EDITORIAL

Activities 2007-2009
During 2007, 2008 and 2009 a number of activities are and will be supported by the FAO-CIHEAM Interregional Cooperative Research Network on Nuts. In March-April 2008, the XIV GREMPA Meeting on Pistachio and Almond will be held in Athens, Greece. Next June, the VII ISHS International Congress on Hazelnut will be held in Viterbo, Italy. In September 2008, the III ISHS International Symposium on Chestnut will be taking place in Beijing, China. In February 2009, the VI ISHS International Symposium on Walnut will be held in Koondrook, Victoria, Australia. Also in 2009 the V International Symposium on Pistachios and Almonds will take place in Sanliurfa, Turkey. The corresponding Proceedings will be published either in Acta Horticulturae or in Options Méditerranéennes in the case of the GREMPA Meeting.

Last year an European COST (Cooperation in the field of Scientific and Technical Research) proposal on bacterial diseases of stone fruits and nuts was prepared by network members and approved by European Commission. COST actions are regarded as a source of financial support to our Research Network for COST Member States. Also an AGRI GEN RES Action acronymed “SAFENUT” was submitted and approved by the European Commission for three years. A challenge for the Network members is to propose competitive R&D projects which address relevant problems of the nut sector. The 7th UE Framework Programme for R+D can be an interesting opportunity for European member countries or associates to be explored. Once carried out the projects, the generated
Information has to be transferred to the stakeholders of the nut sector.

In recent years, the activities of the Nut Network have been affected as FAO is no longer providing specific budget for servicing the Networks and supporting activities. Thus activities to be carried out are hindered. However, the support given by some FAO services and external funding provided by the Spanish INIA, and the co-sponsor and partner CIHEAM allowed that most planned activities could be finally developed like the publication of this Newsletter. In addition, some researchers from developing or transition countries have been and will be supported to participate in different meetings and congresses.

The Nut Network's future
Nut tree production, trade and industry are important economical activities related to sustainable agriculture, often in marginal lands and under rainfed conditions, in both European and Near Eastern Regions. Nuts are of major importance and are typical components of the traditional and healthy Mediterranean diet. The interest towards the nut species is related to their excellent nutritional and nutriceutical properties. Apart from commercial production, they also represent an interesting income for local sustainable production systems in many regions where nut tree crops are not a major agricultural income. To accomplish sustainable development and food security, a future combined effort in R&D, environmental management and communication is needed. A FAO Meeting between ESCORENA Officers to discuss and revise the future of the Networks is planned to be held the 10th-11th of April 2008 at Poznan, Poland. Looking ahead and thinking on our Nut Network financial support, FAO is not providing “ad hoc” funding but will be backing proposals to other funding Agencies like the EC through COST programmes or similar. In addition, CIHEAM is fully committed with the Nut Network's future and providing regular funding since being a partner. Spain is supporting the Nut Network yearly through INIA specific funding (Spanish Trust Fund).

Genetic resources inventories and descriptors
Regarding the Inventories on Germplasm, Research and References, four have been already published: Almond (1997, RTS 51), Hazelnut (2000, RTS 56), Chestnut (2001, RTS 65) and Walnut (2004, REU 66). These inventories published in the REU Technical Series (http://www.fao.org/regional/europe/PUB) are important compilations of the currently available species genetic resources and information on ongoing research projects and bibliography. In addition, one more inventory is being compiled and is close to completion. The inventory on Pistachio is being collated by B.E. Ak and with the help of M. Rovira it is expected to be ready soon. All these catalogues are being funded by FAO’s Regional Office for Europe and the CIHEAM.

Also, a draft Descriptors List for Hazelnut has been developed by Network members led by A.I. Köksal and was submitted to Bioversity International (formerly IPGRI) (www.bioversityinternational.org) for assessment and publication agreement. A thorough review by a number of Network members and outside experts is now completed. Also CIHEAM agreed to co-sponsor this Descriptors List. It will be published during 2008. We expect to distribute the Descriptors List for Hazelnut during the coming VII ISHS International Congress on Hazelnut of Viterbo, Italy.

Proceedings of meetings and workshops
Five publications related to Meetings and Workshops on Almond, Pistachio and Economics of Nuts have been already edited: Cahiers Options Méditerranéennes Volume 33 (X GREMPA) and Volume 56 (XI GremPA); Options Méditerranéennes Série A/63 (XII GremPA); Options Méditerranéennes Série A/5 (Almond rootstocks) and Options Méditerranéennes Série A/37 (Economics of nuts in the Mediterranean basin).

Changes in the FAO European Regional Office and CIHEAM (IAMZ)
Ms. Maria Kadleckova was recently named Regional Representative of FAO Regional Office for Europe and Central Asia (REU) based in Budapest, Hungary is now our link. We would like to thank Ms. Jutta Krause, Regional Representative for Europe and Ms. Karin Nichterlein, Research and Technology Officer, both from the FAO Regional Office for Europe in Rome, Italy for the help provided to maintain active our Nut Network. In relation to CIHEAM, Mr. Dunixi Gabiña and Mr. Antonio López-Francos, placed at IAMZ of Zaragoza, Spain are our focal points.

The Nut Network on the web
Basic information is included in the REU website for ESCORENA (see: www.fao.org/world/regional/REU/content/escorea/index_en.htm). Additional information about the Nut Network can be found at www.iamz.ciheam.org/en/pages/paginas/pag_invesgacion2a.htm.

NUCIS on the web
A full electronic version of each NUCIS (from issue 1 to 14) is now available on the Internet web page of CIHEAM at (www.iamz.ciheam.org/en/pages/paginas/pag_invesgacion2a.htm). The contents of this Newsletter can be browsed through and also copied and printed. Readers will be able to find the whole set of NUCIS issues, some of which were already exhausted.

New section on genetic resources and contributions to NUCIS
From this issue on, we stress the importance of sending technical descriptions for the new Cultivar Descriptions section. The aim is to make available to readers useful agronomical and commercial information of important traditional cultivars and new varieties. As in past NUCIS editorials, we again emphasize that this Newsletter should be an effective vehicle of communication for all the Network members. The pages of this bulletin are open to all readers who would like to suggest ideas or to express their opinion about the work developed by the Network (activities carried out and planned) or to publish short articles and reports on relevant horticultural subjects.
of general interest. We receive generally a sufficient number of contributions from the Mediterranean Basin and overseas for the articles and reports section. However, the sections on news and notes and also on congresses and meetings are usually difficult to cover due to the scarce information received and thus, contributions are most welcomed. Otherwise, the Editorial Committee has to report on the issues he is aware of, but certainly there must be many more issues on-going throughout the year which merit reporting. Also, the place for ‘grey’ bibliography (references and documents which are difficult to search like Masters or Ph Theses) is scarcely filled.

The NUCIS Newsletter is distributed worldwide free of charge to 1,400 readers from over 60 countries. The dissemination of information originated by the Network is of paramount importance and through this bulletin has been largely successful. The first NUCIS was published in 1993, this issue of the NUCIS Newsletter is number 14 and during these fourteen years a great editing effort has been made. I acknowledge and gratefully thank all contributors for their efforts and interest to produce and send me valuable information. The exchange of information between Network members through the pages of this Newsletter is the basis for developing collaboration. The editing task in the thirteen NUCIS issues already published has been huge (NUCIS 1, 9 pages; 2, 20 pages; 3, 24 pages; 4, 28 pages; 5, 36 pages; 6, 52 pages; 7, 44 pages; 8, 46 pages; 9, 68 pages; 10, 48 pages; 11, 48 pages; 12, 52 pages; 13, 72 pages and 14, 44 pages). In order to reduce the time consuming formal editing we are asking contributors who send articles, news, notes, bibliographic references, etc., to the different sections to provide them well organized and elaborated. Information should be sent well structured and clearly written in standard English. Contributions could be sent through Internet using the Scientific Editor’s e-mail. This bulletin is reproduced in black and white only, including pictures. Please send your contributions for the next issue, number 15 by the end of September 2008. We thank all who have contributed to this issue. From this issue an Editorial Committee undertakes the editing and composition of NUCIS and I am only the Scientific Editor. Finally, we wish all Nut Network members and collaborators a healthy and successful 2008.

The Scientific Editor

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This publication contains the collective views of an international group of experts and does not necessarily represent the decisions or the stated policy of the Food and Agriculture Organization of the United Nations, the International Centre for Advanced Mediterranean Agronomic Studies nor of the Organization for the Economic Cooperation and Development.

Contributions should be written concisely in English. Please send contributions on paper and diskette (Microsoft® Word or WordPerfect®). Authors are responsible for the content of their papers. Reproduction of the articles is authorized, provided that the original source is clearly stated.
AUSTRALIAN ALMOND INDUSTRY

The Australian almond industry is predominantly situated along the Murray River corridor, across three states: South Australia (SA), Victoria (VIC) and New South Wales (NSW). Located within those three Australian states are four major almond growing regions, Adelaide (SA), Riverland (SA), Riverina (NSW) and Sunraysia (VIC).

Like most Australian horticultural industries, the Australian almond industry was initially developed, managed and resourced by many small owner-operators. However, in 1998 the industry began to undertake a significant change in dynamics with the introduction of several large developments managed by fewer companies and commonly engaging management separate to the source of investment. Introduction of these larger plantations has substantially been enabled by a continued, global increase in the demand for almonds, as well as the external funding that has been attracted through Managed Investment Schemes (MIS) which have been successful in attracting horticultural investment by offering short term taxation benefits and long term investment gains.

Consequently, the Australian almond industry has expanded significantly, increasing from 3,650 ha in 1999 to 26,000 ha in 2007 (Figure 1). As a result of the recent expansion, 69% of the Australian industry now resides in the Sunraysia region, around the regional town of Robinvale in Victoria. The industry is predominantly planted to a mixture of three Californian varieties, ‘Nonpareil’ (51%), ‘Carmel’ (31%) and ‘Price’ (12%). The primary irrigation system and rootstock is drip irrigation and ‘Nemaguard’, respectively.

The Australian almond industry has also undergone an increase in production over this same period resulting from; an increase in the hectares planted, further maturity of productive plantings and a successful improvement in production techniques. In 2007 Australian almond production totalled greater than 26,500 t of kernel, more than a 65% increase over the previous year’s production. With less than 15% of all Australian almond plantings at full maturity and 58% of total Australian almond plantings less than three years old or non-bearing, future productive capacity is expected to reach at least 77,000 t by 2015 (Figure 2). Consequently, it is antici-
pated that the current “farm-gate” value will increase from $180 million (AUD) to more than $500 (million) AUD. On a percentage basis, this recent expansion now makes the Australian almond industry the fastest growing almond industry and it is expected to become the second largest world supplier of almonds by 2012.

Given the current, strong global demand for almonds being driven by the growing awareness of the taste, versatility and health benefits of almonds, the future outlook for the Australian almond industry is encouraging. Furthermore, the Australian almond industry has invested significant funds into research and development programs in order to achieve optimum obtainable yields, with the benchmark performance indicator now at 3.20 t/ha up from the 2.47 t/ha in 1999.

Figure 2. Current and estimated Australian almond production.
INTRODUCTION
Although fruit quality is mainly related to the chemical composition of the product, including the nutritional and healthy aspects involved in defining its final value, some physical parameters must also be taken into account when evaluating the quality of any fruit. In almond the physical traits do not affect the organoleptic characteristics of the kernel, but have a special importance in the industry because of the different steps involved in almond processing.

Curiously the physical parameters were the only considered until recently and their study was undertaken long time ago, although not from the quality point of view. However, some aspects require a more detailed examination, mainly those related to the shell, since the shell has never been considered as a component of almond quality because it is not related to the chemical composition or to the organoleptic taste of the kernel. Nevertheless, the shell acquires a very important role in all the harvesting and industrial processes, which must also be taken into account during almond cultivar evaluation.

SHELL TRAITS
Shell hardness is inversely related to shelling percentage and does not apparently have any influence on quality, but only on production management. Soft-shell cultivars, as happens with the main Californian cultivar ‘Nonpareil’, possess such a soft and thin shell that sometimes is not well sealed through the suture line, where the abortion of the secondary ovule has taken place (Gradziel and Martínez-Gómez 2002), leaving an entry point for dust, insects and fungi. This problem is aggravated when nuts are harvested and fall on the ground, where they remain for drying and can be easily contaminated with those elements, naturally present in the soil (Reil et al. 1996). This contamination may be further aggravated by the presence of Aspergillus among the contaminating fungi and the production of the toxic aflatoxins, carcinogenic and immunosuppressive mycotoxins (Dicenta et al. 2002; Gradziel and Wang 1994). Although Aspergillus resistance would be very important for almond quality maintainace, no differences between almond cultivars have been found (Dicenta et al. 2002; Gradziel et al. 2000).

Furthermore, soft-shell almonds are more susceptible to insect damage, such as to navel orangeworm, Amyelois transitella Walk. (Rice et al. 1996), because larvae are able to go across a soft shell but not across a hard shell, thus increasing the percentage of damaged kernels and reducing their quality (Crane and Summers 1971). Soft-shell cultivars are also susceptible to bird damage before harvest, a critical problem in particular regions with high populations of birds, such as in Southern Australia.

On the other side, hard-shell cultivars offer an interesting trait from the point of view of maintaining kernel quality, because they may be stored in-shell for a long time without getting rancid, as will be seen when considering the fatty acids. Conversely, soft-shell cultivars must be processed as soon as possible after harvest (Thompson et al. 1996).

Based on these two types of cultivars, two different industries have developed in different growing regions, since the shelling equipments are completely different for each shell type: in the Mediterranean region most cultivars are hard-shelled and the processing plants are designed for cracking hard-shell nuts whereas in California and the growing regions under its influence, mainly in the southern hemisphere (Australia, Chile, South Africa), the plants process mainly soft-shell nuts. As a consequence, the breeding programs in each region put forward a different objective for shell hardness.

Grasselly (1972) considered shell hardness as determined by a single gene with hard shell dominant over soft shell. However, this hypothesis has not been confirmed, and it seems that the regression analysis of the kernel percentage does not reflect the presence of dominance (Dicenta et al. 1993). The different parents used in the estimation of the heritability of this trait may have created a bias on the evaluation of its transmission and the estimation of its heritability. Thus, Kester et al. (1977) estimated this heritability at 0.55 whereas Spiegel-Roy and Kochba (1981) increased this value to 0.82 and Dicenta et al. (1993) agreed with the former with a value of 0.56. More recently, Arús et al. (1998) have suggested two QTLs involved in shell hardness with a major QTL located in linkage group 2.

Another shell aspect to be considered is that the shell is not a compact structure, showing holes and empty spaces inside. The shells of some cultivars are formed by a kind of two concentric layers united by very fragile internal connections. This trait is very characteristic of the French cultivar ëFerragnésí (Felipe 2000; Grasselly and Crossa-Raynaud 1980) and is considered a negative trait from the industrial point of view due to problems at cracking. In this process, usually the outer layer is broken but not the inner one, thus requiring to repeat the operation. In this second cracking, the previous calibration increases the proportion of nuts of small size and requires a better adjustment of the cracking hammers. This second cracking, due to this adjustment, breaks a high proportion of kernels, which are less valued than whole kernels. As a consequence, the repetition of the operation and the kernel breakage are two undesirable factors for the cracking industry and decrease nut quality.

