Following the First Technical Consultation of the Inter-regional Cooperative Research Network on Nuts held in Meknes (Morocco) 1996 and the re-election of the Coordination Board, 1997 served to settle ideas and to start a programme of activities planned for (1997-2002). The Coordination Board Meeting held in Rome in October 1997, was useful in order to assess the work, set priorities, see the strength of the managing group and to inform on the scarce budget available.

The two-day Coordination Board Meeting held at the Istituto Sperimentale per la Frutticoltura (ISF), Rome, last October and locally organized by the late F. Monastra, was focused on the future of the Nut Network. A progress report of the work carried out since the establishment of the Network (1990-97) but concentrating mainly on the future work, was presented by the Coordinator. In addition, each liaison officer presented a short report on the activities and future plans of their respective subnetworks. Useful discussions and joint assessment of important issues were carried out.

A number of activities are planned: The Second International Course on Nut Production and Economics, May 1998, Adana (Turkey) organized by CIHEAM-IAMZ jointly with the Faculty of Agriculture of Çukurova University and FAO, the Second Chestnut Congress, October 1998 and the Fourth Walnut Congress will both take place in September 1999 in Bordeaux (France), the Eleventh GREMPA Meeting on Almond and Pistachio will be held in September 1999 in Sanliurfa (Turkey); and a Meeting of the Economics Subnetwork is planned.

An important issue since the start of the Nut Network has been the production of the Genetic Resources catalogues and R&D inventories for the species included in the Network with the support of the Genetic Resources Subnetwork. The first ‘Inventory on almond research, germplasm and references’ has now been published as REU Technical Series No.51. This was the final and useful contribution of F. Monastra to our Network and to whom a tribute is paid in this issue. The catalogue on Walnut Germplasm, Research and References will follow soon. Other catalogues on hazelnut, pistachio, chestnut and pecan, are in preparation. FAO’s REU and AGPS and CIHEAM IAMZ are funding these catalogues.

Regarding genetic resources, it was also discussed and agreed to develop species descriptor lists in collaboration with
The two species descriptor lists planned are hazelnut and chestnut. For both crops there are already UPOV descriptors for the characterisation of new varieties but not the more agronomical IPGRI descriptors. Work is going ahead and there is already a hazelnut descriptor draft. The development of a descriptor list for carob is also much needed. There is full backing to their development from IPGRI. However due to earlier priorities, no budget is yet available for their production.

After close consideration of the Carob Report (a revision of which is included in the 'Articles and Reports Section'), presented by I. Batlle, which recommended the inclusion of this crop in the Network and lively exchange of views and opinions on its convenience and suitability, it was decided, on the grounds of not being a nut tree and neither a close market related species, not to include the carob tree in our Network. However, as this crop is neglected from most R&D programmes and as germplasm collection and evaluation is one of the main needs identified, it will be closely followed. Support to coordinate efforts will be received from the Genetic Resources Subnetwork. In addition, it will still be included in the Bibliography Section of this bulletin and articles and news on this crop will continue to appear.

We, members of the FAO/CIHEAM Inter-regional Cooperative Research Network on Nuts, firmly believe that international cooperation is the only way to make progress. International R&D cooperation should play an important role in issues of common interest for developing and developed countries. Although within the European countries, experience shows that it is easier to cooperate in basic research than in near market research, developing countries are usually far more interested in applied research. Collaboration between developing and developed countries is very much fostered inside the Nut Network and is one of our main tasks. However, difficulties arise to find suitable sources of funding.

In Europe, R&D in agriculture and the environment have clearly moved from a domestic level to an international level (inter-country projects). In spite of recent views to shift back towards domestic (intra-country projects) and shortage of funding, we believe that international collaboration must be fostered with the active participation of developing countries.

It seems that an important issue, like cooperation on collection and assessment of genetic resources, which used to be conflicting due to contrasting interest between provider and user countries, and in spite of some possible criticism, is now less difficult following the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture (GPA), adopted during the Plant Genetic Resources Conference held in Leipzig in 1996.

In the last NUCIS issue (December 1996), a Nut Network logo contest was launched. As no new entrants were received, we decided to adopt the logo presented by the Nut Network Secretary during the Coordination Board Meeting held in Meknes in 1996, as the Nut Network logo (a nut tree enclosed in an inverted triangle). This logo will help to identify our Nut Network.

An important event for the NUCIS Newsletter, from this issue onwards, is its inclusion in the Internet Web pages of both FAO (http://www.fao.org/regional/Europe/public-e/nucis.htm) and CIHEAM (http://www.iamz.ciheam.org/ingles/nucis6.htm). Now the contents of this Newsletter can be browsed through these pages and also copied and printed. This will further help to spread your information. In addition, general information on the Research Nut Network activities can be found in English at (http://www.iamz.ciheam.org/ingles/nuts.htm) or in French at (http://www.iamz.ciheam.org/frances/nuts.htm).

As in past NUCIS editorials, we again stress that this Newsletter must be an effective vehicle of communication among the Network members. The pages of this bulletin are open to all readers who would like to express their opinions about the work developed by the Network (activities made and planned) or to publish short articles and reports on relevant horticultural subjects of general interest. We receive a sufficient number of contributions from the Mediterranean basin and overseas for the section on articles and reports. However, the sections on news and notes and also congresses and meetings are usually difficult to cover due to the scarce number of accounts received and thus contributions are most welcome. Also the place for 'grey' bibliography (references and documents which are difficult to find) is scarcely filled.

The exchange of information between Network members through the pages of this Newsletter is the basis for developing collaboration. We are asking contributors who send articles, news, notes, bibliographic references, etc. to the different sections, to provide them on diskette and also in printed format. The alternative is to send contributions through Internet using the Editor's Email, which is also welcomed. Information should be sent 'in English'. This bulletin is reproduced in black and white only, including slides and photographs. We thank all who have contributed to this issue. Please send your contributions for the next issue 7 (December 1998) by the end of November 1998. Finally we wish all Nut Network members a creative and happy 1998.

The Editor

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INTRODUCTION
Hazelnuts, almonds and walnuts, in that order, are the three principal edible nuts produced in Italy. Their portion of Italy’s total value of marketable agricultural production is, however, very limited in 1994 only 0.64%.

The history of nut production in Italy has not been a success story. Even though Italy is still today one of the major world producers, its role, both as producer and exporter of nuts, has radically diminished in importance over the years. While in 1961 Italian hazelnut production was equal to 30.4% of world production, that of almonds to 43.4% and that of walnuts to 14.3%, in 1994 those percentages had declined to 19%, 6.6% and 1.1%, respectively. The reduction in importance of the Italian nut sector is even more marked in terms of its role in international trading. From being an important net exporter of nuts in 1964 its overall nut ( almonds, hazelnuts, walnuts, pistachios, pecans and pinions) net trade balance was equivalent to roughly 64.5 million US dollars today italy has become an important net importer in 1995 the net negative trade balance was 88.5 million Ecus.

HAZELNUT
With 18.4% of the production and 15.2% of the global area devoted to hazelnuts production around the world, in 1994 Italy was ranked among the most important producers second only to Turkey (70.7% of world production), and followed by Spain (3.3%), USA (2.8%) and China (1.3%), in that order.

A characteristic, as well as a problem, of hazelnut production in Italy is the very high number of varieties grown, sometimes even within the same area. The different varieties are characterised by different organoleptic traits, different shapes, and different fruit sizes. Moreover, the different varieties lend themselves to greater or lesser extent to mechanical shelling and peeling and differ in perishability. At the beginning of the 1990s the ratio between the price (in shell) of the Tonda Gentile delle Langhe and that of the Tonda Gentile Romana and of the Tonda di Giffoni was 1.4; the ratio with the price of the ‘Lunga di S. Giovanni’ was 1.9, and that with the price of a group of varieties produced in Sicily was a little over 2.

Hazelnut production in Italy is carried out in a wide range of settings, from a relatively small number of modern specialised farms, where hazelnut production takes place on a relatively large scale with production technologies, yields and production costs in line with those of the most efficient producers on the north-west coast of the USA, at one end, to a large number of very small farms which still rely on traditional production methods resulting in high production costs and a lower quality, at the other end. In 1990, hazelnut cultivated area on farms where hazelnut cultivation took up no more than one hectare was 26.8%. At the opposite extreme, hazelnut cultivated area in farms using at least ten hectares for hazelnut production comprised 14.4% of the overall total.

Considering the shelled and the in-shell nuts together, in 1994 and 1995 for the first time since 1961 Italy became a net importer of hazelnuts. Yet, only six years before, in 1989, Italian exports of shelled hazelnuts were equal to a quarter of the world total; the Italian net trade balance was equal to over 85 million US dollars for these alone, and to over 10 million US dollars for the hazelnuts in shell. Despite a significant drop in the prices expressed in liras, Italian exports have lost out to Turkish producers and have declined by over 70% in only six years, from 1989 to 1995; in the same period imports of shelled hazelnuts have tripled.

Despite all these facts, when one looks at what has happened in the Italian nut sector over the last few decades hazelnut has certainly been the best performer.

ALMOND
In 1994 Italian production of almonds was equal to 89,944 tons according to FAO; the area harvested was 102,459 ha. Italy was the third largest producer of almonds with 6.6% of world production, preceded only by the United States (40.3%) and Spain (17.4%), and followed by Iran (4.9%), Morocco (4.2%), Greece (4.1%) and Turkey (3.4%). Still in 1961 Italy with 43.3% of world production was the most important world producer, followed by Spain (26.9%) and the United States (8%). Between the beginning of the 1960s and the middle of the 1990s Italian production contracted by 70%, whereas world production increased by over 80% and production in the United States alone increased ninefold.

As with the cultivation of hazelnuts, but to an even greater degree, one has to talk in terms of the coexistence in Italy of very different kinds of almond producing farms, characterised by different sizes, level of expertise, production technologies, quality of product, production costs and positioning on the market. Almonds production is highly atomised, even more so than for hazelnuts. In 1990 32.7% of almond cultivated area was on farms which utilised no more than one hectare to produce almonds. At the opposite extreme, only 8.7% was on farms where almonds occupied more than 10 ha.

In Italy almond production is characterised by an extremely large number of cultivars - over 1,000 according to some, several hundred according to others - generally with a hard shell and a low yield in shelled product. This means that a lot of inferior varieties as regards quality and/or yields are produced and that production lacks homogeneity, which leads to additional difficulties in marketing.

Around the middle of the 1980s the different dynamics in almonds exports and imports determined a change in the sign of Italy’s net trade position. If in 1961 Italy recorded net exports of 37,391 t of shelled almonds (valued around 36.5 million dollars), in 1994 the net balance was negative and equal to 8,144 t (valued 37.5 million dollars). The self-sufficiency rate for almonds in recent years in Italy has been roughly 75%.

Over the years Italy’s position on the world market has radically changed as the United States become the main producer. It is interesting to underline as the growth in production and exports from the U.S. had different repercussions in Spain and Italy. At the beginning of the 1960s, the United States held less than a 10% share of global exports as against Italy’s 50% and Spain’s 33%. Ten years later, at the beginning of the 1970s, the United States had become the world leader with 40% of the market, Spain was second with slightly under 30% and Italy third with less than 15%. At the beginning of the 1980s the market shares were 60%, 22% and less than 8%, respectively. At the beginning of the 1990s Italy had practically disappeared from the market as an exporter, the United States held over 70% of the market and Spain was still the second most important exporter, with a greater volume of exports than it had 30 years before but with only 16% of the market. The “explosion” of almond production in the US has, therefore, contributed to driving out of the market a large portion of almond production in Italy, where the weakest components have been unable to adjust and compete, causing a decline in production and exports and an increase in imports. The volume of Spanish exports, on the other hand, did
not decrease as US exports grew, although this country’s market share has declined as a result of the growth of the world market.

**WALNUT**

Of the three most important species of edible nuts grown in Italy walnut has always been the least important from the point of view of the value of its production. Moreover, in the most recent years a strong reduction in the quantity produced can be observed; in 1968 81,100 t of walnuts were produced in Italy, by 1994 only 10,244 t.

This reduction in the production of walnuts corresponds to a decline in Italy’s role among the major world producers. In 1961 Italian production of walnuts was equal to 14.3% of world production and Italy was second in world rankings, just behind Turkey (with a 16.2% share) and followed by the United States (12.3%), China (8%) and Rumania (7.2%). By 1994 its share had declined to only 1%, and Italy was 17th in the world walnut production rankings. The first places were occupied by the United States (21.4%) and China (21.4%), followed by Turkey (11.4%) and Iran (6.7%).

Traditionally, farmers in Italy have always looked upon walnuts as being a double aptitude crop (nuts and wood), and this has had negative consequences in terms of production costs and nut quality, because of the choice to leave the trees free to grow and develop vegetation. Specialised walnut farms are still rare in Italy. In addition, the greater part of the production of walnuts in Italy has been carried on in association with the cultivation of other crops. Finally, unlike in California, until not long ago most of the walnut trees in Italy were grown from seed and not through the grafting of selected varieties.

One of the consequences of the techniques of propagation used in Italy is that it takes more time for the plants to become productive, they produce less, the quality of the product is often inferior to that of other competitors and, finally, production is by no means homogeneous, even that obtained from trees of the same variety.

At the beginning of the 1960s, 32.4% of world exports of walnuts in shell and 18.2% of those of shelled walnuts came from Italy. The value of Italian walnut net exports was equivalent to 8.6 million U.S. dollars. Italy’s position on the world scene is much different today: it has become an important net importer of walnuts. As regards shelled walnuts the switch in the net trade position has been far more recent: Italy became a net importing country only in 1991. In 1994 the negative Italian net trade balance for walnuts in shell was 26.4 million US dollars, for shelled walnuts the figure was 2.7 million US dollars. In that year Italy imported 18.2% of the walnuts in shell exchanged on the world market.

**CONCLUDING REMARKS**

The recent history of the edible nuts sector in Italy has not been a successful one. The common problem among all three main edible nuts produced in Italy - hazelnut, and, especially, almond and walnut - is the structural weakness of the vast majority of farms producing them. The small size of most farms and the even smaller scale at which nut production takes place, has caused and still causes many of the problems faced by growers of edible nuts in Italy: the lack of introduction of new production and harvesting technologies which have become available in recent years; the reluctance to replace trees which have been cut down with new ones; the lack of homogeneity as regards to products; the inadequate quality of a large share of production in the face of increasingly sophisticated market demands.

The atomization of supply, as is always the case, has determined in the past, and continues to determine, both a greater need for the farmers to act jointly, and more difficult problems to overcome as regards the diffusion of cooperatives and producer associations, as well as the latter being able to operate effectively.

As regards the prospects for a large share of edible nut production in Italy - that realised by small scale operators in marginal areas - it is hard to imagine any intervention which would restore its profitability. On the other hand, this specific nut production activity often plays an irreplaceable role in maintaining the environment; a role which the agricultural and rural development policies of the European Union appear to be ready to recognise as that of providing a service which should be paid for from public funds. The process of rapid contraction of the areas given over to edible nut cultivation by smaller growers in marginal areas could (and should), therefore, be slowed down in the near future through specific subsidies aimed at keeping them in business in order to maintain the environment and preserve the rural scene, even when this can not be justified in purely economical terms.

However, what has happened in recent years, especially as regards the production of hazelnuts, shows that there is still room for the consolidation and growth of a modern edible nut industry in Italy, albeit on an overall smaller scale than in the past, one capable of holding its own against the competition from other countries.

If considerable efforts are needed to reduce production costs as far as possible, this, for various reasons, is by no means the specific terrain on which Italy can beat its American or Turkish competitors. The battle to increase the competitiveness of the Italian edible nut sector is also a battle to increase its price competitiveness, but, more importantly, is a battle which must be fought on the quality terrain, both of the product itself and of the associated services sold with it such as the ability to deliver consistent quality standards; the reliability of supply; the ability to supply a large range of semi-processed products; the ability to respond quickly to variations in the needs of the industry; and the “reputation” of its commercial operators.

To sum up, therefore, one must aim for a much greater number of specialised farms, sufficiently large to allow for the introduction of modern efficient production and harvesting technologies, but also, and above all, for an improvement of the quality of their products and services. This can be achieved by reducing the number of varieties cultivated to a limited number of selected cultivars, by radically reorganising the conditioning and marketing activities by reducing the number of actors and achieving a much larger product concentration, and by taking adequate steps to promote commercially a product (and the range of services which can be sold with it) which must be seen as “different” (and better) by the industry and by the consumers of nut-based final products.

Not an easy challenge!

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1 This note summarises a longer paper which will appear in 1998 in a special issue of Options Méditerranéennes focusing on nut production and markets in the Mediterranean region, edited by L.M. Abisus.

2 It should also be said that the varieties produced in Sicily have lower yields, both per hectare and in shelled nuts, than the other varieties which have been mentioned.

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INTRODUCTION
At the beginning of this century, in the southeast of France, almond trees were often associated with olive trees and vineyard. But with the decline of the traditional agriculture, almond acreage has decreased from 15,000 ha in 1,900 to 2,000 ha in 1997. The new almond orchards are modern and intensive. Most of them are irrigated and are located in non-frosty areas. There are three regions where the almond planting acreage has increased since 1990: Isle of Corsica (800 ha), in the ‘Costieres du Gard’ near Nîmes (300 ha) and in the Roussillon (250 ha).

