavior of *Gevuina*, and useful for its use as selection criteria for the *Gevuina* improvement program and for an adequate orchard management.

GENE EXPRESSION AND SPOROPHYTIC SELF-INCOMPATIBILITY IN HAZELNUT

C. Beltramo⁽¹⁾, D. Torello Marinoni⁽¹⁾, A. Akkak⁽²⁾, M.L. Destefanis⁽¹⁾, R. Botta⁽¹⁾⁽¹⁾Dipartimento di Colture Arboree, Università degli Studi di Torino, Via Leonardo Da Vinci 44, 10095 Grugliasco (Torino)⁽²⁾Dipartimento di Scienze Agroambientali, Chimica e Difesa Vegetale (DiSACD), Università degli Studi di Foggia, Via Napoli 25, 71100 Foggia**Keywords:** *Corylus avellana* L., S locus, female determinant, differential display**Abstract**

The European hazelnut (*Corylus avellana* L.) is a monoecious tree and exhibits sporophytic self-incompatibility. Self-incompatibility is a genetic system that prevents the self-fertilization allowing the pistil to throw back the pollen of genetically close individuals. Self-incompatibility is controlled by a single multi-allelic locus, the S locus.

Sporophytic self-incompatibility (SSI) has been reported in: Asteraceae, Betulaceae, Brassicaceae, Caryophyllaceae, Convolvulaceae and Sterculiaceae. The involved molecular mechanisms are still partly unknown, with the exception of the Brassicaceae. Studies on gene regulation of fertility, pollination and fertilization in hazelnut are very few; therefore, with this research we aim to contribute to the knowledge about the mechanism of sporophytic self-incompatibility in hazelnut.

In a first stage, the studies on Brassicaceae were used as a possible model to understand the self-incompatibility system in this species. The results obtained point out that the known sequences of *Brassica* cannot effectively be used for finding the responsible factors of self-incompatibility in hazelnut, but it doesn't exclude that the two mechanisms work in similar way.

Therefore, the Differential Display technique was applied for the study of the female determinant of self-incompatibility. Two developmental stages of female flower buds were compared: before styles emergence and full bloom. The results allowed to isolate partial sequences that showed an interesting homology degree with transmembrane serine-threonine kinase receptor of *Brassica oleracea*. Believing that the female determinant of self-incompatibility in hazelnut is very likely a membrane receptor, the efforts to get differentially-expressed sequences of this type were increased. Primers were designed on conserved regions of serine-threonine kinase receptors. Four differentially expressed fragments were isolated from stigmas at full bloom: after blasting in TIGR and NCBI databases, 1 was homologous with a gene for a kinase receptor, 3 were homologous to kinase proteins. The isolated sequences are being studied to check their expression in different style developmental stages and tissues.

PHYSIOLOGICAL ASPECTS OF HAZELNUT TREES GROWN
IN DIFFERENT TRAINING SYSTEMS

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Keywords: comparison between training systems, light penetration into the canopy, influence on fertility and yield, cryostabilization method

Abstract

A three-year (2004-2006) study to evaluate some physiological aspects of hazelnut trees grown in different training systems was performed in a orchard of 'Tonda Gentile delle Langhe' cultivar located in Cravanzana (CN) in a hilly area of the Piemonte region (North-Western Italy). Two training systems, free vase (monocauline form) and bush with three stems, were compared. Sunlight intensity through the canopy was measured using a portable solar bar. Measurements were taken on four replicate plants for each training system, inserting the bar at two heights above the soil and orienting it towards the cardinal points in the central hours of the day in mid June and mid July. Fertility, yield and fruit quality were determined on four branches, of the same plants, oriented towards the cardinal points in order to evaluate the influence of light penetration. In addition, a sample of leaves was collected from both shoots situated in a sunny and a shaded part of the canopy which was South oriented. Samples were submitted to the 'cryostabilization' method and the following parameters were determined on slices obtained with glass blades: leaf lamina thickness, palisade tissue percentage on total lamina, layers of palisade tissue and stomata density. The two training systems observed showed a different model of light penetration into the canopy, although no significant differences were found in fertility and yield. The mean thickness of the leaves in the sunny part of the canopy was 129.6 μm (48.9% of palisade tissue, with an average of 2.5 cell layers), while the mean thickness of the leaves in the shaded part of the canopy was 70 μm (28.7% of palisade tissue, with an average of 1.0 cell layer). Stomata density was 224.9 no/mm² for sunny leaves and 115.7 no/mm² for shaded leaves.

EFFECT OF TRAINING SYSTEM ON HAZELNUT
(*CORYLUS AVELLANA* L.) PHYSIOLOGY

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Keywords: carbohydrates, hazelnut, leaf anatomy, leaf gas exchange, phenols, photosynthetic pigments, training systems, water relations.

Abstract

Orchard management practices to optimize the fruit set, development and yield can be improved by the knowledge of the physiological parameters of the plants. In 2007, variations in leaf anatomy, chemical composition, gas exchange and water relations were studied in *Corylus avellana* L. cultivars Butler and Segorbe, grown freely as multi-stemmed shrubs and as a free single trunk (free vase). The trial was started in 1980 with several commercial hazelnut cultivars in Northern Portugal, at 470 m above sea level. The leaf traits analysed included leaf mass per unit area (LMA), density, area, relative water content (RWC), succulence, photosynthetic pigments, carbohydrates and total phenols concentrations. Other traits described the anatomy of leaves, namely the thickness of palisade and spongy parenchymata and epidermis. Net CO₂ assimilation rate, stomatal conductance, intercellular CO₂ concentration, transpiration rate, intrinsic water use efficiency and leaf water potential were also determined. Cultivar (cv.) Segorbe grown on a single trunk and cv. Butler grown freely had leaves with higher photosynthetic pigments concentration and LMA. Higher LMA was associated with higher leaf density and palisade parenchyma thickness. Trees grown on a single trunk had higher RWC than trees grown freely. Soluble sugars, starch and total phenols concentrations were not significantly affected by treatments. In addition, there were not significantly differences on leaf gas exchange and water relation parameters among cultivars or training systems, except for the trees grown on a single trunk that had higher transpiration rate. From a horticultural point of view, it seems that cv. Butler will benefit if grown freely and cv. Segorbe on single trunk.

HAZELNUT CULTIVAR IDENTIFICATION WITH LEAVE MORPHOMETRIC ANALYSIS: PRELIMINARY RESULTS

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Keywords: hazelnut, shape, geometric morphometric, cultivar identification, CVA

Abstract

The variety identification in hazelnut is an important aspect in the nursery and in the orchard. Methods based on molecular biology are expensive, complex and often ineffective due to the presence of hybrids. Plant taxonomists recognized the importance of leaf features for identifying taxa a long time ago. In this work, authors evaluate the possibility to apply a more rapid and simple, and sometimes more effective, method based on the morphometric analysis of digital leaf images.

In this preliminary work, a comparison of leaf morphology for evaluating differences between three cultivars was conducted through the geometric morphometric analysis. Twenty-four leaves collected from trees of the field station in Fiorano-Rome for three commercial cultivars (Batler, Ennis, Tonda Gentile Romana) of hazelnut (*Corylus avellana*, L. 1753) were analyzed via geometric morphometric tools, after their image scanning (300 d.p.i.; 24 bit color). This method allows the visualization and the quantification of morphological differences by representing the deformations of morphometric points (landmarks) in a coordinate space. Landmarks are defined as homologous points bearing information on the geometry of biological forms. Twenty-eight points along the margins and at the basis of the veins on the inferior side of each leaf's scanned image were digitized using the software TpsDig. A Canonical Variates Analysis (CVA) was performed on the obtained weight matrix (W') in order to discriminate among cultivars. The three cultivars were discriminated with an efficiency of 100%. Further trials on many more samplings and cultivars will be useful to test, implement and give more reliable results. The preliminary results obtained indicated a technical feasibility of the proposed method.

XYLEMATIC POTENTIAL AND STOMATAL DENSITY IN THREE CULTIVARS OF HAZELNUT (*CORYLUS AVELLANA* L.) IN THE REGION DEL BIO BIO, CHILE

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Keywords: hazelnut production, environmental stress, xylematic potential, stomatal density

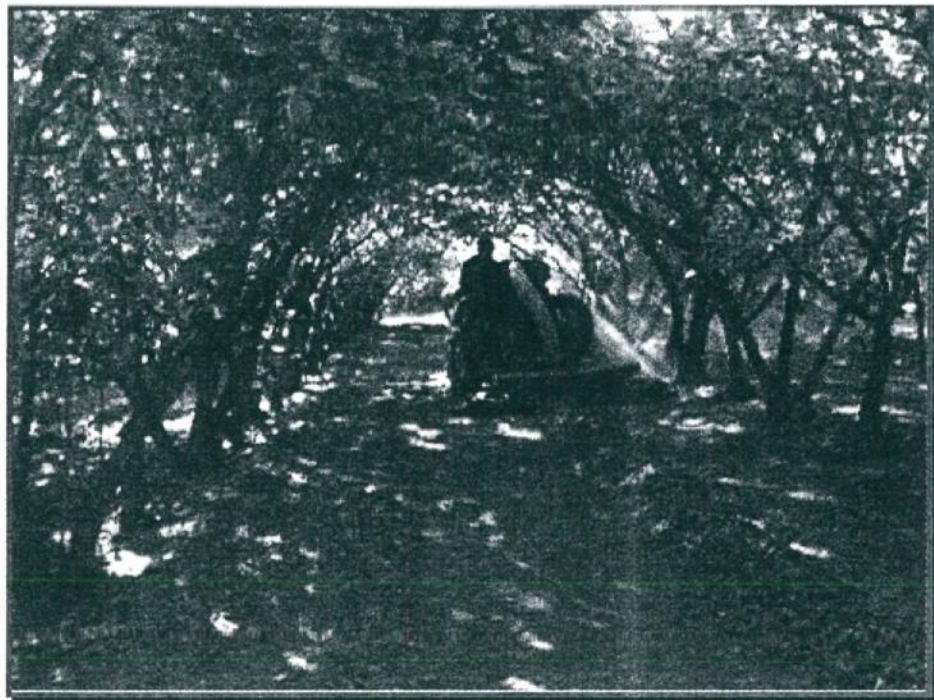
Abstract

The hazelnut growing area and production has been increasing dramatically in Chile since 1995, reaching more than 5.000 ha. Potential growers are permanently asking about cultivar performance in their local conditions in order to take decisions about the cultivar to choose for their needs. In research trials and commercial orchards, a dramatic difference between cultivars performance in relation to adaptation and yield potential was observed. In the case of Barcelona and Tonda di Giffoni, both cultivars show a very good potential, compared to Tonda Gentile delle Langhe, which shows also a low vigor. The climatic conditions of some areas of production may trigger the occurrence of a very high vapor pressure deficit in the plant, due to hot winds and/or low relative humidity in the environment during the growing season. Some species such as *Corylus avellana* are very sensitive to such conditions, as they require between 70 and 80% of relative humidity during the growing season. With the purpose to determine if some physiological traits of the plant, such as xylematic potential and/or stomatal density, allow to explain such a behavior, a trial comparing those three cultivars was carried out. The study was completed between January and March 2007 in the Region del Bio Bio, Chillan. The measurements were performed every ten days, at 6:00 (predawn), 10:00, 2:00 and 4:00 pm. At 6:00, the values of xylematic potential varied between -0.05 and 0.25 Mpa. At 10:00, the values varied between -0.2 and 0.5 Mpa. At 14:00, the values were between -0.4 and -0.8 Mpa; and at 18:00, the values varied between -0.3 and -0.8 Mpa. There was not any difference between the three cultivars at any time of the day and during the study.

Stomatal density was 42.7; 46.6 and 39.5 stoma/mm² in Barcelona, Tonda di Giffoni and Tonda Gentile delle Langhe, respectively; however, the difference was not significant between them. This result does not allow to explain the difference in behavior between the cultivars in terms of xylematic potential or stomatal density.

ORAL SESSION N.3

Orchard Management



Chairman: *Cristina Bignami*

ON THE QUALITY OF HAZELNUT PLANTS OBTAINED BY MOUNDING LAYER

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Keywords: coppice, mother plant, propagation, suckers forcing.

Abstract

In Italy, unfortunately, the material for the plantation of new hazelnut orchards is often obtained taking out the rooted suckers from the plant in the orchard. Of course, this primitive propagation method presents serious genetic and phytopathological problems. However, in the last 15 years, in the Langhe (Piemonte), a few nurseryman used to apply the mounding layer with acceptable results. With the aim to increase these results, some treatments were investigated on mounding layer to a 2-year-old mother plant (Tonda Gentile delle Langhe). The experimental design concerned the use of Agriperlite® as rooting medium instead of soil for mounding. In the other 2 thesis, the water- safe (Hydroretenteur®) polymer and a commercial mycorrhiza product were added and blended to the mounding soil. Immediately after the ringing, rooting hormone (IBAK, at 3000 ppm) was sprayed at the sucker bases near the ringed point. Each thesis were applied to 6 replicates of 50 mother plants each one. At digging time, the rooting percentage, the rooted suckers and the marketable classification were recorded. A remarkable increase in root mass weight was obtained by the addition of mycorrhiza and Hydroretenteur® to mounding soil. The rooting percentage was significantly increased by mycorrhiza and Agriperlite®. The first class rooted suckers and the marketable percentage were significantly increased by mycorrhiza and Hydroretenteur® . The increasing of rooting percentage due to IBAK don't need explications, the positive effects of Hydroretenteur® could be due to its capacity to maintain a good humidity level in the soil during rooting, whilst the positive effect of mycorrhiza seems to need further investigations.

FURTHER INVESTIGATION ON HAZELNUT MOUNDING LAYER

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Keywords: coppice, propagation, rhizogenesis.

Abstract

For 2 years (2005-2006) in a commercial hazelnut orchard of Tonda Gentile delle Langhe, plants which were too old and with unsatisfactory production were cut at the base and the coppice obtained was used as mother plant for mounding layer. In both years, some months after the cutting, that is June – July, the suckers were ringed to force their basal rooting. The effects of IBAK (Indol-butyric acid, Potassium salt at 300 ppm), applied to the suckers and immediately after their ringing on rooting and on plant quality, were studied. The addition of water-safe polymer (hydrorretenteur) to the mounding soil was also investigated. At ringing time the suckers vigour, was evaluated by their number obtained by coppice, and height were recorded. At digging time, the rooting percentage and marketable classification of rooted suckers were evaluated.

A high coppice vigour seems to be needed to obtain a high percentage of first class rooted suckers.

Also, the application at the ringing time of IBAK and the addition of the water-safe to the mounding soil significantly increased the number/coppice of marketable rooted suckers.

EFFECTS OF IRRIGATION ON GROWTH AND YIELD COMPONENTS OF HAZELNUT (*CORYLUS AVELLANA* L.) IN CENTRAL ITALY

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Keywords: drip irrigation, irrigation level, leaf assimilation rate, technological traits, productivity

Abstract

Hazelnut is sensitive to water stress. Because of low water availability and irregular rain yearly distribution, drought conditions are becoming common in the regions of Central Italy, such as Latium, which is the second area of hazelnut production in Italy. Drip irrigation based on water balance is then an appropriate technique to improve production and growth, optimising water use. An experiment was thus set up in 1992 in Viterbo (Central Italy) to study the long term response of vegetative growth and production to irrigation of hazelnut, cvs. Tonda Gentile Romana, Tonda di Giffoni and Nocchione. Four treatments were applied by means of drip irrigation since the second year from planting: an un-irrigated control and three water levels, corresponding to the restitution of 50, 75, 100 % ET_c calculated from class A of evaporation. The results of the adult stage of the orchard life are here reported. Yield, nut traits and defected nuts, oil content in the kernel, vegetative growth (shoot length, trunk cross-sectional area and canopy volume) and leaf assimilation rate were measured on fifteen/sixteen-year-old plants.

Vegetative growth and yield components were positively affected by irrigation. The highest plant yield was obtained at the 75 % ET_c for all cultivars and both years. Nut and kernel weight and size were slightly greater in irrigated than in control plants. The percentage of empty and defected nuts was higher in condition of limited water availability. The oil content in the kernel was slightly higher in 75 % and 100 % ET_c than in the other treatments for all cultivars. Leaf assimilation rates of Tonda Gentile Romana and Tonda di Giffoni showed the highest values in the early morning and low differences between treatments.

In conclusion, water supply of 75 % and 100 % ET_c could be valid irrigation levels for hazelnut cvs. Tonda Gentile Romana, Tonda di Giffoni and Nocchione in areas characterized by insufficient rainfalls during the year.

EFFECT OF DIFFERENT PRUNING INTENSITY ON GROWTH, YIELD AND QUALITY OF THE HAZELNUT CULTIVAR 'TONDA GENTILE ROMANA'

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Keywords: *Corylus avellana* L., light infiltration, trunk cross-sectional area, oil content

Abstract:

In Central Italy (Latium region), the pruning of mature hazelnut trees is usually done during the winter and it is generally limited to the removal of suckers, dead wood and old, diseased or broken branches. Reduction of shoot vigour, low light penetration within tree canopy and yield decline are long-term consequences observed in the main cultivar of this area: the medium-vigour Tonda Gentile Romana. Thus, an appropriate method of pruning for this cultivar is still lacking. In order to study the effect of two different pruning methods, respectively based on low (thesis A) and high (thesis B) intensity of pruning and renewal of the crown, three randomized plots per thesis (4 plants per plot) in an adult orchard of 'Tonda Gentile Romana', with three-stem plants spaced 5 x 5 m, were carried out and compared with an un-pruned thesis from 2004 to 2006. Weight of annual pruned wood, vegetative growth, light infiltration at the base of the plots, yield and nut traits, defects and kernel quality were measured, in order to quantify the plant response to a different intensity of pruning. The results indicate good productivity and vegetative growth in the thesis B at the end of the three year investigation, and yield per hectare slightly decreased only in the first year in comparison with thesis A. Light infiltration at the base of the plants was low in un-pruned plots, whereas thesis B was characterized by better light penetration. The intensity of pruning had only a slight effect on nut traits, but thesis A and B showed a lower incidence of defected nuts than the un-pruned control. On average, the oil content in the kernel was slightly higher in the nuts collected in thesis A, while very low differences were observed in the other chemical components, as soluble sugars and organic acids, starch and fatty acid composition.

DETERMINATION OF HAZELNUT HUSK DECOMPOSITION LEVEL
AND OF THE CONTENT OF SOME PLANT NUTRIENT ELEMENTS
UNDER NATURAL CONDITIONS

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Keywords: hazelnut husk; decomposition, plant nutrient elements

Abstract

Hazelnut husk, a harvest by-product, is a product of great agricultural interest. In addition, nobody has considered yet that this waste causes a problem for producers and enterprises. It was suggested that hazelnut husk would be turned into compost and used as organic fertilizer. However, usage of hazelnut husk compost has not become widespread yet.

This study was carried out to determine the decomposition level of hazelnut husk and the content of some plant nutrient elements which are present under natural conditions. In a 4-year laboratory study (2004-2007), we determined: decomposition level (C/N ratio), organic matter content, organic carbon %, pH, electrical conductivity (EC), cation exchange capacity (CEC), total nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) contents in hazelnut husk. Hazelnut husk kept under natural conditions during the second year had still high C/N ratio and was unfit for usage as organic material. Even if hazelnut husk did not fully decomposed during the third and fourth year, it was practicable in agriculture. Moreover, the content of nutrient elements in hazelnut husk decreased during the decomposition period, but these values did not fall under an acceptable limit to use it as organic material.

EFFECT OF FOLIAR BORON APPLICATION ON FRUIT SET
IN 'TOMBUL' HAZELNUT

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Keywords: boron, fruit set, 'Tombul'

Abstract

Fruit production in hazelnuts mainly depends on number of female flowers that set fruit. Thus, maximizing fruit set is important. The aim of this study was to determine if fruit set could be increased by foliar Boron (B) applications in 'Tombul' hazelnut. The experiment was conducted in a grower orchard near Persembe, Ordu, (Eastern Black Sea region) in Turkey. 300 ppm and 600 ppm B per ocak with 0.25% of nonionic wetting agent (Tween-20) were sprayed with hand gun sprayer in the third week of May. Control ocaks received water plus wetting agent. Leaf and soil analyses for macro and micro elements were performed. In both years of study, 300 ppm was more effective than 600 ppm on fruit set. In the first year, B applications increased fruit set by 28.6% in average. However, only 300 ppm B treatment resulted in increased fruit set (12.15%) in the second year. The results showed that the effect of B on fruit set varies from year to year.

DETERMINATION OF DEFICIENCY SYMPTOMS OF SOME PLANT NUTRITION
ELEMENTS IN HAZELNUT IN WATER CULTURE SYSTEMS

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Keywords: deficiency symptoms, N, P, K, Ca, Mg elements, water culture, hazelnut

Abstract

A balanced nutrition of plants is important in order to attain high amounts of quality yield. This study was carried out to determine the deficiency symptoms of plant nutrient elements such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) in hazelnut in water culture systems. The experiment was arranged according to a completely randomized plot design with three replicates, four doses and five rooted hazelnut plants in each replicate in the water culture system. N was prepared in doses of 0 mg l⁻¹, 100 mg l⁻¹, 200 mg l⁻¹, 300 mg l⁻¹, P in doses of 0 mg l⁻¹, 20 mg l⁻¹, 40 mg l⁻¹, 60 mg l⁻¹, K in doses of 0 mg l⁻¹, 150 mg l⁻¹, 300 mg l⁻¹, 450 mg l⁻¹, Ca in doses of 0 mg l⁻¹, 125 mg l⁻¹, 250 mg l⁻¹, 375 mg l⁻¹, Mg in doses of 0 mg l⁻¹, 25 mg l⁻¹, 50 mg l⁻¹, 75 mg l⁻¹ and in an exact nutrient solution (control).

After rooted hazelnut plants had grown during two months, deficiency symptoms of N, P, K, Ca and Mg were observed. When the five nutrient elements were not in the solution, deficiency symptoms occurred. Deficiency symptoms decreased depending on the increasing nutrient concentration and, in particular, the best growth was observed in nutrient solutions of 450 mg l⁻¹ of K and 75 mg l⁻¹ of Mg concentration. Besides, new adventitious root formation increased in concentrated solutions of 450 mg l⁻¹ of K, 75 mg l⁻¹ of Mg and 375 mg l⁻¹ of Ca. During the experiment, plants were analyzed to determine the nutrition level of the Tombul hazelnut in different nutrient concentrations. The results showed that N, P, K, Ca and Mg contents in the Tombul hazelnut increased depending on their increasing concentration.

FOLIAR NUTRITION APPLIED AT EARLY HAZELNUT DEVELOPMENT
SHOW POSITIVE YIELD AND QUALITY FACTORS
IN THE WILLAMETTE VALLEY OF OREGON

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Keywords: hazelnut production, first choice nut chaser, calcium, boron, foliar nutrition, brown stain, kernel mold

Abstract

The hazelnut acreage in the Willamette Valley of Oregon has held fairly constant over the past 5-10 years between 28,000, (11,331 ha) and 30,000 acres, (12,140 ha).

Hazelnut producers are continually looking for ways to improve nut production and the economic efficiency of their industry. The May application of foliar applied boron on hazelnuts is used to improve nut set and development. The use of timely applied foliar nutrients and nutrient enhancing amino acids are being explored as a means of improving nut quality, yield and tree health.

Typical yield increases of 8-40% have been recorded and observed in replicated trials and large block commercial trials conducted throughout the hazelnut producing area. The applications of proprietary blends of calcium, boron and other micronutrients coupled with nutrient enhancing amino acids, (First Choice Nut ChaserTM) has resulted in increase hazelnut yields and nut quality in Oregon. This foliar nutrient application is specifically applied twice, first during shell development (mid-May), and second during embryo/kernel development (mid-June). Trial results have shown that marketable hazelnut yields and quality have increased due to increased number of nuts per cluster, (21.8%), increased nut in-shell weights (3.5%), increased kernel weight, (8.6%), reduction in unmarketable nuts and reduced Brown Stain, and kernel mold.

FOLIAR FERTILIZERS ON HAZELNUTS IN OREGON, USA

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Keywords: hazelnut production, fertilizer sprays, micronutrients, macronutrients

Abstract

The objective of this three year research study was to determine if the use of foliar fertilizer programs increase hazelnut yields in a cost effective manner. A randomized complete block experimental design was used with four replications of 24 trees plot size (80 ft x 120 ft or 27 x 37 m) per treatment. The overall research plot size for the experiment was nine acres. The trunk cross sectional area was recorded for every tree in the plot to quantify uniformity of the trial orchard. Six different foliar fertilizer product mixes were applied in May, June and July. Foliar fertilizer applications were made with the grower's Rear's Air blast Sprayer using 75 gallons of water per acre (702 liters/ha) at 150 pounds per square inch (10.5 kg/sq. cm) through four D7 orifice plates on each side of the sprayer. The forward speed of the tractor was 4 miles per hour (6.4 kilometers per hour). The six treatments were: 1) Foliar Advance + Break Thru, 2) Multi Mineral Metalosate, 3) Stimplex + Break Thru, 4) Nutrient Express 4-41-27 or 18-18-18 + Calxin + ZMC Express, 5) Foliar Gold + Integrity Ca + Z422 + Phortress + K-Nite + Break Thru, 6) Kelpgrow and 7) an untreated check plot. At the time of harvest the yield was continuously monitored using a tractor mounted Global Positioning System (GPS) and a pressure plate yield monitoring device installed on the harvester. There were no statistically significant differences in yield, nut weights or grades for any of the treatments compared to the untreated check in any of the three years of the study.

The evolution of the hazelnut harvesting technique

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Keywords: harvesters, performances, costs

Abstract

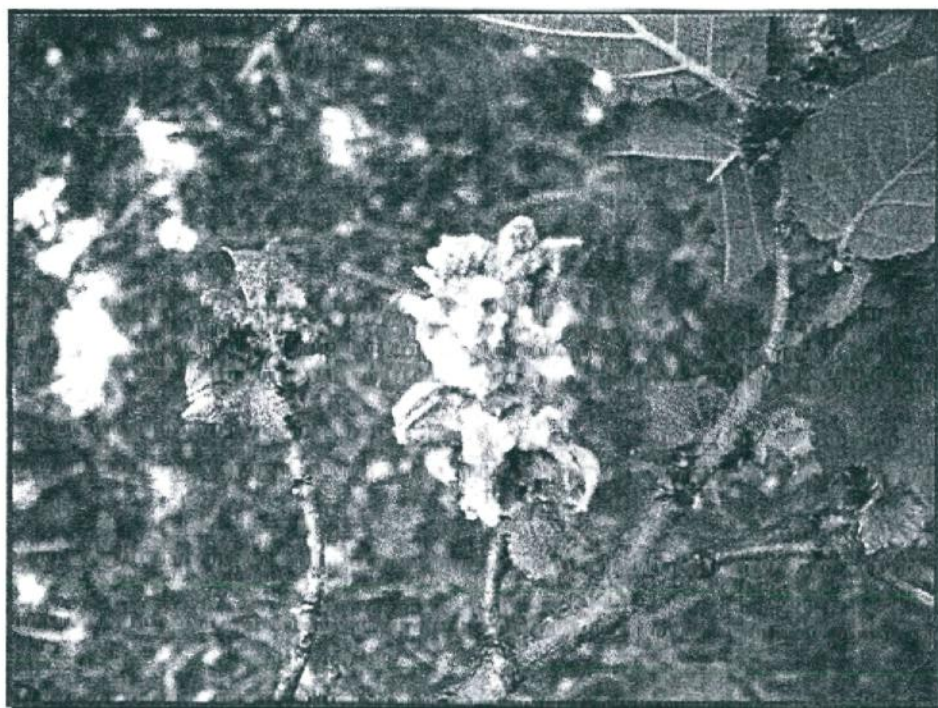
The evolution and the state of the art of hazelnut mechanical harvesting are described in the paper. The development of hazelnut cultivation in Italy is strictly related to the introduction of harvesting machines. In the last 30 years, the total Italian production has grown about 4 times and the average hazelnut production has increased from 0.3 to about 2 tons per hectare. Today, Italy is the second world's producer with a quantity ranging between 100,000 and 120,000 tons (about 20% of overall world production). Production costs are greatly impacted by the harvesting technique.