From a breeding perspective the presence of shell layers must be avoided. However, the heritability of this trait is low, of 0.37 (Arteaga and Socias i Company 2002), thus requiring a selection inside the proge-
However, the other relations, length/thickness (Kester 1965; Kester et al. 1980), dimensions, define the commercial kernel width (L/W), which, together with the linear main dimensions, were mainly determined by the relation length/width (Kester 1965; Kester et al. 1977) at 0.64, and later estimations agreed with this value (Dicenta et al. 1993; Spiegel-Roy and Kochba 1974). The linear dimensions of the kernel, length, width and thickness, have been defined as commercial characteristics as well as the length/width ratio (Kester 1965; Kester et al. 1980). Grasselly (1972) observed the transmission of these linear dimensions, but their heritabilities were not estimated until Kester et al. (1977): length, 0.77; width, 0.62; thickness, 0.71.

Kernel shape may vary according to the different cultivars, since it is maintained as a cultivar trait (Gülcan 1985). Shape is mainly determined by the relation length/width (L/W), which, together with the linear dimensions, define the commercial kernel traits (Kester 1965; Kester et al. 1980). However, the other relations, length/thickness (L/T) and width/thickness (W/T), are also important for characterizing kernel shape and must similarly be considered. Grasselly (1972) observed the continuity of kernel shape in the progenies of his breeding program, but until recently the heritability of the different shape relations has not been estimated (Arteaga and Socias i Company 2002). The results have shown higher heritabilities for the relations L/W and L/T lower for the relation W/T, thus confirming shape heritability in almond, especially for an elongated shape.

Kernel shape, as well as size, is related to the easiness of blanching. In addition, it is important for some specific confectionary uses. Thus, for 'Alicante' nougat, the cultivar ëMarconaí is preferred because its kernels have the right width for the nougat bars. In the past, round kernels were preferred for sugared almonds (dragées) allowing a thin layer of sugar to cover the kernels, whereas at present flat kernels are preferred because these allow a thick sugar layer, due to the different relation of sugar and almond prices at different times. Thus, shape defines kernel quality depending of its further use.

The seed coat has a reduced importance for the consideration of almond quality. Generally a light colour and a smooth surface are preferred, but especially a thin seed coat, with the aim of reducing weight losses at blanching, which may represent from 5 to 10% of the kernel weight (Berger 1969; Felipe 2000; Romojaro et al. 1977; Souty et al. 1973). However, for some industrial uses, such as roasted almonds, a thick tegument may be interesting because of the easiness of pealing after roasting, as it happens with 'Desmayo Largaüeta', being a characteristic trait conferring a special commercial quality to this cultivar.

Seed coat colour shows a medium heritability (0,42), but it is highly inconsistent, showing strong environmental effects and also being dependent in part on the stage of maturity at harvest as well as on the length and type of storage (Kester et al. 1977). Seed coat weight has shown a large variability for genotypes, years and their interaction, thus suggesting a partial genetic control but under the influence of the year conditions (Kodad 2006). Thus, a genetic selection is possible in a breeding program for kernel colour and thickness.

The presence of double kernels is due to the fertilization of the two ovules in the almond ovary. This is considered to be a negative trait, lowering fruit quality rating depending on their proportion (Kester et al. 1980). This is due to the fact that when two kernels are produced in the same fruit, they are deformed and make the processes of cracking, size selection and blanching difficult, although not affecting their organoleptic quality. The percentage of double kernels is a cultivar trait but presents large variations depending on the sample and the year. While some physiological and climatic reasons have been pointed out as possible causes of these variations, none has been clearly defined. Particularly low temperatures before blooming (Egea and Burgos 1994) or at blooming time (Grasselly and Gall 1967; Rikhter 1969; Spiegel-Roy and Kochba 1974) have been mentioned as promoting higher percentages of double kernels. The earliest blooming flowers seem to be the ones that produce the largest number of double kernels (Socias i Company and Felipe 1994). Palasciano et al. (1993) reported that an optimized pollination also increases the percentage of double kernels.

Although this is a complex trait needing additional investigation for its elucidation (Asensio and Socias i Company 1996), it seems that the ability to produce double kernels is a quantitative trait that can be partially inherited; its expression, however, can be modified by different causes (Socias i Company and Felipe 1994). Grasselly (1972) first suggested a quantitative component on the transmission of this trait, and Spiegel-Roy and Kochba (1974) showed that this transmission was complicated by environmental influence making its heritability fairly unpredictable. Kester et al. (1977) estimated this heritability at 0.51, but with a very high standard deviation. Similar low estimates were also reported by Vargas and Romero (1988) and Dicenta et al. (1993). However, the utilization of parents with no double kernels or with a low percentage of them in the different crosses,
as this is considered a negative trait, may have distorted the estimation of its heritability. As a consequence, an individual seedling evaluation must be undertaken for selection against this trait.

An attractive aspect of the kernel is another point to take into consideration for evaluating almond quality (Socias i Company et al. 1998). This aspect, however, is a subjective opinion and it is very difficult to define. Kester et al. (1977) considered that most traits related to the nut and kernel aspect showed a very low heritability; only kernel color had a medium heritability (0.42) but was highly inconsistent, showing the presence of shrivelled kernels. A smooth surface is a positive industrial trait, due to consumer preference, but also a positive commercial trait, as this is considered a negative trait, may have distorted the estimation of its heritability. As a consequence, an individual seedling evaluation must be undertaken for selection against this trait.

Several traits related to kernel aspect are largely conditioned by the genotype but with some fluctuations in different years. Penetration may be involved since only some kernels are affected and only in some years. A smooth surface is a positive commercial trait, due to consumer preference, but also a positive industrial trait because the presence of shrivelled kernels entangles the process of blanching. The presence of depressions on the kernel surface like furrows, called crease, showed a very low heritability (Arteaga and Socias i Company 2002; Kester et al. 1977).

CONCLUSION

All the physical parameters are more or less heritable and must thus be considered in the design of crosses. However, individual selection is essential during seedling evaluation in a breeding programme.

ACKNOWLEDGEMENTS

Review funded by the research project of the Spanish CICYT AGL2004-06674-C02-01. We appreciate the technical assistance of J.M. Ansón, J. Búbal and A. Escota.

REFERENCES


R. Socias i Company, J.M. Alonso and O. Kodad
Unidad de Fruticultura, CITa de Aragón, Apartado 727, 50080 Zaragoza, Spain
E-mail: rsocias@aragon.es
World hazelnut production is based on selections from the wild which are vegetatively propagated for the establishment of new orchards. The leading cultivars in each producing country and region are different, and their weaknesses are well-known. The diversity present in *Corylus avellana* provides a wonderful opportunity for genetic improvement of this crop. The world’s largest hazelnut breeding program was started in 1969 at Oregon State University, and continues to be supported by funds from the state and federal government as well as Oregon’s hazelnut growers. Recent releases include the cultivars ‘Lewis’, ‘Clark’, ‘Sacajawea’ and ‘Santiam’ and the pollinizers ‘Gamma’, ‘Delta’, ‘Epsilon’ and ‘Zeta’. More than 80 advanced selections are currently in yield trials, and we anticipate releasing several new cultivars in the coming years.

Ten cultivars form the base of the breeding population: ‘Barcelona’, ‘Negret’ and ‘Casi-nna’ (Spanish), ‘Daviana’ (English), ‘Ton da Gentile delle Langhe’, ‘Tonda Romana’, ‘Tonda di Giffoni’ and ‘Montebello’ (Italian), and ‘Extra Ghiaghli’ and ‘Tombul Ghiaghli’ (Turkish types imported from Greece). Another 40 cultivars have been used as parents to a lesser extent. Most crosses are now between numbered advanced selections rather than between cultivars, and an eight-year cycle (from seed to seed) allows for continuing improvement. Several advanced selections carry a single dominant allele for complete resistance to eastern filbert blight from ‘Gasaway’. In the past 15 years, a concerted effort has been made to import diverse genetic material as seed from the University of Minnesota but ‘Ratoli’ is a minor Spanish cultivar. OSU 408.040 was selected from seedlings; the nuts were imported as ‘Weschcke hybrid’. Georgain selection OSU 759.010 has also been identified in the interspecific hybrids ‘Grand Traverse’ and ‘Yoder #5’ as well as in selections of *Corylus americana* and *C. heterophylla*.

Quantification of EFB susceptibility has allowed ranking of cultivars and the identification of moderate resistance. High levels of quantitative resistance have been identified in cultivars from Italy (‘Tonda di Giffoni’, ‘Mortarella’ and ‘Camponica’) and Spain (‘Segorbe’ and ‘Closca Molla’) and several selections of Turkish origin. OSU releases ‘Lewis’, ‘Clark’ and ‘Sacajawea’ are less susceptible than ‘Barcelona’. A moderate level of resistance should be adequate for continued production in the presence of EFB if combined with pruning and fungicide applications. However, Oregon growers are eager for the release of good cultivars with complete resistance.

‘Lewis’ (OSU 243.002) was released in 1997 and has been widely planted. It is precocious, productive, and has a grower-friendly tree. Kernel percentage is about 47%, compared to 43-44% for ‘Barcelona’. Kernel blanching is slightly better than ‘Barcelona’. Two drawbacks have been noted. At nut maturity, the husks often remain green and nuts drop over an extended period. Kernel mold (about 6% vs. 2% for ‘Barcelona’) was noted in yield trials prior to release, but the high (16%) incidence of mold in 2005 was especially disturbing.

Cultivars well-suited to the blanched kernel market must combine several desirable attributes, and we have made good progress on most of these. It has been a challenge to combine excellent blanching with EFB resistance, as ‘Gasaway’ kernels do not blanch and pellicle removal ratings of seedlings tend to be worse than the average of their parents. Samples of 50 or 100 nuts are used to determine the frequency of defects. The high frequency of defects - especially moldy kernels and poorly filled nuts - remains a challenge. A high frequency of poorly filled nuts is often associated with a heavy crop load. Some selections can fill their nuts even with a heavy crop, but this ability can often only be evaluated in older trees. The frequency of moldy kernels varies from year to year, although the ranking of genotypes is often consistent over time.

Eastern filbert blight, caused by the fungus *Anisogramma anomala*, originated in eastern North America and is now firmly established throughout the Willamette Valley. Several sources of resistance have been identified and used in breeding. ‘San-tiam’ (OSU 509.084) and many advanced selections carry complete resistance from ‘Gasaway’. Several additional sources of complete resistance have been identified in *C. avellana*. Three sources, when crossed with susceptible selections, transmit resistance to about half of their offspring, indicating simple genetic control: ‘Ratoli’, OSU 408.040 and OSU 759.010. ‘Ratoli’ is a minor Spanish cultivar. OSU 408.040 was selected from seedlings; the nuts were imported as ‘Weschcke hybrid’ seed from the University of Minnesota but appear to be pure *C. avellana* rather than the expected *C. americana* × *C. avellana* hybrids. Georgian selection OSU 759.010 was imported as scions from the Republic of Georgia under the names ‘Tskhenis dzu’dzu’ and ‘Gulishshvela’. Grafted trees of the two are identical but neither is true to name. The genetic control of resistance from other sources including OSU 495.072 from nuts collected in southern Russia, the Serbian cultivars ‘Crvenje 3/96’ and ‘Ubov’, and the Spanish cultivar ‘Culpa’ is currently being investigated. Resistance has also been identified in the interspecific hybrids ‘Grand Traverse’ and ‘Yoder #5’ as well as in selections of *Corylus americana* and *C. heterophylla*.

**HAZELNUT BREEDING AN UPDATE FROM OREGON**

FAO-CIHEAM - Nucis-Newsletter, Number 14 December 2007
‘Santiam’ (OSU 549.130) was released in 2006, and it is too early to predict acceptance by the industry. Trees are moderately vigorous and productive, but less precocious than ‘Lewis’ and ‘Clark’. Nuts mature 10-14 days earlier than ‘Barcelona’, and are 52% kernel by weight. Kernel blanching and quality are excellent, and the frequency of defects is low. Quantitative resistance to EFB is very high, similar to ‘Tonda di Giffoni’.

‘Sacajawea’ (OSU 540.064) was released in 2005, and is the first cultivar that carries the ‘Gasaway’ gene for complete resistance to EFB. Trees are grower-friendly and less vigorous than ‘Barcelona’. Nuts mature early, 10-14 days before ‘Barcelona’, and are 51% kernel by weight. The frequency of blanks and poorly filled nuts is less than for ‘Barcelona’, but the frequency of moldy kernels is slightly higher. Because of the concern over kernel mold, nuts should be promptly harvested at maturity and dried. The kernel quality is acceptable for many end uses but not sufficient to command a premium price. ‘Santiam’ is viewed as a transition cultivar, as advanced selections now in trials have higher kernel quality.

More than 80 selections are in replicated yield trials. Growers are particularly interested in two selections (OSU 703.007 and OSU 688.010) that combine complete EFB resistance with large nuts suitable to the in-shell market. Both have female inflorescences that emerge very late in the season and express alleles S₁ and S₂. Pollinator ‘Gamma’ sheds pollen too early, and pollen of ‘Delta’, ‘Epsilon’ and ‘Zeta’ expresses S₁ and is thus incompatible. Late-shedding compatible pollinizers have been identified and trees are now being propagated.

Micropropagation is now routinely used to multiply new cultivars and advanced selections. Cultures are established of the most promising all advanced selections so that micropropagated trees are available for purchase at the time of their release. Acceptance of micropropagation by growers has been good, and demand for trees has been high.

At OSU, applied breeding is complemented by research on hazelnut genetics. RAPD markers linked to EFB resistance from ‘Gasaway’ are routinely used in marker-assisted selection. DNA markers linked to resistance from OSU 408.040, ‘Ratoli’ and Georgian OSU 759.010 have been identified. Microsatellite or simple sequence repeat (SSR) markers have been developed and used to fingerprint hazelnut cultivars and investigate genetic diversity in our collection. A linkage map has been constructed using RAPD and SSR markers. A BAC library has been constructed that will allow map-based cloning of important loci. The tools of biotechnology and information from genomics offer exciting possibilities for future studies.

Hazelnut breeding is an exciting occupation. The European hazelnut is a tremendously diverse species, and traditional breeding methods can meet all of the current objectives of the program. Past genetic improvement efforts have been very limited and most important traits are highly heritable, so the progress made with each generation of selection is dramatic. Marker-assisted selection and micropropagation are now routinely used in the program. As I wrote in this newsletter a dozen years ago, it is indeed a shame that efforts in other countries to improve hazelnut are so limited.

S. A. Mehlenbacher
Dept. of horticulture, Oregon State University
4017 Ag & Life Sciences Building
Corvallis, OR 97331 USA
E-mail: mehlenb@hort.oregonstate.edu
RESULTS

1. Yielding

The average production from both organic and conventional management in the 3 hazelnut orchards considered is summarized in Tables 1 and 2 and shown in Figures 1 and 2. These tables and figures show clearly that hazelnut orchards grown under organic management are less productive than those grown conventionally, although under similar climatic and soil conditions. The smaller productions obtained from the organic hazelnut orchards in comparison with the conventional plantation, vary from a minimum of 21.1% (Alta Langa, 2004) to a maximum of around 60% (Langa and Monregalese, 2005). In particular, such productions have occurred in 2005, i.e., during the “off” year. Among the 3 areas considered, Monregalese has turned out to be the most productive both in the “on” year and in the “off” year under both organic and conventional management.