MARKET
French almond production reaches about 500 t of kernel. It is very insufficient regarding consumption which is about 22,000 t per year. Almonds imports come from California (14,000 t), Spain (5,000 t), Italy and Greece. The French almond is essentially used for specific markets and traditional confections (Nougat, Calisson, sugar almonds). The eating quality of the French almonds is better than the Californian almonds and they are commercialised with the name ‘Amandes de Provence’; their price is higher than the world price.

Most almond growers (about 250) have joined the cooperative ‘Sud-Amandes’ in Manduel near Nîmes. They can profit from grants of the European community. ‘Sud-Amandes’ is the main factory in France. They sell shelled almond in bulk packages.

CULTIVARS AND ROOTSTOCKS
Before 1990, orchards were planted with 3 cultivars: the main cultivar ‘Ferragnes’, and two pollinators: ‘Ferraduel’ and ‘Ferrastar’ or ‘Ai’. Since ‘Lauranne’ was released in 1989, the new orchards are either monocultures with ‘Lauranne’ which is self-fertile, or either orchards with 2 or 3 cultivars: ‘Ferragnes’, ‘Lauranne’ and ‘Ferraduel’. For instance, only these late blooming cultivars are planted. The number of single-cultivar plantings is increasing because it is easier to manage, in particular for the small orchards.

The main rootstock used is the peach-almond hybrid GF677. For the slightly wet soils, the rootstock Cadaman is preferred. It is an hybrid between the peach (Prunus persica) and Chinese wild peach, Prunus davidiana. Its vigour is as high as that of GF677 and it is resistant to the nematode Meloidogyne incognita. These two rootstocks are multiplied by hardwood cuttings or by micropropagation.

LIMITING FACTORS FOR ALMOND EXPANSION IN FRANCE
Many people don’t understand why the almond acreage are so low in France when other Mediterranean countries have a more important production. In fact, there are different reasons to explain this situation.

- The problems of spring frosts limits the areas where almond growing is possible. Only few regions have very rarely spring frosts.
- There are important problems with the fungus Fusicoccum amygdali and the insect Eurytoma amygdali. ‘Ferragnes’, which is the main cultivar is very susceptible to Fusicoccum and there is more inoculum in the environment. It is possible to prevent the disease with fungicide sprays of benzimidazoles, but when the disease is well established in the orchard, growers should remove the trees or prune all branches.
- Almond is not included in the Extension Service because this species has not economic importance among the fruit and nut tree species grown in France. However during two years, the cooperative ‘Sud-amandes’ has engaged one technician to advise almond growers. They also fund some experimental trials on pruning, irrigation and cultivar evaluation.
- Almond growing is often reserved to the poor soil areas because it is known as rustic tree. The South-east of France is a region of fruit production, and for the irrigated areas, almond production is in competition with some stone fruits (peach, apricot and cherry) and in the non-irrigated areas with vineyards (Controlled Origin Appellation: AOC) and olive trees.
- The almond price is variable and it is not stable, because it depends of the world-wide production and of the exchange rate of the US $. During the last 10 years, kernel price per kg paid to growers has raised from 18 F to 32 F with an average of 24 F. The price of the French almond is slightly higher but the growers need a better stability of the price to invest on almond plantations.
- It is still difficult to obtain regular productions. Beside the problems of spring frosts and diseases, there are difficulties to attain a balanced growth of the trees. Orchard management requires a good knowledge and practices of the pruning, fertiliser application which must be adapted to the yield, the type of soil, the rootstock and the cultivar. Currently, in some orchards, growers can obtain yields of 1 t kernels/ha and per year. But in some other orchards, the average is less than 1 t/ha. With a price of 24 F/kg, yields must be at least 1 t/ha, in order that the growers have some profits.

CONCLUDING REMARKS
Work carried out in France during the last decade has allowed to have an experience for the management of modern almond orchard. The new self-fertile cultivar Lauranne has confirmed its potentiality for high and regular production. Consequently, the French almond production should increase in the coming years. However, new experimental trials should be established and research of new cultivars must be carried on. The recently released Spanish varieties (Masbovera, Glorieta, Francoli) from IRTA and Moncayo from SIA are being evaluated at INRA Avignon and they seem more resistant to Fusicoccum than ‘Ferragnes’. However, it is still necessary to develop other cultivars even later flowering, which is not an utopian objective because later genitors exist in some collections. INRA’s work has developed some interesting varieties. This work must be continued in cooperation with other European almond programmes and with the help of the almond industry. The almond cultivars of all Mediterranean countries have distinct characteristics (hard shell, eating quality) and we have to demonstrate in what the European almond is different from the Californian almond.

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QUALITATIVE TRAITS
IN ALMOND

INTRODUCTION
Almond (Prunus amygdalus Batsch) occupies a very peculiar place among fruit trees. Although it belongs to the genus Prunus, which comprises all the stone fruit species, it is generally placed among the nuts, which even belong to different botanical families: walnut (Juglans regia L.) and pecan (Carya illinoinensis (Wagenh.) K. Koch) to Juglandaceae, hazelnut (Corylus avellana L.) to Betulaceae, pistachio (Pistacia vera L.) to Anacardiaceae... So, when attempting a genetical approach to almond, it is more reasonable to consider this species among the stone fruits, even if in this context the knowledge is very scarce, because almond has been much less studied than the other rosaceous fruits.

Opposite to a closely related species such as peach, where many qualitative traits have been described (Monet et al., 1996), only a few traits have been described in almond, probably because not much attention has been paid to the study of different almond progenies and also because these progenies have been obtained from parents not able to show up these traits. So far, probably only five qualitative traits have been described: kernel taste, shell hardness, self-incompatibility alleles, self-compatibility, and blooming time. Other traits are probably qualitative, but there is not enough data to sustain their qualification as single traits, including bud failure susceptibility, male sterility and glabrous skin. Molecuular markers (isozymes, RFLPs, RAPDs and others) are also qualitative traits, with a general single Mendelian transmission, but they will not be considered here. These few traits make a short list, and some of them, besides, show some doubts on their transmission, clearly indicating the paucity of studies on the genetical transmission of even the qualitative traits in almond, generally easier to study than the quantitative traits (Socias i Company, 1997).

KERNEL TASTE
The first reference to the heritability of kernel taste was by Heppner (1923) who suggested a 3:1 distribution of sweet and bitter seedlings in the progeny of a large number of crosses, thus concluding that sweet kernel was dominant over bitter kernel and that most of the parents involved in the crosses were heterozygous for this trait. He was also the first to suggest that, if the original almond was bitter, a mutation occurred in this bitter almond with the sweet almond as a result. The mutant trait was thus dominant over the wild type and consisted in the loss of the bitter principle present in the wild progenitor.

Heppner (1926) confirmed these conclusions with a larger number of seedlings, as did all further studies (Dicenta and Garcia, 1993a; El Gharbi, 1981; Graselly, 1972; Kester et al., 1977, Vargas and Romero, 1988). Only Spiegel-Roy and Kochba (1974) suggested that these genes could be involved in kernel taste determination, but later they discarded this three-genes hypothesis and accepted the monofactorial determination (Spiegel-Roy and Kochba, 1977; 1981).

The bitter taste in almond, as in the other stone fruits, is due to the production of the glucoside amygdalin. The immediate amygdalin precursor (prunasine) is not produced in the seed, but it is translocated from the mother plant to the developing seed. Thus, the pollen parent, which with the seed parent determines the seed genotype, does not affect the taste of the seed. All the kernels of a tree will have either sweet or bitter kernels and the mother plant is the one that has the sweet or bitter genotype (Frehner et al., 1990). Only Crane and Lawrence (1953) have mentioned a case of xenia in almond taste, but their results have not been confirmed by any further research (Kumar and Das, 1996). The experience of all the research on almond taste shows that all the fruits of a tree reflect the genotype of this tree.

The importance of kernel taste is not only due to the possible commercial acceptance of bitter kernels, involved in some products, including cakes and drinks, where a light bitter taste is especially appreciated, but also to the possible toxicity of the bitter component. The glucoside amygdalin, in the presence of water and the enzyme emulsin, present in the kernel, is hydrolysed to benzaldehyde, hydrocyanic acid and glucose, being the hydrocyanic acid toxic and bitter (McCarty et al., 1952).

SHELL HARDNESS
Shell hardness is related in almond to kernel percentage and it is an important trait because of the different industrial processing of hard- or soft-shelled cultivars. In the Mediterranean regions hard shelled cultivars are generally preferred because of their general better adaptation to non-irrigated culture, resistance to birds and some pests and better storing ability because of their lower rate on becoming rancid. However, in California and the new regions of almond culture, soft shelled cultivars are preferred.

Grasselly (1972) studied the crosses of a few cultivars and suggested that shell hardness was determined by a single gene with hard shell dominant over soft shell, establishing the genotype of the parents involved in these crosses. However, this hypothesis has not been confirmed by other researchers, who have considered shell hardness as a quantitative trait.

SELF-INCOMPATIBILITY ALLELES
Almond possesses a single locus gametophytic type of self-incompatibility (Socias i Company, 1990). Although self-incompatibility was already assessed in almond as early as 1919 (Tufts, 1919), the identification of cross-incompatible groups and self-incompatibility alleles has been slow and it is still relatively reduced. This type of work can only be done in a group of related cultivars and it has been only advanced with some Californian cultivars (Kester et al., 1994a). Cases of cross-incompatibility are not frequent (Socias i Company, 1990) and are only found among cultivars deriving from the same population or the same breeding program. This situation could be the case of two Portuguese cultivars, 'Côco Grado' and 'Côco Miúdo' (Almeida, 1949), belonging to the same population, and of two French cultivars, 'Ferragnès' and 'Ferrali'se' (Crossa-Raynaud and Grasselly, 1985), very closely related genetically since they were developed from the same breeding program.

The long-term observations of Californian cultivars led to the establishment of tentative cross-incompatibility groups (Kester and Asay, 1975). Since that year, new data on controlled pollinations confirmed these groups, which were increased with the newly developed cultivars (Kester et al., 1994a). However, this work carried out in California was practically independent from that initiated in France (Crossa-Raynaud and Grasselly, 1985) with only a single cultivar in common and with a different identification of the self-incompatibility alleles (letters in California and numbers in France). A common terminology has been recently adopted (Kester and Gradziel, 1996), thus allowing a better characterization both of the S alleles and of the cross-incompatibility groups, up to 13.

The identification of these alleles has been by pollination studies, requiring a long and tedious work. Recently, the development of stylar ribonucleasezymograms correlated with incompatibility alleles (Boskovic and Tobutt, 1995) has made this technique applicable to almond, where some of the previously identified alleles have been assigned to specific zymograms and new cases of cross-incompatibility have been detected (Boskovic et al., 1997). These results open the possibility of advancing in the assimilation of the alleles of the Californian and European groups of cultivars.
A mutation of the S allele could also be a trait qualitatively inherited. Kester et al. (1994b) have described a mutation conferring unilateral incompatibility in ‘Nonpareil’ because of the production of a nil allele, showing that the S locus can undergo different types of mutations. Further research would be needed to ascertain which type of mutation has taken place, as it could be due to a non-sense mutation or to a deletion (Socias i Company, 1995), because pollen from the mutant type does not appear to function on its styles.

SELF-COMPATIBILITY

Self-compatibility was discovered in almond in 1945 by Almeida, but no attention was paid to the issue until the seventies. The establishment of its genetic basis is relatively recent and has been based on studies carried along with the breeding programs, involving a small number of seedlings in the offspring (Socias i Company, 1990). After assessing the transmission of self-compatibility (Socias i Company and Felipe, 1977), transmission data suggested that self-compatibility was dominant over self-incompatibility and that the self-compatible cultivars used in the breeding programs were heterozygous (Socias i Company, 1984). The examination of the results of most breeding programs (Grasselly et al., 1981; Grasselly and Olivier, 1984; Jraidi and Nefzi, 1988; Socias i Company and Felipe, 1988) led to confirm this conclusion of dominance and heterozygosity of self-compatibility.

In some crosses deviations are observed from the expected ratios of 1:1 (self-compatible x self-incompatible) or 3:1 (self-compatible x self-compatible). These deviations were explained by the identity of an allele between the self-compatible pollen parent (S,,) and the self-incompatible seed parent (S,,,), so only the pollen grains carrying the S, allele would be able to grow through the pistil of the seed parent and achieve fertilization, giving rise to an offspring of only self-compatible seedlings (Dicента and Garcia, 1993b; Grasselly et al., 1985). However, this does not seem to be the case in all the crosses where identical self-incompatibility alleles are involved (Socias i Company and Felipe, 1994), thus inbreeding or the presence of lethal or deleterious genes have been suggested to explain these deviations (Socias i Company, 1990).

Self-compatibility in almond has been suggested to be allelic to the S locus of self-incompatibility alleles, although no results have confirmed this assumption (Socias i Company, 1990). However, our results on transmission of self-compatibility through several backcrosses to self-incompatible cultivars may evidence, as in Lycopersicon peruvianum, that the mutation involving self-compatibility may have taken place at the S locus (Rivers and Bertanzky, 1994).

BLOOMING TIME

Bloom time is a very important trait in almond because it has been traditionally the fruit species showing the earliest bloom time. This early bloom restricted almond growing to regions with low risk of spring frosts. However, along centuries of almond growing its culture has been expanded into inland regions where the occurrence of spring frosts is important. Thus late blooming becomes an important trait in almond cultivars and most almond breeding programs are trying to develop later blooming cultivars in order to avoid frost damages, when also temperatures are higher and more favourable for pollination and fertilization (Kester and Asay, 1975).

Bloom time is considered to be inherited quantitatively in most fruit species (Anderson and Seeley, 1993) and most results confirm this type of transmission in almond. However, Kester (1965) suggested that in some progenies of the late blooming bud sport ‘Tardy Nonpareil’, a single dominant gene could be involved in determining the blooming date, since a bimodal distribution of blooming dates was observed among the seedlings obtained. Similar results were also obtained with the same cultivar by Grasselly (1978).

The utilization of a selection derived from ‘Tardy Nonpareil’ has allowed to follow the transmission of this late blooming allele after several generations and to see that its behaviour is the same along the different offspring (Socias i Company et al., 1996a). In the case of crosses of two sibs, a 3:1 distribution also confirms the dominance of this late blooming mutation over the normal blooming time (Grasselly and Olivier, 1985). Thus, blooming time in almond seems to be determined by a major gene (Lb) with late bloom dominant over early bloom, and by modifier genes inherited quantitatively (Socias i Company et al., 1996a; 1996b).

BUD FAILURE SUSCEPTIBILITY

Bud failure is considered a genetic disorder since no transmissible pathogen has been identified (Kester, 1976). The condition is perpetuated by vegetative propagation from particular parts of a tree. It has been found only in certain cultivars, significantly in ‘Nonpareil’ and other important commercial cultivars in California (Kester and Jones, 1970). The disorder is recognized by specific symptoms, principally the failure of leaf buds to grow out in the spring.

This disorder appears as a shift from normal to affected trees associated with the increasing age of the clone and to high growing temperatures (Hellali and Kester, 1979). Thus, even if the factor causing bud failure disorder is transmitted from parent to offspring by both the male and the female gametes (Kester, 1968), different percentages of susceptibility appear in the progeny. Consequently, a clear Mendelian transmission cannot be assigned to this disorder, although in almond x peach crosses the number of affected progeny approached 50% (Kester, 1978), suggesting a single heterozygous gene in affected almond, when expressed with a peach gene which was not viable or acted as a null allele. For this reason, bud failure susceptibility can only be mentioned as a putative qualitative trait in almond without a clear definition of its transmission.

MALE STERILITY

A cultivar has been identified as being male sterile by the production of tetrads within the pollen sacs but without pollen differentiation (M. Herrero, unpublished; Vargas and Romero, 1978). No studies have been reported on the possible transmission of this trait, but it can be hypothesized that it can be a monofactorial recessive trait, as it happens with male sterility in peach (Hesse, 1975) and apricot (Prunus armeniaca L.) (Burgos and Ledbetter, 1994).

GLABROUS SKIN

The almond fruit is pubescent, but a form has been identified with a glabrous skin (Socias i Company, 1993). No studies have been conducted on the transmission of this trait, but the origin of this clone and the similarity to that of the glabrous skin in peach, leading to the nectarine trait (Hesse, 1975) may suggest that it is a monofactorial recessive trait. This clone was identified in an orchard in Morocco, where seed propagation is still common (Janick, 1989). The origin of this orchard was from seeds of another orchard where all the trees were sibs, as coming from a single tree. Thus, this mutation could have been in the original tree, being manifested in an F, population (C. Grasselly, unpublished).

OTHER TRAITS

This example also shows that a detailed examination of unusual crosses could lead to the identification of many other traits in almond, as the amount of breeding and crosses either of related or of unrelated cultivars is relatively reduced. Two more traits can be considered in this...
situation, flesh color and flower color, because both have been observed in crosses among related parents (C. Grasselly, unpublished). Yellow color has been observed in the flesh and could be recessive to green color in a similar way that yellow flesh color is recessive to white color in peach (Connors, 1920). Pink flower color could also be recessive to white color, although several gradations on the pink flower color expression are observed in different almond cultivars (A.J. Felipe, unpublished), behaving similarly as in peach (Lammerts, 1945).