Since the 1980s, mechanical harvesting has almost completely replaced manual harvesting, and during this period mechanical harvesters have continuously evolved. The first harvesters appeared in Italy during the 1970s and gradually replaced the manual harvesting which was previously executed by picking the hazelnuts from the plant or by piling and gathering the fallen hazelnuts. However, the design of the selection device of these harvesters caused frequent stops due to blockages caused by aspired leaves or twigs, which limited severely the operating speed. The introduction of a rotating sieve reduced drastically this kind of problems, increasing their field capacity up to 1 ha per day. These harvesters, characterized by easy utilization and low costs, had a widespread use even in small farms. In the Monti Cimini area, many hazelnut harvester manufacturers developed rapidly, and in a short time they were able to compete with the other Italian factories. The competition was useful to improve the reliability and the performance of the models produced, so that, at present, over 4.000 harvesters are operating in the area. During the last 20 years, the performance of the harvesters has led to a considerable increase, from about 100 kg/h to more than 1000 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, with the improvement of 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 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 a trailer), which vary from about 0.2-0.4 ha/h for pulled machines to 0.35-0.5 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. The introduction of even more efficient and reliable machines allows the integral mechanization of the harvesting yards. Reduced costs (from € 5,000 for the smaller towed vacuum harvesters to € 40,000 for the self-propelled) and the lack of seasonal workers has improved their spread even in smaller farms (2-3 ha).

ORAL SESSION N.4

Pests and Diseases



Chairman: *Agostino Tombesi*

SUSCEPTIBILITY OF HAZELNUT TO THE ATTACKS OF THE NUT WEEVIL AND OTHER PESTS

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Keywords: hazelnut variety, *Curculio nucum*, *Gonocerus acuteangulatus*, damage incidence, nut developmental stages

Abstract

Pest attacks are responsible for the highest losses in hazelnut yield worldwide; in particular, the nut weevil *Curculio nucum* (Coleoptera: Curculionidae) is the most widespread and harmful species in Europe and Turkey. The resistance of hazelnut varieties to the nut weevil, as well as to other hazelnut pests, is known but it has been poorly investigated so far. Therefore, in 2004-2005 a research was carried out to investigate factors affecting *C. nucum* attacks on two cultivars (TGL, Ennis) and four selections (Daria, 101, B6, L35) in a 15-year-old orchard of northwestern Italy. In both years nut weevil adults were sampled from May to July on all cultivars and selections, but in greater quantities on TGL and Daria, and in smaller quantities on 101 and B6. By contrast, at harvest time the damage rate varied from 2.6% in TGL to 51.8 in 101, independently of the numbers of the collected adult weevils. However, TGL and 101 were the earliest and latest in kernel development and shell hardening, respectively. In particular, when nut weevil females bore mature eggs (generally when mean temperature exceeded 18°C), TGL showed a more advanced kernel development and shell hardening compared to the other varieties. Therefore, the susceptibility to nut weevil attacks was strictly related to shell hardening; indeed, a rapid hardening of the shell can hamper the oviposition of *C. nucum* females. By contrast, no correlation was found between shell thickness and damage at harvest time. Moreover, in 2004-2005, the susceptibility of hazelnut to bugs, in particular *Gonocerus acuteangulatus* (Heteroptera: Coreidae), was also investigated to assess the incidence of damage in relation to the nut variety, the attack period and the adult behaviour.

AN INSECTICIDE EFFECTIVENESS SCREENING METHOD ON HAZELNUT WEEVIL
(*CURCULIO NUCUM* L. COLEOPTERA CURCULIONIDAE)
FOR FIELD AND LABORATORY STUDIES

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Keywords: hazelnut weevil, *Curculio nucum* L., laboratory test, rearing box, insecticides, endosulfan, methomyl, thiaclopride, deltamethrine, thiamethoxam.

Abstract

The hazelnut weevil *Curculio nucum* L. is the most important pest for the French hazelnut industry (*Corylus avellana*). The withdrawal of active ingredient (a.i.) endosulfan at the European level in 2007 used during a long time with success, then the withdrawal of carbaryl in 2008, resulted in works for new effective active ingredients.

The method set by ANPN and used in 2005, 2006 and 2007 to test new active ingredients, is based on an original principle: first, adult weevils are gathered shocking hazelnut trees branches over a white sheet in an untreated with insecticide orchard in May, and kept in rearing boxes with water and green cherries until the application date. Secondly, trees are treated in an orchard with the chemical products in May or June, then after mixture drying, at least 4 shoots with leaves are excised and put into rearing boxes. The test consists in putting into each box 10 weevils with one treated shoot and with 4 replications. Weevils mortality is noted after 24, 48, 72 hours and after 7 days.

The results of these three years tests compared with the very effective reference Thionex (350 g/l of a.i. endosulfan) at 2,8 l/ha and to a water treated control, showed the very good effectiveness of Lannate 20L (200 g/l of a.i. methomyl) at 3,75 l/ha, of Calypso (480 g/l of a.i. thiaclopride) at 0,30 l/ha, of the association Calypso at 0,25 l/ha + Decis Protech (1,47 % of a.i. deltamethrine) at 0,5 l/ha and of the product A 9584 at 0,4 kg/ha containing 25 % of a.i. thiamethoxam.

The tests also showed a medium effectiveness of Sherpa 10 (100 g/l of a.i. cypermethrine) at 0,5 et 0,6 l/ha, of Dursban 75WG (75 % of a.i. chlorpyrifos-ethyl) at 0,67 kg/ha and of Orytis (75 g/l of a.i. acrinathrine) at 1 l/ha and an insufficient effectiveness of Trebon 30EC (295 g/l of a.i. etofenprox) at 0,6 l/ha, of Agrimec (18 g/l of a.i. abamectin) at 0,75 l/ha, of Admiral (100 g/l of a.i. pyriproxifene) at 0,25 l/ha and of Suprême (20,2 % of a.i. acetamiprid) at 0,37 and 0,50 kg/ha.

The method used seemed to give satisfaction because the reference product resulted in a complete mortality from 48 hours as did the products noted very effective and that almost all the weevils remained alive in the water control until the end of 7 days.

MEANS TO PRESERVE BENEFICIAL ARTHROPOD POPULATIONS
IN FRENCH HAZELNUT ORCHARDS AS PART
OF AN INTEGRATED PEST MANAGEMENT APPROACH

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Keywords: hazelnut integrated pest management, beneficials, non-target effects, biological control by conservation, Ecological Compensation Areas, functional biodiversity

Abstract

Two main pests have to be chemically controlled in French hazelnut orchards : *Curculio nucum* and *Phytocoptella avellanae*.

Recent developments in regulations on pesticide use, which risk to lead to a multiplication of sprays with less efficient pesticide treatments, have raised the prospect of outbreaks of secondary pests that were hitherto controlled naturally by beneficials.

Faced with this situation, it appeared important to identify populations of natural enemy species present in hazelnut orchards, to evaluate what non-target effects these coming chemical substances could have on populations of beneficials and finally, to search which cultural practices can be used to promote the return of predators into plots between two sprays.

The two first points were studied in 2006 and 2007 in five commercial orchards and in one wild orchard: the relative occurrences of the various categories of beneficials were quantified and the negative impacts of seven pesticides were compared. Several were found to be more likely to induce outbreaks of minor pests, due to their toxicity for beneficials that kill aphids or mites in June.

The third objective was approached in 2007 on eight-year-old trees growing in a plot edged by a natural hedgerow. Two levels of chemical control were compared in order to test whether it is possible to manage hazelnut orchards with minimal chemical control; the implication of environment in enhancing functional biodiversity was also observed.

It was concluded that, in a young orchard, restricting insecticides management to a single spray for nut weevil control does not induce an economically prejudicial damage rate, but what would be the outcome if a single spray control program were applied over consecutive years ? The natural hedgerow, the grass cover, and the open space contribute to predator and prey migrations; however, some vegetal species could provide shelter for the hazelnut weevil.

OBSERVATIONS ON THE BIOLOGY AND BEHAVIOUR OF *OBerea LINEARIS* L.
(COLEOPTERA, CERAMBYCIDAE) IN SARDINIA

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Keywords: hazelnut, longhorn beetle, *Oberea linearis*, young shoots

Abstract

In Sardinia, hazelnut is cultivated in the Barbagia di Belvì area (Nuoro) up to 1000 m a.s.l., over a surface of about 570 ha. In this area, a particularly striking hazelnut pest, given the strong visible impact of its attack, was *Oberea linearis* (L.) (Coleoptera Cerambycidae), whose larvae feed on young shoots.

As part of the national project Co.Ri.Bio., a three-year study was conducted taking into consideration the longhorn beetle biology and trying to understand if it was effectively a serious problem for hazelnut production. In order to fulfil these objectives, the following aspects were investigated: adult flight period; characteristics of the young shoots chosen by *O. linearis* to lay eggs; larval gallery development and time in which the young shoots appear dried up.

In Sardinia, the *O. linearis* flight period is short and concentrated in early June. More than 50% of its ovipositions were seen on very straight, vigorous and fruit-free young shoots. Young stems dried up suddenly and almost simultaneously about one month after the flight peak (early July) and nearly 86% of them dried up in a two-week period (within mid July). Until mid August, more than 50% of the larvae stayed in the dried up portion of the young shoots.

O. linearis, which was considered particularly worrying before our surveys, does not seem to cause substantial damage and it is potentially manageable through adequate pruning techniques.

ROLE OF TANNINS IN THE RESISTANCE TO MAJOR PESTS OF HAZELNUT CULTIVATED IN POLAND

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Keywords: *Corylus avellana* L., filbert aphid, filbert big bud mite

Abstract

The consequence of a hazel cultivation's wider area in Poland in recent years, and development of integrated methods for its protection, is of big interest for the cultivars which show the features of resistance to diseases and pests, apart from their productive values. In principle, the cultivars' resistance is extremely stable in the years, irrespective of the pest population number in the vegetation season. The purpose of the presented researches are to reveal the sources of resistance in cultivars of large-fruited hazelnut cultivated in Poland to two of the most dangerous pests, namely filbert big bud mite (*Phytoptus avellanae* Nal.) and filbert aphid (*Myzocallis coryli* Goetze). Four hazelnut cultivars showing significant differences from susceptible to moderate resistance to the both pests were tested in the outdoor and laboratory conditions. None of the tested hazelnut cultivars showed the total level of resistance to the both tested pests. 'White Filbert' cultivar showed partial resistance to *M. coryli*, while 'Hall's Giant' cultivar to *P. avellanae*; however, the partial and complex resistance to both pest was found in 'Luizen Zellernuss' cultivar. The highest susceptibility to filbert big bud mite and filbert aphid was found in 'Minnas' cultivar. The presented results show that the content of secondary metabolites, mainly tannins, was the most important source of constitutive resistance of the large-fruited hazelnut to the filbert big bud mite and to the filbert aphid. Other traits determining the lack of acceptance during the initial selection of host plants differ in individual hazelnut cultivars and they might be overcome by pests during plant settlement. Cultivation of hazelnut cultivars with increased resistance to both pests would be able to contribute the reduction of their population number. Consequently, it would decrease using insecticides, as well as the costs of hazel cultivation in our country.

THE CURRENT STATUS OF THE NEWLY INVASIVE HAZELNUT APHID
IN OREGON HAZELNUT ORCHARDS

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Key words: hazelnut aphid, *Corylobium avellanae*, hazelnut, pest management

Abstract:

Hazelnuts are produced in many countries, including the United States. Here hazelnuts are grown on approximately 15,000 hectares in the Willamette Valley, Oregon. This production area accounts for roughly 99 percent of U.S. production and 5 percent of world production. Current key insect pests in this area include filbertworm, *Cydia latiferreana*; filbert aphid, *Myzocallis coryli*; hazelnut aphid, *Corylobium avellanae*; filbert leafroller, *Archips rosanus*; and obliquebanded leafroller (OBLR, *Choristoneura rosaceana*). Of these, filbertworm and filbert aphid are perceived to be the most important. Before the mid 1980s, the filbert aphid was considered the only important aphid pest of hazelnuts in Oregon. The hazelnut aphid, a newly invasive species, was however first reported by the Oregon Invasive Species Council in October 2003 on hazelnut trees in the northern Willamette Valley in Oregon. Recent collections of this aphid from various orchards and wild habitats show that this pest has spread rapidly into many hazelnut production areas. This species however currently comprise a small proportion of the total aphid population in Oregon orchards. Preliminary data from field work during 2007 show that this species currently have low levels of parasitism compared to filbert aphid. Data show that this species prefer husks to feed on. In severe cases this feeding preference may negatively impact crop levels due to husks drying out prematurely. Levels of hazelnut aphid are therefore cautiously monitored in order to determine changes in species composition. Alternative IPM strategies in order to conserve biological control are discussed.

CHEMICAL CONTROL OF TRUE BUGS (HETEROPTERA: PENTATOMIDAE,
ACANTHOSOMATIDAE AND COREIDAE) TO PREVENT KERNEL DAMAGE
IN HAZELNUT ORCHARDS OF TURKEY

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Keywords: hazelnut, chemical control, Turkey, true bugs, kernel damage

Abstract

Insect pests cause substantial damage in hazelnut orchards. Some insect species of the Pentatomidae, Acanthosomatidae and Coreidae family feed on hazelnut kernels and cause quantity and quality problems. More than 15 insect species causing the aforementioned damage have been determined in Turkish hazelnut orchards until today. Among these insect species, Green shield bug (*Palomena prasina* L. Het.: Pentatomidae) has the highest density in Turkish hazelnut orchards. The main damage on nuts caused by these insects occurs mainly after the nut formation from June to the end of August. In general, there are no control measurements against these pests in Turkey in spite of obvious need.

In this study, the effect of chemical control applied for these insects on nut peculiarities was investigated in 2003. The study was conducted in the three Turkish provinces of Sakarya, Kocaeli and Düzce. Ten hazelnut orchards were selected and sprayed during the growing season. Five orchards were sprayed once and other five orchards twice. First sprays were carried out in 28-30 June, 2003 and second sprays were in 19-20 July, 2003. Half of each orchard was sprayed with insecticide and the other half was sprayed with water as control. Carbosulfan (Marshall 25 EC) was used as chemical in all experiments.

In harvest time, nuts from each orchard were collected and examined in laboratory after shelling in order to determine insect damage. Nuts were classified as empty, healthy and damaged.

As a result of the experiments, it was found that plots sprayed once and control plots showed minor differences in the nut damage caused by insects. When developed kernels were considered, damaged kernel ratio varied between 3.16-11.81% in plots sprayed once, and 4.21-21.65% in control plots. Spraying twice gave better results in preventing kernel damage. In all the experiments in which the spraying occurred twice, kernel damage decreased significantly in sprayed plots. Damaged kernel ratio varied between 1.08-4.45% in sprayed plots and 3.86-11.68% in control plots.

COSTITUTIVE AND INDUCED RESISTANCE IN HAZELNUT CULTIVARS

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Keywords: hazelnut cankers, induced resistance, acibenzolar-S-methyl, β -aminobutyric acid, potassium monophosphate

Abstract

The chemical inducers acibenzolar-S-methyl (BTH), β -aminobutyric acid (BABA) and potassium monophosphate (KH_2PO_4) were tested for their capacity to control hazelnut cankers caused by *Cytospora corylicola*, *Botryosphaeria obtusa* and *Biscogniauxia mediterranea*. Chemicals were applied twice by foliar spray (BTH and KH_2PO_4) or soil drench (BABA) on hazelnut plants, cultivars Tonda Gentile Romana and Nocchione, which represent the most common ones in the district of Viterbo (Central Italy). Treated plants were assayed for the induction in their tissues of pathogenesis related (PR) proteins β -1.3 glucanase, chitinase and peroxidase, as biochemical indicators of resistance. Beside the presence of constitutive isoenzymatic forms, the results show that the chemical inducers activated the differential induction of particular *de novo* synthesised isoenzymes of these proteins. Two dimensional electrophoresis were applied to demonstrate differences between protein species. Moreover, novel protein species previously reported from plant-pathogens interactions and some species with unknown homologues were reported and identified by using mass spectrometry. Hazelnut plants treated with the three chemical inducers of resistance were inoculated with the three pathogens and disease development and severity was evaluated.

GRAY NECROSIS OF HAZELNUT FRUIT:
A FUNGAL DISEASE CAUSING FRUIT DROP

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Keywords: *Fusarium*, hazelnut diseases, *Alternaria*, fungi, fruit drop, nut diseases

Abstract

In the early summer of 2000, a severe fruit drop was observed in several hazelnut (*Corylus avellana*) orchards located near Viterbo (Latium, Italy), resulting in a high yield loss. Dropped fruits showed a brown-greyish spot at the base of the nut which progressed into the fruit with discoloration of the pericarp and embryo tissues, often involving bracts and petiole. The severity of the fruit drop and the unusual type of symptoms suggested a thorough research to understand the etiology and epidemiology of the disease named gray necrosis (GN) on the basis of the symptomatology. The symptoms of GN differed from all other currently reported diseases of the hazelnut fruit. Investigations based on isolation from flowers and fruits, and artificial inoculations led to a definition of the first picture of the causal agents of the disease. *Fusarium lateritium* was the most frequently isolated from both fruit and cankers on twigs, and its occurrence is closely related to GN. Pathogenicity tests confirmed *F. lateritium* as the causal agent of "L" shaped cankers on twigs and shoots. Artificial inoculations with *F. lateritium* evidenced its role as primary agent of the GN disease. In addition, artificial inoculations confirmed the pathogenic attitude of small-spored catenulate *Alternaria* taxa related to *A. alternata* (*A. alternata*, *A. arborescens*, *A. tenuissima*). The role and timing of the different fungi in causing GN will be investigated.

APPLICATION OF GEOSTATISTICS IN STUDYING EPIDEMIOLOGY
OF HAZELNUT DISEASES: A CASE STUDY

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Keywords: dieback, GIS, geostatistics, Kriging, hazelnut diseases, climatic conditions

Abstract

New information management technologies, such as geographic information techniques (GIS) and geostatistics, have been already applied in the past in the study of spatially related data in plant pathology. In particular, geostatistics offer a mean to describe spatial continuity, an essential feature of many natural phenomena, such as the spreading of a plant disease. Various hazelnut diseases and their epidemiology are susceptible to be investigated by means of these technologies. "Kriging" is a regression technique used for the estimation or interpolation of spatially located and spatially correlated data. This work shows an example of the Kriging method applied to the study of the epidemiology of the Dieback hazelnut on Monti Cimini (Central Italy), in relation to climatic factors occurred in 6 years of observation. This method, properly adapted, is susceptible to be also applied to the study of other hazelnut diseases and even to several spatial phenomena interesting the culture. The hazelnut Dieback is a bacterial disease which has been affecting hazelnut orchards in Province of Viterbo since the 1980s. In the last years, many aspects were clarified but, on the other hand, other questions still remain unsolved about the epidemiology, such as the particular incidence of the disease on areas characterised by specific climatic features. The Kriging geostatistic method was applied in order to better explain the role of the temperature and of the rainfall on the progression of the disease in the last years. A major concentration of diseased and dead plants was observed in two peculiar areas of hazelnut cultivation: the first one on the outer part of the volcanic caldera of Lake of Vico, and the second one on the northern inner part of the caldera itself. The disease spread mainly in areas which were still interested by the hazelnut dieback since its first appearance. The results of the semivariogram parameters show a good spatial autocorrelation, especially in the period 1998-2000 and for the year 2003. Also, a high significance statistical correlation between the incidence of the disease and lower winter temperature, late frost injury or average rainfall, was found. Probably the hazelnut dieback can be described as a disease of complex aetiology.

TRIBOSOMAL AND AFLP ANALYSES ARE TOOLS FOR ENRICHING THE KNOWLEDGE OF HAZELNUT DIEBACK

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Keywords: AFLP, bacterial disease, *Corylus avellana* L., molecular marker

Abstract

Dieback of hazelnut is a bacterial disease that determines the decline of hazelnut (*Corylus avellana* L.) both in Northern Greece and Central Italy. Disease symptoms include the rapid wilting of branches and trees, which can be observed from spring to autumn. In this work, AFLP analysis has been used with the aim to discriminate among different bacterial strains picked up from plant material clearly showing the symptoms of dieback. The infected hazelnut plants were located in areas of Latium region, which are typically vocationed for the cultivation of hazelnut. AFLP-polymorphic fragments have been isolated, sequenced and analysed *in silico* to identify possible functions. Specific primers have been designed to transform the polymorphic fragments in SCAR. SCAR and ribosomal analyses have been conducted on the bacterial strains to link them to their area of diffusion.

DISEASES IN IPM HAZELNUT ORCHARDS
OF THE WEST BLACKSEA REGION IN TURKEY

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Keywords: virus, fungus, noninfectious, hazelnut

Abstract

Cultivation of hazelnut (*Corylus avellana* L.) is one of the considerable economic crop in Turkey, in particular, in the Blacksea Region. Hazelnut diseases are the other major detriment to hazelnut cultivation following insect pests in Turkish hazelnut orchards. Damage estimation varies from 20 to 50% depending on the cultural practices, treatment efficacy and environmental conditions. Although 33 diseases were reported on hazelnut as economic significant diseases up to now, a few of them were found to be economic significant in IPM orchards of the west Blacksea region in studies conducted in 1997-2005. A lot of disease symptoms were observed and six of them were found to have economic significance. Symptoms of *Apple mosaic ilarvirus*, powdery mildew, Nectria canker, Armillaria root disease and nutrient deficiency were observed in IPM orchards. The *Apple mosaic ilarvirus* symptom was determined in almost all IPM orchards.

INSECT PESTS OF STORED HAZELNUTS IN THE SAMSUN PROVINCE, TURKEY

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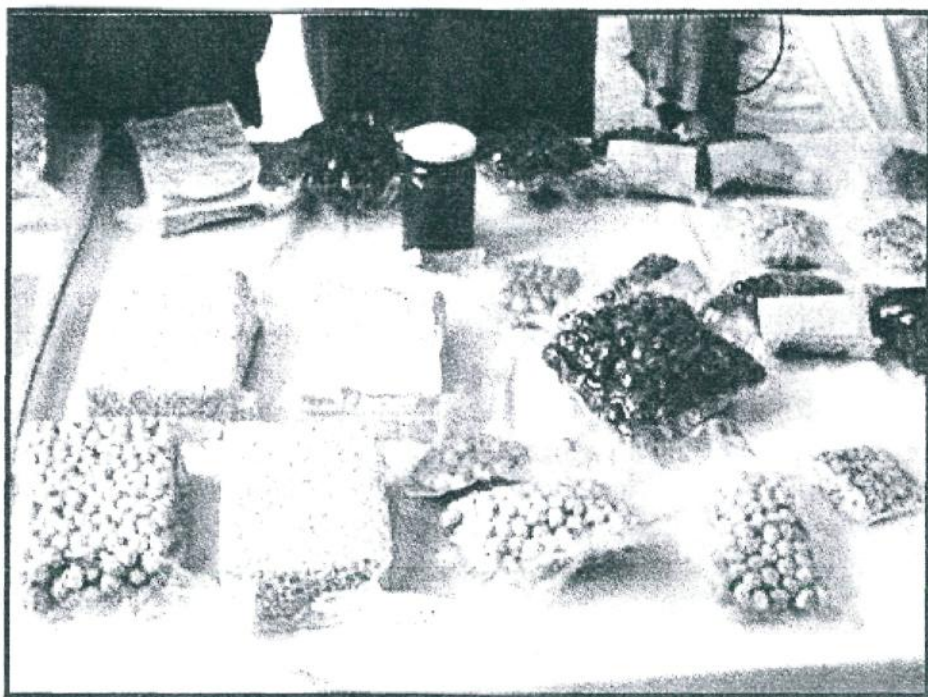
Keywords: hazelnut, processing plants, storage pests, Turkey

Abstract

Turkey is by far the world's leading producer and exporter of hazelnuts. They are processed at processing plants and stored in warehouses prior to distribution and export. Hazelnuts are vulnerable to infestations by insects which are the main pest group affecting the quality and quantity of stored products. This study determined the insect species and their population densities in stored hazelnuts during the summer of 2007 in the Samsun province of the Black Sea region of Turkey. Sub-samples of shelled, in-shell and cracked hazelnuts were randomly collected and mixed at each plant. A 1 kg hazelnut sample was then taken from each plant and stored at 25 °C and 60±5% in the laboratory. The samples were checked every two weeks and insects were identified and counted. Insects were found in all facilities. They were *Plodia interpunctella* (Hübner), *Ephestia cautella* (Walker), *Tribolium confusum* (Jacquelin du Val), *Tribolium castaneum* (Herbst) and *Oryzaephilus mercator* (Fauvel). *Plodia interpunctella* and *E. cautella* were the most common, and *Tribolium confusum* was more common than *T. castaneum*. All 4 species had maximum populations in July. *Oryzaephilus mercator*, which was the rarest, had maximum population in early September. In conclusion, insects are a potential problem in stored hazelnuts. Their number and damage should be closely monitored and treatments applied when appropriate.

ORAL SESSION N.5

Post Harvest, Quality and Industry



Chairman: *Joan Tous*

MOLECULAR MARKERS TO EVALUATE QUALITY AND SAFETY
OF ROASTED HAZELNUTS: AN OVERVIEW

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Keywords: hazelnut roasting, quality and safety, D-amino acids, acrylamide, HMF

Abstract

The roasting process contributes to the developing of Maillard-related compounds and to the consequent aroma development. Time, temperature, moisture and type of process influence the impact on the seed. Some toxic compounds were produced *de novo* during roasting. For example, the carcinogenic acrylamide (a Maillard-related compound, resulting from the reaction of asparagine with reducing sugars) and racemized D-amino acids can accumulate in roasted nuts. Acrylamide is probably carcinogenic to humans (IARC, Group 2A); the toxicity of D-amino acids is still under investigation.

In our study, Acrylamide and D-amino acids were evaluated i) in some industrial samples of TGL cv, roasted using different methods/plants and ii) in seeds roasted in conventional ovens in different conditions.

Acrylamide was recovered in all roasted samples (up to 200 µg/Kg). Acrylamide concentration during roasting showed a characteristic bell-shape profile. A significant impact was highlighted; concerning both protein-bound (i.e. D-Asp: 1,49% ± 0,08) and free D-amino acids (D-ala: 5,87% ± 0,03). D-amino acids showed a linear increase, proportional to the temperature. Other conventional markers (5-hydroxymethyl-2-furaldehyde, peroxides) useful to assess the quality of hazelnut were also considered.

This research will highlight the crucial parameters useful to obtain a "safe" roasting process confirming the need of a process optimization.

NONDESTRUCTIVE APPROACH TO MEASURE QUALITY OF HAZELNUTS DURING STORAGE

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Keywords: hazelnuts, storage, NIR-AOTF, MRI, electronic nose

Abstract

The aim of this work is directly related to the opportunity to apply non destructive technologies for quality determination on hazelnuts during their storage. Hazelnuts of different varieties were stored at different conditions and tested by non destructive techniques such as NIR- AOTF (portable instrument) and MRI (batch instrument). NIR analyses were performed with the intention to discriminate latent damage, oxidized hazelnuts, and fresh and stored hazelnuts. The instrument was able to efficiently discriminate the high quality hazelnuts from the stored ones or the hazelnuts with latent damage even directly from the spectra observation. MRI was used to discriminate Tonda Gentile Romana and Akakocha hazelnuts during the storage under nitrogen, carbon dioxide or air at low temperature. MRI was able to discriminate in term of t1 and t2 the different samples in accord with destructive analyses. MRI was able to discriminate fresh and stored dried hazelnuts. These hazelnuts were discriminated even by electronic nose. All these applications have provided interesting information about the potentiality of some non destructive applications in recognizing qualitative attributes of hazelnuts.