2. Quality

The marketing characteristics of the fruits will be examined, separately, that is whole fruit (nut) and seed (kernel) after shelling.

A)- Marketing nuts characteristics

Average weight of nuts

As shown in tables 3 and 4, the values of this parameter are generally higher for the nuts produced in conventional management, with the exception of Monregalese in 2004. The higher nut weight obtained from conventional management seems to be in contrast with the fact that such hazelnut orchards have shown higher productions with respect to those under biological growth, therefore the nuts would have been lower in weight.

More weight is significant only for nut productions from Alta Langa and Monregalese. Nuts with more weight gathered from conventional management, does not show significance for the Langa hazelnut orchards in both years considered. In Monregalese, too, the higher weight of the nuts obtained from conventional orchard was significant in 2005. In the previous year, the nuts obtained from biological orchards were heavier than those collected from conventional management at Monregalese and the relevant difference (see Table 3) is highly significant. Nevertheless, this result is in contrast with the results from the 2 other hazelnut orchards and with the results of a previous (Roversi & Sonnati, 2006) investigation.

Nuts with Curculio holes

The presence of Curculio “holes” (see tables 3 and 4) results absent or very poor (maximum 14%) independently from the type of orchard management and the area considered. The differences between the results observed in the fruits from both organic and conventional orchards have not been relevant.

Empty nuts rate

The values of this parameter do not show a clear connection with the type of management. In fact, it is higher in the fruits from conventional management (3.95%) in Langa in 2004 than in organic plots (6.50 %) in 2005. In 2004, on the other hand, in the Langa hazelnut orchards, the rate of empty fruits was higher in the nuts from conventional orchards in comparison with those from biological management with a rate of empty nuts of 7.1%. In the other cases,
the rate has varied depending on the type of management, yet the differences have never been significant.

B) Marketing kernel characteristics.

Average kernel weight
Except for Monregalese in 2004, the average weight of the kernel from orchards in conventional management is always higher in the nuts obtained from orchards under conventional management. The differences are always important and significant (see tables 3 and 4) only in the yielding of 2004.

Kernel percentage (kernel weight/fruit weight * 100)
As shown in tables 3 and 4, the values of this parameter result higher for the nuts from conventional management, in comparison with those from biological training. The differences turn out to be highly significant for nuts produced in Alta Langa, Langa and Monregalese in 2004 and only in 2005 for Monregalese.

Seed defects
The rates of mouldy, rancid, shrivelled seeds, or with white spots, or with any other defects are shown in tables 3 and 4 for the different areas considered, and for the 2 different types of management. The tables indicate that the total rates of such defects are higher in organic management in every considered area for 2005. The exception for kernels produced in Langa in 2004 is not significant.

Bug kernel damages
This defect (see Tables 3 and 4 and Figures 3 and 4) is higher in seed obtained in organic management with the exception in Langa 2004 and in Alta Langa 2005 but the differences are not significant. The highest values (over 10%) have been found in 2005 in the organic orchard at Langa and Monregalese, while the lowest have been in 2004 in the conventional Alta Langa and Monregalese orchards with values of 0.32 % and 0.44%, respectively.

Kernel without any defect
Tables 3 and 4 and figures 5 and 6 show that the highest rates for this parameter were in 2004, i.e., in the "on" year. In details, as a result of the different rate of defects found as a function of the type of management, it turns out to be clear that most kernels without any defect were obtained from nuts produced in conventional orchards in Alta Langa and Monregalese in 2004 and in Alta Langa and Monregalese in 2005. The relevant differences (see tables 3 and 4) are not significant, only in Langa in 2004.

Conclusions
The data gathered in 2004 - 2005, in spite of small differences among the 3 different areas considered, shows clearly that:

Table 1. Some traits and productivity of the 6 considered hazelnut orchards.

<table>
<thead>
<tr>
<th>Orchards area</th>
<th>Management</th>
<th>Orchards age</th>
<th>Spacing (m)</th>
<th>Average yielding (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alta Langa</td>
<td>Organic</td>
<td>21</td>
<td>6 x 6</td>
<td>1.31</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>18</td>
<td>5 x 5</td>
<td>1.66</td>
</tr>
<tr>
<td>Langa</td>
<td>Organic</td>
<td>36</td>
<td>5 x 5</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>23</td>
<td>6 x 5</td>
<td>1.59</td>
</tr>
<tr>
<td>Monregalese</td>
<td>Organic</td>
<td>17</td>
<td>5 x 5</td>
<td>1.46</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>22</td>
<td>6 x 4</td>
<td>2.25</td>
</tr>
</tbody>
</table>

Table 2. Average production (t/ha) as related to years, location of hazelnut orchard and their management.

<table>
<thead>
<tr>
<th>year</th>
<th>Alta Langa</th>
<th>Langa</th>
<th>Monregalese</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>O</td>
<td>Δ%</td>
<td>C</td>
</tr>
<tr>
<td>2004</td>
<td>1.66</td>
<td>1.31</td>
<td>-21.1</td>
</tr>
<tr>
<td>2005</td>
<td>0.79</td>
<td>0.42</td>
<td>-46.8</td>
</tr>
</tbody>
</table>

C = Conventional, O = Organic
Table 3 - Some nut traits produced in orchard with conventional or organic management (2004).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Alta Langa</th>
<th>Lang</th>
<th>Monregalese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit weight g</td>
<td>2.13</td>
<td>2.18</td>
<td>0.000</td>
</tr>
<tr>
<td>With Curculio holes %</td>
<td>0.05</td>
<td>0.00</td>
<td>0.0323</td>
</tr>
<tr>
<td>Empty</td>
<td>1.68</td>
<td>4.22</td>
<td>0.011</td>
</tr>
<tr>
<td>Kernel weight g</td>
<td>1.05</td>
<td>0.84</td>
<td>0.000</td>
</tr>
<tr>
<td>Kernel percentage %</td>
<td>49.27</td>
<td>47.18</td>
<td>0.0001</td>
</tr>
<tr>
<td>Other kernel damages %</td>
<td>0.88</td>
<td>3.50</td>
<td>0.0001</td>
</tr>
<tr>
<td>Kernel without any defect %</td>
<td>98.80</td>
<td>90.93</td>
<td>0.000</td>
</tr>
</tbody>
</table>

C = Conventional, O = Organic

Table 4 - Some nut traits produced in orchards with conventional or organic management (2005).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Alta Langa</th>
<th>Lang</th>
<th>Monregalese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit weight g</td>
<td>2.43</td>
<td>2.27</td>
<td>0.000</td>
</tr>
<tr>
<td>With Curculio holes %</td>
<td>0.00</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>Empty</td>
<td>2.13</td>
<td>3.31</td>
<td>0.0774</td>
</tr>
<tr>
<td>Kernel weight g</td>
<td>1.18</td>
<td>1.14</td>
<td>0.254</td>
</tr>
<tr>
<td>Kernel percentage %</td>
<td>48.57</td>
<td>50.30</td>
<td>0.126</td>
</tr>
<tr>
<td>Bug kernel damage %</td>
<td>6.32</td>
<td>4.48</td>
<td>0.263</td>
</tr>
<tr>
<td>Other kernel damages %</td>
<td>4.17</td>
<td>9.47</td>
<td>0.013</td>
</tr>
<tr>
<td>Kernel without any defect %</td>
<td>89.51</td>
<td>86.05</td>
<td>0.000</td>
</tr>
</tbody>
</table>

C = Conventional, O = Organic

In the same area, the average productivity of the organic orchard is lower than the average yield found in the conventional orchard;

The lower productivity of the biological hazel orchards in comparison with conventional orchards is more considerable in the “off” year;

The average nut weight is generally higher in the nuts from organic hazelnut orchards;

The kernel percentage is generally higher in the nuts from organic hazelnut orchards;

The rate of bug damages is also higher in nuts from organic hazelnut orchards compared with conventionally grown nuts;

Other kernel defects - such as moldy, rancid, shrivelled kernels, or with white spots - is generally higher in nuts produced from organic management;

The kernel rate without any defect is notably higher in filberts from conventional orchards;

Some differences in nuts and kernel quality between biological and conventional management seem to be smaller for Monregalese.

Although subject to further experimental confirmations, all these results show clearly that the organic management of filbert orchards turns out to be a problem instead of an opportunity for Italian growers.

REFERENCES


A. Roversi, L. Castellino
Istituto di Frutticoltura
Università Cattolica S. C.
Piacenza - Italy
E-mail:alessandro.roversi@inicatt.it
WALNUT PRODUCTION IN CALIFORNIA

California is one of the world’s largest walnut producers. Recent yields have been up to 322,050 t (2005) and 317,510 t (2006). The major variety is Chandler (38%) followed by the older variety, Hartley (17%). Most of the inshell walnuts are exported (82%). Only 33% of the shelled walnuts are exported, the remainder is sold domestically (67%). Countries that receive inshell shipments include Spain, Germany and Italy, while Japan and Korea receive the majority of the shelled shipments. China is considered a major competitor but they consume over 90% of their product. The quality of California walnuts has been increasing mostly due to the increasing percentage of light-colored ‘Chandler’ walnuts.

VARIETIES

The ideal Persian or English walnut variety for California would be relatively late leafing to escape frost and the rains that spread walnut blight (Xanthomonas campestris pv. juglandis), precocious (yielding more than 500kg/ha in the fourth year), vegetatively vigorous with bearing on both terminal and lateral shoots (lateral bud fruitfulness, LBF). It would have a low incidence of pistillate flower abscission and other types of drop and would not be alternate bearing. It would have high production capacity (>6 t/ha) with low chemical input required. The harvest season would end in early October (in California). The nutshell would be relatively smooth, well sealed and make up no more than 50% of the nut weight. The nuts would fit the category of large or jumbo. The kernel would be plump and light coloured weighing about 7-8 grams and come out easily in halves. The tree would be at least moderately resistant to pests and diseases.

The probability of breeding the ideal walnut is good because most of the traits above have high heritabilities and we have walnut varieties with most of the traits already present, but they all lack some important trait (Table 1).

In California our goal is to breed a variety with ‘Chandler’-like yield and kernel quality but with earlier harvest dates and better shell characteristics. Breeding includes germplasm collection and evaluation, controlled crossing and half-sib mating, progeny evaluation, selection, field trials and release. In the following talk I will discuss our techniques and progress.

Germplasm. Persian or English walnuts, Juglans regia, are native to an area extending from Turkey to the Himalayas. Within their range there is a great deal of genetic variation that includes differences

<table>
<thead>
<tr>
<th>Variety</th>
<th>Bearing acreage (CA)</th>
<th>Positive traits</th>
<th>Negative traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Chandler’</td>
<td>38%</td>
<td>Kernel quality, yield</td>
<td>Late harvest date, shrivel, weak shell</td>
</tr>
<tr>
<td>‘Hartley’</td>
<td>17%</td>
<td>Shell quality and shape</td>
<td>Not precocious, deep bark canker</td>
</tr>
<tr>
<td>‘Serr’</td>
<td>8%</td>
<td>Shell and kernel quality, early</td>
<td>Pistillate flower abscission</td>
</tr>
<tr>
<td>‘Tulare’</td>
<td>8%</td>
<td>Yield</td>
<td>Kernel quality</td>
</tr>
<tr>
<td>‘Vina’</td>
<td>8%</td>
<td>Yield</td>
<td>Blight susceptibility, kernel quality</td>
</tr>
<tr>
<td>‘Howard’</td>
<td>6%</td>
<td>Yield</td>
<td>Lack of vigor</td>
</tr>
<tr>
<td>‘Franquette’</td>
<td>2%</td>
<td>Shell and kernel quality</td>
<td>Yield, late harvest date</td>
</tr>
<tr>
<td>‘Ashley’</td>
<td>2%</td>
<td>Yield</td>
<td>Blight susceptibility</td>
</tr>
<tr>
<td>‘Chico’</td>
<td></td>
<td>Extra high yield</td>
<td>Nut size too small</td>
</tr>
<tr>
<td>‘Lara’</td>
<td>(France)</td>
<td>Yield</td>
<td>Kernel quality</td>
</tr>
<tr>
<td>Germplasm</td>
<td></td>
<td></td>
<td>Kernel quality</td>
</tr>
<tr>
<td>Chinese</td>
<td></td>
<td>Yield, precocity, nut size</td>
<td>Kernel quality</td>
</tr>
<tr>
<td>French</td>
<td></td>
<td>Shell and kernel quality</td>
<td>Yield, late harvest dates</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td></td>
<td>Cold hardy</td>
<td>Yield, kernel quality</td>
</tr>
</tbody>
</table>
Table 2. Traits evaluated in the University of California breeding programme.

<table>
<thead>
<tr>
<th>Field</th>
<th>Crack out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaffing date</td>
<td>Shell texture</td>
</tr>
<tr>
<td>Female bloom: first, peak and last</td>
<td>Shell color</td>
</tr>
<tr>
<td>Male bloom: first, peak and last</td>
<td>Shell seal</td>
</tr>
<tr>
<td>Dichogamy</td>
<td>Shell strength</td>
</tr>
<tr>
<td>Percent overlap: male and female</td>
<td>Shell integrity</td>
</tr>
<tr>
<td>Catkin abundance</td>
<td>Shell thickness</td>
</tr>
<tr>
<td>Female flower abundance</td>
<td>Packing tissue thickness</td>
</tr>
<tr>
<td>Percent fruitful laterals</td>
<td>Nut weight</td>
</tr>
<tr>
<td>Yield</td>
<td>Kernel weight</td>
</tr>
<tr>
<td>Blight</td>
<td>Percent kernel</td>
</tr>
<tr>
<td>Codling moth</td>
<td>Fill</td>
</tr>
<tr>
<td>Sunburn</td>
<td>Plumpness</td>
</tr>
<tr>
<td>Harvest date</td>
<td>Ease of kernel removal</td>
</tr>
<tr>
<td></td>
<td>Color (Extra light, light, light amber, amber)</td>
</tr>
<tr>
<td></td>
<td>Shrivelling</td>
</tr>
<tr>
<td></td>
<td>Veins</td>
</tr>
</tbody>
</table>

in flowering habit, length of the juvenile period (precocity), yield, disease and insect resistance, and nut shape and size. In a breeding programme it is important to have the genetic variation from germplasm as well as the opportunity to avoid inbreeding among related varieties that it offers. In California we have a germplasm collection we use in breeding but it barely taps the range of genetic diversity available in *Juglans regia* around the world. The parents in our breeding programme are selected from evaluated germplasm and current varieties.

**Controlled pollinations.** In controlled pollinations both the male and female parent are selected. Pollen from the male parent is collected from the catkins and dried. Female flowers are bagged prior to receptivity and when the flowers are receptive, pollen from the selected male parent is injected into the bag which is left in place until flowering is over and the small nutlets are visible. At harvest time the nuts from controlled pollinations are collected, dried and planted in a greenhouse or nursery row, prior to being transplanted into a “seedling block”. Because these controlled pollinations are very labor intensive and produce only about 30-50 seedlings per one hundred bags, depending on the cross, we also use supplemental pollinations in isolated orchards. In this case we mix pollens of selected male parents and blow the pollen into a young (without catkins), isolated orchard of the selected female parent. Alternatively we collect open-pollinated seed from our isolated selection block which includes a mixture of the parents that we want. These latter methods result in thousands of seedlings.