ACKNOWLEDGEMENTS
Review conducted under project AGF95-0004-C02-02 (Spanish CICYT). Comments by A.J. Felipe and C. Grasselly are highly appreciated.

LITERATURE CITED
**EARLY SELECTION IN ALMOND BREEDING**

**INTRODUCTION**

Scion breeding programmes in almond as well as in other nut trees are slow and require important human and material resources. To release a new outstanding variety, the aim of all programmes, it is necessary to make many crosses and to study the traits of large number of seedlings. A new variety should have a number of good attributes. If a seedling shows several outstanding characteristics but fails in one which is considered essential it will not pass the selection process.

At the start of a breeding programme, usually many crosses are made and the characteristics of $F_2$ seedling populations are studied in detail, to assess the prospects of improvement and the interest of parents and crosses. The number of seedlings managed per year is not often large, as its study would require considerable resources. At this stage, valuable information can be obtained in relation to outstanding characters in young seedlings. This information is very useful to plan further crossing strategies: it may be advisable to increase the number of seedlings managed and make early selection. Early elimination of inferior phenotypes saves resources and makes possible to manage larger families, increasing thus the chances of obtaining new varieties. In almond, several important agronomic and commercial characters can be detected at early stage, which enables fast removal of unwanted seedlings (Kester et al., 1977; Vargas and Romero, 1984).

In the almond breeding programme conducted at IRTA Mas Bové since 1975, the characteristics of several thousands of seedlings were studied in evaluation plots (Vargas et al. 1984). With the information obtained in the programme, currently, early selection is also conducted at Mas Bové. Large progenies are raised every year and seedlings are removed already in the nursery at high density spacing, without transplanting to spaced evaluation plots. Several traits as flowering date (correlated with flowering date), vigour, growth habit and branching, can be observed in the nursery, easing the removal of undesirable seedlings. In 1996, during the X GREMPA Meeting held in Meknes (Moroco), a first revision was made on the potential of early selection in almond breeding programmes (Vargas et al, 1998). In this paper, after including new data, a review is presented.

**ASSESSMENT OF PROGENIES**

In our almond breeding programme, seeds from 128 controlled crosses made during the period 1975-1993, using 60 parents, were sown in the nursery. After growing for one year, a total number of 5206 seedlings were planted in evaluation plots (planting spaces used were around 4 m x 1.5 m, ie. some 1650 seedlings/ha). During the third-fourth year after planting, records were taken in relation to flowering (date and intensity), vigour, general tree appearance (observations of growth and branching habit, production, vigour, disease susceptibility, etc.) and nut features (shelling percentage, double kernels, kernel appearance and taste). Other observations, as self-
Table 1. Traits considered, records taken, number of seedlings analysed, mean of the records, selection levels used and percentage of discarded seedlings according to levels.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Record</th>
<th>Number</th>
<th>Mean</th>
<th>Seeding (%)</th>
<th>Selection level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Low</td>
<td>Middle</td>
</tr>
<tr>
<td>Blooming date</td>
<td>full bloom*</td>
<td>4771</td>
<td>24.0</td>
<td>&lt; 3</td>
<td>15.75</td>
</tr>
<tr>
<td>Flowering intensity score</td>
<td>(0-9)</td>
<td>5162</td>
<td>3.84</td>
<td>3.49</td>
<td>4.03</td>
</tr>
<tr>
<td>Tree vigour score</td>
<td>(1-9)</td>
<td>4536</td>
<td>5.80</td>
<td>&gt; 3</td>
<td>6.44</td>
</tr>
<tr>
<td>Tree appearance score</td>
<td>(1-9)</td>
<td>4533</td>
<td>4.19</td>
<td>&gt; 4</td>
<td>5.14</td>
</tr>
<tr>
<td>Shelling percentage</td>
<td>% kernel</td>
<td>3801</td>
<td>33.43</td>
<td>&gt; 3</td>
<td>38.12</td>
</tr>
<tr>
<td>Double kernels</td>
<td>% double kernels</td>
<td>3820</td>
<td>12.37</td>
<td>&gt; 15</td>
<td>18.25</td>
</tr>
<tr>
<td>Kernel appearance score</td>
<td>(1-9)</td>
<td>3893</td>
<td>5.12</td>
<td>&gt; 5</td>
<td>6.25</td>
</tr>
<tr>
<td>Flavour</td>
<td>sweet or bitter</td>
<td>3959</td>
<td></td>
<td>Bitter</td>
<td>Bitter</td>
</tr>
</tbody>
</table>

Total: 5206

87.26

97.13

99.79

* Number of days after ‘Cavaliera’. Average full bloom of ‘Cavaliera’ at Mas Bové during 18 years (1979-1997) was February 4th

compatibility and drought and disease tolerance, usually were made on a reduced number of preselected seedlings and thus they are not included here. In relation with those features, it is important to consider that in most crosses made, cross combinations of parents were designed aiming to: late blooming, productivity, vigour, limited branching, medium-upright tree growth habit, nut with hard or semi-hard shell, absence of double kernels, good kernel appearance and sweet flavour (Vargas et al., 1984).

The traits considered, records taken, number and mean of the seedling analysed are presented in Table 1. Some considerations on these traits are mentioned:

- Blooming date (full bloom). To prevent the influence of climate in the blooming date, the number of days after ‘Cavaliera’ was recorded. Late blooming is a main aim in the programme and in almost all the crosses, at least one of the parents used was late blooming (similar or later than ‘Cristomorto’).

- Flowering intensity (score 0-9). This character is related to early bearing and productivity and it is not influenced by unfavourable weather conditions in spring (deficient pollination and frost damage).

- Tree vigour (score 1-9). Records were taken by 2-3 people.

- Tree appearance (score 1-9). With this observation the seedling, as a whole, is evaluated (growth habit, branching, production, vigour, disease susceptibility, etc.). It is a very useful observation to estimate the interest of a seedling. Records were taken by 2-3 people.

- Shelling percentage (percentage of kernel). This character is related to shell hardness. In Mediterranean countries hard shell (shelling percentage less than 40%) is a desirable feature.

- Double kernels (percentage of double kernels less than 5%) is desirable. Prime importance.

- Kernel appearance (score 1-9). Records were taken by 3 people.

- Kernel flavour (sweet or bitter). In the crosses, only sweet cultivars were used as parents.

For each character, three levels of selection (low, middle and high) were considered (Table 1) to estimate the percentage of undesirable seedlings accordingly. For any of these levels, the percentage of undesirable seedlings, as they were under the minimum requirements for one or several of the characters considered, resulted very high (87.3% low level, 97.1% middle level and 99.8% high level). The possibilities of making early elimination of undesirable seedlings are clear.

EARLY SELECTION IN THE NURSERY

Large progenies are raised at Mas Bové every year and seedlings are discarded already in the nursery, without transplanting to evaluation plots. In the selection process, seedlings presenting undesirable characters are fastly removed from the field.

Similarly as before, cross combinations of parents are made aiming to: late blooming, productivity, vigour, limited branching, medium-upright tree growth habit, nut with hard or semi-hard shell, absence of double kernels, good kernel appearance and sweet flavour. In addition, in almost all the crosses made, one parent was self-compatible, which allowed to select for this character after 4-5 years.

Seeds are sown at a distance of about 0.30 m apart, with a space between rows of 4 m (about 8000 seeds/ha). The most useful traits for early selection are the following:

- Tree vigour. By the end of the first growing season in nursery, very weak seedlings can be eliminated.

- Leafing date. The known correlation between leafing and flowering date (Kes-
ter et al., 1977; Vargas and Romero, 1984) allows selection for this important character the first year after sowing.

- Tree appearance (growth habit, branching, vigour, early bearing, etc.). Very useful feature for removing undesirable seedlings.

- Blooming date. If selection is first made by leafing date, number of seedlings removed by early blooming is reduced.

- Nut features. After fruiting, observation of several important traits (hardness of the shell, double kernels, kernel appearance and flavour) is carried out.

Later, other important characters like self-compatibility and self-fruitfulness, disease susceptibility, etc. are studied, but only in reduced number of seedlings, as earlier referred characters would have contribute to large elimination of inferior seedlings.

A summary of the process followed in the early selection of seedlings from crosses made in 1991 (2191 seedlings), 1993 (1401 seedlings), 1994 (2329 seedlings) and 1995 (781 seedlings) is shown in Table 2. The main selection criteria used were: leafing date, vigour, bearing habit, branching, early bearing and nut features. The percentage of discarded seedlings was very high during the first two years after selection.

In progenies derived from crosses with one early blooming parent, the observation of the leafing date (related to blooming date) at the starting of the second year allows the removal of a large number of seedlings. Traits like vigour, tree appearance and even nut features (soft shell, double kernels, and bad kernel appearance) can also be observed easily either in the nursery or in the laboratory.

In addition, handling of large progenies in breeding programmes increases the chances of obtaining some promising genotypes as parents for further use in breeding. When large progenies are managed every year, the available genetic combinations increase.

CONCLUDING REMARKS

The assessment of segregating F1 almond progenies, during the third-fourth year after planting in evaluation plots, regarding flowering, vigour, general appearance of seedlings and nut characteristics, considering three possible levels of selection, showed that the amount of seedlings that could be discarded is very high.

During early selection in the high density nursery, the correlation between leafing and flowering dates allows selection for this important character in the first year after germination. Other important traits, like vigour, growth habit and branching, can also be detected very early, easing the discarding of inferior seedlings. The use of early selection techniques has shortened the time from germination to selection of new genotypes and has decreased the amount of land and labour needed for seedling assessment.

### Table 2. Early selection in the nursery. Main traits used and removed trees (4 examples).

<table>
<thead>
<tr>
<th>Year</th>
<th>Crossing Sowing</th>
<th>Start of selection</th>
<th>Main traits used in the selection</th>
<th>Number of crosses and seedlings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1991 March 1992</td>
<td>1993 February</td>
<td>Leafing date and vigour</td>
<td>18 Crosses 2191 Seedlings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leafling date, vigour, growth habit, branching, blooming date, production, nut traits and self-compatibility</td>
<td>2186 (99.8%)</td>
</tr>
<tr>
<td>2</td>
<td>1993 March 1994</td>
<td>1995 February</td>
<td>Leafing date and vigour</td>
<td>21 Crosses 1401 Seedlings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leafling date, vigour, growth habit, branching, blooming date, production and nut traits</td>
<td>1394 (99.5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leafling date, vigour, growth habit and branching</td>
<td>2153 (92.4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leafling date, vigour, growth habit and branching</td>
<td>668 (85.5%)</td>
</tr>
</tbody>
</table>

* Until December 1997
The use of early selection techniques would also improve the efficiency and economy of most almond scion breeding programmes. In the near future, some other techniques which are being developed, as the use of molecular markers correlated to important agronomic characters like self-compatibility (Boskovic et al., 1998) will be useful for the selection of seedlings. In this sense, the use of ribonucleases (RNases) as markers can assist the breeder both for designing crosses and selecting seedlings and thus would rise breeding efficiency (Battle et al., 1997).

ACKNOWLEDGEMENTS
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REFERENCES


SELECT SELF-COMPATIBLE ALMOND BREEDING TO DESIGN CROSSES AND SELECT SELF-COMPATIBLE SEEDLINGS

INTRODUCTION
Along with classical breeding of almond leading to successful cultivar release (Vargas and Romero, 1994) IRTA, Spain, has been developing molecular markers for about 10 years. The first development was the detection of linkages among 10 isoenzyme loci in F₂ segregating progenies (Arús et al., 1994). Second was the construction of an almond linkage map using a ‘Ferragnes’ x ‘Tuono’ population with 7 isoenzyme genes and 120 RFLPs (Viruel et al., 1995). And later, mapping using an interspecific F₁ peach x almond (‘Texas x ‘Earlygold’) population has resulted in a saturated marker linkage map for Prunus with 235 markers comprising 11 isoenzymes and 224 RFLPs (Arús et al., 1996; Joobeur et al., 1998).

Almond is known to exhibit gametophytic self-incompatibility controlled by a single locus, the S locus, with multiple alleles. Thus almond cultivars will not set fruit unless they are pollinated with cultivars from a genetically distinct pollination group. Most almond breeding programmes aim to obtain self-compatible cultivars suitable for single cultivar orchards and less dependent on bee activity for pollination, combined of course with other desirable traits. Currently at Mas Bové early selection in segregating progenies for a range of characters is conducted which is useful to handle large populations (Vargas et al., 1997 and 1998). We are now starting to use markers to assist cross design and selection in our breeding programme. Recently some American and European cultivars and selections have been characterized for their incompatibility groups by a European team (Boskovic et al., 1997) using stylar ribonucleases. Stylar protein extracts were separated electrophoretically and stained for ribonuclease (RNase) activity which reveals bands corresponding to S alleles. This technique can also predict which seedlings are self-compatible and has shown good agreement with field records of fruit set after selfing and with self pollen tube growth scores (Boskovic et al., 1998). The correspondence demonstrated in almond between the S alleles and the pattern of bands of RNases (Boskovic et al., 1997; Tao et al., 1997; Duval et al., 1998), as in other Prunus species like sweet cherry (Boskovic and Tobutt, 1996), has hastened the possibilities of using markers. In practical plant breeding it can be used as a tool for more efficient almond breeding both for designing crosses and selecting seedlings. In addition, this correlation has been used to locate the self-incompatibility gene in group 6 of the almond linkage map (Ballester et al., 1998) and has opened the possibilities of cloning this gene.

CROSS DESIGN
Before the 1997 crossing season at Mas Bové (February-March), 7 crosses were planned with cultivars of known S genotypes (Boskovic et al., 1997) as presented in Table 1. Each cross is semi-compatible (ie. the two parents have one S allele, S₁, in common) and the self-compatible parent is used as the male parent. Only pollen carrying the S₂ allele should succeed in these circumstances and thus all the resulting seedlings should be self-compatible. This approach was already suggested by Grasselly et al. (1981) andDicenta and García (1993), but, hitherto, relatively few suitable combinations of parents have been known.

SEEDLING SELECTION
Apart from using RNases for cross design this technique was also used to assign S genotypes to 4 self-compatible and 1 self-incompatible GREMPA selection and 13 IRTA selections derived from earlier crosses made to obtain self-compatible seedlings. Although only French and Greek selections were used here, GREMPA material from breeding programmes in various countries (France, Italy, Greece and Spain) was exchanged through the group in 1985/86 for trialing and further use in breeding (Romero and Vargas, 1992). Table 2 shows the genotypes of promising selections and their parents. All cultivar genotypes have been already reported by Boskovic et al. (1997, 1998). IRITA selections were RNase genotyped either at HRI East Malling or at IRTA Cabrits. GREMPA selections were genotyped at Cabrits. The genotype of GREMPA selection (‘Tuono’ x ‘AI’ 6) was deduced after knowing its inter-incompatibility with ‘Ferragnes’ (Ch. Grasselly, personal communication).

CONCLUDING REMARKS
A successful almond cultivar must combi-
ne a high number of desirable characters, some monogenic and some polygenic. Thus large progenies are needed to produce sufficient seedlings having most of the targeted genes. Almond, although it has a shorter juvenile period before cropping when grown on own roots (3-4 years) than most nut and fruit crops, except peach, has required a large amount of land before selection for vigour, habit, resistance, cropping and, eventually for nut quality (Vargas et al., 1997, 1998). In addition, the limited knowledge of the genetics of most of the important characters slows the process (Socias i Company, 1997).

Rapid screening of large progenies to eliminate inferior seedlings at the earliest possible stage is essential for efficient breeding programmes. Early selection techniques have been developed for late flowering (Kester et al., 1977), as have preselection methods for tree type and vigour which can be applied in the first two years after germination (Vargas et al., 1997, 1998). Seedling selection is conducted in the nursery (at 12 months for vigour and at 15 months for time of bud break). Assessment of self-pollination is made in the field or in the laboratory after cropping (3-4 years), along with evaluation of tree architecture (growth habit and branching), vigour, production, disease susceptibility and nut quality (shelling percentage, double kernels, kernel appearance and taste). Final testing is in orchard trials (4-6 years) before final assessment. From a large initial population of over 1,000 seedlings one new cultivar may be chosen 8-12 years after germination. However, there is scope for improvement in early selection and preselection techniques used.

The selection techniques adopted in the discarding of inferior seedlings fall into three groups:

1) Selection for the character itself (vigour, tree architecture, disease resistance, production and nut quality).

2) Selection for a character physiologically correlated with the character of interest (leafing time-flowering time).

3) Selection for an easily identified marker genetically linked to or representing a less readily evaluated commercial character (self-compatibility).

The first may be applied on young seedlings as well as later in the field. The second and third are known as preselection and are usually applied before the key commercial character is expressed. Marker-assisted selection offers the potential of selecting at DNA or protein level eliminating environmental effects and allowing breeders to select for desirable characters in young seedling.