INFLUENCE OF PEDOCLIMATIC CONDITIONS AND ORCHARD MANAGEMENT
ON FRUIT QUALITY CHARACTERISTICS
IN CV.S TONDA GENTILE ROMANA AND TONDA GIFFONI

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Keywords: hazelnut, pedoclimatic conditions, quality, chemical composition

Abstract

Hazelnut represents a significant component of the fruit industry in the Lazio region of Italy, but it is struggling with competition on the international market. One approach to restore the competitive ability of the industry is improving quality assessment and developing strong local association of the product in the perception of the consumer.

It is therefore important to define and evaluate qualitative aspects of hazelnut cultivars such as Tonda Gentile Romana and Tonda di Giffoni related to pedological and climatic conditions, as well as orchard management practices in the typical areas of cultivation.

The following data were collected for both cultivars in five farms located in the Monti Cimini area (Viterbo), including: chemical and physical soil properties, leaf analysis, nut and seed size, percentage of kernel, blanching score, kernel flavor and texture, chemical composition.

Multiple years of observations showed that the combination of pedoclimatic conditions and orchard management practices clearly influences nut and seed traits; particularly, higher levels of organic matter and nitrogen in the volcanic soils of the considered orchards correspond to improved kernel/shell ratio and higher taste panel scores.

Chemical composition of kernels is also influenced by different cultivation areas, with significant differences in quality and quantity of amino acids, carbohydrates and aromatic compounds, which implies the potential for identifying product origin on a chemical basis.

WHITE SPOTS IN HAZELNUT KERNEL: SIMPTOMS, CAUSES AND QUALITY LOSS

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Keywords: green bugs, *Nezara viridula*, *Elamuscha betulae*, quality loss.

Abstract

White spots in the hazelnut kernel may involve up to 60% of total crop, depending on the geographical origin, climate of the year and cultivars. Affected kernels show one or more white zones of different extension that are soft, not wet nor deformed. Such damaged kernels become rancid at least twice faster than normal ones, and whitish spots become more evident after roasting and peeling the kernels, which implies lower prices in the industrial market.

In order to determine the origin of this affection, several studies were carried out since 2004 to 2006, until the real cause was established. These studies included hazelnut sampling at different ripening times, different cultivars, insect trapping, microscopic and macroscopic studies of affected kernels, and several preventive strategies for hazelnut trees.

Fruit sampling in different dates showed that the affection begins at the end of July (in Catalonia, Spain), when the kernel is fully developed and the shell is almost lignified. Microscopic studies revealed that insect biting are the cause of the white spots, while trapping and protective studies pointed out that the bugs *Nezara viridula* L. and maybe *Elamuscha betulae* are responsible for kernel white spots. Earlier, green bugs were considered to be responsible for kernel damaging and it was accepted that they bit hazelnuts only in the first steps of nut development, when the shell is not lignified yet, and they are responsible for black spots and large deformations in the affected kernels. No evidence has been reported relating green bugs with whitish spots appearing in the last stages of fruit development, when the shell is almost fully lignified.

Future studies will consider chemical spraying on hazelnut trees at different stages, with different products, in order to prevent green bug attacks to hazelnut kernels.

PHENOLIC CHARACTERIZATION OF SOME HAZELNUT CULTIVARS FROM DIFFERENT EUROPEAN GERMPLASM COLLECTIONS

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Keywords: *Corylus avellana* L., local germplasm, phenolic compounds, HPLC

Abstract

Sixty-one cultivars, principally the main national varieties or some endangered old cultivars from six countries (France, Greece, Italy, Portugal, Spain and Slovenia) were analysed for their phenolic composition in the frame of the European SAFENUT (Safeguard of hazelnut and almond genetic resources: from traditional uses to novel agroindustry opportunities) project.

Using a high-performance liquid chromatograph (HPLC) with a diode array (PDA) detector, the content of phenolic compounds was analyzed in extracts of the kernels. Gallic, chlorogenic, sinapic, p-coumaric, ferulic and ellagic acid, as well as epicatechin and rutin, were individually identified in all cultivars tested. A large variation in the phenolic content between cultivars was noted. Intercultivar variability was the most expressed in the sinapic, ellagic and p-coumaric acid, as well as in the rutin. The cultivar 'Casina' from France had the highest sum (251.01 mg/kg) of all the identified phenolics. On the contrary, the Greek cultivar 'Polycarpus' was the poorest in phenolic compounds et al. (49,16 mg/kg).

In the chromatograms, two interesting and distinctive peaks were expressed besides the compounds mentioned above. Using the listed standards, it was impossible to determine the compounds which belong to those two peaks. They were called a and b, and they were expressed as equivalents of the chlorogenic acid. 'a' and 'b' were the most abundant phenolics in all studied cultivars (mean value for a was 38.95 mg/kg, and for b was 39.74 mg/kg). With the aim of identifying them individually, an improved method, MS-HPLC, will be used next year.

Phenolic compounds have shown disease preventing and several health promoting effects. Nowadays, they have received great attention among researchers due to their antioxidant activity. The ellagic acid is one of the most important polyphenolic antioxidant. In our study, it appeared in concentrations between 0.56 mg/kg ('Polycarpus', Greece) and 18.55 mg/kg ('Porpurea', Portugal).

Considering the different content of polyphenolics, it can be concluded that the tested cultivars vary in their antioxidant capacity. Consequently, they vary also in their beneficial impact on human health. The antioxidant activity of the kernels in different cultivars will be determined in the following two years.

MONOUNSATURATED FATTY ACID ISOMERS OF
GEVUINA AVELLANA MOL.
NUT OIL AND UV RADIATION FILTER

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Keywords: *Gevuina avellana* Mol., monounsaturated isomers, UV radiation filter

Abstract

The research programme for *Gevuina avellana* Mol. (Gevuin), a tree native from Chile, has developed genotypes with interesting results for phytotherapy and cosmetic purposes. The physical and chemical characteristics of nut oil has several uses as skin care, for restoring treatments (turgor, elasticity, healing) and as UV radiation natural filter. From 2003 to 2007, nut oil of selected clones obtained by cold extrusion was analyzed to determine the lipid composition and UV filter quality. HPLC and GC-MSD methods were used to determine the fatty acid content profile. UV blocker power from different samples was analyzed with a Milton Roy Array 3000 spectrophotometer. Principal monounsaturated fatty acids were: C_{16:1}, C_{18:1}, C_{20:1} and C_{22:1}, with several isomers and a wide range of variation among different genotypes. The maximum value of oil absorbance was in the range of 285 – 315 nm (UVB), with important values in the upper range of UVC (250 – 285 nm) and in the lowest of UVA (315 – 350 nm). This effect is in part due to the particular lipid structure of some monounsaturated fatty acid isomers. The effect of the positional double bond within the acyl chain ($\Delta:\omega$), molecular weight and carbon number, could explain the UV filter behaviour of Gevuin oil.

COUNTRY REPORT: THE EMERGING HAZELNUT INDUSTRY IN CHILE.
WILL IT BE SIGNIFICANT?

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Keywords: global market, Chile, hazelnut industry

Abstract

There is significant interest in the rapid development of the hazelnut industry in Chile. From the 2007 census, it is estimated that over 5,000 hectares of hazelnut orchards have now been planted in Chile with an additional 1000 hectares being added yearly. With the average age of the planted trees put at 2 years, these orchards will not be providing serious volume before another 5-7 years or so. This emerging industry faces significant challenges in production, infrastructure and marketing. At the production level, the predominant variety is called "Armengoli Barcelona" which appears to be large Barcelona-like nut but its actual type is unclear. There is a large variety of pollinizers being planted with significant uncertainty as to which varieties will prove optimal. Although growth rates of the trees are encouraging, the industry has yet to prove the productivity of areas being planted. There is a role for a professional nursery industry to help address these issues. Infrastructure for the handling of the crop has yet to be established. A key and immediate issue is the stabilization of the inshell crop through drying. Marketing also remains a challenge. Although there are already indications of buyer interest by international food manufacturers such as Ferrero, accessibility of the crop to World markets remains to be demonstrated. The Hazelnut Growers of Oregon, an established agricultural cooperative based in Oregon, USA has established local operations to assist in the development of this emerging industry. It is recruiting grower members through the provision of agronomic information, the organization of basic infrastructure and the eventual purchase and movement of product into its expanding global markets.

HAZELNUT PRODUCTION AND INDUSTRY IN IRAN

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Keywords: Iran, hazelnut industry, production, wild trees

Abstract

Iran is one of the most important and well known centers of origin of most plant species in the world. Presently, wild plants of hazelnut constitute the predominant vegetative cover of many Iranian provinces like Ardabil, Gilan and others. Hazelnut cultivation has a privileged position in relation to the other horticultural crops in the country, because it represents a valuable source from a socio – economical point of view, and also because of its notable compatibility and development potentiality in the other Iranian regions. Comparing the statistical curves of hazelnut production on the basis of regional yields, it becomes possible to deduce conclusions on the factors that caused fluctuations of the yields within the country and in the world during the last decade. In this article, other aspects of the hazelnut situation have been pointed out ,such as: production and cultivation areas, agro ecological regions, present situation, issues and constraints, socio-economic importance of the hazelnut industry, prospects of research and development ,government policy, national service, and research organisms.

Conventional and alternative use of biomasses derived from hazelnut cultivation and processing

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Keywords: thermo-chemical conversion, gasification for power, CHP and polygeneration, pruning

Abstract

Biomass is one of the main sources for energy production; indeed, due to its chemical and physical peculiarities, it can be used very well in thermo chemical processes such as combustion, pyrolysis and gasification.

Furthermore, the considerable variability of bio-fuels that can be produced allows the experimentation of new technologies which, with a higher performance, are able to produce not only heat but also electric power.

On the other hand, due to problems in supply and technology, the main disadvantage of such energetic systems consists in its difficult application in a large scale production.

The present study aims to highlight the possible use of biomasses in small energetic districts such as the area of Viterbo: the exploitation of wood and cellulose biomasses are described, and the possible application with flowing bed technology is considered.

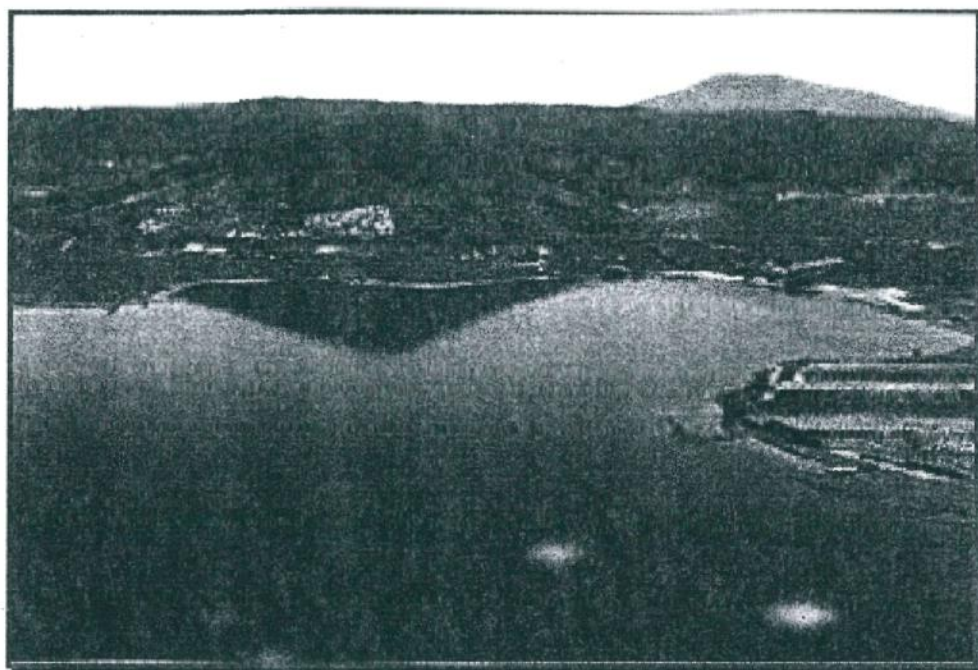
The objective of this study is to technically test the feasibility of a biomass supplied system, taking care of stocks availability and amount, use of the gasification process based on flowing bed technology, chemical characteristic of syngas and energy power production.

Considering the winter trimming of *Corylus avellana* on a surface of 48,7 ha, produced during the 2004/2007 period, the resulting annual amount of biomass ranges from 1.5 to 3.1 t*ha⁻¹ with a mean value of 2.4 t*ha⁻¹.

Considering a kg of biomass/producible kWe ratio equal to 1.3, given by the gasification process based on fluidize bed technology, it is possible to estimate a potential production of electric power of 90 MW.

ORAL SESSION N.6

Marketing, Economics and Policies



Chairman: *Mehmet Bozoglu*

AN ECONOMIC EVALUATION OF THE IMPACT OF PLANTING EASTERN FILBERT BLIGHT RESISTANT HAZELNUT CULTIVARS IN OREGON, USA

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Keywords: annual net return, accumulated net returns, net present value, internal rate of return, cash flow analysis, hazelnut establishment and production costs

Abstract

Since 2000, research and development efforts by plant breeders have significantly improved the quality of plant stock available for hazelnut producers. In 2000, trees began to fruit in year 4 producing approximately 68 kg/tree and 1068 kg/tree at full production in year 12. Hazelnut plants on the market today have been selected for earlier and more uniform fruit bearing resulting in 68 kg/tree in year 3 and 1350 kg/tree at full production. In addition to enhanced fruit bearing characteristics, immunity to Eastern Filbert Blight, has been achieved in some hazelnut cultivars. This breakthrough has reduced pesticide applications in hazelnut orchards having a positive impact on the environment and the economic sustainability of producers. In 2000, with the plant stock available then, producers could expect to generate a positive cash flow, gross income minus cash costs, of US\$22 per hectare in year 9, compared to US\$163 in year 5 for the EFB resistant planting available today. A comparison of the cumulative cash flow in year 10, the year all cash cost are recovered in the modern EFB resistant plantings, the EFB resistant planting with a US\$1222 per hectare surplus, and the EFB susceptible planting at -US\$8822, a difference of US\$10044 per hectare. At the end of the establishment period, the EFB immune planting returns US\$7785 per hectare over cash costs to the grower, as compared to -US\$6381 for the EFB susceptible planting, a difference in cumulative cash flow of US\$14166. The EFB resistant varieties available to Oregon hazelnut producer enhanced economic feasibility by reduce cash flow demands.

PRODUCTIVITY AND PROFITABILITY OF TURKISH HAZELNUT PRODUCTION

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Keywords: agricultural productivity, hazelnut production, inheritance law, agricultural subsidy, regional development

Abstract

This paper examines the Turkish Hazelnut Industry in the Black Sea Region in Turkey and identifies the key issues that challenge both the region and the industry. Unsustainable government policies such as price subsidies and absorption of overproduction to maintain the subsidized prices have led to years of market price instability. This paper ascertains that such policies are important in understanding the region's issues but they are also just a beginning. The problems burdening the Turkish hazelnut industry are expansive in scope and complex in nature. This paper explores why the past and current market prices for this crop were/are insufficient for producers by conducting an extensive review of literature pertaining to Turkish Hazelnut Production. A non comprehensive productivity comparison was conducted with other hazelnut producing regions found both within Turkey and outside by using the Turkish Hazelnut Producer Cooperatives Union's (Fiskobirlik) annual national and international production and export data. Based on the findings of such analysis, this paper claims that the problem of unsatisfactory market prices is closely related to farm structure. Using interviews conducted with key industry specialists, having previously done econometric studies and a statistical analysis based on the Turkish Statistical Institute's (Turkstat) 2001 Agriculture Census, this paper investigates the relationship between factors such as: the average farm size per farming unit or number of farm partners, the number of occupations per farmer, the cost of production and productivity. Relatively low productivity, as a result of the declining average farm size in the region, has negative effects on the profitability of hazelnut farming in Turkey. This paper also discusses the major underlying causes of the decline in the average farm size (i.e. inheritance laws) and, in the final section, examines a number of preventative measures and policies that have been implemented by other developing regions.

THE FIRM SIZE, FARM SIZE, AND TRANSACTION COSTS:
THE CASE OF HAZELNUT FARMS IN TURKEY

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Keywords: hazelnut farming, farm size, farm management, monitoring, farm economics

Abstract

This study analyzes the determinants of the size of the hazelnut farms in Turkey within the framework of the theory of firm and transaction costs (the costs of using the inputs necessary for production). This study argues that, for a farm production function, land is a complex input with many transaction cost-increasing interactions with nature. Natural effects, such as land slope and variation in the weather conditions, can increase transaction costs.

This study utilizes two separate data sets in order to test if the predicted relationship between transaction costs and farm size holds. The first data set explores the individual characteristics of hazelnut farmers. The second data set explores the regional farm characteristics across hazelnut production regions. Based on the OLS and IV estimation results, it is found that holding other factors constant higher land slope and higher variation in rainfall cause a decrease in the size of the hazelnut farms. The study offers implications for farm size related policy options that target the inheritance, transfer, and lease of hazelnut farms.

ECONOMICS OF ORGANIC AND CONVENTIONAL HAZELNUT PRODUCTION IN SAMSUN PROVINCE OF TURKEY

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Keywords: economics, organic agriculture, cluster analysis, hazelnut, Turkey

Abstract

Understanding the economics of organic agriculture is crucial for policy makers in order to support organic production, and for producers in order to facilitate the conversion of their lands to organic production.

The aim of this research is to compare organic and conventional hazelnut producers, in terms of their socio-economic characteristics, production systems and economic performance.

The main data were gathered by means of surveys of 64 randomly-selected conventional hazelnut producers and all the organic hazelnut producers (39) living in villages of the Terme district of Samsun, Turkey in 2005.

The results revealed that, as compared to conventional hazelnut producers, organic hazelnut producers were more educated, had larger hazelnut areas, and spent more time on agricultural activities. This research used also cluster analysis to define relatively similar farmers from both production systems, and to compare variables. Organic producers needed more labor, especially hired workers, and used more lime, organic fertilizer and insect traps, while conventional producers used more synthetic inputs. Organic producers had lower costs of production and had an higher income.

It is recommended that the organic producers be supported financially, and assisted by research and extension services in order to produce and use their own inputs, rather than purchasing from outside. They should also be encouraged to establish associations to increase their marketing efficiency.

AGRICULTURAL INFORMATION SYSTEMS AND COMMUNICATION NETWORKS
FOR ORGANIC AND CONVENTIONAL HAZELNUT PRODUCERS
IN SAMSUN PROVINCE OF TURKEY

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Keywords: agricultural information systems, communication networks, organic agriculture, hazelnut, Turkey

Abstract

This research presents an example for the analysis of agricultural information systems (AIS) and communication networks (CN). The information systems and their communication networks for organic and conventional hazelnut producers in Samsun province of Turkey were analyzed and compared in order to identify the problems of the systems and to improve their performance.

Structured interviews were used to collect main data from 64 randomly-selected, conventional hazelnut producers and from all the organic hazelnut producers (39) living in the study area. This research is a longitudinal study; indeed, a similar research was conducted in the same area in order to compare and to show the historical development of the information systems.

The main function of the agricultural information systems was the dissemination of hazelnut-related information. In general, AIS theory and CN illustration presented an holistic approach and helped to understand the strengths and weaknesses of the current systems which were studied. Specifically, the lack of information supports from the institutional (both public and private) and mass media information sources resulted in developing personal (i.e family members, other producers and leader farmers) information sources to exchange information and diffuse technology among the producers within their villages. More functional cooperation and information exchange between personal and institutional information sources are required in order to stimulate conventional hazelnut producers to convert their farms into the organic production system.

POLICY IMPACT ON THE DIFFUSION OF ORGANIC HAZELNUT CULTIVATION IN THE MONTI CIMINI AREA

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Keywords: organic agriculture, environmental policies, hazelnut production

Abstract

The Monti Cimini show environmental and socio-economic characteristics which have determined a noteworthy specialization in the hazelnut and chestnut production. Hazelnut is cultivated in about 10,000 farms, with a total UAA of 18,000 ha and an average production of 35-40,000 t/year, equal to 4-5% of the world's total. Chestnut farms are more than 2,000, with an area of 2,800 ha and an average production of 8,000 t/year, equal to 10-15% of the national total.

In such a particular situation, organic agriculture has undergone an atypical evolution as well, highly influenced by the product market and, above all, by the presence of EU policies for environment and agriculture.

In the Monti Cimini area, the hazelnut farms managed in an organic regime have reached 4% of the total with a UAA of more than 2,300 ha, equal to 13% of the total, in a few years. The organic hazelnut cultivation shows remarkable differences within the area as compared to the conventional one, both from a structural (the average dimension of organic farms is almost four times bigger than the conventional ones) and territorial diffusion point of view. This second diversity is due not only to technical and phytopathological reasons, but also to the widespread presence of chestnut fruit trees. This last cultivation, which is easily managed in an organic regime and benefits from the communitarian aid even if being part of the forest species, is present in the areas where a "dragging" effect towards the organic farming is mainly operative on the hazelnut as well.

In the period examined in this study (1999-2004), the organic chestnut cultivation registered an inverse trend as compared to the hazelnut one; indeed, although it concerns 10% of farms and almost 40% of the area, a contraction was observed, which led to a reduction of 22% in the number of farms and of 11% in the areas.

The aim of the paper, after a detailed description of the evolution of the organic hazelnut and chestnut cultivation in the Monti Cimini area, is to interpret this phenomenon considering the particular spatial and temporal articulation of policies on aid to organic agriculture.

INCOMES AND PROFITABILITY IN THE HAZELNUT FARMS
OF THE AREA OF MONTI CIMINI

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Keywords: income, profitability, representative farms, input prices increase

Abstract

The study assesses the economic impact of recent price changes on the production of hazelnuts in Monti Cimini and Sabatini. The analysis focuses on the conventional hazelnut production and examines the economic data of various typologies of farms that represent the production of that territory. The structural characteristics and the production technologies are reconstructed for each one of those typologies. This defines the framework of revenues, of cost of production and of incomes achieved in the area. The profitability levels, the employment of resources and the impact of the public interventions of public for regulation and for support of the sector are assessed. In particular, the analysis compares the profitability levels in the 2005/2006 period, with the new framework that presents a significant increase in prices of inputs. This identifies the kind of farms that may be more exposed to serious crisis and the ones which, instead, have still interesting possibility of affirmation.

THE EFFECTS OF TURKEY'S ACCESSION TO THE EUROPEAN UNION ON HAZELNUT MARKETS

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Samsun (Turkey)

Keywords: welfare effects, liberalization, hazelnut market, EU enlargement, partial equilibrium analysis

Abstract

Turkish agricultural policy should be harmonized with the EU Common Agricultural Policy before the accession. It is expected that this harmonization would make important impacts on both Turkey and the EU. As it is well known, Turkey is the major hazelnut producer and the EU is either one of the main producer and importer in the world. In this paper, the welfare effects of liberalizing hazelnut trade between Turkey and the EU is analyzed by applying a partial equilibrium analysis to 1980-2006 data. The results show that liberalization of the hazelnut market and harmonization of the hazelnut policies cause a decrease in hazelnut prices. In spite of the decreasing domestic supply, hazelnut demand would be increased by these low prices both in Turkey and the EU. It is estimated that the EU hazelnut import from Turkey and Turkey's hazelnut import from third countries would be increased. In welfare terms, while hazelnut producers would lose, consumers and taxpayers would gain both in Turkey and the EU. Overall, gains for consumers and taxpayers are estimated to be higher than the losses suffered by suppliers, and therefore net social welfare can be improved by the hazelnut market liberalization. However, Turkey should conform to further issues such as residual food security rules, environmental measures and higher product quality.

THE TRADE EFFECT OF EUROPEAN AFLATOXIN STANDARDS ON TURKISH HAZELNUT EXPORTS

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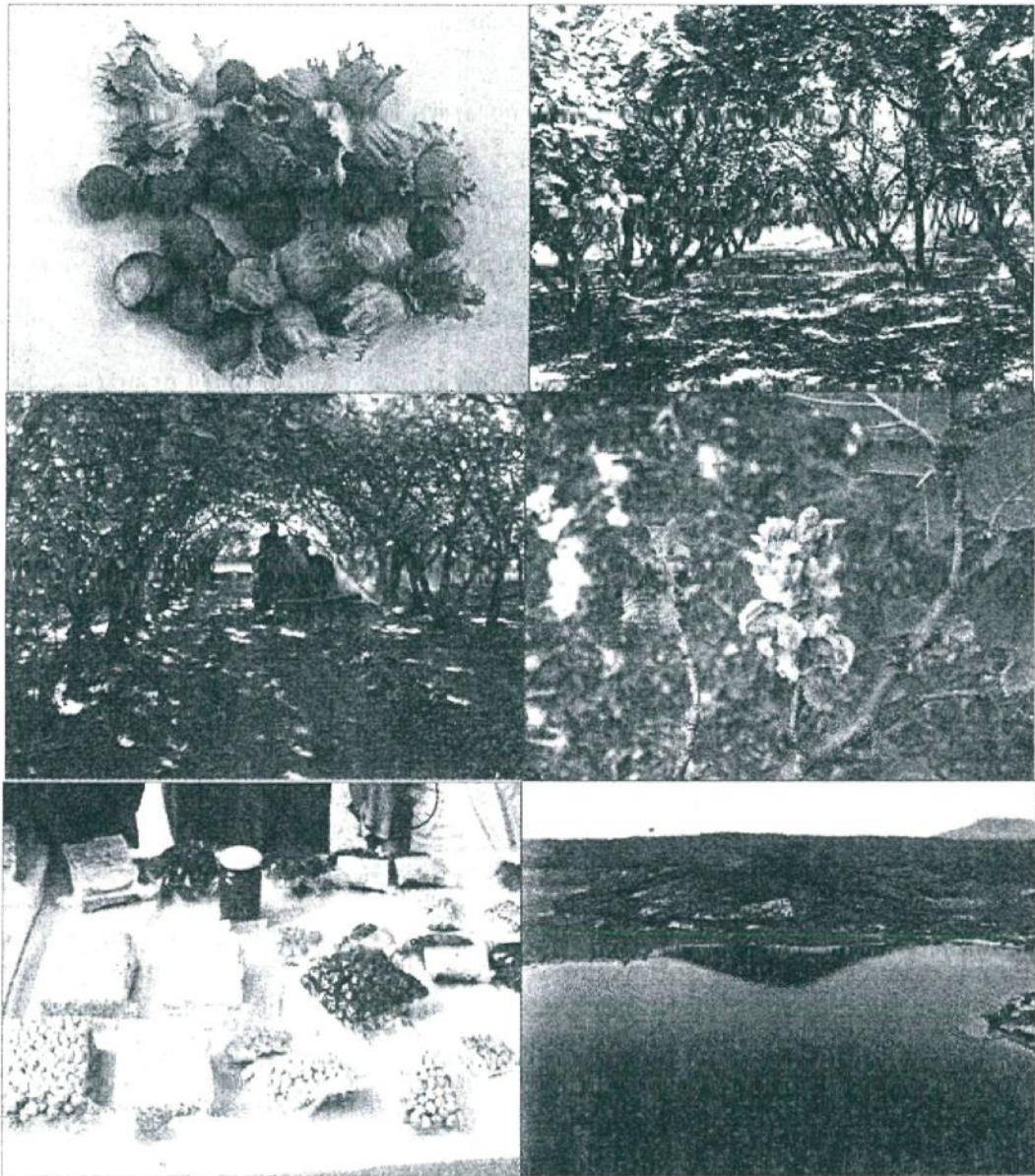
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Keywords: aflatoxin standards, gravity model, food safety, hazelnut trade

Abstract

Turkey is in the first rank for hazelnut export to the European Union (EU) market. The EU has an import regulation for hazelnuts, including aflatoxin standards, which is obeyed compulsorily by importer countries. Therefore, this standard affects mostly Turkish export due to its market share of hazelnut. This study aims to quantify the impact of harmonized aflatoxin standards. Hence, a gravity model is employed to estimate the impact of changes at different levels of the standard which is based on protecting the domestic market in the EU, in contrast with international standards. The analysis is based on trade and regulatory survey data for 15 European countries and Turkey between 1990 and 2005. Empirical results from the study suggest that the implementation of the EU aflatoxin standards has a negative impact on Turkish hazelnut exports to the EU market.

