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e Ricerche
sul Nocciolo



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7th International congress on hazelnut

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Viterbo - Italy



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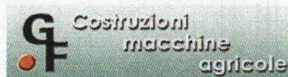


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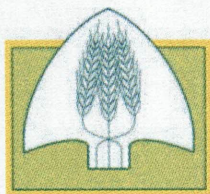
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BOOK OF ABSTRACTS

edited by

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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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INVITED SPEAKERS



Shawn Mehlenbacher

Carlo Fideghelli

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 Bulancak 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'.

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 pollinizer 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 aspecific 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 Phisiology



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 COLUMNA* 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.