The use of RNases as a preselection technique is likely to be most appropriate on seedling progenies that have already been reduced in numbers to a few promising seedlings. Although the stylar ribonuclease assay is used to indicate genetically self-compatible seedlings, they should still be field tested to show they are self-fertile enough in practice (Boskovic et al., 1998). This useful technique uses only about 5-10 flowers and is a quicker method for genotyping cultivars than making a series of crosses and assessing pollen tube growth or fruit set, for which more flowers are required. As just explained, it is proving very useful for cross design and genotyping seedlings.

### Table 1. Crosses designed considering S genotype of parents to obtain wholly self-compatible progenies

<table>
<thead>
<tr>
<th>Cross</th>
<th>Stylar RNAses alleles assigned (S genotype)</th>
<th>Expected seedling S genotype pollinated</th>
<th>Nr. of flowers S genotype</th>
<th>Nr. of sown seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glorietä 'x 'Falsa Baresosa'</td>
<td>$S_S_x S_S_,$</td>
<td>$S_S_,$</td>
<td>417</td>
<td>47</td>
</tr>
<tr>
<td>'Glorietä' 'x 'Filippo Cee'</td>
<td>$S_S_x S_S_,$</td>
<td>$S_S_,$</td>
<td>169</td>
<td>22</td>
</tr>
<tr>
<td>'Glorietä' 'x 'Tuono'</td>
<td>$S_S_x S_S_,$</td>
<td>$S_S_,$</td>
<td>618</td>
<td>73</td>
</tr>
<tr>
<td>'Glorietä' x 'Ferralise' x 'Tuono') 18</td>
<td>$S_S_x S_S_,$</td>
<td>$S_S_,$</td>
<td>285</td>
<td>40</td>
</tr>
<tr>
<td>'Masbovera' 'x 'Genco'</td>
<td>$S_S_x S_S_,$</td>
<td>$S_S_,$</td>
<td>700</td>
<td>200</td>
</tr>
<tr>
<td>'Masbovera' 'x 'Tuono'</td>
<td>$S_S_x S_S_,$</td>
<td>$S_S_,$</td>
<td>383</td>
<td>60</td>
</tr>
<tr>
<td>'Masbovera' x 'Ferralise' x 'Tuono') 18</td>
<td>$S_S_x S_S_,$</td>
<td>$S_S_,$</td>
<td>469</td>
<td>85</td>
</tr>
</tbody>
</table>

The rapidity with which results can be obtained, and the moderate cost of equipment and consumables (except ribonucleic acid) has made possible its effective use in our almond breeding programme though the technique of non-equilibrium pH gradient electrofocusing is not as simple as starch or polyacrylamide gel electrophoresis. In the near future we hope to develop other molecular markers linked to agronomically important characters which would help to speed the process of breeding new almond varieties.

### ACKNOWLEDGEMENTS

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### Table 2. Promising selections analysed for stylar ribonucleases and S genotypes assigned

<table>
<thead>
<tr>
<th>Selection</th>
<th>Parentage</th>
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VULNERABILITY CURVES TO EMBOLISM AND Drought Resistance in Two Almond Cultivars

INTRODUCTION

‘Ramillete’ and ‘Garrigues’ are two almond (Prunus amygdalus Batsch) cultivars, originated from Murcia region, in southwest of Spain (Vargas and Morán, 1984). Empirically, ‘Ramillete’ is considered more resistant to drought than ‘Garrigues’. This latest cultivar is often grown under irrigated conditions or cultivar has a moderated PCL, under high evaporative demand and elevated transpiration conditions, it can be favoured in front of a species or cultivar which has not been shown such PCL (Jones and Sutherland, 1991).

The information provided by vulnerability curves is useful because it allows to make a prediction about the functional behavior of plants under water deficit conditions. This information has applications in cultural techniques as deficit irrigation. On the other hand tree shape, due to leaf morphology and canopy architecture, is considered important for water losses control and improvement of assimilation rate and, consequently, of water use efficiency (WUE) (Givnish, 1986).

This mechanism of resistance to drought stress agrees with Mooney’s hypothesis
in which many adaptive features could only be a mechanical consequence of a few simple options (Mooney, 1989). Thus, leaf size, specific leaf weight, branch insertion angle, crown density, etc. can provide sound information about avoidance mechanisms in almond (Savé et al., 1993; Kozlowski, 1991).

MATERIALS AND METHODS

Plant material

The experiments were carried out during the spring of 1997 on 20 years old ‘Garrigues’ and ‘Ramillete’ almond trees on ‘Mollar de Tarragona’ rootstocks, growing at IRTA-Mas Bové (in northeast of Spain) under field conditions. During the first half of 1997, rainfall was exceptionally high (329 mm), whereas the annual average is about 480 mm, and temperatures were mild (first half 1997 average temperature was 14.2°C, instead of 13.2°C).

Vulnerability curves to embolism

The method used to carry out vulnerability curves is a modification of those described by Sperry et al. (1988) and Cochard et al. (1992). It is based on the measure of the hydraulic conductance of xylem in a stem segment before and after eliminate embolism. Fig 1 represents a scheme of the measuring system used. The hydraulic conductance measures are taken with water under low pressure. Embolism is removed by flushing the stem segment with pressurized water (about 0.2 MPa) for a few minutes. This has been described to be enough to remove air bubbles accumulated in xylem vessels (Sperry et al., 1988). Branches were collected at predawn, between March and July of 1997.

Pressure-volume isotherms

Pressure-volume isotherms of leaves on mature trees of both cultivars following Savé et al., (1994) were taken in July. Osmotic potential at turgor loss point ($Y_{\text{tp}}$), osmotic potential at full turgor ($Y_{\text{os}}$), cuticular transpiration rate (CT), and bulk modulus of elasticity ($E$) were calculated.

Leaf morphology and crown architecture

Mature leafs of both cultivars were sampled between March and July. The area of each leaf was measured with a image analyzer (DIAS, Delta-T Devices, UK). The same leaves were dried and weighted, in order to calculate the specific leaf weight (SLW) (Savé et al., 1993). Crown architecture was measured on current season’s branches oriented to south, in which branch insertion angle (0° for branches vertically oriented to bottom and 180° for branches vertically oriented to top), branch length and number of leaves were measured. From these values crown density (leaves·cm⁻¹) was calculated.

RESULTS AND DISCUSSION

Vulnerability curves of both cultivars (Fig. 2) showed significant logarithmical relation (P<0.05) and they were similar between them. Both cultivars had 50% of percentage of conductivity loss about -0.6 MPa. Maximum specific hydraulic conductance ($k_{\text{max}}$)(ml·mm⁻¹·s⁻¹·MPa⁻¹) in ‘Garrigues’ was 26% higher than in ‘Ramillete’ $k_{\text{max}}$ even though this difference was non significant. So, embolism can affect both cultivars similarly, but ‘Garrigues’ shows the trend to transport a little more water than ‘Ramillete’. When PCL takes place at relatively high water potentials, water efflux from soil stops, and soil water storage can be maintained (Sperry, 1995). This also allows an easier recovery of 100% of xylem hydraulic conductivity. It has been described that embolism
is reversible when it is present at low water potentials, since the tension to break for vessel refilling is lower. (Salleo et al., 1996).

Pressure-volume isotherms (Fig. 3) showed no significant differences in any calculated parameters. It may be possible that the small differences observed in water relations of these two cultivars were due to the atypical wet and mild weather during the first six months of 1997, in which there were no really water deficit conditions. Thus both cultivars did not made any osmotic and/or elastic adjustment in relation to drought stress (To-rrecillas et al., 1996).

On the other hand, differences were found on leaf morphology and crown architecture (Fig. 4). ‘Ramillete’ has leaves of bigger size and less SLW, as well as, a more open and dense crown than ‘Garri-gues’. This means that ‘Ramillete’ has branches of medium inclination towards the top and the bottom (so the average value is aprox. 90°); ‘Garrigues’ instead has branches mainly oriented towards the top. Having a more dense crown, ‘Rami-llette’ has more leaves.cm

higher in ‘Ramillete’ than in ‘Garrigues’, but under water stress conditions, ‘Rami-llette’ shows great reduction of G_s, about 17% more than ‘Garrigues’. Moreover, ‘Ramillette’ shows early senescence and foliar abscission events, described as avoidance mechanism (Tardieu, 1997). It means that ‘Ramillette’ has better control of water losses by stomatal and whole crown control.

CONCLUSIONS

From our work and from those referred it seems that control of water use in these two almond cultivars is mainly located at leaf level. ‘Ramillette’ has a much greater control of water losses than ‘Garrigues’, which has greater ks_max, but less regulation in water losses control and crown ar-chitecture (Coehard et al., 1996). All these traits make ‘Garrigues’ to yield higher than ‘Ramillette’, under irrigation. But, under water stress conditions, ‘Garrigues’ could reach the point of depleting soil water, whereas ‘Ramillette’ has a more conservative strategy and could be productive in spite of water deficit.

More research is needed to be carried out on this subject in order to know the differences among a longer list of cultivars, from different regions and different responses to drought. It should also be completed with a histological study of xylem vessels. We have started this line and preliminary results are hopeful.

ACKNOWLEDGEMENTS

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LITERATURE CITED


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**THE HAZELNUT IN NORTHEASTERN EUROPE: PAST, PRESENT AND PROSPECTS**

**PAST**

*Corylus avellana* has always been a well known plant species in the north of Europe. In ancient times nuts were gathered in many parts of Europe. In England hazel was commercially grown since the 1750s (Bauckmann, 1979). In the Netherlands, commercial plantings, too, are of recent date only. In total, some 40 ha occur, with single stemmed trees (Figure 2). Productive cultivars like ‘Gunslebret’, ‘Lang Tidlig Zeller’, and ‘Butler’ were favoured in the first plantings with ‘Cosford’ as pollenizer. In contrast to England and Denmark, only ripe nuts are harvested for the table-nut market. For this a pellicle free product has preference. Since the kernels of the cultivars mentioned blanch poorly or moderately, in later plantings, ‘Gustav’s Zeller’, ‘Tonda di Giffoni’, ‘Corabel’, and ‘Pauetet’ have also been included. For that same reason the productive ‘Impératrice Eugénie’ and ‘Longue d’Espagne’ are dissuaded. In The Netherlands, several cultivars combine good productivity with good kernel blanching. Examples are: ‘Gustav’s Zeller’, ‘Mortarella’, ‘Pauetet’, ‘Riccia di Talanico’, ‘Tonda di Giffoni’, and ‘Willa- mette’ (Wertheim, 1997).

In England, probably less than 60 ha are of the thousands of acres existing in Victorian times. The main cultivar in these old plantings is ‘Kentish Cob’. Recently, there is a revival in interest. A current recommendation from a commercial nursery is to plant 60% ‘Butler’, 30% ‘Guns-
lebert’, and 10% ‘Ennis’, but the familiar, smaller fruited ‘Kentish Cob’ is still being planted (N.D. Dunn, Tenbury Wells, pers. comm.). Main outlet is the ‘green’ market. The revived English interest in hazelnut growing is illustrated by the existence of the Kentish Cobnut Association counting some 250 members, editing a newsletter called ‘The Cobweb’ (corresponding address: M. Game, 50 Dartmouth Park Road, London NW5 1SN, U.K.) and by a recent booklet advocating the hazelnut both for nuts and agroforestry (Crawford, 1995).

PROSPECTS
The question arises why the hazelnut culture in England dwindled and elsewhere in northwestern Europe did not develop as it did long ago in southern areas in Turkey, Italy, Spain and recently also in France. This difference can not only be ascribed to low cropping levels, for Dutch trial data show that, depending on the cultivar, cropping levels are comparable to those of southern areas (Wertheim, 1997). German and Danish figures also show quite good yields, at least for some cultivars (Baumann, 1979; Falk Kühn & Vittrup Christensen, 1991).

Irregular cropping may have been a decisive factor. A Dutch example is shown in Table 1 for a valuable cultivar, but other cultivars show similar irregularities (Wertheim, 1997). The exact reason for irregular cropping is not known, but climatic factors are involved. Several climatic conditions appear to be limiting for good cropping. Male catkins, when releasing pollen, are sensitive for temperatures below -7ºC and strong winds during male flowering blow pollen out of the orchard. Buds leafing out are sensitive for spring frosts. Fertilization in June depends on warm weather, and strong winds in summer lead to drought stresses. Therefore, it is believed that hazelnut growing should be limited to areas where trees are protected from strong winds, spring frosts do not occur, early summer is warm, rainfall is well spread over the growing season and humidity is high. These conditions are most prevalent in maritime zones between 40 and 45º north latitude (Jany, 1990). This may be true, but growers within this zone still face irregular cropping and outside the zone certain cultivars perform quite well (Table 1 and Wertheim, 1997). Apparently, cultivars greatly differ in their climatological requirements.

Another main factor in the limitation of a northern hazelnut culture may have been a difference in labour costs; the south having the advantage. Especially, the laborious hand harvest could have been decisive. However, current harvest machinery could change the competitive relationships. This is especially relevant now farmers in the north are looking for alternative crops as prices for main agricultural produce are under pressure. Adventitious circumstances are the nearness of the market, the demand for healthy foods, and the growing pressures for landscape preservation or improvement. In all this, hazelnuts can act a

Table 1. Kg/tree (sound nuts with good kernels) of Gustav Zeller’s orchard, planted in spring 1982. Figures averages of 6 bushes planted at 4.5 x 2.75 m

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<td>1.09</td>
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<td>3.41</td>
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<td>5.37</td>
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<td>11.12</td>
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Three-year-old hazelnut plantation in The Netherlands
part. Whether all these developments will indeed lead to commercial hazelnut growing in northwestern Europe will not only depend on prices but also on overcoming irregular cropping. Research should be aimed at the latter problem.

An administrative problem to be solved is the very limited possibility for chemical crop protection. Hardly any pesticide is registered for hazelnut. Understandably, firms are not keen on paying for costly dossiers necessary for the registration for a minor crop. Governments should allow pesticides registered in other fruit crops for related pests and diseases. If not, northern growers and consumers should pursue a ban on import of nuts that have been grown with the aid of relevant compounds.

**LITERATURE CITED**


**WALNUT AND HAZELNUT PRODUCTION IN YUGOSLAVIA**

**INTRODUCTION**

Great nutritious value, excellent transportability and easy storage of nuts make walnut and hazelnut appreciable and required fruit. They do not contain pesticides, in most cases, even in traces. They are used fresh and for processing, especially for canning purposes. Besides kernel, we use shell, leaf and especially wood. Walnut wood is more expensive than mahogany wood, and hazel wood is also valuable.

Ecological conditions of most agricultural regions in our country are suitable for intensive walnut and hazelnut production. In spite of this fact walnut and hazelnut production is very low here and in the world as well. The Yugoslavian production covers only about 50% of our demand for walnut and less than 20% of our demand for hazelnut. Situation is getting better but it is necessary to make the process more efficient.

**ANALYSIS OF WALNUT PRODUCTION**

The average production of walnut, during the past five years, was 20,300 t. which is not sufficient considering suitable conditions for intensive walnut production.

Reproduction of walnut was generative until two or three decades ago. Out of 2,150,000 walnut trees in this country almost 90% are seedlings. Result of such reproduction is a great variability of the walnut population: genotypes with low-quality nuts and early beginning of vegetation prevail, which results in irregular yield due to damages from low temperatures. According to a study of Korac et al. (1990) about 75% of our walnut population have early or medium-early vegetation which often results in damages due to late spring frosts.

During the last four decades FR of Yugoslavia produces between 8,090 t (1979) and 23,050 t (1973) of nuts a year. Analysing the average walnut production per tree it can be concluded that it ranged from 5.4 kg to 17.4 kg or 1:3.2. Out of all continental fruit kinds less stable production was recorded only in apricot - 1:16.5 or 2 kg : 33 kg.

Nut quality is not very uniform, too. There are genotypes with small nuts (nut mass about 3.3 g) whereas some other genotypes have nuts of over 29 g, with a soft shell, there are also genotypes with so hard shells that it is almost impossible to get the kernel halves out. Kernel contents ranges from 25% to 60%, on average 33% whereas the average kernel contents of our cultivars is more than 50%. Colour and taste also vary a lot as production of non-cultivated trees prevails. Therefore it is not possible to provide customers a standardized quality.

More than 80% of walnut trees are grown as single trees in simple rows, in most cases in villages and along old roads. There are no rows along field paths, canals or rivers. Therefore only a small percentage of the production (less than 15%) is traded whereas the biggest part is used for home consumption.

In recent years about 250-300 ha have been planted with grafted walnut nursery plants intended to market demands. The largest walnut plantation, covering 84 ha, is situated in Lipar near Kula. Nursery plants of grafted walnut trees replace about 1.5% of the existing walnut population per year, which is not enough. At least 5% should be replaced a year to give the total of 2,000,000 grafted trees in 20 years, which would result in a significant production of high quality walnuts for domestic and international market.

**ANALYSIS OF HAZELNUT PRODUCTION**

Hazelnut production in SR of Yugoslavia is extremely low, less than 1000 t a year. There is no precise information about hazelnut production as there are no statistic data. As well as walnut trees, hazels are also grown in gardens, more often as hedge than for nuts. Turkish filbert and forest hazel are planted more than hazel cultivars. Until 1991. hazelnuts were imported from the USSR and Turkey, which give more than 60% of the world's production (about 360,000 t). Only during the last decade hazel planting has been intensified, mostly with Italian cultivars ("Takovo" etc.) because machinery intended for gathering and cracking of nuts was imported from this country.