POSTER SESSION



Chairman: *Roberto Botta*

VALORISATION OF LOCAL *CORYLUS AVELLANA* L. GERMOPASMM. Aramini⁽¹⁾, M. Spera⁽²⁾, V. Di Giammatteo⁽³⁾, L. Bacchetta⁽³⁾⁽¹⁾ International Doctoral Program in Agrobiodiversity, Sant'Anna Higher School, c/o ENEA Casaccia, Via Anguillarese 301, 00123 Roma (Italy)⁽²⁾ Consorzio di Ricerche Applicate alla Biotecnologia (CRAB), Italy⁽³⁾ ENEA, Dipartimento Biotecnologie, Agroindustria e Protezione della Salute, Via Anguillarese 301, 00123 Roma (Italy)

Keywords: Genetic resources, *on-farm* conservation, characterization, Tonda Gentile Romana

Abstract

So far, the maintenance of genetic resources is accomplished through *ex situ* gene banks.

Complementarily, the conservation is also organized *in situ* in the agro-systems where the current diversity has been maintained. The evaluation of genetic material *in situ* allows to preserve the relationship between species and their environment, taking into account the continual interaction between physical factors, human factors and crops. In the last years, this concept has evolved. Farmers have become the actors of the creation and maintenance of the present diversity, at all levels of the biodiversity organization: genetics, population, ecosystem landscape.

Italy, the world's second largest producer, boasts several traditional cultivars, which are mainly cultivated in Campania, Latium, Piedmont and Sicily. In addition, a large number of local genotypes are cultivated on small areas for the local market or are handed on from father to son for their interesting agronomical traits or organoleptic qualities. Often, these genotypes represent an interesting income for the sustainable agricultural system and precious food for traditional local use.

The characterization of the autochthonous genetic resources plays an important role in the valorisation of traditional clones, as well as in choosing the useful germoplasm that should be conserved. ENEA in collaboration with Producer's Associations and local Regional Institutions (ARSIAL, Comunità Montana dei Cimini, Riserva Naturale del Lago di Vico) carried out a survey in the local farms of the area of Viterbo in order to identify clones with distinctive agronomic and commercial traits. The selected clones were characterized on the basis of descriptors and analyzed by means of a molecular and biochemical analysis. A preliminary study on the intra-specific genetic variability of cv Tonda Gentile Romana was performed on clones conserved in the *in situ* collection of the Monti Cimini Mountain Community. Moreover, a recovery of *on-farm* conserved hazelnut ecotypes was carried out in different Italian regions to retrieve the maximum genetic diversity in the extinction progress.

EVOLUTION OF A SSR LOCUS FROM *C. AVELLANA* L. IN THE GENUS *OSTRYOPSIS*
AND OTHER FIVE GENERA OF THE *BETULACEAE*

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Keywords: *Betulaceae*, *Ostryopsis*, hazelnut, microsatellite

Abstract

A mutation at a SSR locus, which was developed from *C. avellana*, generated a (CT)_n(AT)_m microsatellite in the genus *Ostryopsis* from (CT)_n microsatellite in the genus *Corylus*. TA Cloning System of ToYoBo and CEQTM8000 DNA sequencing system were used to identify variation of repeat sequences at the locus of two *Ostryopsis* species (*O. davidiana* and *O. Nobilis*) and 15 species of other five *Betulaceae* genera. DNA sequencing for PCR products from four *Betulaceae* genera (*Alnus*, *Betula*, *Corylus*, *Carpinus*, and *Ostrya*) showed that (CT) repeats also appeared at same locus of 15 species of the five genera, although base deletion and substitution was observed in (CT)_n microsatellite sequences of the four genera (*Alnus*, *Betula*, *Carpinus*, and *Ostrya*). Our result suggested that the mutation probably happened in the ancestral plant of the *Ostryopsis*, which was presumed to be generated from a Paleocene fossil genus-*Crenea*, before two extant *Ostryopsis* species were evolved. Sequencing result for 95 genotypes of two *Ostryopsis* species and other five *Betulaceae* genera did not find (CT)_n(AT)_m microsatellites of <13 repeat units and (CT)_n repeats of < 6 repeat numbers. Our observation for (CT)_n(AT)_m microsatellites from 80 accessions of two *Ostryopsis* species also presented that the average length of (CT) repeats was only 1.2 times longer than that of (AT) repeats in all 18 length classes. Based on the facts, the shortest (CT) repeats of ≥ 6 repeat numbers in all the length classes, only two variable internal cores at the length class of 13 repeat numbers, almost same lengths between two motifs of (CT)_n(AT)_m microsatellites, almost same flanking sequences and existence of (CT) repeats of ≥ 6 repeat numbers at the locus of 17 species of the six *Betulaceae* genera, we considered that recombination or an inserter of (AT) ≥ 6 repeat probably originated (CT)_n(AT)_m proto-microsatellite from perfect (CT)_n repeat and replication slippage was only responsible for expansion of (CT)_n(AT)_m microsatellite after genesis of (CT)_n(AT)_m proto-repeat from (CT)_n repeat.

ANALYSIS OF GENETIC DIVERSITY AMONG SIX CORYLUS SPECIES
DISTRIBUTED IN CHINA USING MICROSATELLITE MARKERS

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Keywords: *Corylus heterophylla*, *C. mandshurica*, *C. yunnanensis*, *C. ferox*, *C. chinensis*, hazelnut

Abstract

17 SSR primer pairs of *C. avellana* successfully amplified good PCR products from 81 genotypes of six *Corylus* species in China. PCR products were separated on 6% polyacrylamide gel containing 7 M urea and gels were treated with silver nitrate using a "DNA Silver Staining System" kit (Promega). Variable lengths of microsatellites at some SSR loci of six *Corylus* species were identified by TA Cloning System of ToYoBo and CEQTM8000 DNA sequencing system. A total of 177 alleles, ranging from 4 to 15 at each locus, were found, with an average level of 7.88. Genetic variability in *C. heterophylla*, *C. mandshurica*, *C. heterophylla* var. *sutchuanensis*, *C. yunnanensis*, *C. ferox* var. *thibetica* and *C. chinensis* was investigated with CERVUS 2.0 software. In comparison with low values of PIC and H_e in wild populations of other species and varieties, high PIC and H_e in a wild population of *C. heterophylla*, which grew in relatively vast areas of north China, were up to 0.89 and 0.79 respectively. Based on analysis of shared alleles for all accessions, the genetic distance and a UPGMA dendrogram were constructed for six species and varieties of the genus *Corylus* with POPGENE 32 software. Accurately separating tree and shrub species, Cluster analysis showed that the genetic relationships among them calculated by the SSR markers were almost same as those obtained with traditional taxonomy. Furthermore, genetic relationships of three shrub species and varieties (*C. heterophylla*, *C. heterophylla* var. *sutchuanensis* and *C. yunnanensis*) were correspond to their geographic distributions in China. Our study suggests that SSR of *C. avellana* is a powerful tool for construction of inter-specific genetic map, evaluation of genetic diversity in wild population and conservation of wild genetic resources of six *Corylus* species in China.

ADVANCED SELECTION AND CULTIVAR PERFORMANCE OF HYBRID HAZELNUT IN CHINA

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Keywords: *Corylus avellana* L., *Corylus heterophylla* Fisch, hybrid, cultivar

Abstract

Hazelnut (*Corylus heterophylla* Fisch) has been well known since the ancient times and widely distributed in northern China. Compared with European hazelnut (*Corylus avellana* L.), *Corylus heterophylla* Fisch has a smaller nut size, but it has a very good winter hardiness. An interspecific breeding program was initiated in 1979 in China. The aim of this program included good climatic adaptability, high and constant productivity, bigger nut size, good kernel quality, high winter hardiness.

Hazelnut selections from the breeding program of the Economic Forestry Research Institute of Liaoning Province were evaluated in 4 yield trials to cultivar release. Trials of advanced selections have been established since 1990. Plantings established in 1999 and 2002 are discussed in this paper.

The 1999 trial contained 21 selections plus 'Dawei', the highest yield of the named cultivars in China. The 2002 trial contained 15 selections plus 'Dawei'. Data were collected on tree size, nut and kernel yield, and quality from 2001 to 2004. 4 selections had cumulative nut and kernel yields greater than 'Dawei'; 1 selection had better cold hardiness than 'Dawei'. Of these selections, 84-349, 84-524, 84-226, 85-41 were released as the 'Liaozhen1', 'Liaozhen2', 'Liaozhen3' and 'Liaozhen4' respectively, and 3 selections continue to be evaluated.

SEVERAL HAZELNUT CULTIVARS OF INTERSPECIFIC HYBRID

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Keywords: *Corylus avellana* L., *Corylus heterophylla* Fisch, hybrid, cultivar

Abstract

Hazelnut (*Corylus heterophylla* Fisch) has been well known since ancient times and widely distributed in northern China. The European hazelnut (*corylus avellana* L.) has been introduced into China in the 19th century, but it had not been used as a kind of nut crops till now in China. Compared with the European hazelnut, the nut weight of *Corylus heterophylla* Fisch is lower, and the yield is poor, but it has very good winter hardiness.

A breeding program of interspecific hybridization between *Corylus heterophylla* Fisch and *Corylus avellana* L. was initiated in 1971 in the Economic Forestry Research Institute of Liaoning Province (EFRI). Since 1991, hazelnut variety and advanced selection trials were carried out in different climatic zone in northern China. 5 new varieties were released in 1999. 4 new varieties were released in 2006.

Liaozhen 1: height of the tree at the age of 6 is 2.24 m, diameter of the trunk is 1.65 m, nut weight 2.60 g, kernel percentage 40%, yield per tree is 815 g. Liaozhen 2: 2.12m, 1.35m, 2.57g, 43%, 677g. Liaozhen 3: 2.43m, 1.27m, 2.90g, 47.6%, 1105g. Liaozhen 4: 2.30m, 1.85m, 2.50g, 46%, 1062g respectively. The 4 new varieties performed good vegetable growth and high yield in the Temperate Zone (latitude between N42°-N32°, average annual temperature between 7.5°C-14°C) of China.

GENETIC DIVERSITY AND RELATONSHIPS AMONG ITALIAN AND SPANISH HAZELNUT CULTIVARS

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Keywords: SSR, microsatellite, *Corylus avellana* L., characterization, germplasm

Abstract

The currently cultivated hazelnut varieties were selected over centuries from the germplasm of the European hazelnut (*Corylus avellana* L.), a species naturally widespread in Europe and western Asia. Nut quality as well as relevant agronomic traits of cultivars, such as adaptation-ability to environmental conditions, productivity, and time of ripening, vary greatly among cultivars. Many of them were selected locally from the germplasm but some were recognized as superior varieties and spread outside the area of origin by trade and migrations. In spite of the long domestication history, still little is known about the genetic structure and background of the cultivars, and often homonymy and synonymy cases are found or hypothesized.

In this work, 22 Italian and 36 Spanish accessions from various germplasm repositories were studied at 16 microsatellite markers in order to study: (1) the genetic diversity in the Italian cultivars and (2) their genetic relationships with Spanish cultivated varieties.

The analysis of SSR data showed a high level of genetic diversity among Italian cultivars. Several synonymies reported in literature were confirmed and new cases were identified. A dendrogram generated by UPGMA cluster analysis grouped the 22 Italian cultivars according to their geographical origins. Genetic relationships among 58 Italian and Spanish cultivars were assessed using three distinct approaches: "proportion of shared alleles", " $\delta \mu$ " (delta mu), and "fuzzy set similarity". Results were showed in three dendrograms obtained by UPGMA cluster analysis where the cultivars from South Italy always resulted closely related with the same group of Spanish varieties. 'Tonda Bianca' and 'Tonda Rossa' clustered separately from the other cultivars and showed a different genotype at chloroplast SRR loci. The cultivars from Liguria region were separated from the Spanish accessions, while the position of 'Tonda Gentile delle Langhe' and 'Tonda Gentile Romana' was controversial.

Acknowledgments: the research was funded in part by EU project SAFENUT.

CURRENT PROGRESS IN THE HAZELNUT BREEDING PROGRAM
AT THE TREE FRUIT RESEARCH CENTER - ROME

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Keywords: hazelnut, seedling, cultivar, "Tonda Gentile Romana"

Abstract

The Italian hazelnut industry is mainly based on a few cultivars that are cultivated only in certain areas. In the Latium region, the most common cultivar is Tonda Gentile Romana, which however has undesirable characteristics from an agronomic point of view (high tendency to sucker), mediocre nut quality (poor blanching rate), and high susceptibility to disease (bacterial canker and decline). The improvement of this cultivar is necessary, as it is increasing the number of varieties useful for industry and table use (sold in-shell).

To achieve these objectives, the CRA-Tree Fruit Research Center has been working for the last decade on a clonal selection program for Tonda Gentile Romana and on a genetic improvement program using cross-breeding of the following varieties: for late bud-break, Ennis, Hall's Giant; for early ripening, Tombul, Imperiale di Trebisonda, S. Giovanni and Tonda Gentile delle Langhe; for decreased suckering, Pauetet, Groassal, Daviana and Cosford; for resistance to big bud mite, Tonda Bianca, Tonda Rossa, Mortarella and Barcelona; for tolerance of bacterial diseases, Tonda Bianca, Tonda Rossa, Jean's; for good nut quality, Tonda delle Langhe; for low content of unsaturated fats, Morell, Comune di Sicilia, Barcelona, Mortarella and S. Giovanni.

Since 2005, data have been collected on the vegetative characteristics of seedlings and in successive years data have been collected also for productive and qualitative characteristics of the nuts. Some accessions have good vigor, upright growth, low suckering, high productivity, and good nut and seed traits.

BIOMETRICAL METHODS TO REINFORCE SELECTION EFFICIENCY IN BREEDING
PROGRAMS FOR HAZELNUT (*CORYLUS AVELLANA* L.) CROP IMPROVEMENT

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Keywords: heritability, parent-offspring, regression analysis, fruit shape, fruit tree breeding

Abstract

The success of a hazelnut breeding program is determined by the precision of the screening method used to select an ortet for potential new clonal varieties. The heritability parameters provide an accurate device to develop selection criteria based on traits whose expression is not particularly vulnerable to environmental effects. The heritability has a predictive role in determination of the breeding value of the hazelnut parents using their phenotypic value; moreover, it expresses the proportion of the total variance available for screening in the progeny that is attributable to the average effects of genes in the parents. The regression of half-sib (HS) offspring compared to the mother plant was used as a method to estimate heritability of several hazelnut fruit traits. Five-year old HS plants were obtained from the seeds produced after open pollination of accessions (used as mother plants) from the hazelnut landraces "Tonda Gentile Romana", "Nocchione", "Tonda Gentile delle Langhe", "Nociara", "S. Giovanni", "Longue d'Espagne", "Sivri A" and "Karidati". Traits recorded in offspring and parental plants were: nut weight, nut width, nut shape index, seed weight, husk length and nut length. Nut length showed the highest and significant offspring-one parent regression coefficient indicating the phenotypic parental value for this trait as the most reliable guide to the parental breeding value. The 46 HS-offspring plants analyzed showed larger variation than the parental plants. The scores of the first two principal components (PC1 and PC2) that explain 39% and 29%, respectively, of the observed variability for the eight fruit and seed characters indicated that the PC1 scores were positively correlated with fruit and seed length. Therefore, the variability of fruit length and shape in the offspring, attributable to significant average effects of genes inherited from the parents, is available for screening and selection of an ortet to derive a novel clone expressing new seed shape features.

GENETIC DIVERSITY IN HAZELNUT USING RAPD AND ISSR MARKERS

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Keywords: *Corylus avellana* L., Genetic diversity, Molecular markers

Abstract

Corylus avellana L. (hazelnut) is one of the 5 shrub species of the genus *Corylus* and *C. colurna* (Turkish hazelnut) is one of the 4 tree species. Hazelnut is widely distributed throughout temperate regions of the Northern hemisphere. It is native throughout most of Europe, from the west coast of Portugal to the southern part of the Ural Mountains. In Asia it extends from Turkey through Caucasia to Iran in the east and from the Anti-Taurus Mountains of Anatolia to Syria and Lebanon in the south. *Corylus avellana* is one of the most important economic nut species. Over many countries several cultivars were selected from local wild populations, some of them with high local commercial value. These cultivars are, in general, characterised only by morphological traits, many of which are influenced by environmental factors. As molecular markers are independent of the environment they are good for identifying of cultivars and for estimating genetic diversity. Fourteen old Portuguese genotypes of hazelnut, all from Northern Portugal, and three testers (Butler and Longue d'Espagne of hazelnut and one of Turkish hazelnut) were screened using 20 RAPD markers and 18 ISSR markers. Of the 20 RAPDs primers screened nine produced highly reproducible fragments. These nine primers generated 76 fragments of which 82% are polymorphic. The ISSR markers amplified 160 fragments of which 88.7% are polymorphic. The interpopulation diversity (DST) was 0.078 for RAPDs and 0.139 for ISSRs. The dendrograms generated with RAPD, ISSR and RAPD plus ISSR data, through cluster analysis using UPGMA, grouped the 18 genotypes in two main clusters. The first cluster, which contains all hazelnut genotypes can be divided in three sub clusters. The second cluster is formed only by the *C. colurna* tester. It was observed a good relationship between the distribution of the Portuguese genotypes and their geographic origin.

RESEARCH ON THE GENETIC VARIABILITY OF CHARACTERISTICS IN HYBRID POPULATIONS OF HAZELNUT

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Keywords: *Corylus avellana* L., heritability, breeding

Abstract

The breeding program for hazelnut cultivars carried out at the SCDP Vâlcea from 1985 to 2007 led to the increase of genetic variability based on crossing and the release of four new hazelnut cultivars (two for fresh consumption: 'Cozia' and 'Urișe de Vâlcea', and two for the industry: 'Romavel' and 'Arutela').

The number of hybrid crosses (60) and the hybrids obtained (more than 7,500) are characterized by the genetic variability of characteristics like: fruit size index, fruit weight, thickness of the shell and kernel percentage.

Depending on the hybrid crosses, these characteristics are variable. The analysis of variance and heritability coefficients of fruit weight, thickness of the shell and kernel percentage emphasizes the fact that phenotype variation, genotype variation, environmental variance and additive variance, as well as the broad-sense (H^2) and narrow-sense (h^2) heritability coefficients, are much influenced by the female parent.

For the characteristics analyzed, a strong hereditary determinism is found and the additive effect is completed by epistasis and dominance effects in the case of some characteristics (kernel percentage, thickness of the shell).

The inheritance of these characteristics is different from one parent to another, the most interesting results being obtained when 'TGDL', 'Ennis' and 'Vâlcea 22' were used as parents in crosses.

INTER-SIMPLE SEQUENCE REPEAT (ISSR) MARKERS IN HAZELNUT

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Keywords: filbert, fingerprinting, mapping, inter-simple sequence repeat

Abstract

Inter-simple sequence repeat (ISSR) markers are generated by PCR amplification of DNA using a single primer composed of a microsatellite sequence that is usually anchored at the 3'- or 5'- end by two to four arbitrary, often degenerate, nucleotides. ISSR markers are rapid, simple, inexpensive, and highly reproducible due to their primer length and to the high stringency achieved by the annealing temperature. Since microsatellite or simple sequence repeat (SSR) loci are abundant in plant genomes, ISSR primers often produce multiple bands which may be useful for genotyping and mapping, and also developing SSR markers. We used 100 ISSR primers from the University of British Columbia to amplify DNA of eight hazelnut (*Corylus avellana*) cultivars. Of these primers, 66 produced distinct and polymorphic bands, 11 produced smears or faint bands, and the remaining 23 did not amplify at all. All 15 of the AT-repeat primers failed to amplify. Primers in the first category produce bands that can be scored with confidence, and these markers are useful for genetic studies. The sequences of the bands can also be used to develop SSR markers.

Sixty ISSR primers that gave distinct polymorphic bands in the initial screening were used to amplify DNA of the two parents and six seedlings from our mapping population: three resistant seedlings with S₃ and three susceptible seedlings with S₈. Eleven markers scored in the entire population fit the expected segregation ratio of 1:1 and were assigned to linkage groups. Two markers, 815-540 and 823-600 were placed on linkage group 5S. Marker 815-540 is particularly interesting as it maps close to the S-locus. We plan to clone and sequence this fragment. Based on the primer sequence (CTCTCTCTCTCTCTG) we expect CT/GA repeats at the ends. We plan to obtain the sequences of the flanking regions using the Genome Walker Kit (Clontech), and then develop an SSR marker closely linked to the S-locus.

STRUCTURE AND GENETIC DEVERSIY OF LOCAL HAZELNUT COLLECTED IN ASTURIAS (NORTHERN SPAIN) REVEALED BY ISSR MARKERS

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Keywords: ISSR markers, cluster analysis, germplasm preservation

Abstract

Hazelnut (*Corylus avellana* L.) is traditionally grown in regions of northern Spain such as Asturias. In the years 2003 to 2005, surveys were carried out in this area and a considerable morphological diversity was found. The use of molecular markers in hazelnut was limited mainly to RAPD or AFLP markers although recently a limited set of SSR markers was described. However, ISSR markers (inter simple sequences repeat) can also supply numerous polymorphisms useful in different studies in this species. The objectives of the present study are to assess the usefulness supplied by ISSR markers in hazelnut and to determine the genetic structure of local hazelnut genetic diversity. Fifty trees from these surveys and five local cultivars derived from a previous survey in Asturias were included in this study. In addition seventeen cultivars from Italy (6), Spain (6), Turkey (1) and the USA (4) were used as reference for this analysis. A total of 42 primers, containing different motifs, were tested for amplifications on a panel of six reference cultivars. Considering the number of fragments obtained per reaction and the number of polymorphism, 11 primers were selected to carry out this analysis. ISSR amplification of selected primers generated multiple banding profiles with an average of 11 fragments/primer/accession. This set of primers supplied a total of 66 polymorphic bands. In a total of 24 fragments, the local germplasm and the reference cultivars showed a significant difference in the frequency. A principal component analysis from molecular marker data was performed and variation along the two principal components accounted for 52% and 6.39% of the total variation, respectively. The graph obtained from the two principal components grouped the accessions in two main groups corresponding to local germplasm and reference cultivars. Cluster analysis based on Jaccard distance also showed these two main groups. The results suggest that local germplasm is closely related and relatively distant from foreign cultivars. As a consequence, the conservation of local genetic diversity of this species is of great interest.

INTER-YEAR VARIABILITY OF POMOLOGICAL TRAITS EVALUATED IN DIFFERENT HAZELNUT CULTIVARS IN SLOVENIA

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Keywords: *Corylus avellana* L., cultivars, different origin, quantitative traits, phenotypic variability

Abstract

29 hazelnut cultivars were planted in a collection orchard in Maribor (NE Slovenia), in order to obtain initial information about their behavior in Slovene pedoclimatic conditions. They belong to two groups. The first one (A) was planted in the period 1990-1992. It included 23 cultivars: 12 from Italy, 3 from Spain, 2 from France, 4 from the USA, one from the UK and one from Slovenia. Group (B) consisted of 6 cultivars from Oregon/USA and was planted in spring 1997. 29 quantitative traits relating to phenology, pomology and health status were observed during the years 1995-1999 (A) and 2000-07 (B).

This paper presents inter-year variations measured as standard deviations and coefficients of variability regarding eight quantitative nut traits, i.e. nut shape index, maximum nut diameter, nut weight, kernel percentage, shell thickness, uniformity of nut shape, uniformity of kernel shape, and amount of fibre.

Shell thickness was the most variable trait with KV between 0 % ('T.g. Romana') and 60.6 % ('F. de Coutard'). The last cultivar also had the least uniform kernel shape (scoring from 3 to 7) as well as the most variable kernel percentage (34.9 – 52.9 %). Uniformity of nut shape was the stablest in cultivars 'T. di Giffoni', 'Daviana', 'Morell' and 'Corabel' (KV app. 6 %) compared to the cultivars 'Mortarella', 'Minnolara', 'Torino-119' and 'Pauetet' (KV between 23 and 30 %). The amount of fibre in the kernels also varied greatly from year to year. In 'Corabel', it ranged from score 3 to 8, KV 43.2 %. On the contrary, 'Mortarella' was the cultivar with the greatest homogeneous amount of fibre. Maximum diameter of the nuts varied between 26.5 % ('Daviana') and 1.9 % ('T.g. Romana'). When considering nut weight, 'Campanica' showed the greatest inter-year variability (KV 40.7 %), and 'To-123F' the lowest (KV 5.1 %).

In general, cultivars (A) observed over five successive years, expressed higher inter-year variability of the eight nut traits compared to cultivars (B) which were evaluated over eight years. Since a relatively large cultivar x year interaction was found, evaluation over a longer period is recommended.

HAZELNUT RESEARCHES AT THE UNIVERSITY OF TORINO IN THE FRAME OF THE ITALIAN 'CO.RI.BIO' PROJECT

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Keywords: organic production, selection of new hybrids, comparison of training systems, susceptibility to weevil (*Curculio nucum*)

Abstract

The Co.Ri.Bio. project, short for "Studies on hazelnut aimed at obtaining high-quality organic production", involved eight partners belonging to different Italian research institutes for the 2004-2007 period. The Dipartimento di Colture Arboree of the University of Torino participated in the project with the aim to perform research in orchard management, nut quality and pest control:

- selection and propagation of Tonda Gentile delle Langhe (TGL) individuals with no sucker production;
- comparison between traditional and monocauline training systems. Evaluation of light penetration into the canopy and its influence on yield and nut quality;
- suitability of the new fresh market selection to organic management;
- observation, selection and propagation of selections with fruit suitable to industrial processing and resistant to big bud mite (*Phytoptus avellanae*) obtained by crossing;
- susceptibility to weevil (*Curculio nucum*) assessed on fresh market and industrial cultivars, and selections, studying the factors which predispose to the weevil attacks.

This paper shows the results obtained after three years of experimentation. The researches about comparison between different training systems and susceptibility to nut weevil were already completed. Results of these researches will be presented in two specific papers during the congress. The work concerning the selection and propagation of TGL and new hybrids are still in progress. Five individuals of TGL and 20 selections were selected and propagated using scion grafting followed by trench layering. The average percentage of tree survival after grafting was 70.6% due to the use of the hot-callusing method. In the autumn 2008, a first experimental orchard will be realized with the aim to observe vegetative and productive behaviour in a significant number of plants. In 2005 an experimental orchard was also realized using L35 fresh market selection to evaluate their suitability to organic management.

CARPOLOGICAL AND MOLECULAR RELATIONSHIP AMONG CLONES OF
HAZELNUT CV 'TONDA DI GIFFONI'

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Keywords: hazelnut, clonal selection, carpological traits, RAPD

Abstract

Tonda di Giffoni hazelnut is among the most appreciated Italian cultivars with round nut. To improve some commercial traits (e. g. size and shelling yields), thirty clones of this cultivar, selected from several farms of the 'Monti Picentini' producing area (Campania Region) were grown without irrigation in an observation field at Pignataro Maggiore (province of Caserta), with three plants per clone at 4.5 m of distance in a square arrangement. The recording of bio-agronomic and carpological data started in 2004.

Clones showed differences for male and female flowering times, radical sprouts per plant, shelling yield and fruit weight. Minor differences were found for bud break, nut size and weight. All clones produced nuts without fibres, and most appear resistant to bud mites. Positive linear correlations were observed between fruit and nut weight ($r=0.72$) and between nut weight and shelling yield ($r=0.65$).

The clones 513 and 509 combined the highest scores for shelling yield and nut weight, with nearly round nuts and bud mite resistance, but had also a high number of radical sprouts.

Molecular analyses were performed on the clones in order to compare the genetic profiles of the plants and, to detect intra-varietal variability.

No molecular difference among clones was found when 26 decamer primers (RAPD) were tested. Phenotypical differences are mostly ascribed to genotype-environment interactions.

ARUTELA - A NEW HAZELNUT CULTIVAR FOR THE INDUSTRY

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Keywords: *Corylus avellana* L., breeding, filbert

Abstract

The hazelnut cultivar named 'Arutela' was obtained in 1979 at the SCDP Vâlcea and released in 2005. The use of this cultivar's fruit is for the industry.

Origin: cross between 'Merveille de Bollwiller' (S_5S_{15}) and 'Tonda Gentile delle Langhe' (S_7S_2).