**Evaluation.** Seedlings from the pollinations are planted in a seedling block for evaluation. These seedlings are grown close together and training is aimed at having the nuts within reach. Beginning in the third to fourth year from seed, extensive data is collected (Table 2). Each year, we meet with farm advisors, growers, nurseries and members of the Walnut Marketing Board to review the evaluations and make selections. Each participant has both the data and nut samples to review and comment on. We usually make a first cut based on data analysis but new considerations always come up at the crack out meeting. Typically, participants from the North want low blight scores and those from the South want early harvest dates. Since this translates into late leafing for the North and early leafing for the South and since late leafing precludes early harvesting it appears that varieties will be released for specific areas. For the seedlings produced through open-pollination, we collect limited field data and only do crack out evaluation on those that are vigorous, and laterally fruitful with high yields and early harvest dates.

**Selection.** Selections are made at the crack out meeting based on at least two years complete data. Seedlings that are selected are repropagated into three “selection blocks” in North, South and Central California and evaluations continue. At any time after selection, growers may establish “grower trials” under “test agreement”. These trials may range from one or two trees of a few selections to acres of highly promising selections planted in randomized complete block designs for effective evaluation of traits especially yield. Grower trials, however small, are essential for evaluating field performance under standard cultural practices.

**Release.** Superior selections are patented and released. They are available to California growers only, for the first 5 years after release, after which they are available internationally. Tulare, a very high yielding variety with satisfactory quality kernels was released 11 years ago, 27 years from seed, and will be off patent in 2011. Our new releases are ‘Livermore’, a variety with a red seed coat designed for niche markets and ‘Sexton’, ‘Gillet’ and ‘Forde’. The latter are high yielding, precocious varieties with excellent quality large nuts and a harvest date prior to ‘Chandler’. They are just beginning their 5 year restricted sales period.

**Rootstocks**

The rootstock is the other half of the tree and provides anchorage, absorption of water and nutrients, hormone synthesis, and storage. Rootstocks are more diff-
cult to study because they are mostly underground and rootstock improvement is developing slowly because clonal propagation has just recently become commercialized. Traits of common rootstocks are shown (Table 3). Clearly genetic improvement is needed. Overall the Paradox rootstock (\(J. \text{hindsii} \times J. \text{regia}\)) which exhibits hybrid vigor is best but many other species combinations have not been tested. Paradox is usually seed propagated from \(J. \text{hindsii}\) (northern California black walnut) trees that are naturally pollinated by English walnut pollen.

In California, we have had two major approaches to rootstock improvement. One is aimed at developing a rootstock combining the English walnut response to blackline disease (tolerance) with the vigor and response to other diseases of Paradox. This has been achieved, in theory, by selecting vigorous tolerant rootstocks among seedlings of a backcross generation (\(J. \text{hindsii} \times J. \text{regia}\)) x \(J. \text{regia}\). Six seedlings were selected in 1984 but it has taken until last year to establish grower trials to compare their performance in the field to Paradox and English walnut rootstocks.

The second approach, named the Paradox Diversity Study, was designed to evaluate the different sources of Paradox rootstock available in California and to select superior individuals among them. California walnut nurseries each donated about 500 seed from three Paradox-producing black walnut trees for two years and these were planted in a nursery, measured and divided into subsets. Four subsets were planted and grafted as orchard trees, two subsets were screened for nematode resistance, two for Phytophthora resistance and two for crown gall resistance. In addition DNA analysis was used to determine what black walnut species were involved in the maternal parent. Although Paradox is technically a \(Juglans \text{hindsii} \times J. \text{regia}\) hybrid, several other North American black species were found in the hybrids. These included \(J. \text{major}\), \(J. \text{californica}\), and \(J. \text{ni­gra}\). Only one rootstock source was found to be unsatisfactory due to graft incompatibility and excessive variability. Within the disease and nematode screens about 20 superior individuals were selected. These have been repropagated and are undergoing further trials. It is expected that four or five new clonal rootstocks will be released from this experiment.

Much more work is needed on rootstocks. Since the hybrids appear to have the best vigor it is important to evaluate the performance of different species in hybrid rootstock. One that is readily available in S. America and hybridizes easily with English walnut is \(J. \text{australis}\) from Argentina. Other possibilities are \(J. \text{neotropica}\) (northwestern S. America), and \(J. \text{bianchana}\) (Mexico, and Guatemala).

### BIOTECHNOLOGY

No discussion of genetic improvement is complete without a discussion of biotechnology which includes genetic engineering, marker-assisted selection, DNA fingerprinting, gene cloning and genome mapping. The tools of biotechnology have incredible potential in the field of genetic improvement. Walnuts lag behind many of the ag­ronomic crops due to lack of researchers and funding but already selected genes, developed for other crops can be inserted into walnut. Field trials of transgenic walnuts have been underway for over a decade. Genes expressed in the walnuts code for insect resistance (codling moth), tree architecture differences, blight resistance, and crown gall resistance, the latter two are still under evaluation. Unfortunately, transgenic walnuts will not be commercialized unless there is consumer acceptance. We believe that transgenic rootstocks will be the first to be commercialized because there will be little opportunity for the gene to escape into the wild, there is less possibility of resistance building up in the pathogen population and the gene and its product will not be in the nuts.

Other tools of biotechnology are also in use. These include a marker for detecting hypersensitivity to the cherry leafroll virus that causes blackline disease, used in breeding hypersensitive English walnuts (not covered here). There has also been extensive work on fingerprinting walnut varieties, such that now all the old varieties can be identified through DNA analysis, and fairly soon all the selections in the breeding programme will have their own unique published fingerprint. Efforts in cloning genes unique to walnut are underway but genome mapping is in the not-too­distant future.

### CONCLUSION

Breeding walnuts is a long process, taking between 10-20 years before a new variety can be released. The breeding programme of Gene Serr and Harold Forde which produced ‘Chandler’, ‘Howard’, ‘Vina’ and made the cross for ‘Tulare’ is part of the reason California has been so successful in producing walnuts. But new varieties are seriously needed and the current breeding programme is designed to deliver them. Rootstock improvement has been slower but the development of techniques for clonal propagation (micro­propagation) should make the process quicker and easier. Biotechnology holds great promise for genetic improvement but genetically engineered walnut varieties will not be available unless the consumers respond favourably.

---

**Table 3. Walnut rootstock response to pests, diseases and salt.**

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Crown gall</th>
<th>Phytophthora root and crown rot</th>
<th>Blackline disease</th>
<th>Armillaria root rot</th>
<th>Root lesion nematode</th>
<th>Root knot nematode</th>
<th>Salts</th>
</tr>
</thead>
<tbody>
<tr>
<td>English walnut ((Juglans regia))</td>
<td>susceptible</td>
<td>very susceptible</td>
<td>symptomless</td>
<td>susceptible</td>
<td>very susceptible</td>
<td>susceptible</td>
<td>sensitive</td>
</tr>
<tr>
<td>Northern California black walnut ((J. hindsii))</td>
<td>susceptible</td>
<td>very susceptible</td>
<td>hypersensitive</td>
<td>variable</td>
<td>susceptible</td>
<td>resistant</td>
<td>less sensitive</td>
</tr>
<tr>
<td>Paradox walnut ((J. hindsii \times J. regia))</td>
<td>very susceptible</td>
<td>susceptible</td>
<td>hypersensitive</td>
<td>variable</td>
<td>very susceptible</td>
<td>unknown</td>
<td>sensitive</td>
</tr>
<tr>
<td>Wingnut ((Pterocarya stenoptera))</td>
<td>resistant</td>
<td>resistant</td>
<td>hypersensitive</td>
<td>susceptible</td>
<td>tolerant</td>
<td>unknown</td>
<td>unknown</td>
</tr>
</tbody>
</table>

---

G. McGranahan  
Department of Plant Sciences  
One Shields Ave.  
University of California  
Davis, CA  95616  
E-mail: ghmcranahan@ucdavis.edu
TRIALS OF CONTROLLED POLLINATION OF WALNUT

SUMMARY
Walnut controlled pollination was tried by both whole plant isolation with a fine mesh cloth and flower bagging with paper bags. With the latter method also some pollen management alternatives were compared: direct use of catkins, cooled, frozen and unfrozen-refrozen pollen. Pollination of whole plants was fostered by flowing air through the canopy with a compressor, while bagged flowers were pollinated either by enclosing some catkins in the bags or by injecting pollen with a hypodermic syringe. The whole plant method was easy to apply but failed, because the cover cloth was partially torn by the wind. Use of catkins gave the highest frequency of fruit setting for bagged flowers. Comparable results were obtained with unfrozen-refrozen pollen, while fruit setting decreased remarkably with frozen pollen and its age. Cooled pollen gave the same fruit setting rates of the most aged frozen pollen, probably owing to the interference of an adverse temperature situation.

INTRODUCTION
Walnut bears male flowers in catkins on long shoots and spurs of previous year, with single catkins bringing between 100 and 160 little flowers ordered on a central axis. (Fig. 1). The flower has a bud scale (bract) on which 13 to 18 anthers are inserted (Fig. 2). An anther can spread about 900 pollen grains. Female flowers develop at the apex of spring shoots, single or in couples, rarely in groups of three or more. Stigma receptivity to pollen begins when lobes begin to separate and peaks when lobes are wide open, forming a 90 degree angle (Fig. 3). Female flowers are more abundant in varieties bearing flowers at shoot apices and on most lateral spurs, which can bear fruit for several years: because apical dominance is low, female flowers are produced by most of the canopy (Serr and Forde, 1968; Tulecke and McGranahan, 1994; Castagnè, 1999). In European varieties apical dominance inhibits lateral brindilles, and female flowers are mostly produced on the apical and sub-terminal section of branches bearing fruits, so that only the external part of the canopy contributes to production. Lateral fruit setting has a genetic component and a 39% heritability has been estimated for the Californian environment (Forde and McGranahan, 1997).

Walnut pollination is effected by wind, fecundation following after 3-5 days. Mature pollen lose viability within a week at room temperature, but remains viable for a few weeks if refrigerated and up to one year if frozen. Viability increases by lowering relative humidity to 30-40% (Forde and McGranahan, 1997; Leslie and McGranahan, 1998).

Controlled pollination for breeding is expensive because of the large tree size, while abundant cross progenies are instrumental for retrieving interesting character combinations, given that a number of seeds are usually lost through diseases, parasites and low germination rates.

To enhance the yield of seeds from controlled crosses we have tried some pollen preserving methods for use with bag isolated flowers and the pollination of whole plants, after complete emasculating, helping pollen diffusion by injecting pressured air within the sheltered canopy at 2-3 days intervals during the flowering period. Though unlikely to exclude completely alien pollen, this method has been found suitable to increase the seed yield of crosses (Cecich 1998; McGranahan and Leslie, 2006).

MATERIALS AND METHODS
Controlled pollination trials were performed on the Sorrento, Eureka, Lara and Cervinara varieties, making the reciprocal cross Sorrento x Eureka and the crosses Lara x Sorrento and Cervinara x Eureka. The following pollination methods were compared:
1. bagging and pollination of whole trees;
2. bagging and pollination of single flowers with:
   a. catkins;
   b. fresh pollen;
   c. cooled pollen;
   d. frozen pollen.

BAGGING AND POLLINATION OF WHOLE TREES
Whole tree pollination was evaluated with fresh pollen of the Serr cultivar on three Sorrento plants. Catkin buds were removed before shedding and the more erect branches were shortened to ease plant bagging, which was performed with a white fabric sheet (15 m) of the type used for lining clothes. The sheet borders
were fastened to the trunk below the main branches with an iron thread (Fig. 4). To help spread the pollen, air was blown within the bagged canopy at 3-4 atmosphere pressure with a compressor, pointing the air blow to a basin holding pollen. This operation was repeated twice at three days interval, spreading each time 180 ml pollen per plant.

BAGGING AND POLLINATION

Walnut dichogamy did not allow to achieve balance of design, limiting the choice of crosses and pollination dates to the following:

• Sorrento x Eureka with catkins, 25 April;
• Sorrento x Eureka with cooled pollen, 25 April;
• Sorrento x Eureka with frozen pollen, 2 May;
• Eureka x Sorrento with frozen pollen, 2 May;
• Lara x Sorrento with defrosted-refrozen pollen, 13 May;
• Lara x Sorrento with frozen pollen, 17 May;
• Cervinara x Eureka with frozen pollen, 22 May.

As a control, fruit bearing was recorded for 64 Sorrento flowers under free pollination.

Individual flowers were bagged with white paper bags (25 by 50 cm) at the first opening of stigma lobes, and bags were tied tightly with elastic strings (Fig. 5 and 6). Flowers were pollinated when stigma lobes made an angle between 45 and 90 degrees, and bags where removed when lobe colour changed to brown (Fig. 7).

When basal flowers began to open, showing anthers, catkins were harvested and placed on lattice frames in a dry room at 20-25 °C, to favour shedding. After 2-3 days pollen was harvested by shaking catkins and sieving through a fine mesh, dried and sealed in airtight plastic glass to be cooled at 4 °C or frozen at -20 °C.

Pollination with catkins was performed by placing one catkin in the bag at the beginning of shedding and by shaking the bag after two days to favour pollen dispersion.

The number of fertilised fruits was recorded after three weeks. The relationship between the percentage of fruit setting and the experimental variables (cross, pollen age in days and pollen storage method) was analysed with a logistic model using the R software environment (R Core Team, 2006) and displayed with some functions of the contributed Hmisc package (Harrell, 2006).

RESULTS

Bagging and pollination of whole trees

Bagging and pollination were easily ac-
Results for pollination of individual flowers can give indications on a treatment basis, while evaluation of crosses, pollen age and pollen treatment effects on fruit setting is ruled out by confounding.

Individual pollination of bags by injection with a hypodermic syringe required two operations, one for bagging and another for the injection after some days. So, the method is expensive for flowers which cannot be reached at ground level. Some problem occurred with rains for downward oriented flowers, whose bags were partially filled with water and eventually broke under the weight. Rain and high moisture reduced also availability of pollen grains, which tended to cling to the inner surface of bags.

The low efficacy of cooled pollen could have been determined by a temperature drop (to 8 °C) which occurred a week after pollination. A temperature surge (to 35 °C) the day after pollination could have decreased fruit setting for the treatment with 25 days frozen pollen (Graph. 2). Harmful effects of too low or too high temperatures on fruit setting and fall are well known.

Individual pollination of bags with catkins was done in a single passage, and therefore can be less expensive, but is limited in the range of crosses, because impossible in cases of extreme parental dichogamy. Moreover, pollen shedding appeared to be adversely affected by refrigerated storage.

ACKNOWLEDGMENT

We thank Filippo Piro (CRA-Istituto Sperimentale per l’Orticoltura, Pontecagnano-SA) for data analysis and paper revision.

P. Piccirillo, T. Rosato, A. De Luca, M. Petriccione
CRA - Istituto Sperimentale per la Frutticoltura, Sezione di Caserta
Via Torrino 3, 81100 Caserta - Italy

LATE SPRING FROST DAMAGE IN PISTACHIOS AND ALMONDS IN TURKEY

ABSTRACT

Frost can be damaging for fruit and nut growing. Late spring frost is the most destructive climatic factor in southeastern Turkey. Pistachio is a mass grown crop in Gaziantep, Saniurfa, Adiyaman, and Siirt provinces of Turkey. The temperature dropped drastically below 0 °C the first week of April, 2004 in this region and resulted in crop reduction or crop destruction. Moreover, some frost damage symptoms have been observed on pistachio and almond trees, because of this late spring frost. Pistachio clusters were killed and almond fruitlets dropped by freezing temperature.