Nowadays in our country we plant annually about 10,000 nursery plants grafted onto Turkish filbert and about two or three times more hazel cultivars produced of nursery plants grafted onto Turkish filbert, which is grown as a tree, enabling best application of machinery and therefore increasing economy and interest of producers for its production.

**PROSPECTS OF WALNUT PRODUCTION**

Walnut production is being increased in Yugoslavia. According to the statistic data there were 1,548,000 walnut trees in 1995, and now there are 2,150,000 - the increase is 38.9%. There are many reasons for the rapid extension. Many high yielding cultivars have been developed or introduced, which have better quality nuts and are more resistant to low temperatures and pathogens, mostly to *Gnomonia*.
leptostyla. Production of walnut nursery plants by grafting was significantly increased which enables faster yield, faster turnover of the invested capital and larger production of high-quality walnuts. Besides, technology of walnut growing was improved.

Considering the fact that many wealthy countries, which spend great amounts of walnuts, have unfavourable conditions for walnut growing, disposal of this fruit on the market is guaranteed. It is therefore considered that walnut plantations will soon be established in a larger area as well as rows, mostly along field roads and paths having east-west direction, facing south and therefore leaving the road in the shade. All the areas, where redistribution of land was done, have roads arranged in such direction to enable fields have north-south direction. The area with redistributed land, have roads arranged in such direction to enable fields have north-south direction. The area with distributed land in Vojvodina provides space suitable for more walnut trees than there are in Yugoslavia altogether. Along one kilometre of such a road it is possible to plant about 150 nursery plants. The investment for such production is less than 3% of the income one walnut tree can provide in its lifetime (nuts and wood, not counting benefits of decreased damages of winds).

Besides, high-quality walnut trees will be probably planted in villages and towns as well as along canals, especially drainage (except for canals protecting against floods), where they would grow and yield extremely well using the water surplus from canals (a well developed walnut tree transpires more than 200 litres of water a day during summer).

PROSPECTS OF HAZEL PRODUCTION
Concerning the fact that our demands for this fruit kind are much bigger than our production, conditions for its import are unfavourable (it is a deficient fruit kind and therefore very expensive), conditions for intensive hazel production in Yugoslavia are suitable, we believe that the areas planted with hazel will soon be increased.

Prospects of hazel production have been solved, etc.

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CONCLUDING REMARKS
Analysing walnut production in FR of Yugoslavia it can be concluded that it is about 20,000 t a year but still very variable. It ranged from 8,090 t to 23,500 t as a result of great damages due to low temperatures.

Nut quality differs a lot as a result of productions of non-cultivated trees. Out of 2,150,000 walnut trees almost 90% re-produced by seeds. There are genotypes with nut weight of about 3.3g and some other with nut weight of over 29g, some of them have a very hard shell, with kernel content of not more than 25% and some genotypes have a soft shell, with kernel content of more than 60%. Colour, taste and other characteristics of the kernel are also very different. Yugoslavian cultivars and selections, as well as the best foreign ones examined under specific conditions in our country, give much better results.

As they are reproduced by grafting before yielding, they give a better and more regular yield, enabling high-quality mass production, which is one of the most important requirements of their production. As walnut production is more profitable than production of field crops, for example, we expect a fast expansion of areas planted with walnut trees, both pure and mixed orchards, as well as rows along field paths and roads in villages, towns, along canals and rivers, for forestry, etc.

Current production of 30,000 nursery plants of grafted walnut trees per year replaces only 1.5% of our walnut tree population. However it tends to increase, so in next five or six years we expect production of more than 60,000 a year. About 5% of existing walnut population should be replaced annually.

Our hazelnut production is very low, under 1,000 t per year, which is not enough concerning both our demands and possibilities for hazel production.

The following problems have been solved so far:
- The problem of production of high-quality nursery plants by grafting, which enables application of machinery in hazel production
- High-quality rootstocks of Turkish filbert were chosen
- We chose the cultivars which give the best results under the specific conditions in our country

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RESCUE OF NATIVE WALNUT (Juglans regia L.) GENOTYPES IN ANDALUSIA, SPAIN BY INDIVIDUAL SELECTION FROM NUT BIOMETRICS

INTRODUCTION
Although Persian walnut (Juglans regia L.) is considered as introduced by Romans in the Iberian peninsula, recent palynological research supports the presence of this species in western Mediterranean area during the middle and last glacial stage (Carrión and Sánchez, 1996). Spain yearly walnut fruit consumption, averaged for 1985-1994 ten years period, is 25,058 t, about three times the whole country production of 8621 Tn. This gap leads to an average annual net import of 16,437 t (MAPA, 1994).

In Andalusia, like in most parts of Spain, this species has been, generally, a fruit-bearing tree of scattered distribution linked to farms, scarcely cultivated and of marked domestic exploitation. The walnut production of Andalusia is only 5.8 % of the country production (503 t in 1994). Introduction of French cultivars started in
MATERIALS AND METHODS
A schematic view of methodology used can be seen in the accompanying diagram. The selection process began with an epistolary survey addressed to all the Agrarian Extension Offices of the Andalusian territory, asking for old walnuts nearby with prominent features concerning nut quality or load level. Retrieved information allowed defining a restricted subset of the Andalusian walnut population to initiate selection. A formal on-site appraisal of each individual was performed to assure that, at least, the following requirements were fulfilled to qualify:

- Age over 50 years (assessed from historic data from contributors, in some cases biometrics were used to confirm). This guarantees that genotypes do not belong to a previously selected variety.
- Seedling origin (fixing genotype uniqueness).
- Nutshell height > 30 mm (from ground sample).
- Healthy status (subjective appreciation).

1972 and, only recently, orchards of some extent have been planted with selected cultivars, mostly from California and France but also with Spanish varieties. The farmland set aside program of European Union Common Agricultural Policy is expected to increase regular plantations with this species, overcoming last years trends to maintain the total surface and number of isolated individuals in the country nearly constant.

Walnut timber, used mainly for veneers, is highly appreciated reaching top prices in the last years. These prices are higher as bigger is log cubic footage. Since the incidence of felling affect mainly older trees, this situation has led genetic pool of the species to a strong regression, and the risk that locally adapted individuals vanishes has been notably increased. For that reason the Agricultural Council of Junta de Andalusia initiated studies leading to safeguard, as far as possible, genetic variability of the species in the territory under its rule. Project CA-9202 has been in charge with this task till now. The aim of the project was to carry out the rescue of threatened genetic material from Andalusian walnut population on the basis of nut characteristics. This material has interest for further genetic improvement programmes on the species, as well as for designation of new cultivars. Also local adaptive characteristics encountered in these genotypes would be valuable. It seeks to be a contribution to other works on the species conducted in Spain, especially in Catalonia and Levante (Luna and Rodríguez, 1977; Aletà and Ninot, 1993).

Another aspect to keep in mind is the use of effective pollination varieties. That is essential in monocultivar plantations and in those areas of newly introduction of this species. Pollination of foreign varieties are not always successful in southern Spain, in many cases, early anthesis increase frost risk and crop reduction. It seems advisable to include pollination varieties adapted to specific environmental conditions.

MATERIALS AND METHODS
A schematic view of methodology used can be seen in the accompanying diagram. The selection process began with an epistolary survey addressed to all the Agrarian Extension Offices of the Andalusian territory, asking for old walnuts nearby with prominent features concerning nut quality or load level. Retrieved information allowed defining a restricted subset of the Andalusian walnut population to initiate selection. A formal on-site appraisal of each individual was performed to assure that, at least, the following requirements were fulfilled to qualify:

- Age over 50 years (assessed from historic data from contributors, in some cases biometrics were used to confirm). This guarantees that genotypes do not belong to a previously selected variety.
- Seedling origin (fixing genotype uniqueness).
- Nutshell height > 30 mm (from ground sample).
- Healthy status (subjective appreciation).

1972 and, only recently, orchards of some extent have been planted with selected cultivars, mostly from California and France but also with Spanish varieties. The farmland set aside program of European Union Common Agricultural Policy is expected to increase regular plantations with this species, overcoming last years trends to maintain the total surface and number of isolated individuals in the country nearly constant.

Walnut timber, used mainly for veneers, is highly appreciated reaching top prices in the last years. These prices are higher as bigger is log cubic footage. Since the incidence of felling affect mainly older trees, this situation has led genetic pool of the species to a strong regression, and the risk that locally adapted individuals vanishes has been notably increased. For that reason the Agricultural Council of Junta de Andalusia initiated studies leading to safeguard, as far as possible, genetic variability of the species in the territory under its rule. Project CA-9202 has been in charge with this task till now. The aim of the project was to carry out the rescue of threatened genetic material from Andalusian walnut population on the basis of nut characteristics. This material has interest for further genetic improvement programmes on the species, as well as for designation of new cultivars. Also local adaptive characteristics encountered in these genotypes would be valuable. It seeks to be a contribution to other works on the species conducted in Spain, especially in Catalonia and Levante (Luna and Rodríguez, 1977; Aletà and Ninot, 1993).

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Mean Roundness Index and Weight Yield from nut sample analysis of 63 genotypes studied.

Table 1. Biometrics and physical attributes of walnut nuts used for selection and characterization

<table>
<thead>
<tr>
<th>Nut in shell</th>
<th>Kernel</th>
<th>Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuts/liter</td>
<td>Kernel height (mm)</td>
<td>Heights ratio</td>
</tr>
<tr>
<td>Height (mm)</td>
<td>Cotyledon height (mm)</td>
<td>Sutural ratio</td>
</tr>
<tr>
<td>Suture diameter (mm)</td>
<td>Total height (mm)</td>
<td>Ventral ratio</td>
</tr>
<tr>
<td>Ventrall diameter (mm)</td>
<td>Suture diameter (mm)</td>
<td>Weight difference</td>
</tr>
<tr>
<td>Weight (g)</td>
<td>Ventrall diameter (mm)</td>
<td>Volume difference</td>
</tr>
<tr>
<td>Volume (cc)</td>
<td>Weight (g)</td>
<td>Weight ratio</td>
</tr>
<tr>
<td></td>
<td>Volume (cc)</td>
<td>Volume ratio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weight yield</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volume yield</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean Roundness Index</td>
</tr>
</tbody>
</table>

ANDALUSIAN WALNUT TREE POPULATION

A parallel selection for pollination was incidentally accomplished. In this case additional requirements were established:
- Location in altitude over 600 m.
- Male catkins profusion.
- Late anthesis (April to May)

This phase yielded 63 walnut trees after rejecting those not satisfying requirements. A record sheet was open for each selected individual at this step, registering data concerning age (known or estimate), basic dendrometrics as total height, dbh or girth and crown width. Tentative name, usually from place name or property, precise UTM geographical location (GPS fixed), as well as any relevant circumstances concerning a particular tree were filed too. Phenological data and monitoring of health status were subsequently added, as they became available. At the proper time, an aleatory sample of 25 ripened nuts was picked from each individual in accordance with standards provided by International Union for the Protection of New Varieties of Plants (UPOV, 1989). A set of biometrics and physical attributes, both quantitative and qualitative, were measured from this sample. This group of measurements and derived ratios, shown in Table 1, is considered suitable for performing walnut selection and characterization (Donno et al., 1975; Iftikhar-Ul-Haq et al., 1987; Luna, 1990).

Parameters obtained from nut analysis were used to perform the selection of genotypes. Most influential attributes taken into account were weight yield, Mean Roundness Index (MRI), mean diameter, suture perforation, roughness, and breaking strength.

RESULTS

Figure 2 displays values and tendency lines for two attributes, MRI and weight yield, of the whole trees. First 28 genotypes in x-axis (does not show all genotype names), were selected adding together the significant parameters, the rest were discarded. Some of the pollination genotypes present also favorable nut characteristics, so they can be worth in both aspects. This happens with Ballesteros, Tello-2 and Calvario genotypes.

The following step in the rescue process was to replicate selected genotypes in a clonal orchard settled down in Lanjaron Forest Experimental Station, in which 20 registered varieties from California, France and Spain already exist. Twenty ramets per selected genotype were planted using shield grafting over rootstocks of the same species. Grafting success was variable with genotypes (average 49.5%), needing reiteration and, in some recalcitrant cases, use of multiple crown grafting. The genotype Noria disappeared in the meantime before grafting material was collected, so only 27 genotypes were replicated.

FURTHER RESEARCH

Once enough nut production from clonal orchard is available for each genotype, this work has to be completed with determination of organoleptic preferences and, if convenient, associated studies conducting to designation of some of them as new cultivars. Meanwhile genotypes are in a moderate safe status waiting for their opportunity to contribute to genetic improvement of species.
Table 1. Some nut and tree properties of some selected walnut types in the Kahramanmaras Province of Turkey

<table>
<thead>
<tr>
<th>Type nr</th>
<th>Shelled nut weight (g)</th>
<th>Kernel weight (g)</th>
<th>Shelling percentage (%)</th>
<th>Shell thickness (mm)</th>
<th>Shell colour</th>
<th>Kernel colour</th>
<th>Lateral fruiting habit (%)</th>
<th>Approximate age of tree (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>310</td>
<td>14.43</td>
<td>7.71</td>
<td>53.43</td>
<td>1.07</td>
<td>Light yellow</td>
<td>Light yellow</td>
<td>100</td>
<td>140</td>
</tr>
<tr>
<td>500</td>
<td>22.55</td>
<td>11.05</td>
<td>49.00</td>
<td>0.82</td>
<td>Light yellow</td>
<td>Light yellow</td>
<td>75</td>
<td>70</td>
</tr>
<tr>
<td>162</td>
<td>23.10</td>
<td>10.65</td>
<td>46.10</td>
<td>1.46</td>
<td>Light yellow</td>
<td>Light yellow</td>
<td>85</td>
<td>150</td>
</tr>
<tr>
<td>153/1</td>
<td>14.82</td>
<td>7.75</td>
<td>52.29</td>
<td>1.05</td>
<td>Light yellow</td>
<td>Light yellow</td>
<td>90</td>
<td>105</td>
</tr>
<tr>
<td>155</td>
<td>13.47</td>
<td>7.31</td>
<td>54.26</td>
<td>0.80</td>
<td>Light yellow</td>
<td>Yellow</td>
<td>80</td>
<td>90</td>
</tr>
<tr>
<td>94</td>
<td>17.42</td>
<td>9.51</td>
<td>54.59</td>
<td>0.88</td>
<td>Light yellow</td>
<td>Yellow</td>
<td>90</td>
<td>85</td>
</tr>
</tbody>
</table>
FOLIAR AND FRUIT DISEASES OF PISTACHIO AND THEIR CONTROL IN CALIFORNIA

ABSTRACT

Three major blossom, foliar, and fruit diseases have caused problems in California pistachios: 1) Botryosphaeria panicle and shoot blight caused by Botryosphaeria dothidea; 2) Alternaria late blight caused by Alternaria alternata; and 3) Botrytis cinerea. Minor foliar and fruit diseases that have not caused serious problems include: 1) Sclerotinia shoot blight caused by Sclerotinia sclerotiorum; 2) Powdery mildew caused by an unidentified species of powdery mildew fungus; 3) Septoria fruit spot caused by Septoria pistaciae in California; 5) a keratinized species called stomatitis caused by the yeasts Nematospora coryli or Aureobasidium pullulans; and 6) Aspergillus fruit blights caused by Aspergillus niger and other Aspergillus spp. Symptoms, life cycles, epidemiology, and control methods of these diseases will be discussed.

INTRODUCTION

With the continuously increasing acreage of pistachio grown in California (about 28,500 hectares presently, Anonymous, 1997), fungal diseases which cause significant losses to the industry, are becoming of major importance. For many years Verticillium wilt was the only fungal disease reported on pistachio trees in California and was the major threat to the pistachio production (Ashworth & Zimmermen, 1976). Verticillium wilt has caused killing of trees, mainly because the commonly used rootstock Pistacia atlantica is susceptible to this pathogen. In the spring of 1983, however, after a period of heavy and prolonged rains and cool weather, a Botrytis blossom and shoot blight was observed and described for the first time (Bolkan et al., 1984). In the summer of 1984, Botryosphaeria panicle and shoot blight was first observed in an orchard in Butte County and later in several orchards in northern California, and sporadically, in orchards in central California (Fresno and Tulare counties) (Michailides, 1991a). In the last four to five years, however, Botryosphaeria blight became very damaging in several orchards in the San Joaquin Valley and caused major grower concerns. Alternaria late blight became a problem as the trees have grown and resulted in more closed canopies initially in orchards irrigated by flooding. But Alternaria could be widespread even in orchards with other type of irrigation, particularly when in late August and during September the relative humidity and the dew periods in the orchards increase (Michailides & Morgan, 1991). This disease is more frequent and severe in sprinkler- or flood-irrigated, low-infiltration orchards where water standing on the floor for 7 to 10 days can caused humid conditions than in orchards irrigated by drip irrigation or micro-sprinklers. Severe infections of fruit hulls can cause dark shell staining, thus reducing fruit quality. Because of the recently spread of Botryosphaeria disease in the Central Valley of California (Michailides et al, 1997) where most of the pistachios are grown, this disease is now considered as the number one disease by the California Pistachio Commission because when severe, it can cause tremendous yield and nut quality losses.