The tree is vigorous, with a semi-upright habit, with fairly dense branches and average suckering. Blooming is early in the Vâlcea climate and takes place at the beginning of February. Both types of flowers (catkins and female ones) bloom simultaneously (homogamy). 'Arutela' has a good tolerance to low temperatures (-20°C) during blossoming. The tree is precocious, goes into the bearing process quite early (4th leaf), and it produces constant yields (2.8-3.0 t/ha).

The fruits are rarely attacked by *Monilinia fructigena* and *Balaninus nucum*. Fruits are small (2.0-2.5 g), round in shape and uniform. The involucre does not cover the fruit and allows to detach it easily. The color of the fruit is brown with a series of fine stripes on the shell. The kernel is spherical, with a small blunt tip; it has a rounded base and a discreet side indentation. The kernel fills well the shell, has a thin tegument which can be detached very easily in the industrial processing and a good taste. Kernel efficiency is 50-51 %. Fruit ripening takes place early (end of August).

The cultivar is suited for planting in all favorable areas for hazelnut growing in Romania.

A HAZELNUT BAC LIBRARY FOR MAP-BASED CLONING
OF A DISEASE RESISTANCE GENE

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Keywords: hazelnut, filbert, disease resistance, eastern filbert blight

Abstract

The European hazelnut, *Corylus avellana* L., is a diploid with a 1C genome size estimated to be 413 Mb. Because of its small genome size, relatively short life cycle, availability of a dense linkage map, and amenability to transformation by *Agrobacterium*, hazelnut could serve as a model plant for the Betulaceae. A bacterial artificial chromosome (BAC) library for selection OSU 703.007 has been constructed using the cloning enzyme MboI and the vector pECBAC1(BamHI site). The BAC library consists of 39,936 clones arrayed in 104 384-well microtiter plates. The average insert size is estimated to be 110 kb, with 1% of clones lacking inserts. The genomic coverage is estimated to be about 9.5 genome-equivalents. A map-based cloning approach is being used to isolate the 'Gasaway' gene which confers resistance to eastern filbert blight caused by the fungus *Anisogramma anomala*. OSU 703.007 is heterozygous at the resistance locus. In order to rapidly identify specific BAC clones, we are using a PCR-based pooling and super pooling screening approach. As a first step in chromosome walking, we are using primers designed from the sequences of RAPD markers that either flank the resistance locus or co-segregate with it.

THE "EVERGROWING" GENOTYPE OF *CORYLUS AVELLANA* L.
IS EXPRESSED IN THE OFFSPRING OF "TONDA GENTILE ROMANA",
"NOCCHIONE" AND "TONDA DI GIFFONI"

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Keywords: hazelnut, growth cycle mutant, phenology, bud dormancy, plant breeding

Abstract

The hazelnut (*Corylus avellana* L.) "evergrowing" phenotype (EVG-d) fails both to cease growth and to enter dormancy under the dormancy-inducing (i.e. short days) conditions suitable for the EVG-D phenotype. The EVG-d phenotype is expressed by the homozygous genotype for the recessive allele *d* and was described for the first time as "nondormant" mutant in 1985. The EVG-d phenotype has phenological similarity to the "evergrowing" trait coded by the recessive gene *evg* in peach. The EVG-d phenotype is expressed in the fall season by saplings less than one-year old transplanted in the field at the end of the spring season. It appeared in half-sib progenies of intercrossed "Tonda Gentile Romana" (TGR) and "Nocchione" (NOCC) or TGR-NOCC-"Tonda di Giffoni" (TGIF) intercrops. It was also expressed in saplings raised from full-sib progenies obtained after T. GIFF x TGR and TGIF x NOCC controlled pollination. The EVG-d:EVG-D phenotypic ratio was 42:91 in half-sib progenies from the TGR-NOCC intercrossed orchard, and 6:23 in the total half-sib and full-sib progenies involving TGIF as seed parent. In both cases there is no evidence of a significant deviation from a 1:3 ratio, suggesting that the TGR, NOCC, and TGIF parental plants were heterozygous *Dd* at the "evergrowing" locus. Anthesis of male and female flower and bud sprouts on EVG-d plants occur in mid fall. Damage to the apical meristem or female flowers (necrosis) was observed at winter freezing temperatures from -1°C to -5°C, which occurred for about 20 hours within 3 consecutive days. Female flowers which escaped the freezing-temperature damages set mature seeds at the end of July. The EVG-D plants start to exit dormancy and begin bud sprouting at 773 Utah chilling units. The "evergrowing" genotype does not require chilling units to sprout and it might contribute to the expansion of the hazelnut crop in warm climatic regions devoid of air temperature events below 0 °C.

In order to generate molecular markers associated with the "evergrowing" trait in hazelnut, we will analyze EVG-D and EVG-d plant groups by using the DNA bulk segregant approach and the novel PCR-marker system named TRAP (Target Region Amplified Polymorphism). TRAP markers will be designed for the functional domains of CONSTANS- and FLOWERING LOCUS T-like genes and other gene family members of the MADS box transcription factors involved in the regulatory network (s) of dormancy induction.

MICROPROPAGATION OF ITALIAN CULTIVARS OF HAZELNUT:
IMPROVEMENT TOWARD AUTOMATION

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Keywords: acclimatization, carbohydrates, in vitro rooting, temporary immersion, vermiculite

Abstract

Plant propagation through tissue culture has limitations due to the requirement of highly skilled labor. For this reason, temporary immersion techniques, which can avoid the time-consuming sub-culturing, necessary with the use of solid media, was recently assessed in various species in order to increase the multiplication rate and to automate the plant production. In this work, in vitro grown shoots of Italian cultivars "Montebello" and "Tonda Gentile Romana" of *Corylus avellana* L, originated from axillary buds of mature plants, were cultured on a solid, stationary liquid or in a temporary immersion system (30, 60 or 120 minutes of immersion per day performed with bottle devices already described and used for other fruit species), using a basal culture medium previously defined. Carbon source and type and concentration of cytokinins were also evaluated to determine the best cultural conditions for shoot proliferation. The temporary immersion system enhanced multiplication and quality of the shoots, limiting hyperhydricity which was evident under the stationary liquid culture. Shoots obtained with this system were easily induced to root by quick dipping in a high concentrated (80 mg l⁻¹) IBA solution, and the root expression was performed either in gel rite, agar and/or vermiculite. The use of vermiculite positively affected the rooting and the acclimatisation response. Hazelnut showed a good potential to be multiplied in vitro with the temporary immersion system and the scale-up for the automation of the micropropagation process in this species seems to be applicable.

PROPAGATION OF *CORYLUS COLURNA* L. THROUGH TISSUE CULTURE

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Keywords: *Corylus colurna* L., explant, filbert, hazelnut; *in vitro* culture, micropropagation, nutrient medium

Abstract

As *Corylus colurna* L. does not have any sobole, it is used as rootstock for the ornamental forms of the *Corylus* L. genus. However, difficulties of the *C. colurna* L. vegetative propagation by layering are caused by the lack of soboles, which restrains the direct application of *C. colurna* L. into the filbert nurseries. The use of rootstocks such as *C. colurna* L. seedlings does not provide the expected uniformity of rootstocks and engrafted planting stocks. Cultivars and ornamental forms of the *Corylus* L. genus graft badly on *C. colurna* L. The other *C. colurna* L. characteristics are useful for filbert nurseries: for instance, a quick formation of wound callus which is very important for the fast grafting of rootstocks and scions, and an evident difference in bark color and texture which makes the sorting of grafted planting stocks easier. Difficulties in the traditional *C. colurna* L. vegetative propagation encourage us to look for alternative methods, *in vitro* culture methods being among them. In spite of some progress in the application of the *in vitro* technique for a rapid propagation of the *Corylus* L. representatives, some elements need essential improvement. To study the possibility of the vegetative propagation of *C. colurna* L., a *in vitro* culture was conducted on the best seedlings of *C. colurna* L., according to the histocompatibility with the national filbert cultivars. The nutrient media were used in 14 variants. Modified nutrient media were prepared according to Murashige and Skoog (MS) or Lloyd and McCown (WPM) with a different number of inorganic substances and different phytohormones with their synthetic analogues. In modified nutritive WPM-media, the effectiveness of explants proliferation, as well as that of the initial phases of shoot growth and root formation of *C. colurna* L. microcuttings in the *in vitro* culture, was lower than in the modified MS-media. The data obtained prove that at the stage of *C. colurna* L. explants, establishment into the *in vitro* culture, with a 0.1 mg/l kinetin concentration against a background of half of the inorganic substances from the MS-base content and 0.01 mg/l IAA, favoured an explant culture. In the proliferation phase, substitution of kinetin with BAP and IAA with IBA, addition of 1.0 mg/l gibberellic acid A₃, introduction of double Fe-helat into the nutrient medium MS with 0.1 mg/l BAP (instead of kinetin) and 0.01 mg/l IAA ensured the best morphogenesis and shoot growth. Root formation proved to be the most efficient in the MS kinetin-free nutrient medium, which contained (mg/l): 0.1 — BAP, 0.8 — IBA and 1.0 — gibberellic acid A₃. The combination of 0.1 mg/l 2,4-D with 0.01 mg/l BAP was effective for root formation, but less effective than complex MS with BAP, IBA and gibberellic acid A₃. Thiamine•HCl in 0.5 and 1.0 mg/l concentrations expedited *C. colurna* L. explant establishment into the *in vitro* culture, as well as its proliferation and morphogenesis. There is an opinion that adenine sulfate•dihydrate is the essential element of the nutrient medium for the *in vitro* culture, but a positive effect of this complex was obtained only in small concentrations (0.5 and 1.0 mg/l) which were much lower than the MS base level. After soil transplantation, even the best test-tube plants with roots and 5–7 leaves ceased their growth, their leaves wilted and fell off: as a result a lot of plants died. In order to introduce the *in vitro* culture methods into the commercial filbert nurseries, it is necessary to elaborate technologies for the adaptation of test-tube plants to the *ex vitro* conditions and to extend the growing of rooted plants according to the market standards.

EFFECT OF AUXINE AND PUTRESCINE TREATMENTS ON ROOTING OF LEAFY CUTTINGS OF THREE HAZELNUT CULTIVARS

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Keywords: *Corylus avellana* L., Putrescine, indole-butyric acid, cuttings

Abstract

The effect of IBA, putrescine and collection time on the rooting of leafy cuttings from subapical twigs of hazelnut (*Corylus avellana* L.) cultivars was investigated. Indole-butyric acid (IBA), dispersed in talc at concentration of 0, 1000 and 2000 ppm were applied to the base of cuttings of three typical cultivars of Central Italy: "Tonda Gentile Romana", "Tonda di Giffoni" and "Nocchione" collected during the months of June, July and September. In addition, the cuttings collected in September were treated with the same IBA concentration supplemented with 1600 ppm putrescine. The cuttings, with four nodes and two leaves reduced of 1/3 of the surface, were placed in a basal heated bench, sealed with polyethylene film, filled with perlite, and maintained at a constant temperature of 23°C. Percentage of cutting with callus, percentage of rooting and number of roots per cutting were recorded after two months from the cutting preparation. Leafy cuttings collected in July showed a limited rooting attitude in all cultivars tested. The rooting was promoted by IBA treatments mainly in 'Nocchione' and 'Tonda di Giffoni' when the collection time was in June and September, however the percentage of rooting was not more than 55%. The best results, more than 75% of rooting, were observed in cuttings of "Tonda Gentile Romana", collected in September when treated with 1000 ppm IBA + 1600 ppm putrescine.

ROOTSTOCKS OF *CORYLUS COLURNA* L. FOR NURSERY PRODUCTION

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Keywords: *Corylus colurna* L., selections, seed germination, growth indicators

Abstract

The turkish filbert (*Corylus colurna* L.) is terciary relict. It is interesting for preservation biological diversity and breeding. The results obtained were used for determing the optimum technological procedures to be applied in the production of quality nursery plants of Turkish filbert and to define the usefulness of Turkish filbert in the fields of landscape design, forestry and fruit production.

The first part of the investigation determine the dominant factors associated with the production of seed materials of Turkish filbert.

Turkish hazelnut (*Corylus colurna* L.) can been used as a rootstock for grafting hazelnut cultivars. Turkish hazelnut used as a rootstock do not form suckers, it is long living, resistant to frost and drought, and regarding soil condition have wide tolerance.

Results of seedlings testing during 2004. showed that highest rootstock height (49.27 cm), root neck diameter (12.22 mm), tree mass (19.89 g) and root mass (21.85 g) had genotype B8. This genotype also has very long root system (35.63 cm).

Longest root system had genotype B9 (38.7 cm). This genotype also had a high number of primary roots (31.47), high tree mass (15.09 g) and high root system mass (17.03 g).

The highest number of roots had genotype B7(31.93), with genotype B9 having similar value.

Using appropriate nursery techniques, like irrigation and nutrition, it is possible to get, in first year, appropriate rootstocks seedling development suitable for grafting.

GRAFTING METHODS IN NURSERY PRODUCTION OF HAZELNUT GRAFTED ON
CORYLUS COLURNA L.

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Keywords: hazelnut, grafting, *Corylus colurna* L.

Abstract

Since 1992, at the Faculty of Agriculture, Institute for fruitgrowing and viticulture, Novi Sad, *Corylus colurna* has been under observation with the selection goal to select nonsuckering rootstocks for cultivated hazelnut. Seedlings from selected *C. colurna* mother trees appear to be of interest as rootstocks. The paper presents the data on hazelnut grafting and the results of nursery plant production of hazelnut cultivars Tonda Gentile Romana, Istarski dugi, Cosford and Contorta. Best budtake had Tonda Gentile Romana, average 92.6%. Very low bud take was observed with Contorta due to incompatibility. Budtake in varieties Istarski dugi and Cosford was 80%.

CONTRASTING FRUIT PROPERTIES OF HAZELNUT CULTIVARS GROWN ON DIFFERENT ROOTSTOCKS

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Key words: Hazelnut, rootstock, cultivars, fruits.

Abstract

Grafting and cultivation of hazelnut on *Corylus colurna* seedling have been initiated only lately, therefore practical experiences are currently considered incomplete. It is for this reason that pomological and technological properties of fruits of identical hazelnut cultivars planted on individual roots and *Corylus colurna* rootstock have been contrasted. The trial included cvs Rimski, Istarski Dugi, Tonda Gentile Romana and Kosford. The spacing on individually rooted plants was 4 x 4 m, and 5 x 4 m, in those grafted on *Corylus colurna* seedling. The trial was set up in the region of Zaječar (Eastern Serbia) characterized by high air temperatures, frequent droughts, and fairly low rainfall, which is considered unsuitable for growing hazelnut.

Vigorous root system of *Corylus colurna* resulted in larger fruits and greater fruit weight in the studied cultivars. Several-year results suggest that fruit and kernel dimensions of cultivars grafted on *Corylus colurna* were larger by 3.0 x 1.4 x 0.9 mm and 0.4 x 0.5 x 0.6 mm (length, width and thickness) respectively, as compared with those of cultivars grown on individual roots. Average fruit and kernel weight, and kernel content were increased by 14.6% (0.37 g), 19.3% (0.22 g) and 2.5% respectively. Oil content in fruits of cultivars grown on individual roots was higher by 3.6%, whereas raw protein content was identical. Mineral matter content in the kernel of fruits of these cultivars was also higher by absolute 0.24%.

LONG-TERM RESULTS OF STUDY OF SOME HAZELNUT CULTIVARS GROWN IN THE REGION OF ČAČAK

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Key words: Hazelnut, cultivars, phenology, cropping, fruits

Abstract

The paper presents major biological and pomological properties of some Italian hazelnut cultivars (Riccia di Talanico, Giromelo, Mortarella, Tonda di Giffoni, Tonda Gentile Romana, Tonda Gentile delle Langhe, Comune) studied under the agroecological conditions of Central Serbia (Čačak). Aiming at a contrasting study, cv Barcelona was included in the trial field. Some phenological properties, i.e. catkin pollination, flower opening, ripening time have been assessed, along with vigour, cropping and cropping potential. Fruit size and weight, shell thickness and kernel ratio have also been determined. The study included the evaluation of chemical composition of kernel, i.e the content of water, ash, mineral matter, oils and raw proteins.

Cv Barcelona was ranked among the most vigorous. As regards cropping, Italian cultivars were superior to cv Barcelona. A greater number of fruits per flower bud were evidenced in Italian cultivars.

Over a long-term period, the average fruit weight ranged from 3.06 g (Comune) to 2.76 g (Mortarella), whereas fruit ratio ranged from 48.95% (Riccia di Talanico) to 42.81% (Comune). Kernel oil content and raw proteins content were within the range of 65.29% (Tonda Gentile Romana) to 58.36% (Giromelo) and 16.71% (Giromelo) to 14.90% (Comune) respectively, whereas mineral matter content ranged from 2.92% (Tonda Gentile Romana) to 2.30% (Tonda Gentile delle Langhe).

EVALUATION ON COLD RESISTANCE OF THE SELECTIONS OF HYBRID
HAZELNUTS (*C.HETEROPHYLLA* × *C.AVELLANA*)

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Keywords: hybrid hazelnut, cold resistance, integrated assessment

Abstract

This paper is purposed to evaluate the cold resistance of selections of hybrid hazelnuts (*C.heterophylla*×*C.avellana*). One-year-old shoots of 18 advanced selections were taken before sprout at early spring and the shoots were cut into slips of 20-25 cm with 4-6 buds. The slips were treated at different temperature of 0°C, -6°C, -10°C, -14°C, -18°C and -22°C. The temperature was reduced sequentially, start from 0°C, reduced 2 °C per hour and kept for 2 hours when reduced to the designed treatment temperature, and then sequentially up at 2°C per hour to 0°C. The treated slips were kept for 8 hours at 0°C and moved to the incubator of 23°C for sprouting. The sprouting rates of all treatment were investigated and the treatment of -22°C was chosen as the evaluation temperature of the cold hardiness according to the relationship of low-temperature and sprouting rate. Eight biology and physiology factors of -22°C treated shoot were measured, and soluble sugar, soluble protein, electric conductivity, LT50, and ABA were chosen as the 5 indicators for the cold resistance assessment of 18 advanced selections of hybrid hazelnut selected by correlation analysis. The 5 indicators were converted into an integrated index by principle component analysis, and their weight was determined to establish the assessment system. The integrated index value of cold resistance of each advanced selection, based on its weight and function value, was obtained. According to the integrated index value, the cold resistance order of 18 advanced selections was 84-349, 81-23, 85-127, B-3, 84-69, 84-545, 81-9, 83-33, 84-1, 84-72, 84-254, 84-48, 84-402, 84-237, 82-11, 84-226, B-21, 84-572. The advanced selection of hybrid hazelnut could be divided into 4 groups by cluster analysis. 84-349, 81-23 and 85-127 had the most strong cold resistance; B-3, 84-69, 84-545, 81-9, 83-33 and 84-1 had better cold resistance; 84-72, 84-254, 84-48, 84-402, 84-237, 82-11, 84-226 and B-21 had weaker cold resistance and 84-572 had the most bad cold resistance.

AGRO-ECOLOGICAL ZONES OF HAZELNUT IN GEORGIA

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Keywords: garden, species, Gulshishvela, micro-zone.Abstract

The culture of hazelnut is ancient and gives valuable production. The fact that this culture exists since ancient times is confirmed by historical-ethnographical and scientific research. Hazelnut grows as well in the regions of Caucasus, among which is Georgia, where it is spread in almost all regions.

In Georgia, diversity of the environment facilitates the supply of the world market with high-grade hazelnuts, which requires an advantageous thoughtful of zones and the development of the culture on an industrial scale. Climate, relief/features of the place and height above sea level have considerable influence on its growing and productivity.

In zones with good humidity, hazelnut gives high-grade and steady yield, which is of great importance in order to choose spreading zones and micro-zones. In case of storage with humidity, the fruit becomes deformed and the cover gets harder early.

Based on complex relief conditions of Georgian climate, the agro climatic indicators/features are determined by vertical zones. For the rational transfer of endemic and strange species of hazelnut, growing and yielding regularities were ascertained: in particular, the Imereti zone from 50 m. to 750 m, the Guria-Adjara from 100 m. to 600 m., and the Samegrelo-Abkhazia from 30 m. to 650 m, all in the west of Georgia; the Kakheti zone from 250 m. to 650 m., and the Kvemo Kartli from 350 m. to 600 m, in the east of Georgia. The temperature sum of early ripening species should be 1700-19000 C, 3200-37000 C for medium ones, and 3900-40000 C for late ripening species. Spreading zones were determined according to height above sea level, ripening and period of the species. Intensive treated technologies of cultivation and growing of industrial gardens are present.

LICHEN BIODIVERSITY: A TOOL FOR ESTIMATING ECOLOGICAL QUALITY IN HAZELNUT ORCHARDS?

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Keywords: biodiversity, environmental quality, lichen

Abstract

Lichens are perennial, slow-growing organisms highly dependent on the atmosphere for nutrients. Their use for the assessment of environmental quality is widely accepted in many countries and they are used as a sensitive indicator of the biological effects of air pollutants. Until now, there have been only a few studies published about lichens growing on *Corylus*, but not, as far as we know, in agricultural areas.

This study is a part of a project aimed at the development of tools, to be used in agriculture, for studying whether hot spots of biodiversity could be related to quality of orchards.

Epiphytic lichens, occurring up to two metres above the ground, in coppices of *Corylus avellana*, have been investigated. Number and abundance of each lichen species are given together with several environmental variables in each site.

Nearly all macrolichens were identified in the field, while microlichens required microscopic examinations and chemical analyses to identify at the species level.

The results of this preliminary study show that the floristic composition of epiphytic lichen communities is determined by substratum qualities (age, part of the tree where the lichen is growing, bark texture) and by habitat conditions (e.g. age and history of the orchards, climate and pollution levels in the site).

The lichen diversity on *Corylus* in a specific site seems to reflect the regional species pool, therefore it is controlled by local ecological conditions. The lichen distribution seems to be closely related with the nutrient availability through farming and atmospheric deposition.

EFFECTS OF THE DIFFERENT SOIL MANAGEMENT TECHNIQUES IN THE
PLANTATION LINE ON VEGETATIVE BEHAVIOR AND CHEMICAL,
PHYSICAL AND BIOLOGICAL FACTORS OF THE SOIL
OF CV. BARCELONA (*CORYLUS AVELLANA* L.) IN THE SOUTH OF CHILE

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Keywords: hazelnut, synthetic covers, inert organic covers, conventional plowing

Abstract

During the first year of the planting, a research was carried out (2007-2008) on a volcanic origin soil (Andisol) in the Loncoche area (39° 17' S lat, 72° 23' W long), Province of Cautín, in Southern Chile, in order to determine the effects of the different management techniques on the vegetative behavior, the undergrowth and weed control, and the chemical, physical and biological features of the soil in hazel tree orchards (cv. Barcelona) in one growing season.

Four management treatments were performed: Conventional Plowing (CP), Black Polypropylene Plastic Cover (BPC), White Polypropylene Plastic Cover (WPC) and Inert Wheat Chaff Organic Cover (COC), with four repetitions and full blocks at random. The obtained results show that the greater vegetative growth (height, trunk diameter) was with BPC (1.27 and 2.9 cm), the greater length of the main sprout (75.5 cm) with BPC and the highest number of lateral sprouts was obtained with the BPC treatments (5.0 sprout/plant) with more significant differences as compared to the other treatments.

The smallest emission and effect of the shoots was obtained with the BPC treatment (0.33/tree and 13 cm respectively). With regard to the chemical soil composition, the major percentage of organic matter (23.2%) and content of Nitrogen (60 ppm) was determined with the BPC treatment. Also, with the BPC treatment, a major percentaged temperature was obtained during the growing cycle of the trees (1.5°), higher than all other treatments. In the three different types of covers used, the presence of undergrowth weeds was not observed. In the CP treatment, the presence of annual and perennial weeds was observed, even though it had been controlled mechanically four times during the season. The dry matter production of weeds (kg/ha) was 4 tons/ha. The major earthworm activity was found with the COC treatment, with 18 individuals for each unit of 400 cm² of soil, with statistically significant differences as compared to the other treatments. The BPC showed a high level of active biota in the soil (52.6 ± 0.9) (Fluorescence Diacetate Hydrolysis, ug, g⁻¹).

HAZELNUT RESEARCH IN PIEDMONT (NW ITALY): STRATEGIES FOR THE IMPROVEMENT IN YIELD AND QUALITY

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Keywords: cutting, breeding, irrigation, hazelnut pests, post-harvest, Tonda Gentile delle Langhe

Abstract

Hazelnut plantings in Piedmont (NW Italy) have increased in the last 5 years and the crop is spreading outside the traditional area of cultivation. This trend is accompanied by a strong demand for nursery plant material and by a renewed interest in improving cultivation techniques. The Regional Administration is funding a 3-year project (CORIFIL) aimed at: developing techniques of propagation for the construction of a modern system of nursery production; testing the susceptibility of cultivars to pests and evaluating new selections and clones; evaluating the impact of irrigation on yield and quality of Tonda Gentile delle Langhe (TGdL); testing innovative storage methods to increase the preservation time.

Research on propagation is being carried out using the cutting technique and the micropropagation as means to improve the processivity of nursery plant production and favour the spread of selected material and new cultivars.

Irrigation is not common in Piedmont, but the dry climate trend of the last years caused a decrease in yield and nut quality in some areas. Different irrigation regimes are being tested in order to define the minimum amount of water required for a good orchard performance.

Cultivar susceptibility to main nut pests is being evaluated in field trials in order to develop new defence strategies based on the breeding of resistant or tolerant genotypes. Post-harvest research is aimed at estimating composition and structure, sensory features, conservation and technological attitudes of hazelnut cultivars and selections: TGdL (clones MT5 and PD6), Daria, L35 and Ennis (for table consumption). Controlled atmosphere techniques are also tested as means to prolong the conservation time of TGdL.

MIDDAY STEM WATER POTENTIAL AND INFRARED CANOPY TEMPERATURE AS AN INDEX OF IRRIGATION REQUIREMENTS FOR HAZELNUT

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Keywords: plant water status, stem water potential, canopy temperature, irrigation scheduling

Abstract

Hazelnut is sensitive to water stress, and irrigation is a key factor for quantity and quality of yield in many areas of central and southern Italy. Hazelnut growers currently use empirical methods to evaluate irrigation requirements, and find it difficult to choose the correct timing and volume of irrigation. As it has been done previously for other crops (almond, plum, peach), this project evaluates two simple tree water status measurements to aid irrigation scheduling for hazelnut: midday stem water potential (MSWP) and thermal crop water stress index (CWSI).

Field trials using four levels of drip-irrigation (un-irrigated and irrigated with 25%, 50% or 100% of evaporation) were carried out in a farm located in Vitorchiano (Viterbo) in the Latium region. The experimental design included blocks of six plants, repeated four times, for each of the four irrigation treatments. The following data were collected: trunk and shoot growth, yield and fruit quality parameters, stem water potential, infrared canopy temperature, photosynthesis, and stomatal conductance.

The vegetative and productive data, as well as the photosynthesis and stomatal conductance data, show significant differences between the irrigation treatments. MSWP corresponded well to the true plant water status, whereas CWSI did not correlate well to the plant water status because it was negatively affected, as reported in literature, by high levels of relative humidity in the air.

EFFECTS OF HAZELNUT SUMMER PRUNING PERFORMED IN DIFFERENT MONTHS

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Keywords: green pruning, hazelnut yield, fruit quality

Abstract

Different times of hazelnut green pruning were investigated with the aim of obtaining practical and helpful suggestions for growers when they have to decide about pruning rejuvenation of fruiting branches, and when they need to improve the plants' light interception. The trials were carried out in an 28-year-old hazelnut orchard of 'Tonda Gentile delle Langhe', sited in Cravanzana (CN), with trees spaced 6 x 5 m, trained as multistemmed bush, and with the foliage of contiguous trees strongly intersected. Four different periods of green pruning were tested, that is to say, in April, May, June and July (4 theses), and the time needed to prune plants and the pruning intensity was recorded for each of them. On the contrary, yield and nut quality were recorded during the following 4 years. Every pruning time results significantly different from the others; nevertheless, a significant increase in yield for all the theses of pruning time, starting from the second year after the cut operations, is evidenced. Quality parameters such as nut weight and kernel ratio percentage, as well as less interior kernel defects, seem to be significantly improved only in the production season following the pruning.