INTRODUCTION

The ecology is a main factor which determines if a fruit or nut tree can be commercially grown in a region. Low temperatures are very important, especially during winter and spring. Low winter temperatures can damage the trees and even kill them. Fruit and nut tree tolerance varies from one species to another. For example fig, kaki or pomegranate may suffer damage by temperatures below -10 °C or -15 °C in winter time (Dokuzoguz, 1974; Ozbek, 1977). Young olive trees can reduce productivity at -7 °C while adults at -12 °C (Pallotti and Bongi, 1996; Larcher, 1970) and the carob tree can be damaged by temperatures below -4°C when young or -7°C when adult (Battle and Tous, 1997). Late spring frost is another important climatic factor for early flowering species like almond.

In general there is a range of temperatures over which damage occurs with more buds damaged at lower temperatures until all the fruit buds or fruits are killed. Often freeze will only damage some of the flowers such as the most developed flowers in the bottom of the tree. The pictures of frost damaged buds, flowers and fruit for growers and home fruit growers who wish to determine frost damage after a freeze. Growers like to know if a frost has damaged fruit immediately after the freeze. It is best to wait several hours (until the afternoon) to let frozen tissues thaw. Dead and damaged tissues will turn black or brown (Longstroth, 2005a).

Some fruit trees are very susceptible to spring frost as reported above. Site is important to establish fruit trees. The orchards should not be established in frost pocket areas (Shoemaker and Teskey, 1959; Westwood, 1978). Such air drainage areas are very important to protect the

DISCUSSION

Overheating of canopy and cover cloth disruption by winds invalidated the whole tree bagging treatment. We deduce that this method is not reliable in practice, unless applied in temperate environments with storm occurrence unlikely during blooming.
trees from damage. Almonds are very susceptible to late spring frost in fruit species (Ozbek, 1978; Kodad and Socias i Company, 2004). Pistachios start flowering during the first and second week of April (Ayfer, 1964; Ak, 1992). Almond flowers or fruitlets are frequently damaged. Therefore, breeders are working on breeding late flowering varieties (Kester and Asay, 1975). Generally pistachios do not suffer damage because of spring frost but some extreme years they are damaged in pistachio producing countries.

MATERIAL AND METHODS
In Southeastern Turkey, March 2004 was warmer than usual. Thus fruit trees opened their flowers earlier. The night of April 5, 2004 the temperature fell down. At that time pistachios were reaching their flowering period and almond fruits were in an early development stage. Observations were made on trees and fruits.

<table>
<thead>
<tr>
<th>Temperature during the night of April 4, 2005 in Gaziantep.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hours</strong></td>
</tr>
<tr>
<td>01</td>
</tr>
<tr>
<td>02</td>
</tr>
<tr>
<td>03</td>
</tr>
<tr>
<td>04</td>
</tr>
<tr>
<td>05</td>
</tr>
<tr>
<td>06</td>
</tr>
<tr>
<td>07</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION
April 4, 2004 temperature was very low in the pistachio growing region in Turkey; During the freezing Pistachio trees were on flowering stage. Almonds were at small fruitlet stage.

Female pistachio trees;
- Flower clusters were killed and newly started sprouts dried (Fig 1).
- Apical vegetative buds were on the stage of bursting (Fig. 2). They dried and crushed (Fig. 3).

Male pistachio trees;
- Flower clusters dried.
- Pollen shedding did not occur.

In almonds: fruitlets shriveled and dropped (Fig. 4). The middle part of the fruits turned brown and black (Fig. 5). The current shoots, however, developed normal growth.

In pistachios: flower clusters and newly started sprouts dried, even in young plants. Water sprouts increased on the stem of old trees (Fig. 6). Each leaf has only one leaflet (Fig. 7). When the new apical buds sprout side buds awakened. Small branchlets were grown from apical buds (Fig. 8).

CONCLUSION
Spring frosts can cause significant crop losses. Classic radiation frosts with clear skies and calm conditions are common in all fruit growing regions, generally. In a radiation frost the ground cools by radiation. The cold ground cools the air above. It is this cold air which causes frost or freezing damage. It is advisable to assess the air drainage on the farm. Plant growth and size will cause air drainage to change over time and maintaining good air drainage can save a grower a crop in years when frost hits a region (Longstroth, 2005b).

Reduction in frost injury is possible by controlling the orchard environment with heaters, wind machines and other devices

REFERENCES
Figure 4. Some almond fruitlets shrivelled and dropped.

Figure 5. Frost almond damage inside the nuts.

Figure 6. Freezed watersprouts on the trunk of pistachio tree.

Figure 7. Unleafed leaves.

Figure 8. Small branchlet at the apical part of shoot in winter.


B. E. Ak
University of Harran, Faculty of Agriculture.
Department of Horticulture
63200 Sanliurfa – Turkey
E-mail: beak@harran.edu.tr
STONE PINE ORCHARDS FOR NUT PRODUCTION: WHICH, WHERE, HOW?

The Mediterranean stone pine *Pinus pinea* produces the genuine pine nuts or “pignoli” used in Mediterranean and Arabian cuisine. Due to their supreme quality, they achieve higher prices than lower-quality surrogates like seeds from the Chinese *Pinus koraiensis*. On the Iberian Peninsula alone, stone pine covers more than 550,000 ha, and Spain and Portugal are the main pine-nut producing countries. Although stone pine, a native or at least protohistoric archaeophyte in most Mediterranean countries, is said to have been ‘cultivated’ since the Neolithic, actually hardly any effort seems to have been made for its proper domestication as nut crop (or at least to have achieved it): there are no defined cultivars, but nearly the whole current stone pine nut production is still harvested from forest stands where no cultivation techniques are applied except seeding or planting of new stands, thinnings for stand density regulation and some pruning in the lower or inner crown to ease manual harvesting or, historically, for fuel wood (Mutke et al., 2000a). Even the small pine groves or isolated border trees so typical of Mediterranean rural landscapes are usually seed-grown without known pedigree.

But the interesting market prices for pine nuts and the crisis of traditional rainfed crops in Mediterranean countries has drawn in the last years the attentions to Stone pine as an alternative woody crop on farmland. In farmland afforestations after the CAP reform in 1992, stone pine has been widely used for combining productive woodlands (also the most vigorous annual shoot tips, location of female flowering exclusively on the vertical co-dominant shoots of the crown surface. This positive association at shoot scale between vegetative vigour and reproductive investment contrasts with the classical model in fructiculture of a dichotomy between vigorous, vertical woody shoots and weaker, bended fruiting shoots so typical in most Angiosperm fruit species, putatively due to a different phytohormonal regulation of apical differentiation than in stone pine.

The stone pine crown architecture presents also a strong phenotypic plasticity depending on light environment. In open-grown stone pines, the lateral branches in full sun-light grow as much as or even more than the leader shoot, sustaining also similar branching ratios and secondary growth that stiffen them in an ascending, co-dominant position, producing the typical polyarchic crown that is “wider than deep”, spherical in youth and characteristically umbrella-shaped in older trees, bearing cones on the whole upper crown surface. On the other hand, shaded branches in the inner crown or in the closed canopy of denser stands show steep trends to reduce their successive yearly terminal shoot length as well as lateral bud number per whorl, the supported needle mass and diameter increment, and to withdraw also female flowering, tending to masculinity. In consequence, dense-grown stone pines develop a vertical, monopodial crown architecture similar to other pine species.
the terminal bud of the stock’s leader shoot

AND ROOTSTOCKS

marily as gene banks by forest administra-
to the fact that they were established pri-

the lack of even the least cultural treatment

where the studied plantations are located)

tion between years (masting) reflect (apart

the initial delay and the existing yield varia-

less than ten years after grafting. But both

is the most vigorous) reached mean an-

The mostly used propagation technique is

by a bud scion of the selected clone, using

As in stone pine woody grafting is not fea-
sible, scions are obtained from long shoot
terminal bud scars (still green soft tissue),
best at the moment of starting the spring
flush. In order to allow a fast callus onset
and early sap supply between tissues, the
stock might be slightly more advanced, af-
ter bud burst though before complete shoot
elongation. Phenology thus constricts the
most adequate time window to about two
weeks each spring, in March in the warmer
southern coast area of Andalusia and not
before May in the Spanish inner highlands.

But it can vary in several weeks between
years, depending on the accumulated day-

The grafting point is tied up with a parafilm
ribbon and protected during several weeks
both from water and from outdrying air by
a transparent perforated plastic bag. In the
moment of grafting, stock branches are cut
back for avoiding competition with the
scion; they are lopped completely in au-
tumn once established the grafting’s own
needle biomass.

For rootstocks, no defined material is used,
but any well-formed seedling of Stone or
Aleppo pine serves (the latter for calcare-
ous soils in thermo-Mediterranean climatic
zones). Some trials of micro-propagation
aiming clonal rootstocks for studying root-
stock influence on the tree behaviour have
been performed, without conclusive re-
sults in the field at the moment (Alonso et
al., 2006). The relevance of vigorous shoot

and crown growth for cone production
will limit greatly the possibility of dwarfing
stocks or high-density plantations.

ROOTSTOCKS

Up to the present, the few existing grafted
plantations have evidenced a delayed coming-into-production, with annual mean
cone yields normally less than 2 kg per
tree (rendering about 0.4 kg pine nuts)
during the first decade, especially in too
dense planted trials where canopy cover
was complete in few years and trees could
not develop the expanding crown ideotype.

On the contrary, in spacing of at least 6 m
tax (278 trees/ha), the best trees (that
is the most vigorous) reached mean an-
nual cone yields of 4-6 kg and maximum
yields of 12-15 kg (2-2.5 kg pine nuts) in
less than ten years after grafting. But both
the initial delay and the existing yield varia-
tion between years (masting) reflect (apart
from the harsh environment in Inner Spain
where the studied plantations are located)
the lack of even the least cultural treatment
as pruning, fertilization or weed and pest
control of most of these plantations, owing
to the fact that they were established pri-
marily as gene banks by forest administra-
tions, not as agronomic trials.

PROPAGATION

AND ROOTSTOCKS

The mostly used propagation technique is
the tip-cleft grafting substituting in spring
the terminal bud of the stock’s leader shoot
with tiers of small, dominated branches.

Only vigorously growing stone pine trees
with ‘expanding’ crowns will hence render
high cone yields (Mutke et al., 2005b).

The response of pinecone yield to different
spacing might be highlighted by the results
of two thinning experiences. The first one
is an afforestation that had been grafted in
the field in 1987, five years after plantation
(850 trees/ha; mass-selected, non-labeled
scions). After reaching complete closure of
the grafted crowns few years later, in
1999 two-thirds of trees were extracted in
a systematic thinning. The remaining trees
responded immediately with an increment
of strobilus induction and since then, the
trees of the six thinned plots (6.5 m²/ha ba-
asal area, namely the sum of stem sections
above the grafting point in 2006) render all
years four- to ten-fold the mean yield of the
trees in the three unthinned control plots
(BA 17 m²/ha), without significant yield dif-
ferences between plots before thinning.

That is, the thinning nearly doubled the
annual mean cone yield/ha from 180 kg to
350 kg in the last six years.

The PRUNING

given in stone pine female flowering
occurs mainly on the crown surface and
there is no adventitious sprouting for sub-
stituting eliminated branches, no pruning is
applied in the upper crown, whereas pru-
ning of the shade crown does not influence greatly the upper shoots, except in excessively dense plantation where thinnings should be applied instead. Thus though some weak or lower branches might be eliminated, at least for facilitating cultural or harvest operations, pruning hardly will make sense financially.

Moreover, if there is no extern pollen supply by nearby adult stone pine stands, pollination will depend on the own male flowering of the orchards, thus the weak, dominated branch tips of the lower, shaded crown will be essential to support a correct cone setting. Actually, the development of vertically differentiated crowns with enough pollen output might be the main constraint for coming-into-production of new orchards placed out of established stone pine growing areas. Though this shortcoming can be solved by an artificial, electrostatic pollen supply, used for example by the French CEMAGREF in clonal Larix seed orchards (P. Baldet, pers. com.), this (expensive) technique for forcing small new-grafted trees into a precocious cone production would hardly make sense financially. The sound alternative is to optimise the growth conditions for archiving a fast but equilibrated crown development of the trees.

SOIL MANAGEMENT AND FERTILIZATION

The effective control of herbs and forbs by ploughing is as important as in any rainfed crop. Yield increments in cone number and size by application of fertilizers have been achieved, especially on oligotrophic sands or gravels where also meliorations by organic matter would improve soil structure and water and nutrient retention capacity (Calama et al., 2007). But they must be extremely careful with animal manure that might burn the sensible conifer roots or mycorrhiza. Moreover, nutrient uptake will depend mainly on the water availability, which is the principal shortage in the stone pine’s growing area. On the other hand, though irrigation would improve the cone yield, if there is access to water supply, stone pine seems hardly to be an interesting investment alternative to other, well-known crops like irrigated annuals, grapevine or even its most direct alternative, the almond.

PEST AND DISEASE CONTROL

There are few pests or fungi that affect vigorous pines, neglecting thus opportunists on decrepit trees for example at inadequate soils or in excessive densities. The larvae of the moth Thaumetopoea pityocampa Schiff. can cause some defoliations, but its population is easily controlled by chemical treatments, as it is one of the most common pine-forests’ pests which control is habitually aerial at greater scales. In plantations of small, grafted trees it may be eradicated even mechanically (if an organic-agriculture label is looked for) by cutting out its winter nests from the crowns. There are two insects, the weevil Pissodes validirostris Gyll. and the moth Dioryctria mendacella (Stgr.), whose cone-boring larvae can destroy or diminish the yield. The moth larvae are still inside the cones during cone harvest in winter, hence the damaged cones can be easily sorted out by their different, brownish colour, and burned, whereas the control of the (rarer and less out-spreading) weevil requires a timed chemical treatment during its short imago phase in spring or, again, if an organic-agriculture label does not allow that, by sacrificing the whole unripe harvest of the (usually a few) affected trees when detected.

HARVESTING

As well as currently in pine forests, in the future the cones might be gathered also in commercial, grafted plantations by harvesting machines, that is special vibrating jaws coupled on a jib of a farm tractor. When mechanical harvesting is envisaged, the lower tiers of the tree branches should be pruned during the first years after grafting, in order to form a robust, straight cylindrical stem of at least 2 m beneath the crown base to allow the free shaking and swinging of the vibrated crown. Besides, the clean basal stems and a bare-soil management will guarantee the orchard’s defence from spreading occasional fires that are a relevant and recurrent element in Mediterranean forest and farmlands, and thus should be taken into account. Currently, strips with few, spaced lines of grafted stone pines have been tried out successfully as fire defence areas along roads or forest tracks, self-financing the bare-soil maintenance by the incomes from the cone yield (Prada et al., 1997).