BLOSSOM AND FOLIAR DISEASES

Botrytis blossom and shoot blight, caused by Botrytis cinerea Pers.:Fr (perfect stage Botryotinia fuckeliana (de Bary) Whetzel). This disease has been reported in pistachios in Butte, Fresno, Merced, Madera, Solano, and Yolo counties in 1983 (Bo lkan et al., 1984). The disease caused significant shoot blight on both male and female trees during the wet spring seasons in 1983 and 1986 but was insignificant during 1987-1992 because of very dry conditions. In later years, Botrytis blight has been sporadic in certain orchards.

The first symptoms developing in early spring are wilting, shriveling, and drying of leaves at the tips of young shoots. The shoots die but the leaves remain attached to the twigs (flagging). Infections of the male inflorescences result in blossom blight; infections of blossoms of the male cultivars ‘02-16’ and ‘02-18’ result in cankers (sometimes up to 25 cm long) that can cause current or two-year-old shoots to blight. Diseased petioles, blossoms, and bases of shoots are generally covered by buff-colored masses of conidiophores and conidia of B. cinerea, if conditions continue to be wet in the spring. Symptoms are more severe in male than in female trees, especially in ‘02-16’ and ‘02-18’ male cultivars because the inflorescences of these cultivars are larger and more compact and favor retention of free water for longer periods of time following rain or dew (Michailides, 1991b).

Disease cycle. The source of spore inoculum of the fungus can be found in the pistachio orchards. Blighted shoots provide inoculum not only during the growing season (sporulation at their basal portion) but also in the following spring. Under humid conditions in the spring, the fungus can colonize and sporulate on male inflorescences on the tree or on those droped on the ground. Other sources of inoculum come from sporulation of the fungus on weeds or other crops neighboring pistachios. Contamination of flower or vegetative buds by spores of the pathogen can result in blossom and shoot blight, respectively. The fungus can develop initially in the senescing or dead bud scales and then infect the bases of blossoms (male inflorescences or panicles) or shoots. Other sources of inoculum are the conidia produced on fungal sclerotia. The disease is prevalent during cool and wet springs and can cause some losses, primarily killing current season shoots, thus reducing fruiting wood for the following season.

Control. Benomyl (Benlate 50 DF) has been registered for one application during full bloom of pistachios at a dosage of 1-1.5 lb/100 gallons of water. It can also be applied by air. Pruning blighted shoots and removing them from the orchard can reduce the dead wood that can be colonized by Botryosphaeria dothidea, the cause of Botryosphaeria panicle and shoot blight (see below).

Botryosphaeria panicle and shoot blight, caused by Dothiorella dothidea (perfect stage Botryosphaeria dothidea (Moug.:Fr.) Ces. & de Not). This disease was first discovered in the summer of 1984, in a commercial pistachio orchard in Butte County and later in other orchards in several counties in California. Isolations from infected plant parts consistently yielded Dothiorella dothidea although the perfect stage has not yet recovered from pistachio.

The fungus B. dothidea, reported previously under the synonym B. ribis Gross. & Dugg., causes branch and trunk cankers on a variety of woody plants and fruit rots. In California, a Dothiorella species, the pycnidial stage of the fungus, was reported to cause black cankers in the crotches and limbs and, occasionally, sudden wilting and drying of branches of English walnut (Juglans regia L.). Similar symptoms caused by the same fungus occurred in willow trees (Salix lasiolepis Benth.). A fruit rot of avocado caused by a Dothiorella sp. was reported as early as 1935 in certain coastal areas where avocados were grown in California (Horne & Palmer, 1935). The fungus attacks more than 50 plant species, representing 34 genera and 20 families. B. dothidea, first reported on almond (Prunus dulcis [Mill.] Webb) cv. ‘Nonpareil’ in California in 1966, causes a bandlike canker on the trunk or scaffolds of vigorous young trees. Again, a Dothiorella sp. was consistently isolated from almond band cankers then and more recently in our laboratory.
Symptomatology. Vegetative and flowering buds that were killed during the previous fall or winter will not emerge, instead they will remain attached to the shoots with or without exuded gumming. Early in May young fruit clusters and shoots blight because of partially infected buds from the previous growing season and the rachises of these blighted clusters and shoots become discolorized black. When temperatures increase in late spring and summer (May–July), the fungus moves into shoots of the previous year, causing blighting of fruit clusters. These blighted shoots, leaves, and clusters are discolorized brown.

Secondary infections of clusters usually originate at the base of branching points of rachises that are discolored black and these, in turn, cause panicle blight. Secondary infections on the fruit start as small black lesions that coalesce later and cause fruit blight. Blighted fruit will have black hulls but in late August–September, infected fruit is covered with pycnidia (black flask-like structures containing the spores of the fungus) and as they dry become characteristically light beige in color. This type of fruit with pycnidia is distinct from the non-infected but blighted fruit, the latter being dark brown. Secondary infections on leaves also start as small black lesions, which attain chlorotic margins and can develop black pycnidia in their center. Leaflet and entire leaf blight can be the result of multiple leaf lesions, infections in the mid rib of leaflets and infections in the stem, respectively. By late summer and fall (August–October), instead of the small black lesions, large necrotic lesions with pycnidia in the center appear on leaves of male and female trees. Scars of absceded buds or leaves also are infected, resulting in sunken cankers above and below the scars that cause bud or leaf blight. Infections rachises usually hang on trees for 3 or more years, providing inoculum for the following growing season(s). Production of clear or amber-colored resin at the infection sites is not always characteristic of Botryosphaeria infections.

Sources and spread of inoculum. Pycnidia present on dead shoots of both male and female trees, rachises hanging on the tree from previous year(s), petioles, dead buds, fruit-mummies, and cankers are the sources of spore inoculum for spring and summer. During fall and winter, sources of inoculum will again be rachises, shoots, and petioles killed during the previous growing season or during the previous 2 years if these are still hanging on the trees. Most pycnidia are found on the basal portion of rachises, shoots, and petioles. They are single or in groups of 5 to 8, black in color, but white when sectioned because of the colorless (hyaline) pycnidiospores. Each pycnidium bears an opening (ostiole) on top through which the spores exude in a gelatinous matrix (cirrus).

Since flask-like pustules of B. dothidea that contain airborne ascospores were not found in pistachio and since the conidia of the fungus are embedded in a mucilaginous matrix, conidial dispersal is water- and insect-dependent. If spring rains do not occur during the growing season (May to July), spore dispersal depends entirely on water from sprinkler irrigation (Michailides & Morgan, 1993). Sprinkler water, in fact, dissolves the gelatinous matrix and splash-spreads the spores on the surface of shoots, leaves, panicles, and buds. Secondary infections occur on all leaf or bud scars, leaves, and panicles, and contamination of buds which results in partial infections.

Disease cycle and epidemiology. Infection of shoots, rachises, fruits, and leaves are caused by secondary spread of spores in water from spring and summer rains or through sprinkler irrigation. The fungus is favored by high temperatures (27-32°C) and produces new generations of spores in pycnidia by mid summer and fall. The pycnidia can be found on the base of blighted shoots, rachises, petioles, fruits, and leaf and killed buds and leaves with lesions. Optimum temperature for growth, sporulation of the fungus, and disease development is 27-30°C, and the disease becomes very severe during late spring to summer when temperatures and relative humidity in pistachio orchards become high. B. dothidea was recovered from a high percentage of fruit that had symptoms of epicarp lesion (punctured by hemiptera insects) in the orchard. In fact, in insect transmission experiments in the summer of 1995 and 1996, large hemiptera insect were able to transmit the disease experimentally. Furthermore, in 1996 bird-damaged fruit had a high incidence of infections by B. dothidea, suggesting that perhaps birds may be involved in spreading the disease in pistachio orchards. Although this disease has been initially a problem in orchards of the Sacramento Valley (Glenn, Butte, and Tehama counties), it has spread recently to the central (San Joaquin) Valley (Michailides et al. 1997).

Control. Proper management of sprinkler irrigation (i.e., lowering the sprinklers so that the water does not reach the tree canopy for more dispersal), shortening irrigation duration (Michailides & Morgan, 1992 & 1993), and/or applying a benomyl spray during bloom in the spring reduce the incidence of disease. Fixed copper (Kocide 101) was not effective in controlling Botryosphaeria panicule and shoot blight in two orchards with high inoculum levels. Both these fungicides are registered for pistachios in California. Another fungicide that was effective was iprodione but it is not currently registered. Pruning the infected shoots and clusters, removing out from the orchard and burning the brush should be an effective sanitation practice. Scouting the orchards periodically to detect and remove the initial few infection by B. dothidea seems to be very important for the management of this disease because after the disease reaches epidemic levels within an orchard, it is very difficult to control.

Alternaria late blight is caused by Alternaria alternata (Fr.) Keissl. The first record of Alternaria blight of pistachio is from Egypt in 1974 (Wasfy et al., 1974). The name “late blight” was chosen for Alternaria blight of pistachio in California because the disease develops in its most severe form late in the season when the pistachio fruit start to mature. Alternaria late blight, causes fruit spots and small or large angular or circular lesions on leaves, was first noticed in the summer of 1985. It is a problem particularly in orchards irrigated by sprinklers or flooding. The disease becomes very severe from late August to September on mature pistachios.

Symptomatology. Symptoms of Alternaria blight on green (immature) pistachio are small black lesions about 1 mm in diameter associated with lenticels of the epicarp. On mature fruit, both small (1-2 mm) and large (approximately 5 mm), black lesions, usually surrounded with purple-reddish margins, are present on the epicarp. Lesions initiate from lenticels or from cracked hulls. On leaves, angular or circular, brown necrotic lesions can develop with or without black sporulation, especially in the center of the lesions. Longitudinal black lesions can also develop on petals and the main veins of leaf blades; lesions on the leaf margins become common as leaves start to senesce. Leaf and fruit lesions are common on both ‘Kerman’ and ‘Red Aleppo’ varieties, as well as leaves of ‘Peters,’ ‘02-16,’ and ‘02-18’ male cultivars. Multiple lesions on leaves and fruits cause leaf blight and deterioration of hulls, resulting in defoliation and shell staining, respectively. Early-split pistachios are easily colonized by Alternaria first before lesions on leaves appear.

Epidemiology of the disease. A. alternata is widespread in nature and can easily develop on debris and orchard weeds. Although there is not yet information on
the epidemiology of Alternaria blight of pistachio, it seems that the fungus is favored by high relative humidity. This contention is supported by the fact that orchards close to rivers or those irrigated by sprinklers or flooding develop severe symptoms of Alternaria late blight much earlier than orchards irrigated by drip irrigation or micro-sprinklers. The dark, multicelled spores of Alternaria are produced on short, free conidiophores and can be spread by air currents or splashed by water drops.

In a 1989 study, we showed that propagules of A. alternata were present on developing fruit from the early April until harvest. Propagules of A. alternata ranged from only a few to up 300/g fresh fruit tissue. However, under California conditions, propagules on fruit collected from orchards irrigated by sprinklers ranged from 50 to 300/g fresh tissue during August and September, but only 5 to 100 propagules of Alternaria/g of fresh tissue on fruit from orchards irrigated by drip (Michailides & Morgan, 1990).

Leaves from shoots bearing fruit are most susceptible to infection by A. alternata than leaves of non bearing shoots. Because pistachio is an alternate crop, under similar environmental conditions, bearing pistachios (during an on year) will suffer more disease than non-bearing (during an off year) pistachio.

Control. Fixed copper (Kocide 101) applied twice (April and June) significantly reduced the propagules of A. alternata on pistachio fruit. As of 1990, Kocide 101 has been registered and can be used by the growers at a rate of 4-8 lbs/acre and for more than one application following one
cially inoculated with *S. sclerotiorum* resembled those on naturally infected twigs due to either *S. sclerotiorum* or *B. cinerea*, but reisolation from these twigs yielded only *S. sclerotiorum*. Twig infections caused by *B. cinerea* can sometimes be distinguished from those of *S. sclerotiorum* by the buff-colored sporulation of *B. cinerea*, especially in cool, wet weather. Frequently, however, no distinguishing signs are present to separate the two causal organisms. For correct diagnosis, therefore, isolation from blighted twigs that lack sporulation of *B. cinerea* is required. In 1992, 80% of the blighted shoots collected from a commercial orchard had *S. sclerotiorum*. Although not as common as Botrytis blight, Sclerotinia shoot blight can become a major disease of pistachio in California under certain conditions.

Other minor shoot blights: a) Phomopsis blight is caused by a *Phomopsis* sp. Symptoms of this blight on trees are very similar to those caused by *B. cinerea*. Pycnidia of *Phomopsis* with the characteristic a (elliptical) and b (filiform) pycnidiospores of the fungus can be found easily in shoots blighted by the fungus. b) Septoria leaf blight is caused by *Mycosphaerella pistaciaria* A. Chitizandis; conidial stage: *Septoria pistaciaria* Caracc. The disease was reported for the first time in the United Sta-
In 1990, in an orchard in Tehama County, California, Septoria was found on Kernman pistachio fruits, causing very distinct grayish to brown lesions (1-4 mm) in diameter surrounded by a distinct reddish halo (Michailides, 1991c). Black, flaslike, fruiting structures (pycnidia) of the fungus were present on these lesions, ranging from 1 to 26 per lesion. The pycnidiospores of S. pistiaeae isolated from California differed from those of S. pistisaciar L. in Arizona. In Texas, sprays of zinc ethylnebils [dithiocarbamate] [zineb] at 2-week intervals in late August and September were very effective in preventing further spread of the disease. However, this fungicide is not registered for pistachios in California and growers cannot use it.

Powdery mildew of pistachio, caused by an unidentified powdery mildew species (lack of cleistothecia development). However, Phylactinia guttata (Wallr.: Fr.) Lev. has been reported on Pistacia terebinthus L. in Greece. The disease is very sporadic in California pistachios. The fungus grows superficially as white 'powdery' mycelial masses. Later the mycelia die, leaving a brown scar, resembling russetting. Similar symptoms can be found on racchi, fruit stems, petioles, underside of leaf blades, and young shoots. The conidia of the fungus are produced in short chains and are hyaline, one-celled and barrel shaped. The disease occurs commonly on ‘Trabonella’ and sporadically on ‘Kerman’ cultivars throughout California.

FRUIT DISEASES
Stigmatomycosis. The term stigmatomycosis is the general name for a disease that occurs in a number of crops, such as cotton, soybean, pecan, pomegranate, and citrus, in the United States. Stigmatomycosis of pistachio has been reported in Iran (1974), in Russia (1976), and in Greece (1979). Generally, this disease has been reported from almost all the countries where pistachios are grown.

In California pistachio, this disease is caused by Nematospora cortily Peglion or Aureobasidium pullulans (de Bary) G. Arnaud transmitted by large coreid and pentatomid hemipetra pests (Michailides & Morgan, 1990). More than ten different species of hemipterans have been reported as pests of pistachio which affect feeding on pistachio nuts cause epicarp lesion on developing fruit early in the Season and kernel necrosis (KN) later in the season after feeding directly on the kernels of nuts (Michailides, Rice, & Ogawa, 1987).

Symptomatology. Stigmatomycosis of pistachio is characterized by the wet, smelly, rancid, slimy appearance of the kernel. In contrast, typical KN symptoms caused by large hemipterans are dry, punky, areas in the kernel, spongy at times, usually appearing in the area close to the stem end or along the split line of the shell. Three major symptoms of stigmatomycosis were observed in kernels collected from various orchards: 1) small kernels not fully developed, dark green with brown funiculus, in contrast to kernels with underdeveloped embryos (blanks); 2) kernels which develop normally and fill the shell cavity but are partially or totally wet, smelly, and rancid in contrast to healthy, green kernels. Outer surfaces of the kernels are slippery and sometimes sticky or slimy; the integrity of the kernel is not destroyed but those infected become dark green to light brown; 3) kernels which fill the shell cavity but look abnormal, being white or light yellow and jelly-like, with a loboid (myeloid = brain-like) appearance. Very sporadically, KN and stigmatomycosis symptoms can be present in the same fruit.

Although first symptoms can be detected in fruit as early as June, the disease becomes more frequent in samples collected later, in July through September, a period that coincides with the period of kernel development. Stigmatomycosis is more severe in orchards irrigated by sprinklers than in those irrigated by drip, microjets, or flood, suggesting either greater activity of hemipterans in sprinkler-irrigated orchards or more abundant propagules of pathogen that causes stigmatomycosis.

Transmission of the disease. Three common pest stinkbugs of pistachio, Thyanta palidovirens, Chlorochroa uhleri, and C. ligata, and a leaffooted bug, Leptoglossus cyopleus (Coreidae), transmitted N. cortily or A. pullulans, and caused typical symptoms of stigmatomycosis in pistachio kernels. Smaller hemipterans, such as Lygus and Calocoris spp. were not shown to be vectors of the disease in pistachio. These latter smaller hemiptera insects are unable to puncture pistachio fruit with pericarp firmness ≥ 1.8 kg force after May. The epidemiology of the disease in not known.