A SIMPLE SUMMER PRUNING TRIAL ON HAZELNUT

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Keywords: *Corylus avellana* L., bug, kernel quality, nut yield

Abstract

Even if the positive hazelnut pruning effects have been demonstrated by experimental trials, in one of the main Italian hazelnut production areas, pruning is not usually applied or it is limited to the removal of only some old branches every 3-5 years. In order to give just a practical demonstration of the pruning usefulness to hazelnut growers, a simple pruning trial was devised.

In a 15-year-old hazelnut orchard (Tonda Gentile delle Langhe), an intense spring pruning (in May) was applied to plants usually not pruned. These pruning thesis and control were applied to 5 randomized replications of each of the 15 plants. The quantity of green material (branches, twigs, etc.) was more than 20 kg/plant and the pruning was not repeated in the following 4 years.

As expected, a lack of yield was observed in the year of pruning due to the heavy removal of branches and twigs bearing a lot of growing fruits. In the following years, starting from the first after pruning, the yield recovered, especially in the "one-year-olds".

An increase in nut quality was obtained immediately starting from the year of pruning, even if not always in a significant way. These positive effects of pruning on yield and nut quality were recorded only for 3-4 years, and therefore this kind of pruning could be applied every 3-4 years.

EFFECT OF FOLIAR FERTILIZATION ON HAZELNUTS GROWING IN THE ETNA AREA

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Keywords: 'Tonda Gentile Romana', hazelnut yield, nitrogen fertilizer

Abstract

Corylus avellana (L.) is cultivated on Mount Etna between 500 and 1200 meters above sea level. In this area, uneven soils and slopes do not allow to cultivate hazelnut in wide orchards. For this reason, production costs are particularly high and growers frequently reduce cultural practices so that the yield is often compromised. However, in rational orchards, higher yields may be achieved using appropriate cultural practices.

The aim of this research is to verify the effect of foliar fertilization on yield parameters. The analyses were carried out between 2005 and 2007 in a flat field placed in the north-east of Etna, in Castiglione di Sicilia. The planting was established in 1987 using the Tonda Gentile Romana cultivar, at a spacing of 5x5 m; the orchard was not irrigated and the trees were trained to develop single trunks. We purchased a 8.5% nitrogen fertilizer and a 20-20-20 titer plus chelated microelements from commercial sources: the first one was applied with a concentration of 1%, while the second one with a concentration of 3%. Two different trials, with ten replications for each one, were set up. Trial A: two treatments, one after fruit set (late May) and the other during nut increment (late June). Trial B: three treatments, two like trial A plus a third treatment during shell hardening in mid-July. Nut weight, kernel weight, nut caliber, kernel caliber and kernel percentage of treated plants were evaluated and compared with those of non-treated plants. The treatments, especially in trial B, resulted in a significant increase of kernel percentage. It is important to underline that the increase in production costs was particularly low, since the foliar treatments were associated with the conventional insects control.

INTERACTION BETWEEN AVAILABLE PHOSPHORUS AND LIME TREATMENTS ON
EXTREME ACID PH SOILS OF HAZELNUT ORCHARDS

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Keywords: *Corylus avellana* L., soil reaction, soil properties

Abstract

When the pH of extreme acid soils of hazelnut orchards can be increased with lime, some available plant nutrient elements can be increased as well. In this study, the interactions between liming and soil acidity, and the amount of available phosphorus were determined. In the study, fifteen hazelnut orchards showing soil acidity between 3 and 4 pH were selected. The experiment was arranged in a completely randomized design with four incubation times and with three replicates in laboratory conditions. Firstly, the applicable amounts of lime on extreme acid soils were assessed. After an incubation period of four weeks, the amounts of available phosphorus in the soils were determined for each week.

In the result of the study, it was determined that to raise the soil pH up to a neutral level the amount of lime applied to the soil should be increased basing it on a very low pH and according to the buffering property of the soils. The soil pH rose from 3 to neutral by liming and the amounts of available phosphorus in the soils increased. Moreover, the prolongation of the incubation period caused a rise in the soil pH, and thus the amounts of available phosphorus in the soils were increased.

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

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Keywords: *Coryllus avellana* L., potassium, nut, kernel

Abstract

This study was carried out to determine the effects of doses of Ormin-K fertilizer (potassium compounds 57 %; N, P₂O₅, SO₄, CaO, MgO, Fe, Mn, Zn, Cu and Mo compounds 33 %, organic matter 8 %, moisture 2 %). Fertilizer application methods (broadcasting and banding) were researched 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, kernel percent and kernel quality. There were no significant differences in application methods regarding nut and kernel traits.

SOIL PLANT RELATIONSHIPS IN THE CIMINI - SABATINI HAZELNUT DISTRICT:
PLANT NUTRITION AND SOIL BIOLOGICAL FERTILITY STATUS

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Keywords: *Corylus avellana* L., soil quality indicators, soil organic carbon; soil microbial biomass, foliar analysis

Abstract

Soil and plant nutritional status are strictly interdependent and determine also the rate of fertiliser application with implication on both yields and fruits quality. In the framework of the project "Study of the hazelnut weaving factory in the Cimino-Sabatini productive district" (founded by the Italian Ministry of agricultural, food, and forestry policies), a survey on plant nutritional conditions and soil biological fertility was carried out. In particular, the typical pedo-climatic conditions of such area suggest a possible vulnerability of these soils to hazelnut cultivation with consequences on both soil quality and plant nutritional conditions. Moreover, the occurrence and diffusion in the productive area of a hazelnut disease called "moria", which causes the plant death without evident previous signals, suggested to include in the investigation also the comparison between healthy and sick plants. The objective was to verify the ecological equilibrium of soil microbiota functionality together with the corresponding plant nutritional status, as detected by foliar analysis.

Two main research lines were followed: (1) determination of some soil quality indicators involved in soil organic matter turnover; (2) determination of macro and micro-nutritive elements contained in hazelnut leaves in comparison with standard values determined in the same area.

The study was carried out on five representative hazelnut farms, chosen according to the cultivar (main cv is Tonda Gentile Romana), the orchard management, the eventual occurrence of diseases, the planting age. Soil and leaves sampling were carried out according to standardised protocols, in order to minimise the environmental variability. In the farms where plant disease was detected, a comparison among healthy and sick trees was carried out. The main results did not show in general a direct relationship between values of soil and plant analysis, nor significant differences between soil quality indicators under healthy and sick trees. As a general trend, poor organic carbon stocks were stored in soils, both as total and as microbial pool, comprising one organically-managed farm. However, no stress condition for soil microbial biomass activity was detected, probably due to adapting phenomena of soil micro-organisms activity. Indication for a possible change of soil microbiota metabolism was deduced by data obtained in a young plantation with different cover crops under trees.

Finally, foliar analysis showed values close to those established as provisional standard values of the cultivar Tonda Gentile Romana in the Province of Viterbo.

SOIL-PLANT RELATIONSHIPS IN THE CIMINI-SABATINI HAZELNUT DISTRICT: SOIL CHARACTERISTICS

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Keywords: *Corylus avellana* L., soil organic carbon; soil microbial metabolism, soil hydraulic arrangement

Abstract

The Cimini-Sabatini hazelnut district lies in the "volcano laziale" area, where distinct volcanic systems are present: Cimino, Vicano and Vulsino. The main lithological features are characterised by acidic substrata.

From the pedological point of view, the soils of the province of Viterbo are mainly influenced by the erosion and transport processes occurred on the volcanic substrata. In general, these soils are rich in calcium and potassium and show a good agronomic fertility, although the high amounts of Fe and Al can act as antagonists towards the other nutritional elements, depending on the soil pH, as showed by a recent study carried out within the experimental fields of the Università della Tuscia. Further nutritional constraints can occur between the potassium and the ammonium ions.

In the more elevated area around the lake of Vico, there is an important occurrence of soils with andic characteristics; these soils are characterised by sub-acidic pH reaction, high capacity of organic carbon storage and high water holding capacity. The presence of amorphous allophanic phases often allows a high aluminium content which can act with a toxic effect on the soil microbial metabolism. For these reasons, these soils are considered as potentially vulnerable when subjected to intensive cultivation, the main threat being a possible worsening of their soil quality after hazelnut cultivation. A collection of historical data of soil analyses carried out in several sites within the Cimini-Sabatini hazelnut district showed a critical trend of lowering in soil pH values towards more acidic conditions, together with a depletion of soil organic carbon content, when compared with the results of the soil characteristic survey carried out in the framework of the project MIPAAF "Study of the hazelnut weaving factory in the Cimini-Sabatini productive district". Whereas no correlation was found with the occurrence of plant diseases, as the "moria" phenomenon, possible changes of soil hydraulic arrangement and orchard management were considered among the multi-factorial impacting agents

LONG TERM EFFECTS OF HAZELNUT HUSK COMPOST APPLICATIONS ON SOIL PERMEABILITY

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Keywords: *Corylus avellana* L., compost, water retention capacity, hydraulic conductivity, soil properties

Abstract

This study was carried on Tombul hazelnut orchards to evaluate the long-term effects of hazelnut husk compost (HHC) on soil permeability between 2001 and 2007. The amendments were only applied in 2001. The experimental design was replicated three times with four doses as a randomized complete block of hazelnut husk compost. The amendment was applied at rates of 0, 20, 40, 80 and 120 ton ha⁻¹ dry weight replicated. During the experiment, disturbed and undisturbed soil samples were collected once a year. Hydraulic conductivity, water retention capacity, available water content, porosity, macropore/micropore ratio and some soil properties were determined.

Organic material applications increased the hydraulic conductivity of the soil, but this effect declined in the long term. In the first year, compost applications amended selected soil properties. On the other hand, this positive effect decreased in the six years depending on the decomposition of the hazelnut husk compost.

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

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Keywords: *Corylus avellana* L., filbert, Tombul cultivar

Abstract

A study was carried out at the Hazelnut Research Institute (in Giresun) in 2001-2007. The training orchard was established in 1992 with the Tombul cultivar. In the experimental design, nine trees or nine ocak (three trees per ocak) were used in each of the three treatments. In the results of this study, statistical differences between training systems were not shown, but yields from single trunk training systems were higher than the ones from the ocak, and some nut characteristics were also better.

MECHANICAL AND PHYSICAL CONTROL OF HAZELNUT SUCKERS

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Keywords: basal shoots, Tonda Gentile Romana, thermal control, steam, flame

Abstract

The emission of suckers is a characteristic of hazelnut (*Corylus avellana* L.). Their presence at the vegetative restarting can cause several problems both to plants and to crop management. Cultivated trees are trained either to a single trunk or to a multi-branched structure. Both trainings require many applications to eliminate basal shoots every year, with associated recurrent costs. With the single trunk, mechanization for sucker removal is much easier. Desuckering can be done on herbaceous or lignified suckers. Different methods can be used ranging from mechanical to physical and chemical ones. A thermal control management is a recently investigated procedure.

With the aim of ascertaining the effectiveness of thermal control techniques, desuckering tests with steam and flame were performed in a hazelnut orchard, with cv "Tonda Gentile Romana" and 5x5m plant spacing. With both techniques, a short blast of intense heat was carefully directed at the basal shoots keeping a short distance from the target. Both treatments cause scalding of plant tissues and in a few days exposed vegetation will wilt and die.

A small steam generator-applicator machine was used. Steam flows at approximately 300°C out of the boiler and can be directed through a handheld outlet pipe. Flaming was carried out with a tractor-drawn model, equipped with a handheld single-torch flamer and two LPG tanks placed in a housing with warm water. The two methods were compared for fuel consumption, resulting in 215 g/min of diesel fuel and 77 g/min of LPG. Two different parameters for heat contact-time were used: a 60 sec and a 30 sec half time exposure. The growth stage is a key factor in determining control effectiveness. As the results suggest, it is preferable that small suckers be treated, as they then die completely. No damage to plants was observed. Flaming is easy to use, requires low cost equipment and low fuel consumption. Steam applications need slow speed, large amount of water and fuel, and expensive equipment, but collective ownership of devices may be an option.

PRUNE AND RECYCLE: MECHANICAL HAZELNUT PRUNING AND ENERGETIC RECOVERY OF ITS BIOMASS

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Keywords: mechanical pruning, manual pruning, biomass evaluation, 'Tonda gentile delle Langhe'.

Abstract

In Piedmont, many problematic conditions are emerging in the hazelnut agricultural sector due to the high percentage of old plants which are still yielding, but have not been pruned for a long time, and the high labour costs. Our previous research on hazelnut evidenced the positive role of pruning on quality parameters, and the possibility to apply mechanical pruning. Again, the individuation of alternative sources of energy is of topical interest. In order to deepen the information on hazelnut mechanical pruning, but also to study the biomass produced by pruning as an energetic source, specific investigations were carried out in the period 2006-2007 in Piedmont on 'Tonda gentile delle Langhe'.

In particular, 4 farms were chosen among those which represent best the local production, taking into consideration mainly the pedo-climatic environment and the age of the orchards. In each farm and year, non-pruned trees were compared to mechanical or manual pruned trees. Pruning cuts were performed in spring for 2 farms and after harvest for the remaining 2 farms.

Observations for each thesis of pruning regarded: # pruning as a cultivation practice (e.g. time spent for cut execution; number, position and diameter of the cuts); # biomass production by pruning (e.g. fresh and dry weight of the cut material, its calorific power and basal density); # production and quality of hazelnut (e.g. nut weight, technical and commercial rate, internal seed defects).

After 2 years of investigations, it was observed that manual pruning produces an higher quantity of biomass as compared to the mechanical one, although for both pruning theses the biomass dry weight and its calorific power is not significantly different. A decrease in yield is registered for the pruned trees; but, for those mechanically pruned, yield reaches a certain amount of nuts already in the season after pruning operations. The better quality of hazelnut produced by pruned trees is also confirmed.

OVERALL MECHANIZATION OF HAZELNUT ORCHARDS SOUTHERN ITALY

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Keywords: agricultural practices, machines

Abstract

The mechanization of agricultural practices in hazelnut orchards, in order to achieve a drastic cut of production costs, is not sufficiently widespread in southern Italy. The present research aims to understand the agronomical and technical conditions which limit mechanization, in order to increase and improve its level.

Obstacles for an extensive use of machines are related to farming techniques. Farm management, cultivar choice and plant spacing must be appropriate for the mechanization requirements.

The study was carried out in orchards located in Campania and Calabria, as an example for the improvement of future hazelnut expansion in southern Italy.

The research regarded the following mechanized operations: desuckering with a swing arm shredder; brush cutter and manual tools; soil management for harvest (either tillage and rolling, or mowing a natural grass ground cover); harvesting with vacuum machines (front and side pick-up machines, with or without windrowing).

Harvesters can perform single or multiple tasks (windrowing, harvesting and cleaning): in the first case, fruits accumulated around the trunk must be removed using blowers (back-carried or tractor-drawn), hand raking or sweeping; in the second case, the combined machine sweeps into a windrow, blows away from the trunks and lifts up the nuts (vacuum or pick-up machine), separates debris and cleans the product.

Desuckering with a swing arm disk shredder is efficient on single trunk trees. Brush cutter is speedy but can cause trunk damage. Hand tools are labour-intensive and slow.

In all harvesting methods, the best soil surface is obtained mowing a natural grass cover: the benefits range from lower dust production to the possibility of working on damp soil. The best harvest performance is obtained with self-propelled vacuum harvesters. Pick-up harvesters are efficient on wet ground and on turf, but they are slow and need a clean field. Suction fans raise a lot of dust even when equipped with cyclone dust separators.

OPERATIVE PERFORMANCE AND WORK QUALITY OF A HAZELNUT PICK-UP MACHINE

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Keywords: harvest, farm machinery, “Tonda Gentile Romana”, picking efficiency

Abstract

Highly efficient mechanical harvesting systems for the hazelnut crop can reduce labor need and associated costs, thus increasing profitability. Moreover, high field capacity allows repeated runs through the orchard, and consequently a shorter on-ground stay for nuts, thus improving product quality.

Unlike vacuum harvesters, in which an air stream is used to suck fruits from the ground and for the cleaning, pick-up harvesters, in which a rotating-brush is used to lift fruits while cleaning mechanisms remove debris, can work with a grass ground cover, thus reducing dust problems in the groves, with no need for herbicides.

The Jolly 2800 harvester developed by GF, was tested for its operational performance, productivity and work quality. This tractor-drawn unit was connected to the three-point hitch of a tractor with a driver seat rotation system to invert the driving direction.

Field tests were carried out on different picking surfaces. Good results were obtained both on bare ground (rolled for a smooth orchard floor) and on natural ground covered with grasses, mown before fruit fall. The machine can harvest exactly in the same way with a considerable weed growth after frequent rainfall during the harvest period.

The tests resulted in a good hourly productivity (2.6 t h^{-1}), and high operative working capacity (0.4 ha h^{-1}), thus allowing repeated runs. A low dust production was observed, with less air pollution in the orchard environment, since the pick-up brush and the transfer/cleaner augers are enclosed, and no fans are installed for product cleaning.

The multiple step cleaning process, with augers that move the product through tube chambers, with revolving cylinders for removing leaves and metal meshes for separating dirt from the product, allows a high degree of product cleaning (97%).

A fine adjustment of the distance between the picking head and the orchard floor and a wide range of brush rotating speeds, resulted in a good picking efficiency with a low percentage of fruit losses on the ground (8%).

MECHANIZATION OF CROP MANAGEMENT AND ANALYSIS OF THE INFLUENCE
ON PRODUCTIVE, QUALITATIVE AND PATHOLOGICAL ASPECTS

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Keywords: hazelnut cultural practices, productivity

Abstract

The objective of this study is to verify if the introduction of cultivation in hazelnut fields which had not been cultivated for a long time could determine remarkable variations in the production and in the yield of the product without kernel.

Such tests were carried out in farms located in the Monti Cimini area which were very representative of the territory. All the examined farms had been implementing the cultural technique of the "controlled greening" for about twenty years and showed evident signs of field tiredness.

In an area of these plantations, a field treatment was carried out at the center of the row, using a subsoil mixing plough at a depth of 40 cm. The treatment was carried out proceeding with alternate rows in the two years of the experiment; the decision not to treat the entire field resulted from the will to reduce to the minimum the damages that the treatments could determine on the root apparatus, already extremely superficial. Such a treatment preceded a successive clod chipping of the ground, which was realized through a milling and a following rolling, operations which are necessary to allow the mechanized harvest of the product.

A zone next to it was left as "lawn", therefore not treated and used as a term of comparison.

The yield was partially weighted in situ and partially transferred to a laboratory where the yield was evaluated without kernel. The evaluation of the interactions between the treatments and the culture productivity was estimated through the elaboration of the data obtained in this way.

SAFETY AND HEALTH OF WORKERS: EXPOSURE TO DUST, NOISE AND VIBRATIONS

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Keywords: safety and health, exposure during harvest, dust, noise, vibrations

Abstract

Working in nut farms results in the exposition of workers to different risks for their safety and health.

The use of agricultural machines exposes workers to risks which can have a physical (noise, vibrations), chemical (dust and chemical agents in the air, smokes) and biological nature (spores, micro-organisms, pollen, which are conveyed with the dust).

The harvest of nuts is different from the harvest of other fruits in that it is carried out with machines realized for that specific purpose, often by artisan manufacturer. For this reason, and because of the high concentration of work which characterizes the harvest, the research focused on this cultural operation and on the main risk factors for the health of the workers: noise, vibrations and dust.

The evaluation of the exposure to noise during harvest was performed with the aid of integrator phonometers, through which the sound pressure levels were measured in correspondence to the exposed workers' hear. The applied methodology was the one according to decree law 195/06, Italian reception of the directive 2003/10/ CE.

The evaluation of the risk given by exposure to vibrations for the workers was carried out separately for the vibrations transmitted to the whole body (WBV- Whole Body Vibrations) and those transmitted to the system hand-arm (HAV – Hand Arm Vibrations). The evaluations were performed according to decree law 187/05, Italian reception of the directive 2002/44/CE, based on norms ISO 5349 and ISO 2631.

With concern to the exposure to inorganic dust, tests on different harvest machines were carried out, with the objective of evaluating the exposure of workers. The samplings were performed with the aid of aspirating pumps SKC and "cone-shaped" samplers for breathable dust, on cellulose filters.

FUNGAL DISEASES AS AN IMPORTANT CAUSE OF LOSSES IN HAZELNUT CROP

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Keywords: fungal diseases, hazelnut, losses of production

Abstract

Fungal diseases are still a considerable limiting factor of both quantitative and qualitative production of *Corylus avellana* L. growing in Central Italy. Among them, root rot, shoot cankers, wood decay, twig blight, fruit rot, anthracnose, grey necrosis and powdery mildews are particularly important. The first critical step in the hazelnut crop occurs during the transplant, when the rootstock can be affected by several root rot fungal pathogens. The most dangerous hazelnut fungal disease seems to be still the "Cytospora canker" (mal dello stacco) associated with the presence of *Cytospora corylicola*. This is a necrotrophic pathogen which attacks stressed plants causing bark and cambium infection and necrosis; additionally, apoplexy, blight and shoot cankers appear in the host. The presence of other 2 fungal species (*Biscogniauxia mediterranea* and *Phomopsis* sp.) was detected during 3 years of survey in hazelnut farms with a high incidence of *C. corylicola*. The monitoring results show that this disease has a chronic trend and leads to a strong decline in production. The measured losses were as follows: -35% in 2004, -38% in 2005, -34% in 2006. Moreover, a low, constant level of qualitative loss, ranging from 3% to 5%, in shelled nuts was found. Through mycological investigations carried out into buds, flowers and nuts, *Fusarium lateritium*, *Alternaria* spp., *Epicoccum* spp., *Phomopsis* sp., *Penicillium* spp. and *Aspergillus* spp. were identified. The last two fungi (which are of considerable interest due to their ability to produce mycotoxins) were actually toxin producers only in 0.5% of total cases. Recommended control measures are: replacement of old weakened plants, use of pathogen-free propagating material, preference to single-trunk tree, regular application of scouting for new cankers, therapeutic pruning, infected residual removal, fungicide treatments.

TEBUCONAZOL EFFICACY IN THE CONTROL OF
"GREY NECROSIS" OF HAZELNUT

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Keywords: tebuconazole, grey necrosis, hazelnut

Abstract

The aim of this study is to evaluate the action of tebuconazole (Folicur® SE Bayer CropScience) in the control of "grey necrosis" of hazelnut. This disease causes a brown-greyish spot at the base of the nut which progresses into the fruit with the discoloration of the pericarp and the embryo tissues. The "grey necrosis" of hazelnut is caused by many different fungal genera: *Fusarium lateritium*, *Alternaria* spp., *Phomopsis* spp. In 2006 and 2007, trials were made in two farms in the district of Viterbo (Central Italy). In each farm, the experimental hazel field was subdivided in trial plots corresponding to three experimental thesis (1 = no treatment ; 2 = tebuconazole; 3 = conventional chemical treatment). In each year, two treatments were made with tebuconazole, respectively in the first and in the last week of May (a period in which hazel plants seem to be more susceptible). During the first year only the productive data were determined. In the second year, samples of fruit, taken in different growth stages, were analyzed in Petri dishes with PDA as substrate. The developing fungal colonies were isolated, studied under microscopy, identified and counted. The results show the lower presence of *F.lateritium*, *Alternaria* spp., and *Phomopsis* spp. in theses treated with tebuconazole. Mycological analysis demonstrated a good efficacy of tebuconazole in the control of the agents of "grey necrosis" of hazelnut (in particular *F.lateritium* and *Alternaria* spp.). In conclusion, hazel plants treated with tebuconazole give better results than the conventional treatment in terms of production and quality of product.

REMOTE SENSING IN MONITORING THE DIEBACK OF HAZELNUT ON THE "MONTI CIMINI" DISTRICT (CENTRAL ITALY)

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Keywords: dieback, GIS, remote sensing, hazelnut diseases

Abstract

During the last years, new methodologies for remote analysis, such as the remote and proximal sensing, have been added to the various standard techniques for plant disease monitoring. In particular, multi-spectral images, acquired at a high radiometric and geometric resolution, by means of digital airborne systems or by satellite, can be useful for monitoring some diseases of woody plants. This work first reports the results of the application of one of these systems, called A.Sp.I.S. (Advanced SPectroscopic Imaging System) for monitoring the Dieback of hazelnut in the province of Viterbo, as a case study. This is a bacterial disease which affected hazelnut orchards in province of Viterbo since the 1980s. The spatial data sources were aerial photographs taken during a decade of growing seasons, from 1996 to 2006. Moreover, satellite images (Quick Bird) were used in order to previously scan wide areas of the territory affected by the disease. The satellite images, once overlaid and manipulated by means of a dedicated software (Image calculator – IDRISI™), were used as a basis for drawing new elaborated "differential" digital images. The digital elaboration showed annually, in different grey scales, the plants which were suspected to have died the season before. The suspected plants were then automatically identified by means of E-cognition™, a segmentation GIS software which performs object-oriented image analysis. The results were then confirmed comparing the A.Sp.I.S. images and by proper ground activities performed *in loco*. The software was able to recognize the main part of dead or wilting plants when applied to the images. Finally, a protocol of investigation was set up, by means of vectorial GIS, in order to follow in time and in the space the local spread of the disease. The potential of such applications for our purposes is currently under validation. Moreover, the possibility of using these techniques to other agro-forestry environments is of great interest.

INTEGRATED PEST MANAGEMENT IN FRENCH HAZELNUT ORCHARDS:
A GLOBAL APPROACH BASED ON RECENT STUDIES FOCUSING ON
OPTIMAL PEST MANAGEMENT STRATEGIES FOR
THE CONTROL OF *BALANINUS NUCUM* AND *PHYTOPTUS AVELLANAE*

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Keywords: integrated pest management, chemical controls, entomopathogenic nematodes, beneficials, hazelnut weevil, filbert bud mite

Abstract

The French Hazelnut Growers Association (ANPN) prioritises efforts to reduce damage caused by insects and diseases affecting hazelnut orchards. In recent years, three different pest management approaches have been developed to control pest populations. The suppression of chemical insecticides (endosulfan and carbaryl) has left French hazelnut producers defenceless against *Balaninus nucum* and *Phytoptus avellanae*. Joint evaluations of new insecticides have been carried out with CTIFL (Technical Centre of Fruits and Vegetables) and SRPV (Regional Service of Plant Protection) since 2005. The results of these trials have demonstrated the effectiveness of new active materials which should now be given fast-track approval.

Used alone, biological controls were shown to be ineffective in controlling populations of weevil larvae in the soil, with entomopathogenic nematodes and parasitic fungi. However, combining their use with chemical sprays could restrict the pressure of the pest and limit the need for chemical intervention.

The study of beneficials present in hazelnut orchards and their responsiveness to chemical treatments should allow pest management calendars to be adjusted with new pesticides efficient against pests and less harmful to the environment.

At present, pesticides offer the only means to ensure the economically viable production of hazelnuts in France. However, although the new active materials have a less impact on the environment and are less harmful to human health, their use has not been authorised yet and growers are therefore unable to take advantage of them.

For this reason, we have to continue investigating alternative methods of pest control. To bring together resources and know-how in the area, ANPN recommends the establishment of an international working group and is actively seeking contributions from potential scientific and technical partners who are willing to participate in such a project.