CONCLUSIONS

The current knowledge about stone pine as nut crop in specific plantations might be resumed in the following points: the genetic control of seed productivity seems to be quantitative; no related major genes are still known. The association of vegetative and reproductive effort at shoot level apparently limits the potential selection of high productive dwarf varieties for modern intensive, dense fructiculture. Anyway, the managed grafted trials with selected genotypes have allowed multiplying several times the productivity of the forest land where they are located, in comparison with traditional stone pine forests. Thus their major potential might be just in the limit
between areas with and without agronomic aptitude: marginal stony or sandy Mediterranean farmlands where herbaceous crops or extensive sheep grazing are not longer profitable without subsidies and where traditional afforestations would offer only environmental benefits but no direct incomes for the land owner. But this agronomic limit is currently pushed forward towards better soils by the European common agricultural policies and the ongoing rural depopulation. An agronomic programme for optimising the cultural management and for assigning the best performing clones or varieties for each agro-region is therefore undertaken currently through collaborations between the Polytechnic University of Madrid, the Spanish National Institute for Agriculture and Food Research INIA and State and Regional Forest Administrations, which will be shared in 2008 by the Institute for Agriculture, Research and Technologies (IRTA) with new plantations in Catalonia.

ACKNOWLEDGEMENTS

This paper is based on results of the Research Project CPE03-001-CS ‘Bases para la gestión sostenible de las masas de Pinus pinea en la Península Ibérica’ of the Strategic Plan INIA. The field experiences were made in the framework of Stone Pine Improvement Programmes of the Junta de Castilla-León and the Spanish Environment Ministry.

REFERENCES


S. Mutke1, R. Calama1, J. Gordo2, D. Álvarez3, L. Gil3
1CIFOR-INIA, Ctra. La Coruña km 7.5, E-28040 Madrid - Spain
2Junta de Castilla y León, C/Duque de la Victoria 5, E-47071 Valladolid
3ETS Montes, U. Politécnica de Madrid, Ciudad Universitaria s/n, E-28040 Madrid
E-mail: Mutke@inia.es

FAO-CIHEAM - Nucis-Newsletter, Number 14 December 2007 25
INTRODUCTION
In the Mediterranean ecosystems water and nutrients are the major limiting factors for plant growth (Mooney, 1981). Under these stress conditions, crop plants need to be selected in order to allow an efficient use of these abiotic factors for yield optimization. The efficient use of water depends on the relative rates of assimilation and evapotranspiration that is determined by the genotype and the environment. Also, most of the Mediterranean soils are nutrient limited, mainly by nitrogen and phosphorous (Arianoutsou and Paraskevopoulos, 1992), which implies a necessary input of nutrients for yield maintenance and improvement.

Traditionally, in the Mediterranean basin, under water shortage conditions, non-irrigated and non-fertilised orchards of carob-trees (Ceratonia siliqua L.) are common. This species has been considered for many years as a minor, poor known crop but in the last years this view changed considerably, based on the new uses of seed and pulp. The endosperm of the seed is a polysaccharide, which is used in the human food industry as a thickener and stabilizer (Battile and Tous, 1997) and the seed embryos are rich in proteins (50% of the weight). Recently, it was shown that carob fibre, which is obtained from the pulp, is effective in dietary treatments of cardiovascular diseases. Also, this product has a high content of polyphenols exhibiting a high antioxidative potential, superior to other products rich in polyphenols (Kumazawa et al., 2002). These new applications are promoting and renovating the interest in this crop and new orchards are being established. In these new plantations, irrigation and fertilisation are implemented and as a consequence, there is a need for results and information.

The aim of this work is to resume some results of the effects of water and nutrients on carob-tree orchards as well as to propose some practical recommendations.

IRRIGATION
Carob-trees should be irrigated, at least, during 2-3 years after field transplant and one year after grafting. Table 1 proposes an irrigation plan for 2 years-old rootstocks and with 1 m height. Each tree will receive 360 l per year distributed between April and September. These amounts assume that rainfall, during the previous hydrological year, is under the normal range for Mediterranean climates. Another factor which must be considered is the tree size. If commercial available rootstocks are small (<50 cm), the amounts indicated on Table 1 should be adjusted to, at least, half of this value. The frequency of irrigation was not yet studied. In clay loam soils, one or two applications per month are proposed (Table 1), in order to ensure an efficient deep root system. Localized irrigation systems cause a concentration of roots in the area wetted by the emitters. Daily or weekly irrigation, particularly in sandy soils, may lead to an excessive growth of the canopy comparing with root system, i.e. low root/shoot ratios, and therefore originating unbalanced trees.

The information regarding irrigation of mature carob-trees orchards is scarce. However, in a field trial, 30-years-old non-irrigated carob-trees were submitted to irrigation based on class A pan evaporation values: 0%, 50% and 100% during four years. In this experiment, irrigation increased yield and vegetative growth (Correia and Martins-Loução, 1995), but water use efficiency (expressed as the ratio between fruit production and amount of water added during spring/summer period) was higher in the non-irrigated trees (Correia and Martins-Loução, 1993). A close analysis of these results and integrating isotopic discrimination values, it was found that these trees were using a deep source of water, which is closely coupled to the pattern of rain events. In another experiment, conducted under dry-farming conditions it was observed that less than 250 mm of rain registered between October 1998 and June 1999, vegetative growth of the canopy was totally suppressed (Correia and Martins-Loução, 2004).

<table>
<thead>
<tr>
<th>Month</th>
<th>Amount (l/tree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>40</td>
</tr>
<tr>
<td>May</td>
<td>60</td>
</tr>
<tr>
<td>June</td>
<td>70</td>
</tr>
<tr>
<td>July</td>
<td>80</td>
</tr>
<tr>
<td>August</td>
<td>60</td>
</tr>
<tr>
<td>September</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>360</td>
</tr>
</tbody>
</table>

Table 1. Irrigation plan for young 2-3 years-old carob-trees. Two drippers per tree may be used. Each amount (l/tree) should be applied in one or two applications.

The decision to irrigate mature trees must be considered with care. It is possible that the application of water can stimulate root growth in upper soil layers but there is a real dependence from deep water resources and without guarantee that yield irregularity will be overcome. If irrigation of mature, large trees, is a matter of discussion, there is no doubt regarding the importance of irrigation in the first years, at transplanting stage.

NUTRITIONAL REQUIREMENTS
As for other crops, carob-tree nutritional evaluation relies on leaf analysis. For nutritional assessment, leaf sampling should be made during vegetative rest, between December and January, in northern hemisphere. Each sample should contain 30-40 mature (9 to 10 month-old) leaves collected in all canopy orientations and in the external side of the canopy. Branches containing inflorescences should be avoided since these organs are sinks for P and N. Previous works (Correia and Martins-Loução, 2002) indicate that leaf mineral
Carob pods.

Table 2. Leaf analysis standards for female carob trees. Macronutrients (N, P, K, Ca, Mg) are expressed as % dry weight and micronutrients as ppm per dry weight.

<table>
<thead>
<tr>
<th></th>
<th>Insufficient</th>
<th>Optimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (%)</td>
<td>&lt;2.20</td>
<td>2.20-2.70</td>
</tr>
<tr>
<td>P (%)</td>
<td>&lt;0.09</td>
<td>0.10-0.15</td>
</tr>
<tr>
<td>K (%)</td>
<td>&lt;0.90</td>
<td>0.90-1.30</td>
</tr>
<tr>
<td>Ca (%)</td>
<td>&lt;1.5</td>
<td>1.50-2.50</td>
</tr>
<tr>
<td>Mg (%)</td>
<td>&lt;0.15</td>
<td>0.15-0.35</td>
</tr>
<tr>
<td>Fe (ppm)</td>
<td>&lt;40</td>
<td>40-80</td>
</tr>
<tr>
<td>Mn (ppm)</td>
<td>&lt;25</td>
<td>25-40</td>
</tr>
<tr>
<td>Zn (ppm)</td>
<td>&lt;10</td>
<td>10-20</td>
</tr>
<tr>
<td>B (ppm)</td>
<td>&lt;40</td>
<td>40-70</td>
</tr>
<tr>
<td>Cu (ppm)</td>
<td>&lt;6</td>
<td>6-20</td>
</tr>
</tbody>
</table>

composition is related to yield in carob tree orchards and in Table 2, nutrients levels (insufficient and optimal) are shown. These values were obtained under different edaphic-climatic conditions, and under different crop management practices. Carob tree leaves are rich in N, a structural component of proteins, nucleic acids and chlorophyll, and the lack of this nutrient lead to poor growth and slight chlorosis in older leaves.

In marginal, degraded soils with low organic matter content, it is possible to observe severe chlorosis through the entire canopy. Phosphorus is involved in high energy processes but even under low leaf P concentrations there are no visible deficiency symptoms (Correia and Martins-Loução, 2003). K is involved in carbohydrate metabolism and developing fruits are particularly rich in K. Mg is the central atom of the chlorophyll molecule and in potted plants deficiency symptoms can be observed by the delta shaped dark green, which are at the base of the leaflets. Carob-tree leaves are also rich in calcium and deficiency symptoms (deformation of young leaves) were only observed in hydroponically-grown plants, with no Ca in the solution (Correia and Martins-Loução, 2003). Regarding micronutrients, the lack of Fe leads to chlorosis of young leaves, but maintaining a fine network of green veins. These symptoms may be associated to calcareous soils, but in field-grown carob-trees it is extremely rare. In soils with a high percentage of active lime, leaf Mn concentration is lower than 40 ppm but in slightly acid soils, these values can be higher than 100 ppm.

**SOIL FERTILIZATION**

Fertilization practices of mature trees should take into consideration the availability of irrigation water. It is known that most of the existing carob-trees orchards around Mediterranean region are only rainfed. This implies that rainfall events are only able to dissolve fertilizer salts. Like in other fruit tree crops, nutrients may be applied as simple fertilizers or compound fertilizers.

Phosphorus application has not yet been studied in carob-tree orchards. Trees are normally established on soils with low P, and in calcareous soils, there is a large inaccessible fraction of P due to the formation of insoluble phosphate of Ca. In order to increase P uptake, phosphate should be applied close to the roots. As stated above, P deficiency symptoms are not clearly seen in leaves or fruits of carob-trees, partially for this reason but also due to low soil P mobility, farmers do not apply phosphate in established mature tree orchards. Thus, it is important to study the response to phosphate application and also the role of root colonization by mycorrhiza on P uptake. P may be applied as superphosphate in one single application at the beginning of winter. However, it is a common practice to apply P fertilizer in the proximity of roots at transplanting stage to increase P uptake.

Carob pods are strong sinks for potassium, particularly during the stage of high fruit growth rate, which occurs between
April and June. Potassium may be applied as potassium sulphate or potassium chloride. The former one was already tested on carob-tree leading to an increase in leaf K concentration, even with high soil K availability. At field level, the response to other essential nutrients, like Ca, Mg, S and micronutrients are not known. Fruit quality (seed and pulp) in particular the reological properties of carob gums, are probably related to tree nutrients, but this assumption needs to be studied. K may be fractionated also between February and June.

At nursery level, fertilization of carob-trees rootstocks is a common practice and it is normally done by control released fertilizers or foliar application. The amounts of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O shown in table 3 are indicated for plants grown in small containers (< 3 l volume) and are referred to the total of one single growing season (between March and September). In these conditions, a continuous growth throughout the season is expected but the application of nutrients is dependent on irrigation. At this level, fertilization is also possible but data on this topic are scarce. In Table 3 macro-nutrients concentrations in irrigation water are proposed, based on the results obtained by Planelles et al. (2001) for carob-tree seedlings grown in 2.3 l containers.

In Table 4 a fertilization plan (N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O) is proposed for carob-trees. Mature trees with 15 to 20 years-old are expected to achieve its maximum potential yield. At this stage, maximum N doses should not be greater than 1 kg of N per tree per year. In a field experiment conducted during 4 years, mature trees received 0.9 kg of N (ammonium nitrate with Ca) each year. Leaf N concentration was around 2.50 % (dw) in winter sampling and fruit production increased each year (Correia and Martins-Louçã, 2002). Lloveras and Tous (1992) also tested several N amounts (0 up to 5 kg per tree per year) on large trees (more than 40 years old and with an average height of 5 m) and the pod yield increased significantly. Straight fertilizers can be replaced by compound N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O fertilizers. A proportion of 2:1:1 may be used in the first 4 years but afterwards it is advisable to change to 2:1:2 due to the importance of K for fruit development and drought resistance.

If irrigation is available, an extended growth season is expected and late application of fertilizers is possible. Trees can be irrigated by means of a micro-sprinkler system, one per tree, placed close to the tree trunk, delivering 40 l per hour with a range of 360°.

**FOLIAR FERTILIZATION**

In order to circumvent ion soil fixation or exchange reactions, as occurs in calcareous soils, foliar application may be a good

---

**Table 3. Macronutrients (N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O) concentrations in irrigation water as proposed by Planelles et al. (2001) for carob-tree seedlings at nursery stage.**

<table>
<thead>
<tr>
<th>N (100-150 mg/l)</th>
<th>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt; (70 mg/l)</th>
<th>K&lt;sub&gt;2&lt;/sub&gt;O (100-150 mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

**Table 4. Amounts (g) of nitrogen, phosphorus and potassium proposed for carob-trees, considering straight and compounds (NPK) fertilizers.**

<table>
<thead>
<tr>
<th>Tree age (years)</th>
<th>N</th>
<th>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</th>
<th>K&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>N: P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;: K&lt;sub&gt;2&lt;/sub&gt;O</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>1.0:1.0:1.0</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>1.0:0.5:0.5</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>1.0:0.5:0.5</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>30</td>
<td>30</td>
<td>1.0:0.4:0.4</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>50</td>
<td>80</td>
<td>1.0:0.5:0.8</td>
</tr>
<tr>
<td>6</td>
<td>200</td>
<td>30</td>
<td>150</td>
<td>1.0:0.2:0.8</td>
</tr>
<tr>
<td>7</td>
<td>300</td>
<td>40</td>
<td>200</td>
<td>1.0:0.1:0.7</td>
</tr>
<tr>
<td>8</td>
<td>400</td>
<td>60</td>
<td>300</td>
<td>1.0:0.2:0.8</td>
</tr>
<tr>
<td>9</td>
<td>500</td>
<td>80</td>
<td>350</td>
<td>1.0:0.2:0.7</td>
</tr>
<tr>
<td>10</td>
<td>600</td>
<td>100</td>
<td>500</td>
<td>1.0:0.2:0.8</td>
</tr>
<tr>
<td>12</td>
<td>650</td>
<td>200</td>
<td>550</td>
<td>1.0:0.3:0.8</td>
</tr>
<tr>
<td>15</td>
<td>800</td>
<td>200</td>
<td>700</td>
<td>1.0:0.2:0.9</td>
</tr>
</tbody>
</table>

---

**Hermaphrodite carob flowers.**

**Carob pods.**
once a year. In this crop, it is important to ensure a deep-rooting system. We must be aware that in future scenarios of water shortage, irrigation will be diverted to horticulture and other fruit crops, like citrus, and irrigation of carob-trees will not be an option. Therefore, carob-trees should be prepared to rely exclusively on deep water resources. These guidelines are merely a proposal and other aspects will have to be considered.

ACKNOWLEDGEMENTS
The author is indebted to Maribela Pestana for her critical review, to João Caço for his additional comments and to Joan Tous for the invitation to write this paper. Unconditional support for many years from the people of AIDA is greatly acknowledged. Most of this work would not have been possible without the guidance of M.A. Martins-Loução.