Control. Fungicide applications are not effective in controlling stigmatomycosis; however, insecticides can reduce hemipterans and subsequently reduce stigmatomycosis in pistachio orchards.

Fruit blights. Depending on the weather conditions during maturation of pistachio nuts or at harvest, several fungi can infect and colonize the nuts, causing blight of the entire fruit or the kernel. These fungi include A. alternata, Cladosporium herbarum, Stemphylium botryosum, B. dothidea, Aspergillus niger, A. flavus, A. parasiticus, A. ochraceus, and species of Fusarium, Pestalotiopsis, and Phomopsis. The shriveled epicarp of fruit infected by A. niger becomes bright yellow in color; after breaking the epicarp, one can easily recognize the abundant powdery, black sporulation of A. niger underneath. These symptoms and the sporulation of the pathogen can be used to diagnose infestions by A. niger. Other fungi that are frequently isolated from moldy nuts are Aureobasidium pullulans, Epicoccum purpureascens, and Trichotheicum roseum.

Control. Preventative measures should be taken especially during maturation of the pistachio nuts when hulls become more susceptible to fungal infection and deterioration. Although late irrigations favor an increase in the incidence of split nuts, they may aggravate certain of these molds by increasing humidity in the orchard. Preharvest fungicide applications may help reduce moldy nuts but fungicides that have been registered for preharvest sprays in California pistachios are only a few. Harvesting as soon as the nuts are mature and drying them is necessary to avoid any further increase of molds in mature pistachio nuts.

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THE STONE PINE IN ANDALUSIA, SPAIN: CURRENT SITUATION AND PROSPECTS

INTRODUCTION

Pine nut production is acquiring a rising importance in Andalusia, due not only to the spread of the pine stands, but also because of the increasing relative value of this product, which is becoming higher than the timber value of the forest stands. Nowadays, the main management target of most pine stands is the enhancement of timber value of the forest stands. Nowadays, the main management target of most pine stands is the enhancement of pine nut rather than timber production.

The stone pine (Pinus pinea L.) has been very widely used in afforestation of non-forested lands in Andalusia. The reforestation of these lands has had several purposes, but pine nut harvesting is compatible with them in most cases, so multipurpose management should be the main way of managing these pine stands. The Andalusian forest administration is developing a set of tools to enhance and improve this forest resource:

a) forest management plans to enhance pine nut production
b) development and promotion of new research programmes on silvicultural treatments and tree breeding on this species
c) foster the establishment of local manufacturing industries to increase the added value of the product in the region.

The aim of this paper is to show an overview of the current situation of pine nut production in Andalusia, its main problems and its future opportunities.

EXTENT OF Pinus pinea STANDS IN ANDALUSIA

Andalusian stone pine stands spread over some 200,000 ha. Out of these, 70,000 ha. are regarded as natural stands and the rest as artificial. These figures place Andalusia in the first position among the Spanish regions with regard to the extent of stone pine stands. Andalusia has 43% of the total area of Spanish stands and 33% of the world’s. According to the Spanish Forest Resource Survey made in December 1986, the total area covered by these stands in Spain amounts to 456,648 ha.

Andalusian stone pine stands are located mainly in the western provinces: Huelva, Cádiz, Sevilla, Córdoba and Jaén. The oldest stands are those of the coastal region of Huelva and Cádiz, growing on the sandy soils of the wide Guadalquivir mouth, while those on more continental and mountainous zones, specially in Sierra Morena range, come mainly from reforestation.

Pinus pinea has been widely used in reforestation tasks in all Sierra Morena, the main mountain range that separates Andalusia from the northern lands of the Iberian Peninsula, mainly in the provinces of Córdoba and Jaén. With the exception of a large part of Córdoba’s stands, which are mostly adult and already producing, the remaining stands are mostly young, still growing. Due to the increase of pine stand...
area, by reforestation in the last 50 years, the surface distribution of the main stone pine stands in Andalusia is changing, and the same changes are taking place on the main pine nut local production sources accordingly. The provinces of Córdoba and Jaén are increasing their pine nut production as their stands reach the cone production age.

Table 1 shows the present area of stone pine stands in Andalusian provinces and Spain, as well as 20 years ago. It shows a general increase in the total area and the relative changes within Andalusia by provinces.

PINE NUT PRODUCTION AND YIELD
Pine nut production is highly variable from year to year, so in order to have a realistic estimate of mean annual production it is necessary to consider several years. The causes for this high variability are:
a) the specific characteristics of this biological production
b) the wild nature of the trees
c) the fluctuating Mediterranean weather
d) the characteristics of the current way of harvesting, marketing and production control.

These later problems will be considered below.

From the available figures of the last 15 years (1982-1996) (see Figure 1), the mean Spanish annual production of pine nut is 6.023 t/year of pine nut with shell (the general accepted conversion factors in Spain are: pine cones yield 20% in weight on pine nuts with shell and pine nuts with shell yield 20% on pine kernels). Andalusian mean annual production, according these figures, (2.372 t/year) is about 40% of the total national production.

In spite of the high year-to-year fluctuation, as shown in Figure 1, Figure 2 shows an increasing trend of the Andalusian share of national production. The reason for this change may be the extent of newly established stands in Andalusia, originated in afforestation with this species during the last decades, and their gradual reaching of productive age.

Figure 3 shows the evolution of the annual production by province within Andalusia. Different trends could be observed in each province. Córdoba and Jaén are becoming more productive zones in the last years, while the traditional more productive provinces, Huelva and Cádiz, present more hazardous trends. Nevertheless, a general decline of the production all over Andalusia could be seen starting in 1993, which is also expected to extend over 1997 and 1998 according to the current appraisal of the next crops (Consejería de Medio Ambiente, pers.comm). This downturn of production is in line with the last five year period of draught all over the region; its effect will still show the following years because of the long maturation period of this fruit (three years from flowering to cone ripening). Nevertheless, these figures are not very reliable, as we will see below, so the observed trends may also be the result of insufficient records. A possible source of apparent variation could be the lack of control and transparency of this production process. This problem will be described in the next paragraph.

MAIN CURRENT PROBLEMS AND CHALLENGES
Pine nut production has, at present, different kinds of problems in Andalusia which should be solved in order to improve this
increasingly important resource. Most of them are the result of a lack of real interest on this product in the past, which used to be regarded as a minor product of the pine stands, being the timber the main one. Main problems and challenges for the future improvement of this production deal with management and silvicultural treatments of pine stands, harvesting techniques, trading and processing (manufacturing industries) of the product.

Management of pine stands shortage of proper cultural treatments

In Andalusia, as in almost all the Spanish forest lands, only the public forests are managed according to a plan. These plans should allow the manager to know and manage the achievable forest products in space and time. However, most of the existing forest management plans, and the corresponding inventories in which they are based, are aimed at timber production as the main objective, so they failed to plan pine nut yields. This is so because the silvicultural tradition coming from Northern Europe that has prevailed here until recently, did not use to consider any forest products other than timber. So one of the most important challenges the Andalusian Forest Administration has to face now is to change the planning and inventory methods in order to take pine nut production into account.

Another existing problem related with management of the pine stands is the lack of proper silvicultural treatments over most of the pine stands, particularly on those coming from reforestation. This is so, due both to the shortage of economic resources to afford the tending of the great extent of newly established stands, and also due to the limited knowledge on the most suitable silvicultural treatments to foster pine nut production. In the last years, some research programmes have been started on these issues supported mainly by the Andalusian Forest Administration.

Harvesting and yield

This stage of the productive process shows also several shortcomings in Andalusia. The current method of cone harvesting remains the same as in the past: the worker climbs to the tree and pulls down the cones to the ground from where they are collected and carried to the loading yard. These manual tasks are very worktime consuming, specially in the years of scarce yield in which there are few cones per tree, and the rising cost of manual work is causing a decrease in returns. This way of harvesting involves also a high accident risk, even more due to the large size of the trees which have been tended for timber production. This task requires skilled labour which is now decreasing because of the rural exodus, and the high risk and seasonality of the

Table 2. Figures of Spanish production and market by autonomous regions

<table>
<thead>
<tr>
<th>Autonomous Region</th>
<th>Area of pine stands (ha)</th>
<th>Share on national area (%)</th>
<th>Annual cone production(*) (t)</th>
<th>Share on national cone production(*) (%)</th>
<th>Value of pine kernel exports (10^6 pts)</th>
<th>Share on national exports (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalonia</td>
<td>97.160</td>
<td>21.3</td>
<td>10.090</td>
<td>30.2</td>
<td>929</td>
<td>74.5</td>
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<tr>
<td>Castilla y León</td>
<td>55.889</td>
<td>12.2</td>
<td>4.290</td>
<td>12.8</td>
<td>280</td>
<td>22.5</td>
</tr>
<tr>
<td>Madrid</td>
<td>12.182</td>
<td>2.7</td>
<td>1.495</td>
<td>4.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Castilla la Mancha</td>
<td>61.592</td>
<td>13.5</td>
<td>170</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Valencia</td>
<td>5.515</td>
<td>1.2</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Murcia</td>
<td>500</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Extremadura</td>
<td>25.156</td>
<td>5.5</td>
<td>520</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Andalusia</td>
<td>198.654</td>
<td>43.5</td>
<td>16.835</td>
<td>50.4</td>
<td>14</td>
<td>1.1</td>
</tr>
<tr>
<td>Spain</td>
<td>100</td>
<td>33.400</td>
<td>100</td>
<td>100</td>
<td>1.244</td>
<td>100</td>
</tr>
</tbody>
</table>

(*) These figures do not match exactly with the ones issued before because of the period of 9 years used here to calculate the mean values is shorter (9 years) than the previous one (15 years).

Sources: Instituto de Comercio Exterior. EGMASA (1997)
work. The job of cone harvester - “piñero” - is disappearing in the rising generation.

Another kind of problems related to the harvesting deals with the lack of control of this activity, which causes a high percentage of the cone production to be stolen. It is, of course, detrimental to the owner, but it also prevents from getting reliable information about yield capacity of the stands. This is a major problem in order to manage the whole production process and also to manage the pine stands in terms of planning and tending issues.

The challenges for the future on this matter should be faced to enhance the effectiveness of the harvesting tasks by improving the techniques, perhaps by some kind of mechanisation, and by developing appropriate silvicultural treatments such as proper pruning which make harvesting easier. Training courses are also needed in order to retain the cone harvester job. The improvement of silvicultural treatments on pine stands oriented to enhance their yield capacity on per hectare basis would have the best effects not only on the effectiveness of the harvesting but also on the whole production process and its returns.

Pine nut markets and disposal
The marketing and trading of pine cone and/or pine nut is somewhat obscure and complex. The market prices have a lack of transparency. The pine stand cone harvest is sold by auction when it is still on the trees, the price is based on a previous appraisal. The margin of error of this appraisal can be of some importance.

The distribution network is controlled by very few firms, which also has an effect on the prices. An additional problem is the fact that most firms are based outside Andalusia and have no link with the producers (pine stand owners). Most of the yield added value does not go to the raw material producers nor to the production process itself. This can be seen in the figures of Table 2, which shows that Andalusia, with 50.4 % share of the national cone production, only accounts for 1.1 % of global exports, which is a good piece of evidence of what happens in the whole stone pine market network.

The lack of transparency is actually a characteristic of the whole production process, especially of the supply stages; this also eases cone theft and prevents from obtaining reliable data on cone production capacities.

Manufacturing industries
Most part of Andalusian cone yield is sold away as raw material; manufacturing (obtaining of pine nuts from cones and kernels from nuts in shell) takes place in other regions. There is only one manufacturing industry in Andalusia whereas there are 29 industries in Catalonia and 12 in Castilla-León. This lack of industrial transforming capacity is one of the major problems that stone pine production has currently in Andalusia.

The main topics being considered for research deal with:
- Suitable stand density and thinning schedules (Montero and Candela, 1997)
- Effects of pruning and other pine stand silvicultural treatments on cone production (Montero et al., 1997; EGMASA, 1997)
- Breeding programme (universities of Huelva and Córdoba- Consejería de Medio Ambiente)
- Grafting techniques and other intensive cultural treatments such as irrigation and special pruning
- Cone yield appraisal techniques
- Cone quality parameters

FUTURE PROSPECTS AND CHALLENGES
There is a suitable framework in Andalusia to re-launch pine nut production due to:
- the extent of pine stands already producing and those reaching the proper age for it in the near future
- the raising value and market demand for this product
- the extent of marginal agrarian lands which could be very suitable to establish new intensive pine cultures, based on results of their breeding programme.

All these arguments provide good prospects for the future of this production in Andalusia. But some shortcomings need to be solved in order to succeed.

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ETSI. Agrónomos y Montes. (2) Universidad de Huelva. EPS. La Rábida.
CURRENT SITUATION AND POSSIBILITIES OF DEVELOPMENT OF THE CAROB TREE (Ceratonia siliqua L.) IN THE MEDITERRANEAN REGION

BACKGROUND
During the Third Coordination Board Meeting of the FAO Inter-regional Cooperative Research Network on Nuts held in Alcobaca (Portugal) in June 1995 it was raised and widely agreed by the Board members that a study on the possibilities of establishing a Subnetwork on carob within the Nut Network should be carried out. This was asked to I. Batlle and a account of the report including its conclusions is presented here. The author made an oral presentation of an advance of this report during the First Technical Consultation of the Inter-regional Cooperative Research Network on Nuts held in Meknes (Morocco) in October 1996.

In May 1997 the ‘Report on the possibilities of establishing a Subnetwork on carob (Ceratonia siliqua L.)’ was completed and sent to all the Network Liaison Officers and Coordination Board members for assessment. During the Fifth Coordination Board Meeting of the Research Network on Nuts held at ISF in Rome (Italy) last October, the carob report was widely discussed and, although the conclusions were favourable, the decision of not including this crop within the Network on the grounds of not being a nut tree and neither a close market related species, was taken by the Board members. However it was accepted that the carob tree, as a traditional and neglected crop of the Mediterranean basin, will be considered as a close species of our Network and thus references will still be included in the Bibliography section of the NUCIS Newsletter and short articles and notes will often still be published. In addition, there is the will to explore ways of funding surveys on genetic resources and to provide support to summit R&D proposals. A revision of the report entitled ‘Current situation and possibilities of development of the carob tree (Ceratonia siliqua L.) in the Mediterranean region’ is presented here.

INTRODUCTION
The carob tree has been grown since antiquity in most countries of the Mediterranean basin, usually in mild and dry places with poor soils. Its value was recognized by the ancient Greeks, who brought it from its native Middle-East to Greece and Italy, and by the Arabs, who disseminated it along the North African coast and towards the north into Spain and Portugal. It was spread in recent times to other Mediterranean-like regions such as California, Arizona, Mexico, Chile and Argentina by Spaniards, to parts of Australia by Mediterranean emigrants and, to South Africa and India by English.

The scientific name of carob tree (Ceratonia siliqua L.) derives from Greek keras, horn, and Latin siliqua, alluding to the hardness and shape of the pod. The genus Ceratonia belongs to the family Leguminosae (syn. Fabaceae) of the order Rosales. Legumes are important members of tropical, subtropical, and temperate vegetation throughout the world. There is a second species of Ceratonia, C. oreoanthauma, Hillcoat, Lewis and Verdc. which was only described in 1980. Two subspecies were distinguished, subsp. oreoanthauma, native to Arabia (Oman), and subsp. somalensis, native to the north of Somalia (Hillcoat et al., 1980).

The carob is a dioecious species with some hermaphroditic forms; thus male, female and hermaphrodite flowers are generally borne on different trees. Rarely there are unisexual and bisexual flowers in the inflorescence. The diploid chromosome number for Ceratonia is 2n = 24 (Goldblatt, 1981).

The carob is a long-lived evergreen and thermophilous tree thriving in habitats with mild Mediterranean climates. It grows well in warm temperate and tropical areas, and tolerates hot and humid coastal areas. Carob and orange trees have similar temperature requirements but carob stands poorer soils and needs much less water. The carob tree is more tender than the olive. Regarding resistance to dry environments it is surpassed only by pistachio (Ereinoff, 1955).

The carob tree is an important component of the Mediterranean vegetation and its cultivation in marginal and prevailing calcareous soils of the Mediterranean region is important environmentally and economically. Traditionally, grafted carob trees have been interplanted with olives, grapes almonds and barley in low intensive farming systems in most producing countries. Carob pods with their sugary pulp have been a staple in the diet of farm animals and were eaten by children as snacks or by people in times of famine. However, currently the main interest is seed production for gum extraction. Kibbled pods have been shipped from producing countries to all over Europe. Because of low orchard management requirements the carob tree is suitable for part-time farming and shows potential for planting in semi-arid Mediterranean or subtropical regions. The trees are also useful as ornamentals and for landscaping, windbreaks and afforestation. Cattle can browse on leaves and the wood is suitable for fuel.

PRODUCTION AREAS
The carob growing surface in the world is around 200,000 ha (Table 1) of which the southern countries of the European Union with some 148,000 ha (Spain 82,000 ha, Italy 30,000 ha, Portugal 21,000 ha and Greece 15,000 ha) account for 74% of the growing surface, and about 70% of the world production (Table 2).