FIRST SURVEYS ON *AGRILUS* SPP. (COLEOPTERA: BUPRESTIDAE)
INFESTING HAZELNUT IN NORTHWESTERN ITALY

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Keywords: wood-boring beetle, field surveys, life-history, egg-parasitoid, Hymenoptera Encyrtidae

Abstract

In the last years, severe attacks of wood-boring beetles, belonging to the genus *Agrilus* (Coleoptera: Buprestidae), have been reported in the hazelnut growing area of Langhe (Piedmont, NW Italy). Similar attacks were already observed and attributed to the species *A. viridis*, larvae of which can cause shrivelling of hazelnut branches with their strong wood-boring activity. Therefore, in 2006-2007, research was addressed to identify the *Agrilus* species present in the hazelnut agroecosystem of our region, to assess rate and harmfulness of their attacks, and to evaluate efficacy of egg-parasitoids, with the aim to implement effective and environment-friendly control tactics. From May to August, sampling was carried out weekly in hazel groves using yellow sticky traps, and by visual inspection of branches to collect adults and egg-patches, respectively. Seven *Agrilus* species were sampled: three only occasionally and four more frequently; among these last species, the most abundant and widespread was *A. olivicolor*. Adult beetles were always captured from May to early August, showing a long flight activity in the hazelnut agroecosystem. Egg-patches were collected starting from May, and larvae emerged from late May to mid-July. An egg-parasitoid, *Oobius zhaikevitshi* (Hymenoptera: Encyrtidae), was obtained from egg-patches in both years; in 2007, the parasitization rate fluctuated from 8% to 58% of total field-collected egg-patches in the surveyed hazel groves.

EUROPEAN SHOT-HOLE BORER (*Xyleborus dispar* F.): COMPARISON
BETWEEN CAPTURE WITH CHEMIO-CHROMOTROPIC REBELL® ROSSO TRAPS
AND MODIFIED MASTRAP® TRAPS

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Keywords: IPM, insect, scolitidae, European shot-hole borer, *Xyleborus dispar* F.

Abstract

Xyleborus dispar F. (Coleoptera, Scolytidae) is one of the key pests of the hazelnut tree in the Palearctic region. It is well-known that Rebell®rosso traps do not only capture the target species, but also numerous useful insects, thus causing great damage to the ecosystem. For this reason, a comparison was carried out between the Rebell®rosso trap and the Mastrap®L trap which was modified by us.

The results show that there was not a great difference regarding the total number of insects captured with the two types of trap. The Mastrap®L trap, which we modified, could be used in IPM programs for controlling the populations of shot-hole borers using the technique of mass trapping, as they not only capture the same number of insects as the Rebell®rosso traps, but they are also highly selective.

NEW OBSERVATIONS REGARDING THE BIOLOGY OF THE EUROPEAN SHOT-
HOLE BORER (*XILEBORUS DISPAR* F.) ON HAZELNUT TREES
IN NORTHERN LATIUM (CENTRAL ITALY)

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Keywords: insect, scolytidae, European shot-hole borer, *Xyleborus dispar* F.

Abstract

Xyleborus dispar F. (Coleoptera, Scolytidae) is one of the key pests of the hazelnut tree in many nations of the Palaearctic region. In this paper, some new aspects were defined on the biology and ethology of this insect.

The results show that the flight of the insect is particularly influenced by rainfall and temperatures (minimum and maximum). In rainy periods and/or with low temperatures, the flight of the insect is interrupted until the weather conditions improve. The coleopteran starts its flight with a temperature of 14°C; therefore, in central Italy, it is advisable to install traps for the mass capture of the insect at the beginning of March. By observing the spermathecae, we can deduce that the insect mates outside the galleries of proliferation.

SEVEN YEARS OF OBSERVATION OF THE PRESENCE OF DIFFERENT PLANT BUG
SPECIES IN THE HAZELNUT ORCHARDS
OF 'TONDA GENTILE DELLE LANGHE' IN PIEDMONT

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Keywords: Plant bug frequency, hazelnut orchard characteristics, 'Tonda Gentile delle Langhe'.

Abstract

Since the end of the past century, the technical service for assistance to hazelnut growers united in the Associazione Produttori Corilicoli Piemonte (Asprocor) arranged a system to monitor the insect presence in hazelnut orchards by *frappage*. These controls were made to better address the phytosanitary treatments mainly against plant bugs. Indeed, this kind of insects represents the major cause of internal defects in the seeds.

With the *frappage*, during the last 7 years, the moving forms of the following species of plant bugs were looked for and identified: *Acanthosoma haemorrhoidale*, *Coreus marginatus*, *Dolycoris baccarum*, *Gonocerus acuteangulatus*, *Palomena prasina*, *Pentatoma rufipes*, *Pantilius tunicatus*, *Graphosoma italicum*, *Rhaphigaster nebulosa*.

The *frappage* was performed in 80 farms, sited in 30 communes which represent 40 % of local production.

All the data give the possibility to determine, for each bug species, its frequency in relation to the year (that is to say, climatic conditions) and to the different yielding district, and orchard characteristics (e.g. nearness to other cultivations or to the wild).

These results should be useful not only to deepen plant bug ethology knowledge, but also to point out agronomic factors that support plant bug presence in hazelnut orchards.

BIOLOGY, POPULATION DENSITY AND FLUCTUATIONS OF THE GREEN SHIELD
BUG (*PALOMENA PRASINA* L., HETEROPTERA: PENTATOMIDAE)
IN HAZELNUT ORCHARDS OF TURKEY

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Keywords: hazelnut, *Palomena prasina* L., population, density, fluctuations

Abstract

There are many insect pests in hazelnut orchards. Some of the true bugs are important pests in hazelnut orchards because they feed on flowers, nuts and kernels. The most important species of this group is the Green shield bug (*Palomena prasina* L. Het.: Pentatomidae), both in Turkish hazelnut orchards as well as in some other countries. This species deserves great attention in relation to hazelnut production and kernel quality.

This study was carried out in order to determine population density and seasonal fluctuations of the Green shield bug in the Samsun, Ordu and Giresun provinces of Turkey between 2001 and 2003. Nine hazelnut orchards from the Samsun province were visited three times in a month during three years, while nine orchards of other provinces were surveyed twice a month during 2001. Adults and nymphs were collected through the beating sheet method. Eggs were found by examining leaves after the appearance of adults in field conditions.

The first overwintering adults were mostly seen in mid-April in hazelnut orchards. The new generation of adults appeared in July. The adults were present in orchards from mid-April until the end of October. The adult population density reached the highest level during August in general. Eggs were seen during May and June. Nymphs were mostly observed from June until the end of August in hazelnut orchards. The first two stages of nymphs tended to be on herbs in hazelnut orchards. Population density reached the peak level at the end of July and revealed as 10 insects/10 "ocak" (in Turkish "Ocak", which is consist of 8-10 sigle trunk together) in the Ordu province in 2001. The peak time of population density in the Giresun province was again late July and density levels were 15.2 insects/10 ocak in the same year. Population density reached the highest level in early August in the Samsun province for 3 successive years. Population levels were 14.9, 51.5 and 45.5 insects/10 "ocak" for 2001 and 2003 respectively.

In general, population density, fluctuations and biology of the Green shield bug changed depending on years and locations.

INTEGRATED CONTROL OF HAZELNUT WEEVIL (*CURCULIO NUCUM* L.): AN EVALUATION OF ENTOMOPATHOGENIC NEMATODES AND PARASITIC FUNGI

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Keywords: hazelnut weevil, biological control, entomopathogenic nematodes, *Heterorhabditis*, parasitic fungus, *Beauveria*, *Metarrizium*

Abstract

Since 2003 French hazelnut growers have been experimenting with alternative and/or complementary methods to the use of insecticides. In 2007 a biological control trial was carried out using containers with a capacity of 46 litres placed under a cold plastic greenhouse. The experiment has consisted of bringing a fungus or a nematode strain on the earth surface of containers where weevil larvae were recently buried. Larvae had been previously recovered with a grill system in which infected nuts were laid out. Larvae sowing was performed from 27 July to 13 August. 44 to 45 larvae were placed in each container. We used four products: Nematop® (*Heterorhabditis bacteriophora*, E-nema GmbH, Germany), Beaupro® (*Beauveria brongniartii*, Andermatt Biocontrol AG, Switzerland), Metapro® (*Metarrizium anisopliae*, Andermatt Biocontrol AG), Naturalis® (*Beauveria bassiana*, Intrachem Bio, Switzerland). Seven thesis were investigated with respect to their efficiency : 1) untreated control, 2) Nematop at 1×10^6 IJs/sq.m, 3) Nematop at 1.35×10^6 IJs/sq.m, 4) Nematop with two applications 0.675×10^6 IJs/sq.m, 5) Beaupro at 10 g/sq.m, 6) Metapro at 10 g /sq. m, 7) Naturalis at 0.5 ml /sq. m. Fungi were applied on 28 May, the nematodes on 10 August (thesis 2 and 3) and the fractional treatment 4 was applied on 7 and 10 August. Each thesis was replicated in 5 containers, according to a complete randomisation. Observations on the efficiency against larvae were carried out from 27 September to 3 October, 2007. The proportion of recovered larvae or empty earth cells varied in a range between 30% and 55%, with a significant influence of treatments. Overall products efficiency was low relative to 8% rate of natural mortality observed in control plots. Nematop gave better results (23% to 37% efficiency) than fungi (15% to 18% efficiency). 66% of larvae were buried between 11 and 30 centimetres depth, and only 1.5% were buried deeper than 40 cm.

STRATEGIES FOR IMPROVED PEST MANAGEMENT IN TURKISH HAZELNUT GROWING

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Keywords: hazelnut, processing plants, storage pests, Turkey

Abstract

Turkey is the world's leading producer and exporter of hazelnuts. A hazelnut agroecosystem stretches across some 500,000 hectares of Turkey's eastern Black sea region. Substantial losses in production are attributable to pests. The main pests are the big bud mite *Phytoptus avellanae* and the hazelnut weevil *Curculio nucum*, with others locally important. The big bud mite has been reported to reduce yield by up to 70%. Hundreds of thousands of growers respond to pests with a wide spectrum of approaches, varying from non-intervention to organic growing and multiple chemical treatments. This paper reviews the range of current pest management practices and highlights opportunities for improved pest control through IPM and organic growing research, research and extension coordination, grower education and government policy changes.

CONTROL OF *CURCULIO NUCUM* L., THE HAZELNUT BORER,
BY ENTOMOPATHOGENIC NEMATODES

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Keywords: *Curculio nucum* L., *Heterorhabditis bacteriophora*, hazelnut, biological control, field application.

Abstract

Hazelnut borer *Curculio nucum* L. is a very harmful pest that can cause up to 80% of losses in hazelnut plantations. The pest is expanding fast, it is difficult to fight, as its larvae are protected in the nuts or in the soil, and few available insecticides are still authorised. Entomopathogenic nematodes from the genus *Heterorhabditis* are obligate parasite of insects: they have the ability to search and parasitize the prey in the soil. The attacked larvae died within two-three days and became a source of nutrients for the nematodes, which reproduce inside the preys' cadavers. In this work, we present the field application of an entomopathogenic-based product containing infective larvae of *Heterorhabditis bacteriophora* to control the hazelnut borer. Nematodes were applied by the end of July, when the larvae of *C. nucum* start falling on the soil. The number of applied nematodes was 500,000 infective larvae/m² distributed in one and two application times. The soil was irrigated before and after the application. Alternative treatments were performed by applying the nematodes with *Beauveria brognartii* and by applying another species of entomopathogenic nematodes, *H. megidis*. The efficacy of the treatments was assessed by scoring dead and alive larvae of the hazelnut borer buried in the field trials in tube cages. The best result, with 72% of efficacy, was obtained with two applications of *H. bacteriophora* at the rate of 250,000 larvae/m². *H. bacteriophora* is a valid tool to combat the infestation of *C. nucum* in hazelnut plantations and to safeguard the production economy. Its insecticidal activity reaches a high level of insect control, with a preventive action on the larvae before their development into adults. The entomopathogenic nematodes are safe for humans and the environment and they do not present residues.

NATURAL SPREAD OF *VERTICILLIUM LECANII*, AN ENTOMOPATHOGEN FUNGUS
OF BROWN SCALE
IN HAZELNUT ORCHARDS IN TURKEY

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Keywords: biological control, hazelnut, fungus, scale

Abstract

Brown scale (*Parthenolecanium corni-rufulum*) is one of the major pest affecting hazelnut cultivation in Turkey. In addition to their direct damage, brown scale insects cause indirect damage to hazelnuts as they produce fumagine. Therefore, they cause an early ageing of hazelnut orchards. Due to their being polyphagous, their control is very difficult. In the past, chemical control was proposed against them. However, after the detection of *Verticillium lecanii* as an entomopathogen fungus of *P. corni*, chemical control was cancelled. In this study, natural spread and intensity of *Verticillium lecanii*, as well as the places where hazelnut cultivation is most effective against scales, were studied and determined.

ARTHROPOD PEST MANAGEMENT IN ORGANIC HAZELNUT GROWING

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Keywords: hazelnut, arthropods, insect pest management, organic growingAbstract

Organic agriculture has been growing very fast worldwide during the last decade. Hazelnut is one of the main crops produced as organic in Turkey. Most of the hazelnut produced organically in Turkey is exported. Unfortunately, organic production has not been supported adequately by rigorous research regarding arthropod pest management. Nowadays, approaches to arthropod pest management in organic production only consist of general pest control methods for many crops, as well as for hazelnut. However, many producers openly need more specific information addressed to their own crop and pest problems. In spite of the lack of sufficient information about pest management practices that can be used in organic hazelnut production, organic hazelnut growing is now continuing, and there is a need to evaluate available literature and experience in order to establish an arthropod pest management program for organic hazelnut production.

In this study, available results of researches and experiences about arthropod pests of hazelnut were evaluated, and control measurements for main arthropod pests were suggested for organic hazelnut growing. Cultural, mechanical and biological control methods of arthropod pests for organic hazelnut growing were discussed on the basis of pest species, in addition to the use of insecticides approved for organic systems.

ASSESSMENT OF GENETIC RELATIONSHIPS BETWEEN HAZELNUT CULTIVARS
USING RANDOM AMPLIFIED POLYMORPHIC DNA (RAPD) MARKERS

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Keywords: *Corylus avellana* L., genetic variability, random amplified polymorphic DNA (RAPD), PCR

Abstract

The objectives of this study is to assess the genetic variability between six hazelnut cultivars which grew in Poland using RAPD markers. DNA was extracted by Milligan's method from fresh leaves. Amplificated PCR products were separated on 1.5% agarose gel, visualized and photographed. 30 decamer primers were selected from 80 primers. This primers yielded a total of 243 bands, of which 146 were polymorphic. The total number of amplification products ranged from 2 to 12, with an average of 8.1 bands per primer. 21 primers amplified 31 unique bands for specific genotypes. Genetic pairwise similarities between studied genotypes were evaluated according to the Dice's formula. Cluster analyses were performed using the UPGMA method. The phylogenetic tree showed that only three cultivars clustered together. The rest of them were located on the outskirts of the dendrogram. This research showed that hazelnut cultivars in Poland are genetically diverse. The RAPD technique is an useful tool for the evaluation of genetic relationships between hazelnut cultivars.

A PRELIMINARY SURVEY OF HAZELNUT (*CORYLUS AVELLANA* L.) VIRUS-LIKE DISEASE IN PORTUGAL: A CASE STUDY

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Keywords: deformation trunk, hazelnut, rope symptoms, virus-like.

Abstract

Last year, several commercial hazelnut cultivars (*Corylus avellana* L.) located in the north of Portugal (Felgueiras region) on an antrosol at 370 m a.s.l. presented an unknown symptomatology. The local climate can be defined as temperate, with cold winters, mild springs and hot summers of the Mediterranean type. Rainfall reaches 1300 mm per year, although the summer season is generally dry. The trial was a rectangular field plot with 245 plants of 26 cultivars, twenty-years-old, spaced 5 x 3 m and trained as a single trunk. Only recently, 41 trees of different cultivars (Couplat, Grifol, T. G. delle Langhe, Ribet, T. G. Romana, Pauetet, L. d'Espagne, Siciliana, Casina, Da Veiga, S. Giovanni e Mortarella), some of them grafting onto Segorbe (just the first six cultivars), located at the centre of the trial, began to show external bark deformations at several branches and at the trunk; the deformations have a rope aspect and no symptoms were evident on the leaves. This type of bark deformations was also observed in several plants of *Camellia japonica* near to the hazelnut trial. The viruses reported on hazelnut cultivars, namely *Apple mosaic virus* (ApMV), *Prunus necrotic ring spot virus* (PNRSV) and *Tulane apple mosaic virus* (TAMV), usually do not induce these symptoms. *Apple stem grooving virus* (ASGV), which infects apples and citrus and *Citrus psorosis virus* (CPsV) in citrus, may induce similar deformations mainly in the trunk. The deformations observed suggest a vascular type of disease that could have a biotic or abiotic origin.

The objective of this work is to identify the causal agent of this virus-like disease or other non-biological cause. Biological, serological, molecular and electron microscopy studies, as well as nutritional analyses, will be prosecuted.

THE CONSUMPTION OF FRESH HAZELNUTS: QUALITY AND STORAGE

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Keywords: hazelnut production, storage, quality, fresh consumption

Abstract

The cultivation of hazelnuts on the territory surrounding Viterbo represents a great source of work. The search for competition at a commercial level is achieved by reaching some priority objectives: the improvement of quality, the rationalization and simplification of the system of production, and, lastly, the promotion of consumption through a commercial increase in value of the product. It is in reference to the latter that there is good reason to believe in a different use of this fruit: the consumption of fresh hazelnuts.

As it is a fresh product, the main problem concerns storage and therefore it is necessary to evaluate the possibility of opening a new market; so, there is a need of maintaining the organoleptic qualities of the product over a period of time.

The aim of this experiment was to determine the best harvest time in relation to the organoleptic qualities of the fruit, and the most adequate methods of storage for the product. Hazelnuts were harvested at 3 different stages and the following analyses were carried out: deformation, colour, acidity, peroxides, weight loss and furthermore hazelnuts were evaluated by a trained panel test.

The fresh hazelnuts were therefore stored in a controlled atmosphere using different percentages of O₂ and CO₂, and 2 different temperatures: 4 and 10°C.

The best result was obtained using the lowest temperature, while the best harvesting time was when the deformation of the fruit reached 0.18 mm applying a compression force of 10N.

DETERMINATION OF RELATIONSHIPS BETWEEN NUT AND KERNEL
CHARACTERISTICS IN HAZELNUT (CV. PALAZ)

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Keywords: hazelnut, Palaz, regrestion analysis, pomology

Abstract

This study was carried out on Palaz hazelnut cultivar grown in villages of Ordu province. The interrelationships between nut weight, kernel weight, kernel percentage, shell thickness, nut size, marketable kernel and pellicle removal were determined using correlation analysis.

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

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Keywords: hazelnut, nut, kernel, husk number, correlation

Abstract

This study involved 'Tombul', 'Palaz', 'Kalinkara' 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 nut weight (g), nut size (mm), shell thickness (mm), kernel weight (g), kernel size (mm), internal cavity (mm), kernel percentage (%), poor fill (%), 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, poor filled, 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; a significant negative correlation was noted between husk number- full pellicle removal and husk number- average pellicle removal.

STATE AND PROSPECTIVES OF HAZELNUT GROWING IN SERBIA

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Keywords: hazelnut, production, leading producers, assortment, fruit qualityAbstract

A growing interest in hazelnut production has been observed in Serbia over the past decade. In terms of its ranking among other kernel fruits, hazelnut ranks second, just below walnut. Interest in hazelnut fruits is particularly observed in candy industry on account of its nutritive and aromatic properties. Wider growing of hazelnut is promising for many reasons. Firstly, shortage in hazelnut can be duly controlled. Secondly, growing technology is simple, and finally, hazelnut plantings are not prone to serious pests and diseases, which makes the production cheaper.

Leading global producers and exporters of hazelnut fruits are Turkey, Italy, Spain, USA, Greece, etc. As for Serbia, hazelnut production has not been registered yet, however, it is estimated to be about 800 – 1,000 t.

One of the most serious problems in wider growing of hazelnut in our country is shortage in respect of high quality planting material. Expansion of hazelnut growing in Serbia should be further supported by the assortment that will be adequate for growing under our agroecological conditions. In view of the fact, our recommendation should include the following cultivars: Tonda Gentile delle Langhe, TG Romana, Tonda di Gifoni, Nocchione, Tonda Bijanca, Mortarella, Negret, Ennis, Barcelona Istarski dugi, Haleški džin, Mogul, Multiflorum, Kosford, Lambert, Davijana.

The proposal meets requirements of the candy industry which presupposes expansion of cultivars with smaller and round fruits.

PERFORMANCE OF HAZELNUT VARIETIES IN IRAN

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Keywords: hazelnut varieties, fruit set, pollination

Abstract

Hazelnut is one of the oldest nut crops which is important as food. Hazelnut is cultivated in more than 20 countries. Iran is one of the biggest producers in the world. The purpose of this research is to evaluate qualitative and quantitative characteristics of 25 collected varieties during 2000-2004 in the research station of Kamalshahr. Characteristics such as date of catkins and female flowers appearance, pollen ripening and pollen shedding, appearance of stigma, type of flowering, leaf morphology, date of leaf abscission, browning of leaf margin, date of harvesting, fruit characteristics (length, diameter, weight, protein and oil content of kernel) and yield were studied. In this study, we found that the varieties are divided in 3 groups: protogyne, protander and homogame. It was found that Fertile du Cutard has the highest yield (1.4 Ton /ha), while the lowest yield recorded relates to Mahalie Karaj (0.2 Ton /ha). The studies on pollination and fruit setting showed that most of the varieties were cross pollinated and some had pollen compatibility, so the rate of fruit set in isolated flower has significant differences with open pollinated ones.

In this study, it was found that Rasmy and Fertil du Cortard varieties had the highest degree of self fertility, while varieties of Pashmineh and Gerge had the lowest.

Moreover, it was found that Gerdooii variety was an excellent pollinizer for the following varieties: Fertil du Cortard, Rasmi, Gerdooii, Shastak and Negret. Finally, among 25 varieties in this experiment, 9 varieties are compatible to Karaj conditions and the nuts present high quantity and quality in such a condition.

PRODUCTIVE AND ORGANOLEPTIC EVALUATION
OF NEW HAZELNUT CROSSES

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Keywords: *Corylus avellana* L., cross-breeding, horticultural performance, sensory evaluation.

Abstract

This study presents the results of ten years of observation about the agronomic traits, the nut and kernel characteristics, and the sensory analysis of eight crosses of Tonda Gentile Romana and Tonda di Giffoni, selected during a hazelnut breeding program carried out since 1983 in Central Italy.

On the basis of the collected data, the most interesting crosses resulted to be the following:

- F6P200: for early nut maturity (last ten days of August, at the same time of Tonda Gentile delle Langhe), steady and high yield, few suckers, spheroidal nut, high pellicle removal (74%) and good flavour of roasted kernel;
- F15P5: for high yield, good kernel percentage (48%) and round index (0.91);
- F21P12: for good yield and very good kernel percentage (54%);
- F4P32: for few suckers, round index 1.02, high kernel uniformity (76%), high pellicle removal (75%), good flavour of roasted kernel;
- F25P29 and F13P9: for very good kernel percentage (around 51%).

The crosses F4P32, F25P29 and F13P9 showed very interesting nut characteristics, such as kernel quality and percentage, while yield must be improved by specific cultural techniques or by further breeding.

NUT QUALITY AND SENSORY EVALUATION OF HAZELNUT CULTIVARS

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Keywords: sugars, starch, fatty acids, phenol content, sensory analysis

Abstract

Nut quality depends on morphological, physical, chemical and organoleptic properties affecting the acceptance by industry and consumers, and the revenue for hazelnut growers. Sensory analysis gives a comprehensive evaluation of several quality components, allowing a deeper knowledge of varietal differences in nut external and inner quality.

The aim of this research is defining the quality of seven cultivars: the Italian Mortarella, Nocchione, San Giovanni, Tonda di Giffoni, Tonda Gentile delle Langhe, Tonda Gentile Romana, and the Turkish Tombul, through the study of biometric traits, chemical composition and sensory attributes of external appearance, texture and flavour. Nuts were sampled in a germplasm collection in the Italian province of Viterbo. Quantitative and qualitative determinations of sugars, organic acids and lipids revealed good nutritional and health potential of the nuts. The total content of oil and sugars ranged from 58.87 to 64.21 g 100g⁻¹ dry weight (DW) and 4.06 to 4.75 g 100g⁻¹ DW respectively. Fatty acid and sugar profile, starch and total phenolic content varied between cultivars, and a significantly higher palmitic acid concentration (7.46%) was found in the cultivar Tonda Gentile Romana, while a lower saturated fatty acid concentration and a higher unsaturated/saturated acid ratio (11.39) were observed in the cultivar Mortarella.

Multiple regression showed a significant positive relationship between global preference and taste and texture components, such as sweetness and oiliness. Sensory analysis was able to reveal varietal differences in attributes related to taste and smell. The perception of low sweetness and high bitterness and astringency determined a low level of appreciation for the cultivars San Giovanni and Mortarella. A positive relationship between sweetness scores and sugar concentration was observed. The information relating to secondary components, such as sugars, organic acids and phenolics was useful in order to discriminate between the cultivars. Due to the effect of these compounds on the sensory attributes perceived by consumers, their concentration and the varietal differences can be regarded as primary indexes of nut quality and should be taken into consideration when planning the cultivar choice.

SENSORY ANALYSIS AND HEADSPACE / GAS CHROMATOGRAPHY OF ITALIAN HAZELNUT VARIETIES

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Keywords: roasted hazelnut, descriptive sensory analysis, flavor, volatile compounds

Abstract

This study presents the preliminary results of the comparison of volatile components and sensory responses of Tonda Gentile Romana, Tonda di Giffoni and Mortarella cultivars. The sun-dried, natural hazelnut samples were roasted at 120°C for 20 min., using a hazelnut roaster (Brovid R1/900-OB-V). The characteristics of the roasted hazelnuts were described and evaluated by a panel made up by 8 tasters. Each taster tasted 3-5 hazelnuts at time and the panel test was done 3 times per each cultivar. Descriptive sensory analysis showed that Tonda Romana was mainly characterized by almond-like flavour, Mortarella hazelnut by oily taste and Tonda di Giffoni hazelnut by caramel-like flavour. The most important flavour attributes are nutty, caramel-like and cooked-bread-like. The taste and aftertaste attributes detected are sweet, salty, bitter, almond-like, nutty, burnt, oily. The bitter taste attribute was not detected in Tonda di Giffoni. Tonda di Giffoni showed the highest intensity of nutty aroma and of sweetness. The hazelnut varieties were characterized for their chemical composition of volatile components. Compounds including ketones, aldehydes, terpenes and cyanide derivatives were detected and identified by SPME-GCMS analyses. Among these classes of compounds, qualitative and quantitative differences were found in the different varieties. Specific compounds such as filbertone, linalool and 1.4 cineole showed significant variations between the three different cultivars. Therefore, the experimental results indicate that the combined DSA/GCMS technique is suitable for qualitative and quantitative analyses of hazelnut volatiles, and to support the sensory attributes in order to define hazelnut quality.

QUALITY AND NUTRITIONAL PROPERTIES OF HAZELNUT OIL AND HAZELNUT DEFATTED FLOURS

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Keywords: hazelnut oil, defatted flours, nutritional properties, quality

Abstract

Hazelnut oil and partially-defatted flours from *C. avellana* seeds are two interesting products, under nutritional and technological point of view. These products are not largely commercialized in Italy; despite the deep knowledge about the chemical composition of hazelnut oil, the chemical characteristics of totally- or partially-defatted hazelnut flours have not been investigated until today. The roasting process strongly influences the quality and the stability of hazelnut seeds during their shelf-life, concerning the peroxidation of the lipid fraction. Different binomial time-temperature programs lead to different impacts on hazelnut products.

Our aim was to characterize some samples of hazelnut oil and some partially-defatted hazelnut flours, obtained with a cold pressing technology from TGL cv. Concerning oil samples, different roasting degrees were evaluated, confirming a strong impact on the tocopherols fraction; beta- and gamma-tocopherols showed a decrease from 2.47 mg/100g (oil from raw seeds) to traces; alfa-tocopherol decreased up to 19.5% (in oil samples from seeds roasted using high-temperature).

Partially-defatted hazelnut flours (10-30% fat) showed an interesting amino acidic profile (very similar to those of unroasted seeds); an interesting amount of branched chain amino acids were present, also in roasted flours (1.67, 2.45 and 1.31 g/100g, respectively for valine, leucine and isoleucine, in high roasted samples).