REFERENCES


P.J. Correia Centro de Desenvolvimento de Ciências e Técnicas de Produção Vegetal (CDCTPV) Universidade do Algarve Campus de Gambelas 8005-139 Faro, Portugal E-mail: pcorreia@ualg.pt

CULTIVAR DESCRIPTIONS

Starting from this NUCIS issue a new section including tree nuts and carob genetic resources is open to breeders and pomologists in the Newsletter. This section will consider both important traditional or local cultivars and new varieties of nut trees (almond, hazelnut, walnut, pecan, pistachio, chestnut and stone pine) and carob appeared recently. The aim is to make available to readers useful agronomical and commercial information and results of the performance of important cultivars and new varieties. The cultivar description of each cultivar or new variety will need to outline at least (name, synonyms, origin, distribution, purpose, morphological characters of tree, nut or fruit and leaf). In addition some agronomical and commercial considerations should be included to more useful traits related to nut or pod chemical composition and molecular markers for identification, which would also be most useful. Pictures showing the whole tree and fruits should be included.

In this issue, four outstanding almond varieties recently released from the IRTA’s scion breeding programme are featured.
‘CONSTANTÍ’

• Breeders’ reference: IRTAMB-A22-120.
• Breeding number (almond variety breeding programme IRTA): ‘22-120’.
• Origin: seedling derived from the cross ‘FGFD2’ x o.p. made in 1993 at Mas de Bover (Constantí, Tarragona). ‘FGFD2’ is selection 2 from ‘Ferragnes’ x ‘Ferraduel’.
• Protected variety: patent submitted by IRTA to OEVV in 2005 (exp. n. 20054626, Bulletin OEVV n. 96). Temporary protection granted.

POMOLOGICAL TRAITS

• Tree vigour: vigorous. Its vigour allows to maintain an optimum balance between production and vegetative growth (future crop sides).
• Foliage density: medium.
• Growth habit: medium-upright.
• Branching density: medium.
• Training and pruning: very easy.
• Bearing habit: most flower buds on spurs but also on one-year old shoots.
• Blooming time: late (similar to ‘Guara’ and ‘Glorieta’). At Mas de Bover 27 days after ‘Desmayo Largaleta’ (average of 10 years of observations).
• Self-compatibility (S genotype): S3Sf
• Pollination: self-fertile. Cross-pollination unneeded. Selfcompatible variety, with a good autogamous level (capable to produce in isolated conditions).
• Pollinizers: for the improvement of cross-pollination (always an advisable practice, even for self-fertile varieties), could be combined in the orchard with ‘Vairo’, ‘Glorieta’, ‘Francolí’, ‘Guara’, etc.
• Blooming density: high.
• Length of blooming: medium.
• Bearing precocity: precocious.
• Cropping capacity: high-very high.
• Cropping consistency: good. Low alternate bearing.
• Drought resistance: considering its behaviour at Mas de Bover, it seems tolerant.
• Fusicoccum (Phomopsis amygdali) resistance: it shows some sensibility.
• Harvesting season: medium (at the end of August at Mas de Bover).
• Harvesting ease: good. At maturity nuts keep attached to their branches. When shaking they drop easily.
• Husking ease: good. The husk is separated easily from the shell.

GLOBAL ASSESSMENT
‘Constantí’ shows fair productive capacity, vigorous and, apparently, well adapted to rainfed farming. It is late blooming and self-fertile, with good autogamous level. Easy to train and prune. Produces good kernels. It is slightly sensitive to “fusiccum”. Cross-pollination can be improved using ‘Vairo’ or other cultivars having similar blooming dates (‘Glorieta’, ‘Francolí’, ‘Guara’, etc).

COMMERCIAL TRAITS

• Nut shape: round.
• Nut size: medium (1,2 g).
• Shelling percentage: 27 %.
• Shell texture: hard.
• Double kernels: almost zero (1,4 %).
• Kernel appearance: attractive. Thin clear skin, with some shrinks.
• Kernel composition (% on dry material): oil: 56,6 %; crude protein: 22,5 %; crude fibre: 7,1 %; sugars: 2,5 %.

ACKNOWLEDGEMENTS
INIA and EU (projects SC97-049, RTA01-081, RTA04-030 and TRT2006-00021-00-00).

F.J. Vargas, M. Romero and I. Batlle
IRTA. Mas de Bover. Ctra. Reus-El Morell, Km 3,8.
E-43120 Constantí, Tarragona, Spain.
E-mail: francisco.vargas@irta.cat

‘Constantí’ fruiting behaviour.

‘Constantí’ almond tree.

‘Constantí’ almonds.
**‘MARINADA’**

- **Breeders’ reference:** IRTAMB-A23-57.
- **Breeding number** (almond variety breeding programme IRTA): ‘23-57’.
- **Origin:** seedling derived from the cross ‘Lauranne’ x ‘Glorieta’, made in 1994 at Mas de Bover (Constantí, Tarragona).
- **Protected variety:** patent submitted by IRTA to OEVV in 2005 (exp. n. 20054627, Bulletin OEVV n. 96). Temporary protection granted.

**POMOLOGICAL TRAITS**

- **Tree vigour:** medium. Its vigour is enough to maintain an optimum balance between production and vegetative growth (future crop sides).
- **Foliage density:** highly dense.
- **Growth habit:** medium-upright.
- **Branching density:** medium-low.
- **Training and pruning:** very easy.
- **Bearing habit:** mainly on spurs.
- **Blooming time:** very late (after ‘Ferragnès’). At Mas de Bover 34 days after ‘Desmayo Largueta’ (average of 10 years of observations).
- **Self-compatibility (S genotype):** S, S.
- **Pollination:** self-fertile. Cross-pollination unneeded. Self-compatible variety having a good autogamous level (capable to produce in isolated conditions).
- **Pollinators:** for the improvement of cross-pollination (always an advisable practice, even for self-fertile varieties), could be combined in the orchard with ‘Tarraco’, having a similar blooming date.
- **Blooming density:** very high.
- **Length of blooming:** medium.
- **Bearing precocity:** extremely precocious.
- **Cropping capacity:** very high.
- **Cropping consistency:** good. Low alternate bearing.
- **Drought resistance:** considering its behaviour at Mas de Bover, it seems tolerant.
- **Fusicoccum** (Phomopsis amygdali): it seems tolerant.
- **Harvesting season:** medium (at the end of August and the beginning of September at Mas de Bover).
- **Harvesting ease:** good. At maturity nuts keep attached to their branches. When shaking they drop easily.
- **Husking ease:** good. The husk is separated easily from the shell.

**COMMERCIAL TRAITS**

- **Nut shape:** cordate.
- **Nut size:** medium (1.3 g).
- **Shelling percentage:** 31%.
- **Shell texture:** hard.
- **Double kernels:** without doubles (0.3%).
- **Kernel appearance:** attractive. Skin smooth and clear.
- **Kernel composition (% on dry matter):** oil: 54.0%; crude protein: 22.2%; crude fibre: 12.1%; sugars: 2.9%.

**GLOBAL ASSESSMENT**

‘Marinada’ is highly productive and very precocious. It flowers very late. Self-fertile, showing a good autogamous level. Very easy to train and prune. Produces good nuts. So far, it has not shown special sensitivity to any disease at Mas de Bover. Pollination can be improved using ‘Tarraco’ as pollinator. The combination of these two varieties, both very precocious and showing midvigour, can be interesting for establishing semi-intensive orchards at close spacing.

**ACKNOWLEDGEMENTS**

INIA and UE (projects SC97-049, RTA01-081, RTA04-030 and TRT2006-00021-00-00).

F.J. Vargas, M. Romero and I. Batlle
IRTA. Mas de Bover. Ctra. Reus-El Morell, Km 3,8.
E-43120 Constantí, Tarragona, Spain.
E-mail: francisco.vargas@irta.cat
‘TARRACO’

- **Breeders’ reference**: IRTAMB-A21-169.
- **Breeding number** (almond variety breeding programme IRTA): ‘21-169’.
- **Origin**: seedling derived from the cross ‘FLTU18’ x ‘Arxaneta’, made in 1991 at Mas de Bover (Constantí, Tarragona).
- **Protected variety**: patent submitted by IRTA to OEVV in 2005 (exp. n. 20054625, Bulletin OEVV n. 96). Temporary protection granted.

**POMOLOGICAL TRAITS**
- **Tree vigour**: medium. Its vigour is enough to maintain an optimum balance between production and vegetative growth (future crop sides).
- **Foliage density**: dense.
- **Growth habit**: medium-upright.
- **Branching density**: medium-low.
- **Training and pruning**: very easy.
- **Bearing habit**: mainly on spurs.
- **Blooming time**: very late (after ‘Ferragnès’). At Mas de Bover 35 days after ‘Desmayo Largueta’ (average of 10 years of observations).
- **Self-compatibility** (S Genotipe): S<sub>1</sub>S<sub>9</sub>.
- **Pollination**: Cross-pollination needed.
- **Pollinators**: ‘Marinada’, having a similar blooming date.
- **Blooming density**: very high.
- **Length of blooming**: medium.
- **Bearing precocity**: extremely precocious.
- **Cropping capacity**: very high.
- **Cropping consistency**: good. Low alternate bearing.
- **Drought resistance**: considering its behaviour at Mas de Bover, it seems tolerant.
- **Fusicoccum” (Phomopsis amygdali)**: it seems tolerant.
- **Harvesting season**: medium (at the end of August).

**COMMERCIAL TRAITS**
- **Nut shape**: oblong.
- **Nut size**: big (1,7 g).
- **Shelling percentage**: 32 %.
- **Shell texture**: hard.
- **Double kernels**: without doubles (0,1 %).
- **Kernel appearance**: attractive. Skin smooth and clear.
- **Kernel composition (% on dry matter)**: oil: 56,6 %; crude protein: 21,9 %; crude fibre: 7,5 %; sugars: 3,3 %.

**GLOBAL ASSESSMENT**
‘Tarraco’ shows some outstanding traits. It is highly productive and very precocious. It flowers very late. Adapted to rainfed farming. It is very easy to train and prune. Good fruit, big-sized. Considering its behaviour at Mas de Bover, it seems tolerant to “fusicoccum”. It is self-incompatible and therefore needs cross-pollination. It can be associated with ‘Marinada, as they share the same blooming time. The combination of ‘Tarraco’ and ‘Marinada’, both very precocious in bearing and showing midvigour, can be considered for establishing orchards at close spacing.

**ACKNOWLEDGEMENTS**
INIA and UE (projects SC97-049, RTA01-081, RTA04-030 and TRT2006-00021-00-00).

F.J. Vargas, M. Romero y I. Batlle
IRTA. Mas de Bover. Ctra. Reus-El Morell, Km 3,8. E-43120 Constantí, Tarragona, Spain.
E-mail: francisco.vargas@irta.cat
**‘VAIRO’**

- **Synonym**: ‘Vayro’
- **Breeders’ reference**: IRTAMB-A21-323.
- **Breeding number** (almond variety breeding programme IRTA): ‘21-323’.
- **Origin**: seedling derived from the cross ‘4-665’ x ‘Lauranne’, made in 1991 at Mas de Bover (Constanti, Tarragona).
- **Protected variety**: patent submitted by IRTA to OEVV in 2005 (exp. n. 20054628, Bulletin OEVV n. 96). Temporary protection granted.

**POMOLOGICAL TRAITS**

- **Tree vigour**: very vigorous. Its vigour allows to maintain an optimum balance between production and vegetative growth (future crop sides).
- **Foliage density**: medium.

**COMMERCIAL TRAITS**

- **Nut shape**: cordate.
- **Nut size**: medium (1.2 g).
- **Shelling percentage**: 28 %.
- **Shell texture**: hard.
- **Double kernels**: without doubles (0.1 %).
- **Kernel appearance**: attractive. Skin smooth and clear, without shrinkels.
- **Kernel composition** (% on dry matter): oil: 56.7 %; crude protein: 21.3 %; crude fibre: 9.9 %; sugars: 2.3 %.

**GLOBAL ASSESSMENT**

‘Vairo’ shows some interesting traits. It is highly productive because of its considerable bearing intensity and vigour. Self-fertile, with good autogamous level. Late blooming. Easy to train and prune. Produces good kernels. It seems to be tolerant to rainfed farming and to “fusicoccum”. Cross-pollination can be improved using ‘Constanti’ or other cultivars having similar blooming time (‘Glorieta’, ‘Francoll’, ‘Guara’, etc).

**ACKNOWLEDGEMENTS**

INIA and UE (projects SC97-049, RTA01-081, RTA04-030 and TRT2006-00021-00-00).

F.J. Vargas, M. Romero and I. Batlle
IRTA. Mas de Bover. Ctra. Reus-El Morell, Km 3,8. E-43120 Constanti, Tarragona, Spain.
E-mail: francisco.vargas@irta.cat
SAFEGUARD OF HAZELNUT AND ALMOND GENETIC RESOURCES

In the frame of the European Community programme on genetic resources in agriculture, an European project for the valorisation of native almond (Prunus dulcis) and hazelnut (Corylus avellana L.) genetic resources was approved and it has been started in April 2007, with a duration of three years. The countries involved in the project acronymed “SAFENUT”: France, Greece, Italy, Portugal, Slovenia and Spain, represent 86.6% and 95% of the entire UE production for almond and hazelnut production, respectively. The project will benefit from the participation of eleven partners from 6 European Countries including the ONG Lega Ambiente and Farmer’s Association (Coldiretti). The partners involved are reported below.

From France: INRA (Institut National de la Recherche Agronomique), From Greece: NAGREF (National Agricultural Research Foundation-Pomology Institute), NAGREF-IUSPOT (National Agricultural Research Foundation-Institute of Olive Trees and Subtropical Plants); from Italy: CRAB (Consorzio di Ricerche Applicate alla Biotecnologia), CRA-ISF (CRA-Istituto Sperimentale per la Frutticoltura), ENEA (Ente per le Nuove Tecnologie, l’Energie e l’Ambiente) and UNITO (Università degli Studi di Torino); from Portugal: UTAD (Universidade de Trás-os-Montes e Alto Douro); from Slovenia: Univerza v Ljubljani, Biohniska Fakulteta and from Spain: CITA (Centro de Investigación y Tecnología Agroalimentaria de Aragón) and IRTA (Institut de Recerca i Tecnologia Agroalimentàries). The coordinator of the project is Loretta Bacchetta, from ENEA (loretta.bacchetta@casaccia.ene)

The project is aimed to increase the knowledge of the European germplasm of these two species. One of the main objectives of the project is the recovery and valorisation of local endangered germplasm in the traditional productive areas of the Mediterranean basin. The purpose is to describe genetic resources from different points of view: morphological, biochemical, molecular, as well as ecological and traditional significance for people who has conserved it and in some cases, improved it. The objective includes the establishment of a core collection both for hazelnut and almond species. In order to share and spread all the information compiled the final goal is to set up a web based on the inventory linked with the major thematic international database. The gathered information will also be used to promote a wider application of traditional knowledge, agricultural practices as well as to raise stakeholders awareness on the values of biodiversity components from the biological, economical and socio-cultural perspective.

The project management has been organised with six different work packages:

WP1. Survey of local, national and European Corylus avellana L. collections and on farm recovery of ‘ecotypes’.

WP2. Recovery old endangered almond varieties and in situ characterisation of germplasm.

WP3. Evaluation of Corylus avellana L. plant material.

WP4. Ecological, economics and socio-cultural aspects related to sustainable production and traditional knowledge.

WP5. Conservation of germplasm by designing a core collection


(More information is available in: http://safenut)

M. Rovira
FAO-CIHEAM Nut Network Coordinator
IRTA-Centre Mas de Bover
E-mail: merce.rovira@irta.es
One day International Symposium on Nut Tree Crops was held at Lleida, Spain, the 28th of September 2007. The Symposium was organized by Agro Latino within the venue of the three days International St. Michael Agricultural Fair which is organized annually. Several well-known researchers from the University of California and from several Spanish Research Institutes (CITA Aragon, CEBAS-CSIC, Murcia, “El Chaparrillo”, Castilla-La Mancha, IRTA Catalonia, Girona University, Seville University and Lleida University) participated. Also speakers from some private companies like Vitrotech Biotecnologia Vegetal, SL and Laboratorios Ferrer took part.

The species considered were almond, walnut, pistachio. In addition, communications on irrigation technology, propagation and disease management were also given and discussed. At the end of the one day Symposium a broad discussion with the participation of representatives of the Spanish nut industry (AGROLES, AEOFRISE, and Foment Agrícola de Les Garrigues, S.A.) was held.

Almond and Pistachio
XIV GREMPA Meeting of the Mediterranean Research Group for Almond and Pistachio
Date: 31 March - 5 April, 2008
Place: Athens, Greece
Convener: E. Tjamos
Address: Agricultural University of Athens, Department of Plant Pathology, 75 Iera Odos, Votanikos 11855, Athens, Greece
Phone: 00 30 210 529 4505
Mobile: 00 30 6932 365566
E-mail: ect@aua.gr

V International Symposium on Pistachios and Almonds
Date: 2009
Place: Sanliurfa, Turkey
Convener: B.E. Ak
Address: University of Harran, Faculty of Agriculture, 63200 Sanliurfa, Turkey
Phone: 90 4142 4703 84
Fax: 90 4142 4703 84
E-mail: beak@harran.edu.tr

Hazelnut
VII th International Congress on Hazelnut
Date: June 23-27, 2008
Place: Viterbo, Italy
Convener: L. Varvaro
Address: Dipartimento di Protezione delle Piante. Università della Tuscia, via San Camillo de Lellis, 01100 Viterbo, Italy
Phone: 39 07 61 357 461
Fax: 39 07 61 357 473
E-mail: varvaro@unitus.it
Web: http://www.hazelnut2008.it

Chestnut
IV International Chestnut Symposium.
Date: September 9-12, 2008
Place: Beijing, China
Convener: L. Qin
Address: Beijing Agricultural College, No 7 Beinong Road, Changpin District, Beijing 102206, China
Phone: 86 1080 799136 / 1080 799126
Fax: 86 1080 799004
E-mail: qinlingbac@126.com
Web: http://www.chestnut.org.cn

Walnut
VI International Walnut Symposium
Date: February 25-27, 2009
Place: Melbourne, Australia
Conveners: B. Goble
Address: 222 Kerang-Koondrook Rd, Koondrook, VIC 3580, Australia
E-mail: bigoble@westnet.com.au
Conveners: L. Titmus
Address: PO Box 417, Devonport, TAS 7310, Australia
Phone: 61 364 283 539
E-mail: leigh.titmus@webstered.com.au
BIBLIOGRAPHY

ALMOND


De Giorgio, D; Leo, L; Zacheo, G; et al., 2007. Evaluation of 52 almond (Prunus amygdalus Batsch) cultivars from the Apulia region in Southern Italy. JOURNAL of Horticultural Science & Biotechnology, 82 (4): 541-546.


CAROB


Mendez, A.; Guerra, P.; Madeira, V.; et al., 2007. Study of docosahexaenoic acid production by the heterotrophic microalgaa Cryptococcum cohnii CCMP 316 using carob pulp as a promising carbon source. World Journal of Microbiology & Biotechnology, 23 (9): 1209-1215.


CHESTNUT


Elliott, K.; Swank, W., 2007. Long-term changes in forest composition and diversity following early logging (1919-1923) and the decline of American chestnut (Castanea dentata). Plant Ecology, in press: 13 SEP.


Pierson, SAA.; Keiffer, CH.; McCarthy, BC.; et al., 2007. Limited reintroduction does not always lead to rapid loss of genetic diversity: An example from the American chestnut (Castanea dentata; Fagaceae). Restoration Ecology, 15 (3): 420-429.


HAZELNUT


of the presence of refined hazelnut oil in
271-275.
Compost Science & Utilization, 14 (4):
hazelnut husk on growth of tomato plants.
Ozenc, D.B., 2006. Effects of composted
eastern filbert blight. Hortscience, 42 (1):
2006. Segregation for resistance to eas tern
filbert blight in progeny of ‘Zimmerman’ ha-
2007. Occurrence of Pseudomonas syringae pv. coryli on hazelnut orchards in
Italy, characterization by fluo-
rescent amplified fragment length polym-
orphism. Journal of Phytopathology, 155
(7-8): 397-402.
Britannica. Investigación y Experimentación.
several hazelnut germplasm
virus on yield and quality characteristics of hazelnut (cv. Palaz) in a hedgerow training
system. Canadian Journal of Plant Sci-
ence, 87 (3): 595-597.
Beyhan, N., 2007. Effects of planting den-
sity on yield and quality characteristics of hazelnut husk on growth of tomato plants.
Compost Science & Utilization, 14 (4):
Effects of composted residues (corn, cotton, and soybean) on growth and yield of black
walnut, pecan and hazelnut. Southwestern
tree fruit and nut science, 20 (3-4):
169-174.
715-717.
Silva, A.P., 2006. Variedades de Aveleira
(in Portuguese). Projecto AGRO 162: 45
of black walnut and pecan cultivars in re-
sponse to an early hard freeze. Journal of
Kelly, J.H.; Sabate, J., 2006. Nuts and cor-
ronary heart disease: an epidemiological
perspective. British Journal of Nutrition, 96
(1): S61-S67 Suppl. 2.
Moodley, R.; Kindness, A.; Jonnalagadda,
S.B., 2007. Elemental composition and
chemical characteristics of five edible
nuts (almond, Brazil, pecan, macadamia
and walnut) consumed in Southern Af-
rica. Journal of Environmental Science
and Health Part B-Pesticides Food Con-
taminants and Agricultural Wastes, 42 (5):
585-591.
of black walnut and pecan cultivars in re-
sponse to an early hard freeze. Journal of
the American Pomological Society, 60 (2):
90-94.
NUTS AND HEALTH
Blomhoff, R.; Carlsen, M.H.; Andersen,
L.F.; et al., 2006. Health benefits of nuts:
potential role of antioxidants. British Jour-
nal of Nutrition, 96 (1): S52-S60 Suppl.
2.
Nuts: source of energy and macronutri-
ents. British Journal of Nutrition, 96 (1):
S-4-S28 Suppl. 2.
Chun, H.S.; Kim, H.J.; Ok, H.E.; et al.,
2007. Determination of aflatoxin levels in
nuts and their products consumed in South
Crespo, J.F.; James, J.M.; Fernandez-Ro-
driguez, C.; et al., 2006. Food allergy: nuts
and tree nuts. British Journal of Nutrition,
96 (1): S95-S102 Suppl. 2.
The potential of nuts in the prevention of
S87-S94 Suppl. 2.
Griel, A.E.; Kris-Etherton, P.M., 2006. Tree
nuts and the lipid profile: a review of clini-
cal studies. British Journal of Nutrition,
96 (1): S68-S78 Suppl. 2.
Gruendel, S.; Otto, B.; Garcia, A.L.; et al.,
2007. Carob pulp preparation rich in in-
soluble dietary fibre and polyphenols in-
creases plasma glucose and serum insulin
responses in combination with a glucose
load in humans. British Journal of Nutri-
tion, 98 (1): 101-105.
Hamly, J.M.; Doherty, R.F.; Beecher,
G.R.; et al., 2006. Flavonoid content of
US fruits, vegetables, and nuts. Journal of
Agricultural and Food Chemistry, 54 (26):
9966-9977.
Jenab, M.; Sabate, J.; Slimani, N.; et al.,
2006. Consumption and portion sizes of
tree nuts, peanuts and seeds in the Euro-
pean Prospective Investigation into Cancer
and Nutrition (EPIC) cohorts from 10 Euro-
pean countries. British Journal of Nutrition,
Kelly, J.H.; Sabate, J., 2006. Nuts and cor-
ronary heart disease: an epidemiological
perspective. British Journal of Nutrition, 96
(1): S61-S67 Suppl. 2.
Moodley, R.; Kindness, A.; Jonnalagadda,
S.B., 2007. Elemental composition and
chemical characteristics of five edible
nuts (almond, Brazil, pecan, macadamia
and walnut) consumed in Southern Af-
rica. Journal of Environmental Science
and Health Part B-Pesticides Food Con-
taminants and Agricultural Wastes, 42 (5):
585-591.
Ohr, L.M., 2006. Health nuts. Food Tech-
ology, 60 (12): 81.
weight and insulin resistance. British Jour-
Ritter, MMC.; Savage, G.P., 2007. Soluble
and insoluble oxalate content of nuts.
Journal of Food Composition And Analy-
Ros, E.; Mataix, J., 2006. Fatty acid com-
position of nuts - implications for cardio-
FAO-CIHEAM - Nucis-Newsletter, Number 14 December 2007 39


PECAN


Pistacia vera (Pistacia vera) allergens of 11s globulin (Pistacia vera) in food samples. Industrie Alimentari, 42 (3): 694-696.


STONE PINE


WALNUT


Nearing, M.A.; Nichols, M.H.; Stone, J.J.; et al., 2007. Sediment yields from unit-source


BOOKS


Manejo técnico del cultivo del almendro en el norte de Marruecos (in Spanish), 2007.


THESES


**THE FAO-CIHEAM INTER-REGIONAL COOPERATIVE RESEARCH NETWORK ON NUTS**

<table>
<thead>
<tr>
<th>Network</th>
<th>Coordination Centre</th>
<th>Network Coordinator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nut tree crops</td>
<td>IRTA - Mas de Bover, Mediterranean Fruit Trees</td>
<td>M. Rovira</td>
</tr>
<tr>
<td>Stone Pine</td>
<td>Crta. Reus - El Morell, km 3.8, E-43120 Constantí (Spain)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel: 34- 977 328424, Fax: 34- 977 344055</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:merce.rovira@irta.es">merce.rovira@irta.es</a></td>
<td></td>
</tr>
<tr>
<td><strong>Subnetworks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Almond</td>
<td>IRTA - Mas de Bover, Mediterranean Fruit Trees</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crta. Reus - El Morell, km 3.8, E-43120 Constantí (Spain)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel: 34- 977 328424, Fax: 34- 977 344055</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:francisco.vargas@irta.es">francisco.vargas@irta.es</a></td>
<td></td>
</tr>
<tr>
<td>Hazelnut</td>
<td>Ankara University, Faculty of Agriculture</td>
<td>A. I. Köksal</td>
</tr>
<tr>
<td></td>
<td>Department of Horticulture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>06110 - Ankara (Turkey)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel: 90 - 312 3170550, Fax: 90 - 312 3179119</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:ikoksal@agri.ankara.edu.tr">ikoksal@agri.ankara.edu.tr</a></td>
<td></td>
</tr>
<tr>
<td>Walnut and Pecan</td>
<td>Institut National de la Recherche Agronomique INRA</td>
<td>M. Lafargue</td>
</tr>
<tr>
<td></td>
<td>Unité de Recherches sur les Espèces Fruitières et la Vigne</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B.P. 81 - 33683 - Villeneuve d’Ormon (France)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel: 33 - 556 843277, Fax: 33 - 556 843274</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:milafargue@bordeaux.inra.fr">milafargue@bordeaux.inra.fr</a></td>
<td></td>
</tr>
<tr>
<td>Pistachio</td>
<td>University of Harran, Faculty of Agriculture</td>
<td>B. E. Ak</td>
</tr>
<tr>
<td></td>
<td>Departement of Horticulture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>65200 - Sanliúra (Turkey)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel: 90 - 414 2472697, Fax: 90 - 414 2474480</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:beak@harran.edu.tr">beak@harran.edu.tr</a></td>
<td></td>
</tr>
<tr>
<td>Chestnut</td>
<td>Università degli Studi di Torino</td>
<td>G. Bou nous</td>
</tr>
<tr>
<td></td>
<td>Dipartamento di Colture Arboree. Cattedra di Arboriculture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Via Leonardo Da Vinci, 44, 10095 - Grugliasco (TO) (Italy)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel: 39 - 011 6708653, Fax: 39 - 011 6708658</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:bounous@agraria.unibo.it">bounous@agraria.unibo.it</a></td>
<td></td>
</tr>
<tr>
<td>Genetic Resources</td>
<td>IRTA - Mas de Bover, Mediterranean Fruit Trees</td>
<td>I. Batlle</td>
</tr>
<tr>
<td></td>
<td>Crta. Reus - El Morell, km 3.8, E-43120 Constantí (Spain)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel: 34- 977 328424, Fax: 34- 977 344055</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:ignasi.batlle@irta.es">ignasi.batlle@irta.es</a></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>CITA - Centro de Investigación y Transferencia Agroalimentaria</td>
<td>L. M. Albisu</td>
</tr>
<tr>
<td></td>
<td>Diputación General de Aragón. Apartado 727</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50080 - Zaragoza (Spain)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel: 34 - 976 576361, Fax: 34- 976 575501</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:albisu@mizar.csic.es">albisu@mizar.csic.es</a></td>
<td></td>
</tr>
<tr>
<td><strong>FAO</strong></td>
<td>Regional Office for Europe and Central Asia (REU):</td>
<td>Maria Kadlecikova</td>
</tr>
<tr>
<td></td>
<td>Benczur utca 34 H-1088 Budapest (Hungary)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel: 36 - 1 4612000, Fax: 36 1 3517029</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:maria.kadlecikova@fao.org">maria.kadlecikova@fao.org</a></td>
<td></td>
</tr>
<tr>
<td><strong>CIHEAM</strong></td>
<td>Instituto Agronómico Mediterráneo de Zaragoza IAMZ</td>
<td>Duníx Gabriñeta</td>
</tr>
<tr>
<td></td>
<td>Apartado 202, 50080 Zaragoza (Spain)</td>
<td>Antonio López-Francos</td>
</tr>
<tr>
<td></td>
<td>Tel: 34 - 976 71 60 00, Fax: 34 - 976 71 60 01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:gabina@iamz.ciheam.org">gabina@iamz.ciheam.org</a></td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:lopez-francos@iam.ciheam.org">lopez-francos@iam.ciheam.org</a></td>
<td></td>
</tr>
</tbody>
</table>

**Network Coordinator:** M. Rovira  
**Scientific Editor:** I. Batlle  
**Editorial Committee:** N. Aletà, D. Bono, M. Rovira, J. Tous and F. J. Vargas  
**Editorial staff:** M. Lannoye  
**Typeset by:** Carácter Gráfico, S.L.  
**E-mail:** cg@ediho.es  
**ISSN:** 1020-0797