Nutritional quality of partially defatted hazelnut flour suggests its use as food ingredient useful to aromatise bakery products characterised by a low-fat profile.

DETECTION OF HAZELNUT (*CORYLUS AVELLANA* L.) AS HIDDEN INGREDIENT IN FOODS: PCR APPROACH VS ELISA

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Keywords: hazelnut allergens, end-point PCR, multiplex PCR, real-time PCR, competitive-Elisa

Abstract

"Food allergen detection" is of increasing interest for food labelling purposes. With the Directive 2003/89/EC (up-dated by EU 2006/142/EC) it is mandatory for producers to label all ingredients and derived substances, highlighting the potential presence of food allergens. Hazelnut (*Corylus* spp.) contains different allergens (Cor a1-2, 8, 11) and may cause severe adverse reactions in sensitized subjects, even if in traces. Hazelnut allergens are thermal-resistant; their activity after roasting was highlighted in literature. Beside the traditional direct approach of detection (ELISA, immunoblotting) the use of PCR has been increasing up during the last years.

We aimed to evaluate the efficiency and the sensitivity of different analytical tests (*home-made* validated PCR protocols, commercial competitive-Elisa kits).

Firstly, an End-point PCR protocol (with positive inner control) was optimized. Two Real-time PCR protocols (the first based on Sybr-green unspecific dye, the second one based on a Taqman probe designed on Cor a1.04 gene) were then compared. Sensitivity and robustness were estimated on raw and roasted samples. The lowest detection limit was 0.1 ng of genomic DNA. Genomic DNA is partially degraded by roasting, allowing under-quantification in real samples. Also in the ELISA approach roasting hazelnut leads to some methodological troubleshootings.

Our results show that ELISA is a simple approach useful to detect trace of hazelnut in food; the ready to use kit showed high sensitivity and reliability. Real-time PCR protocols, based on Sybr-green or Taq-man chemistries, allow to obtain a more precise quantification of hazelnuts as ingredients in a complex food, showing a good reliability also in the case of roasted samples contained in traces.

PROANTHOCYANIDIN CONTENT AND TOTAL RADICAL SCAVENGING CAPACITY OF TONDA GENTILE DELLE LANGHE (TGL) HAZELNUT SEED SKIN

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Keywords: hazelnut skin, proanthocyanidins, total antioxidant capacity

Abstract

The aim of this work is to qualitatively define the proanthocyanidinic fraction contained in the seed skins of TGL hazelnuts (Piedmont, Italy) and to evaluate the antioxidant properties.

Polyphenolic compounds are widely distributed in higher plants and are an integral part of the human diet. Recent interest in polyphenols has been stimulated by their potential health benefits, which are believed to arise mainly from their antioxidant activity. The antioxidant activity of flavonoids was studied in detail; a fundamental group of flavonoids is represented by proanthocyanidins, contained in high quantity in different common foods (i.e. grape, wine, berries, tea, cocoa, nuts). The bioactive properties of proanthocyanidins are strictly related to their antioxidant properties as well as to their degree of polymerization. The three most important mechanisms of their action are i) free radical scavenging activity, ii) chelation of transition metals, and iii) inhibition of some enzymes. Moreover, taking into account the organoleptic properties, proanthocyanidins are astringent substances able to allow a dry, puckering mouthfeel.

Hazelnut skins, a by-product directly obtained from hazelnut seeds after roasting, were previously chemically characterized in our laboratory, showing an interesting total content of polyphenols (ranging from 119.68 to 190.88 mg catechin equivalents/g hazelnut skins, dry weight) and an effective total antioxidant-antiradical capacity.

In this work the proanthocyanidin identification in phenolic extracts obtained from roasted hazelnut skin (two different roasting conditions) was performed using LC-MS and HPLC with fluorescent detection methods; we showed the presence of catechin-based procyanidins, with a typical polymerization degree up to dodecamers. Prolonged roasting time allows the decreasing of the polymeric fraction.

The total antioxidant capacity was evaluated as radical scavenging activity (DPPH and ABTS radical methods), chelating activity and inhibition of lipid peroxidation. The comparison with other antioxidant standard compounds confirmed a significant activity for roasted hazelnut skins. The application of the highest hazelnut roasting (180 °C, 20 min) appeared to improve the total antioxidant capacity in hazelnut seed skin.

IDENTIFICATION OF SOLUBLE PHENOLIC ACIDS IN HAZELNUT
(*CORYLUS AVELLANA* L.) KERNEL

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Keywords: phenolic acids, hazelnut, kernel quality, HPLC

Abstract

Phenolic acids are a subclass of a larger category of compounds commonly referred to as “phenolics”. They are a very important group of secondary plant metabolites whose roles are still unknown. Due to their antioxidant behaviour and the potential health benefits associated with these simple phenolic compounds, many authors have proposed different techniques to extract these compounds from vegetable foods. Therefore, the aim of this work is to compare the experimental conditions commonly used to detect soluble phenolic acids (both free and esterified) in order to investigate the phenolic constituents in hazelnut kernel extracts. Phenolic compounds present in defatted samples were extracted using different solvent mixtures under reflux conditions at different temperatures; afterwards, the extraction and hydrolysis of phenolic acids was performed. HPLC analysis of the extracts obtained highlighted the presence of twelve phenolic acids. The main compounds identified were gallic acid, caffeic acid, *p*-cumaric acid, ferulic acid and sinapic acid. In all extracts, gallic acid was the most abundant, in both the free and esterified form. Ethanol solution (80% v/v) at 80 °C was the most effective solvent for the quantitative extraction of benzoic acid derivatives, but extract obtained with acetone solution (80% v/v) at 50 °C showed the highest number of identified phenolic acids. All the other suggested methods showed low extraction capacity for these compounds. Using these optimized methods, new researches are in progress to define the effect of storage and roasting on these compounds.

EFFECTS OF STORAGE CONDITIONS ON HAZELNUT (*CORYLUS AVELLANA* L.)
TEXTURAL CHARACTERISTICS

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Keywords: textural analysis, hazelnut quality, shelf-life

Abstract

Texture analysis is a very important new tool to define the characteristics of foods as its responses could be correlated to consumer evaluations. In this work, texture analysis was applied to samples of the hazelnut variety "Tonda Gentile Romana" (*Corylus avellana* L.), harvested in 2005 and stored for one year in a refrigerating room, in a freezer and under a nitrogen-enriched atmosphere, in order to define the effect of these treatments on textural characteristics of the products. The analyses were performed on the fresh product and after 4, 8 and 12 months of storage. Raw and roasted products were examined. Rupture force (N), rupture energy (mJ) and nut specific deformation (N/mm) were measured by a Universal Testing machine TA.HDr Texture Analyser under three compression loading positions (x, y and z axes). In comparison to the fresh samples, the textural parameters showed the highest differences after 4 months of storage. After 12 months of storage, the values of the force required to break the nuts ranged from 84.8 to 103.1 N for raw hazelnuts and from 80 to 98 N for roasted. The lowest values of force were generally obtained in raw frozen hazelnuts, while in the same storage conditions roasted hazelnuts had the highest. The lowest values of rupture force were usually noticed along the x-axis (length), the highest along the y-axis (width). The obtained results showed that rupture force and nut specific deformation were the most discriminating parameters for raw hazelnuts, while rupture energy was the most discriminating parameter for roasted hazelnuts. Finally, rupture force was strongly correlated with both rupture energy ($R^2=0.95$) and nut specific deformation (0.94). These results show that texture analysis is a very suitable method for hazelnut analysis, and for the study of storage effects on the textural characteristics of this fruit.

FRACTIONS OF VITAMIN E (TOCOTRIENOLS AND TOCOPHEROLS)
IN NUT OIL OF *GEVUINA AVELLANA* MOL.

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Keywords: *Gevuina avellana* Mol., vitamin E, tocopherols, tocotrienols

Abstract

The nut oil of *Gevuina avellana* Mol. (Gevuin), a tree native from Chile, has interesting results for phytotherapy and cosmetic purposes. Vitamin E plays an important role in the antioxidant complex of Gevuina nut oil together other components of the lipid matrix like unsaturated fatty acid isomers and phytoesterols. Vitamin E is a fat-soluble vitamin that exists in different forms. Each form has its own biological activity, which is the measure of potency or functional use in the body. The objective of this study was to evaluate the content of different fractions of vitamin E (tocols: tocotrienols and tocopherols) in the nut oil of *Gevuina* clones. From 2006 to 2007, nuts from seven clones were analyzed to determine the tocol composition, with lipid extraction by Soxhlet method, HPLC and Gas Chromatography-Mass Spectrometry (GC/MS). The results demonstrated an important range of variation in total tocols among clones, with less average content in total tocopherols (1.42 µg/g). A significant level of α-tocotrienol, which represented 97 % of vitamin E fractions, ranged from 63.41 to 163.74 µg/g within clones. Other fractions were β, γ and δ tocotrienols with 1.08, 9.47 and 0.12 µg/g, respectively. These data are important in relation to the selection of genotypes with a superior antioxidant complex quality.

CHANGE OF RHEOLOGICAL, COLORIMETRIC AND AROMATIC
CHARACTERISTICS OF TOASTED HAZELNUTS DURING THE STORAGE AT
DIFFERENT TEMPERATURE AND GAS ATMOSPHERE

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Keywords: hazelnuts, storage, temperature, gas atmosphere

Abstract

Hazelnuts "Tonda Gentile delle Langhe" were toasted and divided in two lots one at 18°C for 4 weeks and the other lot at alterned temperature, one week at 18°C, the next one at 25°C, then one week at 4°C and the last one at 18°C. The samples were kept under nitrogen or in air. Analyses of resistance to compression (bioyield), of internal and external colour by spectrophotometer Minolta, and of volatile compounds were performed. Bioyield values were lower for hazelnuts kept continuously at 18°C in air, while samples in nitrogen, regardless the treatment, kept the bioyield values similar to the initial one. Hue angle of the surface decreased in all the samples due to the increase of "a" parameter. Internal hue angle decreased to a greater extent than the external one without differences between the samples. Acidity values, very low initially, increased slightly, but not in nitrogen samples. Peroxides increased with time, above all in air sample and in samples kept at alterned temperatures.

Two quality markers were identified, esanal and esanol, which increased in samples kept with alterned temperature.

INSTRUMENTAL TECHNIQUES FOR POMOLOGICAL CHARACTERIZATION AND HAZELNUT CULTIVAR CLASSIFICATION

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Keywords: hazelnut, cultivar classification, shape, cultivar identification

Abstract

Qualitative characterization and cultivar identification are assuming a growing importance in agriculture. The assessment of these properties is important in order to deliver a product with specific characteristics that will satisfy industries and consumers' expectations. The most used technologies are based on visual evaluations, which are made considering reference models; therefore, they are subjective, and paired up with more complex methods based on bi- or three-dimensional fruit shape, which require high costs and time of acquisition.

This work tried to develop advanced and sophisticated instrumental methodologies, for an online rapid application, for pomological characterization and hazelnut cultivar classification. The research concerned 4 Italian cultivars: Tonda Giffoni, Tonda Gentile Romana, Mortarella, San Giovanni. In particular, the following analyses were carried out: morphological analysis of fruit and seeds (weight, size), consistence test (max force) obtained by a digital dynamometer, spectro-colorimetric evaluation and shape analysis. For the shape analysis, high resolution digital images of lateral view, polar view and random plane view for in-shell and kernel were acquired. The outline of each hazelnut was then processed by the elliptic Fourier analysis. The results evidenced that the cv. San Giovanni presents a significantly harder shell compared with the other three cultivars (ANOVA). The colorimetric test ($\Delta E > 6$, perceivable by human eye) showed important differences between the cultivars Tonda Giffoni, Tonda Gentile Romana and Mortarella. Moreover, cultivar identification *via* shape analysis showed good results of correct classification (PLSDA) for the random plane view of in-shell (87.8%). In conclusion, the studied methodologies, even if applied in a pilot research, could be considered as a base for a broader evaluation, keeping into account the possibility to operate an efficient classification and characterization for a merceological and qualitative product selection.

TRIALS ON DRYER FUNCTIONALITY IN THE FIRST CONDITIONING OF 'TONDA GENTILE DELLE LANGHE'.

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Keywords: small hot air dryers, hazelnut quality, 'Tonda Gentile delle Langhe'.

Abstract

In certain harvest seasons (e.g. rainy) and/or when the different hazelnut plots of the farm have very different harvest dates, or when the Grower Cooperative Plant for hazelnut conditioning is too distant, the grower suddenly faces the problem of drying sufficiently its production. A solution can be offered by farm drying using hot air dryers, possibly small and movable. The functionality of these dryers is not well known, and in particular no data are available for Piedmont and 'Tonda Gentile delle Langhe'. In order to determine their efficiency and control the influence of this first conditioning treatment on the principal traits of hazelnut, trials were carried out in the years 2004-2005.

In the hazelnut Cooperative plant of Cissone (Cn), 3 hot air dryers with similar device composition but with different capacity (increasing from 1 to 3 tons) were used. For 2 consecutive harvest seasons, 46 tons of hazelnuts, from 12 different farms of the Langhe, were dried with a single cycle of exsiccation (consisting in a heating phase followed by a ventilation one), for a total of 19 cycles. For each cycle, physic- chemical and commercial parameters were determined before, during or after the exsiccation, on the hazelnut samples or on their bulk in the silos. Therefore, initial moisture and physic and commercial traits of hazelnuts were determined before the exsiccation, whereas the duration of each phase and the trend of temperature and moisture of the hazelnut bulk were registered during the exsiccation. After the exsiccation, final moisture and physic and chemical (mineral composition and lipidic content) traits were determined, and a commercial evaluation was made.

Correlations between some important parameters and the regression model are proposed to check the efficiency of exsiccation.

The preliminary results of these trials point out the suitability of small dryers in lowering hazelnut moisture, especially the 2-ton one, while the hazelnut commercial and physical-chemical characteristics are not significantly different using the 3 types of dryers.

HIGH-TECH PRODUCTION OF BIOACTIVE α -TOCOPHEROL FROM *CORYLUS AVELLANA* ADVENTITIOUS ROOTS BY BIOREACTOR CULTURE

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Keywords: hazelnut, tissue culture, Vitamine E, anticancer, antioxidant

Abstract

The *Corylus avellana* L. (hazelnut) contains potent antioxidant molecules such as vitamin E, which may represent a preventive measure against chronic diseases, including cardiovascular and Alzheimer's pathologies, and relieve aging symptoms. The most bioactive antioxidant vitamin E of hazelnut is α -tocopherol. The potential role of α -tocopherol, which is related with its antioxidant functions, has been investigated in the prevention of cancer. Humans do not synthesize α -tocopherol which is obtained from plant dietary intake or pharmaceutical products. However, the natural α -tocopherol isomer (RRR) seems to be assimilated in a more efficient manner than the enantiomer (SSS). The impossibility of obtaining the bioactive RRR- α -tocopherol by chemical synthesis for the nutraceutical demand makes biotechnologies a tool for industrial exploitation. Several secondary metabolites of pharmaceutical interest are accumulated into the roots. As an alternative to GMO, currently the adventitious root culture for the production of relevant bioactive therapeutic molecules represents a novel strategy from research laboratory to large-scale industrial application. In the present work, we report on the production of RRR- α -tocopherol by culture of *C. avellana* adventitious roots in bioreactors. The main goal was to optimize the conditions in order to obtain a high biomass of adventitious root production and elicitor (methyl jasmonic acid) concentration to enhance the target molecule accumulation. Among hormones, IBA seems to be more effective than NAA in promoting root growth; the biomass increased till the maximum level after 25 days of subculture. Moreover, methyl jasmonate strongly increased the production of α -tocopherol in adventitious roots: after a treatment of 100 μ M/L of methyl jasmonic acid for 5 days before harvesting, the bioactive antioxidant increased about 4 times. Thus, the established protocol for α -tocopherol production by means of bioreactors in hazelnut biofactories can produce natural vitamin E, which is pesticide-free, with reduced labour cost and year-round production.

IN-VITRO AND IN-VIVO ANTIOXIDANT POTENTIAL
OF PHENOLIC EXTRACTS OBTAINED
FROM HAZELNUT SKIN BY-PRODUCTS

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Keywords: hazelnut skin by-product, natural antioxidants, antioxidant activity

Abstract

Recently, a growing interest in replacing synthetic antioxidants with natural ones has fostered research on the screening of plant materials in order to evaluate new antioxidants. Phenolic compounds are the major plant metabolites with antioxidant properties. Many of these can be potentially exploited as antioxidant agents and nutraceuticals.

The aim of this research was to evaluate the antioxidant potential of a crude phenolic extract obtained with 80% ethanol from hazelnut skin by-products by means of an improved extraction procedure. The extract was screened for *in-vitro* antiradical, reducing and chelating activity. Moreover, an *in-vivo* test carried out on rats was performed. The long-term stability of the extract dissolved in ethanol was tested during storage for six months at room temperature and under refrigerated conditions.

The results showed that the defatted hazelnut skin by-product is an excellent source of natural and very efficient phenolic antioxidants. The defatted skins provided a high yield in the crude extract (over 30%); the extract showed a very high phenolic content (743.5 mg gallic acid equivalent/g d.w.), high antiradical efficiency (superior to pure BHT, BHA, Trolox and α -tocopherol), Fe^{+3} reducing activity and Fe^{+2} chelating capacity. The *in-vivo* study showed an evident biological activity of the extract, which was able to improve the antioxidant potential of plasma in rats. The results of the storage tests showed that hazelnut skin extracts can be kept at room temperature for several months maintaining their antioxidant capacity high.

Because of their potential antioxidant and nutraceutical properties, phenolic extracts derived from hazelnut skin could satisfy the demand for new natural products in the preparation of innovative foods and beverages with a high dietetic/functional value.

ORCHARD ECONOMICS: THE COSTS AND RETURNS OF ESTABLISHING AND PRODUCING HAZELNUTS IN THE WILLAMETTE VALLEY - STANDARD VERSUS DOUBLE DENSITY

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Keywords: Hazelnut production costs, economics of establishment, standard density, double density

Abstract

As the Oregon hazelnut industry prepares to rejuvenate itself through the planting of improved varieties, this cost of establishment and production study provides growers with a tool for economic management and decision making. This study of the costs and returns of establishing and producing hazelnuts in Oregon's Willamette Valley is based on a 20-acre block of hazelnuts, with a standard tree spacing of 20 X 20 feet (6 X 6 m) which gives 108 trees/acre (269 trees/hectare). Yield and price assumptions include a price of \$0.70/pound (\$1.54/kg) or \$1,400/ton (\$1,543/metric ton). Commercial yields begin in the third year and full production of 2,800 marketable pounds/acre (1.4 tons/acre or 3.14 metric tons/hectare) is reached in year 12. In a standard spacing gross income exceed variable costs beginning in Year 5. An analysis of planting a double density orchard planted at 10 X 20 feet (3 X 6 m) showed the gross income minus the variable costs at a positive return in year 4 of \$210/acre (\$519/ha), compared to \$88/acre (\$217/ha) in year 5 for a standard density. A comparison of the cumulative cash flow show the double-density orchard covers all cash costs in year 8 with a surplus of \$598/acre (\$1,478/ha) while the standard density orchard shows a positive \$495/acre (\$1,223/ha) in year 10. Based on total cash costs and gross incomes in Table 9, the additional cash costs to plant a double-density orchard are \$1,883/acre (\$4,653/ha) and additional revenues are \$5,583/acre (\$13,795/ha) resulting in a net gain to the grower of \$3,700/acre (\$9,143/ha). When an even higher density of trees are used as in 9 X 18 feet (2.7 X 5.5 m) thinned to 18 X 18 feet (5.5 X 5.5 m), the time it takes to cover all cash costs is accelerated. Planting a double-density orchard results in a higher economic benefit to the grower and therefore illustrates the usefulness of using this economic principle in hazelnut production to generate a greater return on investment.

$$6 \times 6 = 269 \text{ plant/ha} = \text{uf } 1,542 / \text{ton.}$$

inicio prod 3 años, y en plena prod 3,14 ton/ha (año 12)

3 x 6 → año 4, uf \$519/ha (utilidad) → Año 8 se cubren los costos
uf \$1,478/ha

6 x 6 → año 5, uf \$217/ha (utilidad) → Año 10 cubre los costos
uf \$1,223/ha

A DISTRICT FOR HAZELNUT SECTOR: RURAL OR AGRO-FOOD SYSTEM?
ANALYSIS OF NATIONAL AND REGIONAL LAWS FOR THE GOVERNANCE OF
'MONTI CIMINI' TERRITORY

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Keywords: district, territorial development, territorial governance, local systems

Abstract

Today, the analysis founded on agricultural systems is very useful in the territorial programming of characteristic regions. Using the scheme of "district" developed in the industrial economy studies (Marshall analysis), different kinds of models were used in the agricultural sector analysis. In Italy, national and regional laws were formulated taking into account the importance of a global and territorial approach in the local development.

More specifically, the National Law 228/2001 introduces two different ways to govern the territory: the rural and agro-food district. In particular, the first is used when there are many activities carried out in the territory, while the second is applied in presence of a sectorial specialization in some agricultural production. Consequently, the kind of interventions in the District Plan is different.

Lazio has individuated a district for Monti Cimini (Viterbo Province) with the Regional Law 1/2006. In this territory, hazelnut cultivation is one of the most important sectors, characterized by an high level of specialization (from the mechanical sector to the commercialization of products).

The objective of this study is to illustrate why the choice of the agro-food district for hazelnut rather than the rural district has been more adapted for Monti Cimini governance.

Starting from an analysis on rural concept, based on different indicators that measure a kind of "rurality degree" (defined using the population density and the services workers number of the General Population Census), the study put on evidence that the most rural areas of Viterbo Province are not those in which hazelnut sector is highly developed and specialized. So, in these last areas, the institution of an agro-food district seems more appropriate and could permit to carry out targeted intervention to support the hazelnut sector.

adunato
Costo impianto a 6 x 3 → 4.652 uf/ha Neto
regionalizzato 6 x 3 → 13.795 uf/ha Neto
9.142 uf/ha Neto

ECONOMIC RESULTS OF THE ORGANIC HAZELNUT CULTIVATION

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Keywords: organic agriculture, cultural account, hazelnut market

Abstract

In order to analyze the economic results of the hazelnut cultivation in an organic regime, two productive techniques were reconstructed. The two typologies, due to the different level of inputs, can be considered as "extensive" and "intensive". The extensive technique is characterized by low-specialized plantations situated in less suited areas, whose yield is 1.5 ton/ha on average. On the contrary, the intensive technique is adopted in farms whose land dimension and configuration allow a greater mechanization of the cultivation. In these cases, higher yields are obtained, 2.4 ton/ha on average with maximum peaks of 3 ton/ha, thanks to repeated interventions with fertilizing technical means and pesticides, too.

Costs and productive value were evaluated for the two techniques and, afterwards, a comparison with the conventional management was carried out, referring to a representative technique which allows to achieve average yields of 2.7 t/ha, with a yield point slightly higher than the one which can be obtained in an organic regime (0.42 vs 0.40).

The cultural account elaboration highlights a substantial homogeneity in variable costs, which are slightly higher than 1,000 €/ha for all the three techniques considered, although remarkable variations can be observed in the different categories (raw materials, mechanization, work).

On the contrary, the production which can be sold varies remarkably according to the different orchard management forms. Such a thing is linked to the price dynamic, and depends as well on the premium price and on the presence of public aid. With concern to hazelnut prices, in particular with reference to the last decade, an extremely uncertain trend is registered, and it is linked in a great way to the offer conditions of the Turkish product. The price of organic nuts results to be 15-20% higher than the one of conventional nuts on average; yet, this premium price is effective only at the beginning of the campaign; whereas, in the following months, conventional nuts, following the market trend, are subject to further price reductions or can even reach an higher price than the one of organic nuts.

A comparison of margins shows that the result of the conventional management is intermediate between those of the two techniques in an organic regime. This result justifies the contrasting opinions of hazelnut producers on the relative convenience of the two management forms. The only certainty is that, when the organic hazelnut production is able to guarantee better economic results, it depends exclusively on public aid.

RISK ATTITUDES OF ORGANIC AND NON ORGANIC HAZELNUT PRODUCERS IN SAMSUN PROVINCE OF TURKEY

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Keywords: organic agriculture, hazelnut, risk attitudes, barriers for conversion, Turkey

Abstract

The purposes of this research are eliciting and comparing the risk attitudes of organic and non-organic hazelnut producers, as well as determining the additional barriers to their risk attitudes towards conversion to organic agriculture in the Turkish province of Samsun.

The Equally Likely Certainty Equivalent (ELCE) model was used to elicit utility for producers. The data used in this study were collected by using a structured survey both for 64 randomly-selected, non-organic producers and for all organic hazelnut producers (39) in the research area.

The results of the research revealed that organic hazelnut producers were more risk-loving than non-organic producers. It was also found that the variables of operators' education level, farm income, total capital, time allocated to activities outside the farm, farm land area, size of hazelnut orchard, number of hazelnut plots and total information score were other barriers to the conversion to organic hazelnut production, in addition to the producers' risk attitudes.

Providing better extension services and farmer training activities relating to organic agriculture and land consolidation, focusing on raising the educational level of producers, facilitating producers with greater access to credit to increase farm land and to enhance farm assets, are factors which may accelerate the process of conversion to organic hazelnut production.

IMPACT OF A NEW PRICE SUPPORT POLICY ON THE TURKISH HAZELNUT INDUSTRY

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Keywords: new hazelnut price subsidy policy, hazelnut market efficiency, vector error correction model, Turkish hazelnut production

Abstract

In this research, time-series analysis and periodic decomposition based on monthly prices received by farmers and export prices are used to address the dynamics of price adjustment and causality along the Turkish hazelnut marketing channel. In this paper, the impact of eliminating price subsidies on the Turkish hazelnut sector is investigated by focusing on the short-run dynamics of price adjustment and price transmission along the Turkish hazelnut marketing channel to see whether the new policy brought by an agreement with the World Bank affected the price margins along the supply channel.

Considering the fact that in recent years food industries faced notable structural changes and an higher market concentration, an important research question is to what extent the new policy change/shock in the Turkish hazelnut sector was transmitted through the supply chain and impacted prices at farm and export levels. Market concentration and the likely presence of market power can potentially influence the degree and dynamics of price transmission, leading to differential price effects on different stages of the chain. The data, historical hazelnut market prices received by farmers and hazelnut export prices, were gathered from the producer cooperative (Fiskobirlik), the Turkish Statistical Institute (Turkstat), and the Turkish Hazelnut Commodity Exchange Market. The study also employs a vector error correction (VEC) model along with directed acyclic graphs and periodic decomposition to investigate the dynamics of price transmission along the Turkish hazelnut supply chain. Not only does the VEC model allow us to estimate the short-run speed of adjustment for the price series, but it also preserves the long-run relationships among the variables. Co-integration is also used as a tool to evaluate market efficiency and it can analyze both perfect and imperfect market conditions.

RECENT DEVELOPMENTS IN TURKISH HAZELNUT MARKETS

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Keywords: hazelnut market, recent developments, liberalization, Turkey

Abstract

The aim of this paper is to examine and make a general evaluation of the Turkish hazelnut sector with concern to production, industry, domestic marketing, export and import, and government policy during the 2000-2008 period. Turkey provides about three-quarters of hazelnut production and four-fifths of hazelnut export in the world. Hazelnut plantations in Turkey are about 640,000 hectares, a number which is estimated to be even higher, and production reached over 700,000 tons in the last years. However, domestic consumption (70,000 tons) and export (500,000 tons) are lower than this production potential. The Turkish government intended to liberalize hazelnut markets since the beginning of 2000. Therefore, it stopped the price support system and substituted it with direct incomes, gave financial independence and administrative autonomy to the Hazelnut Sale Cooperatives and FISKOBIRLIK, and encouraged alternative crops instead of hazelnut. Nonetheless, the government had to intervene in hazelnut markets through the Turkish Grain Board in 2006 because of potential hazelnut surpluses in the market, lack of competition, and absence of new instruments to compensate the farmers' losses.

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