Table 1. Area of carob in producing countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Area (ha)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>82,000</td>
<td>41.0</td>
</tr>
<tr>
<td>Italy</td>
<td>30,000</td>
<td>15.0</td>
</tr>
<tr>
<td>Morocco</td>
<td>25,000</td>
<td>12.5</td>
</tr>
<tr>
<td>Portugal</td>
<td>21,000</td>
<td>10.5</td>
</tr>
<tr>
<td>Greece</td>
<td>15,000</td>
<td>7.5</td>
</tr>
<tr>
<td>Cyprus</td>
<td>12,000</td>
<td>6.0</td>
</tr>
<tr>
<td>Other (1)</td>
<td>15,000</td>
<td>7.5</td>
</tr>
<tr>
<td>Total</td>
<td>200,000</td>
<td>100.0</td>
</tr>
</tbody>
</table>

(1): Algeria, Australia, South Africa, Turkey, USA, etc
Source: Batlle (1997)

Old and new carob plantings growing aside in Tarragona, Spain
Commercial world production of carob pods is estimated currently around 310,000 t, and it is mainly concentrated in Spain (43.5%), Italy (14.5%), Portugal (9.7%), Morocco (8.4%), Greece (6.5%), Cyprus (5.5%), Turkey (4.8%), Algeria (2.3%) and other countries. There is some production in Croatia, Tunisia and Malta and small amounts are also produced in Australia, California and South Africa. World pod and seed production is shown in Table 2. Yields are very variable depending on cultivar, region and farming practice. Pod and seed production in different countries are not parallel because of differences in seed yields of cultivars and wild types.

Carob production in the world has declined dramatically over the past 50 years from 650,000 t in 1945 (Orphanos and Papaconstantinou, 1969) to the 310,000 t today. In Spain alone production has fallen 400,000 t, from 550,000 t in 1930 to 150,000 t in 1990 (MAPA, 1994). The main reasons are low prices coupled with farming mechanization and coastal planning development. Farmers’ interest in carob in most Mediterranean countries diminished because of low pod prices and self-consumption, and use of coastal land for roads, housing development and industrial estates.

Carob expansion in Spain took place in two main phases: first the agricultural development during the 17th century when marginal lands were brought into use, and later when vineyards were pulled out due to ‘phylloxera’ break up in the 19th century and substituted by this crop in coastal places (Tous and Batlle, 1990). The largest growing area (190,000 ha) was reached towards the 1930s (MAPA, 1994). Spanish production has halved between 1970 and 1995 (MAPA, 1994). The current Spanish growing area and production (82,100 ha and 135,000 t) (MAPA, 1994) is distributed in five regions: C. Valenciana (54,200 ha and 60,500 t), Catalonia (12,700 ha and 28,000 t), Balearic Islands (12,200 ha and 30,500 t), Andalusia (1,000 ha and 11,000 t), and Murcia (2,000 ha and 5,000 t). There are estimated to be 182,000 isolated trees (not in orchards), some of which are intercropped with other species such as almonds, olives, figs, grapevines, etc. An important number of naturalized trees thrive in Andalusia.

Carob production in Italy (45,000 t) is mainly located on the island of Sicily (provinces of Ragusa, 21,000 t, Siracusa 11,000 t and elsewhere 5,000 t), and mainland 8,000 t (Apulia and Campania). Production in Sardinia is negligible. Italian production has halved between 1955 and 1995. The current tendency is crop to reduce area (Licitra, 1996).

The carob growing region in Portugal is concentrated in the south with some 21,000 ha and 30,000-35,000 t of production depending on years (Droste, 1993). The Algarve is the main producing region and around 60% of the total surface is located in 4 places, Silves (3,200 ha), Faro (3,000 ha) and Loulé and Tavira with 2,500 ha each. In the Alentejo region there are also some orchards in Mértola (100 ha) (Martins-Louçâo and Brito de Carvalho, Arpaia, 1990). The Portuguese carob production has declined over the past 20 years and the area under cultivation has reduced by at least 25% (Droste, 1993).

The production in Morocco, based on wild populations, is very variable and has increased during the last 15 years and, it is estimated to be about 26,000 t of pods. However, this production can be much larger depending mainly on weather conditions (rainfall) and interest for harvest (carob price). The main spontaneous populations are concentrated in the regions of Tafechma in the north and Ait Ishaq in the south (Ouchkit, 1988). However, three areas are commercially known Fes, Marrakech and Agadir. Acreage of spontaneous carob in Morocco is estimated around 30,000 ha. Carobs thrive together with a number of other species of the maquis (Pistacia, Olea, Quercus etc.). Some new orchards have recently been planted and Moroccan production is expected to rise in the coming years. Carob pod production in Tunisia is also from spontaneous trees and was estimated in the 1950s to be about 2,800 t (Crosa-Raynaud, 1960), however no records are available since. The situation of this crop in Algeria is largely unknown.

Turkish total production is about 15,000 t, which is collected from isolated trees (360,000) as there are no carob orchards. The production is concentrated along the coast in the Aegean (4%) and Mediterranean (96%) regions from Urla (Izmir) to Samandag (Hatay) (Vardar et al., 1980). The main producing provinces are: İçel, Antalya, Mugla, Adana, Burdur and Aydın.

In Israel, Goor et al. (1958) reported some 250,000 carob trees scattered in forests. In the early 1950’s about 2,000 ha were planted either as groves, on grazing land, as forests or as roadside trees. Currently still some plantings are productive but the tonnage seems to be decreasing.

In California during the 1950s, there was a well publicised ‘Carob crusade’ promoting this species as a dryland crop needing little irrigation, and several plantings were made throughout the south. However, due mainly to low productivity of the tree under dryland culture and high cost of land and processing the project failed (Colt and Rittenhouse, 1970; Ferguson and Arpaia, 1990).

In Australia, the crop was introduced around 1850 by Mediterranean emigrants. However it was only in the 1980s that interest in carob lead to planting some orchards, mainly in Western Australia and South Australia but also in New South Wales and Victoria. Australian carob growing area is only about 170 ha and there are also some 30,000 isolated trees. Its production is estimated around 750 t per year (Tous, 1995).

### Table 2. Carob pod and seed production in the world

<table>
<thead>
<tr>
<th>Country</th>
<th>Pod (t)</th>
<th>%</th>
<th>Seed (t)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>135,000</td>
<td>43.5</td>
<td>12,000</td>
<td>37.5</td>
</tr>
<tr>
<td>Italy</td>
<td>45,000</td>
<td>14.5</td>
<td>4,000</td>
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</tr>
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<td>Portugal</td>
<td>30,000</td>
<td>9.7</td>
<td>3,600</td>
<td>11.3</td>
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<td>Morocco</td>
<td>26,000</td>
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</tr>
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<td>Greece</td>
<td>20,000</td>
<td>6.5</td>
<td>1,800</td>
<td>5.6</td>
</tr>
<tr>
<td>Cyprus</td>
<td>17,000</td>
<td>5.5</td>
<td>1,700</td>
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</tr>
<tr>
<td>Turkey</td>
<td>15,000</td>
<td>4.8</td>
<td>1,800</td>
<td>5.6</td>
</tr>
<tr>
<td>Algeria</td>
<td>7,000</td>
<td>2.3</td>
<td>800</td>
<td>2.5</td>
</tr>
<tr>
<td>Other (1)</td>
<td>15,000</td>
<td>4.8</td>
<td>1,500</td>
<td>4.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>310,000</td>
<td>100.0</td>
<td>32,000</td>
<td>100.0</td>
</tr>
</tbody>
</table>

(1): Australia, South Africa, USA, etc.

Source: Battle and Tous (1997).

### GENETIC RESOURCES

In most Mediterranean countries the carob has been traditionally cultivated and thus growers have empirically selected and grafted high pulp content cultivars for animal feeding which instead yield usually low seed content. Currently, the main use of the pod is the seed for gum extraction and thus cultivars with high seed content are needed. There is a broad field of work on carob germplasm.

Wild carob trees are still frequently found in most eastern Mediterranean region and naturalized in the west. Throughout the Mediterranean region wild or natural-
Female plants have been always selected in preference to the hermaphrodite ones, being better pod bearers. The most common cultivars in commercial orchards are female, only a few hermaphrodites having sufficiently desirable attributes. Hermaphrodites are never the main producing trees in orchards, and often, male pollinators are isolated seedling trees or branches left on the rootstocks after budding female cultivars. However hermaphrodites have interest as pollinators and some should be selected for this purpose.

Centuries of cultivation have originated to a number of local cultivars differing in habit, vigour, size and quality of pods, seed yield, productivity and, pest and disease resistance. Commercial cultivars from different geographical areas differ markedly. Most cultivars are of unknown origin and represent the germplasm of each region. Wild carob trees are still frequently found in most eastern Mediterranean basin and naturalized in the west. Throughout this region wild or naturalized carob trees in situ were often used as stocks for budding with selected cultivars.

The main selection objectives have traditionally been large pod size and high pulp and sugar content. It is known that pulp and seed content show a negative correlation. Thus growers have been selecting against seed yield which is currently more valuable commercially. For this reason some collecting from wild (naturalized) populations has been carried out in Andalusia (Spain) (Batlle and Tous, 1994) and, should be undertaken in countries like Morocco and Turkey (Batlle and Tous, 1997).

The most relevant features of the domesticated carob genetic resources are:

- Low number (less than 50) and antiquity of named cultivars.
- Limited diffusion of cultivars, mainly local.
- High genetic variation regarding some traits:
  - Morphological (size, shape and colour of the pod, seed yield, etc.)
  - Agronomical (vigour, habit, resistance to pest and diseases, productivity, etc.)

Technological (flavour and sugar content, quality and gum content, etc)
- Low polymorphism for molecular markers (isozymes and DNA).

In the existing carob collections it seems that there is enough genetic diversity for crop improvement. However as the main use for carob pods is currently the seeds, whereas most cultivars maintained in collections were selected for high pulp content, it is worth selecting and collecting more wild types with high seed yield and trialling them in orchards.

AGRONOMY

Carob shows some outstanding features like rusticity, drought resistance, reduced orchard management, etc. and it is also well suited to part-time farming. In addition modern carob orchards start bearing earlier (4th year after budding) than traditional ones and increase yield steadily in response to minimum cultural care and deficit irrigation. The development of a useful method of propagation by cuttings would make a favourable impact on carob growing. There are factors limiting the planting of carob in new areas -insufficient cold hardiness- and factors limiting the profitability of the crop in existing areas -suitability for modern orchards. In addition there are external economic factors (Batlle and Tous, 1997).

Agricultural sustainability has been increasing in importance recently. In most poor soils and dry environments of coastal areas of the Mediterranean basin carob cultivation has no alternative crops. Although carobs produces reduced yields in old plantations (1.500-3.000 Kg/ha) in modern orchards production potential is higher (5.000-7.000 Kg/ha). However, important cropping differences between female cultivars in ongoing comparative trials are being observed (Batlle and Tous, 1998). In addition, in optimum habits it requires a minimum of inputs compared to most other fruit, nut or vegetable crops. In many semiarid regions where carobs are cultivated, quantity and quality of irrigation water are major limitations to production.

PROPERTIES

The two main carob pod constituents are (by weight): pulp (90%) and seed (10%). Chemical composition of the pulp depends on cultivar, origin and harvesting time (Orphanos and Papaconstantinou, 1969). Carob pulp is high (48-56%) in total sugar content (sucrose, glucose, fructose and maltose mainly). In addition it contains about 18% of cellulose and hemicellulose. Constituents of the seed are (by weight): coat (30-33%), endosperm (42-46%) and embryo or germ (23-25%) (Neukom, 1988). The seed coat contains antioxidants (Batista et al., 1996). The endosperm is the galactomannan carob bean gum (CBG). It is a polysaccharide molecule composed of mannose and galactose sugar units (ratio 4:1) rather similar to guar gum (ratio 2:1) and tara gum (ratio 3:1) but having better properties. The main property of this natural polysaccharide is the high viscosity of the solution in water, over a wide range of temperature and pH (Garcia-Ochoa and Casas, 1992).

The carob product most widely used especially for the food industry is the carob bean gum (CBG), or locust bean gum (LBG). This gum comes from the endosperm of the seed and chemically is a polysaccharide, a galactomannan. By weight, about a third of the seed consists of gum and it is obtained from the kernel after removal of the coat and grading. One hundred Kg of seeds yields an average of 20 kg of pure dry gum (Jones, 1953). Carob gum is produced in various degrees of purity depending on how well the endosperm is separated from the embryo.
and seed coat. Specks of cotyledons and testa are usually present in commercial CBG preparations. For used as a natural food additive, known as E-410, only high grade is admitted, for petfood more residues are allowed (Battle and Tous, 1997).

USES
The carob is one of the most useful native Mediterranean trees. In producing countries, carob pods have traditionally been used as animal and human food and currently the main use is the seed for gum extraction. Carob pods provide fodder for ruminants but also for nonruminants. In the wild, carob shelter, foliage and beans attract browsing animals. The pods contain indigestible and valuable seeds. Carob timber is hard and close grained, and has been used to make utensils as well as fuel. Carob wood was also traditionally used to make slow burning charcoal. C. oreothauma is extensively used for goat fodder in its native ranges (Hillcoat et al., 1980).

The pods are used after crushing to separate seed and pulp. The main products derived from the carob pod and some uses are presented in Table 3. The pulp can be ground into a fine powder for use in human nutrition. Carob powder consists of 46% sugar, 7% protein and small amounts of numerous minerals and vitamins and is thus quite nutritious (Whithside, 1981). After oven drying the powder can be added to cakes, bread, sweets, ice-creams or drinks as a flavouring (NAS, 1979; Vidal, 1985). Carob powder “cocoa” has advantages over chocolate in that it has fewer calories and neither caffeine nor theobromine (Whithside, 1981; Craig and Nguyen, 1984). Its flavour is not as rich as dark chocolate but resembles milk chocolate.

PROCESSING
Carob pods are crushed mechanically using a kibbler followed by separation of the kernels. The processing of the carob beans and the products obtained are shown in Fig. 1. This first coarse grinding can be followed by fine grinding of the pod pieces (kibbles) either at the same plant or at the feed or food factories. The feed factory grinds the deseeded pulp to different sizes in relation to the kind of livestock to be fed. The food industry processes the pulp further by roasting and milling to obtain a fine powder which is traded as ‘carob powder’ (Battle 1997).

The carob seeds are transported in bulk by lorry to the gum factories. The kernels are difficult to process, since the seed coat is very hard. Kernels are peeled without damaging the endosperm and the embryos (germs). The two main procedures applied to remove seed coat are (Puhan and Wielinga, 1996): acid (seeds treated with sulphuric acid to carbonise the coat) or roasting (kernels roasted in a rotating furnace to peel off the coat). After the peeling process the endosperm can be split from the cotyledons due to their different friabilities. The carob bean gum is the ground endosperm and the carob germ meal is a by-product of the seed processing (Battle and Tous, 1997).

PROSPECTS
Since the start of the 1980s this crop has raised a considerable interest because of generally sustained demand and increasing prices of the carob pods (pulp and seed). However, this trend has been sharply modified twice in the last 10 years: in 1984-1985 (0.25 US$/Kg) and 1994-1995 (0.8 US$/Kg) when prices peaked. The high pod prices led to a loss of competitiveness of the carob bean gum versus other natural (guar and tara) or artificial hydrocolloid substitutes, producing both times a subsequent decline of pod prices (Battle and Tous, 1997).

There is an important point of strength in the carob sector as it is fairly well organized in the main producing countries. Thus although growers, kibblers, industries, the agrofood industry and R&D have different interests, all are aware that a more transparent sector would be beneficial to each other. Most of the carob bean gum producing companies are grouped since 1972 in the Institut Européen des Industries de la Gomme de Caroube (INEC) which is placed in Brussels (Belgium) with a Secretariat in ETH Zürich (Switzerland).

INEC was launched by most of the important producers of CBG as a cooperative non-profit organization to meet the extensive toxicological investigations requested by the FAO/WHO and the EU on food additives to be considered harmless. The INEC could play an important role in supporting studies on production and application of the CBG as the natural gum with best properties for the food and pharmaceutical industries. In addition the INEC could foster programmes to conserve the carob crop and develop crop technology, encourage new plantings in developing regions, and improve the use and economics of carob kernels.

Most CBG factories are placed in Mediterranean countries of the European Union (EU) (Spain, 5, Portugal, 2 and Italy, 1) as is the leading world carob producing region and this is expected to remain in the future. However newly established industries are operating in developing African countries like Morocco (2). There is also a small processing plant in Turkey. The current CBG world demand by the

### Table 3. Main products derived from the carob pod (pulp and seed) and some major uses

<table>
<thead>
<tr>
<th>Product</th>
<th>Processing</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pulp</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kibbles</td>
<td>Any</td>
<td>Animal feed (horses and ruminants)</td>
</tr>
<tr>
<td></td>
<td>Milled</td>
<td>Human food and animal feed</td>
</tr>
<tr>
<td></td>
<td>Extraction and purification</td>
<td>(ruminants and nonruminants)</td>
</tr>
<tr>
<td></td>
<td>Fermentation and distillation</td>
<td>Sugar and molasses</td>
</tr>
<tr>
<td></td>
<td>Extraction</td>
<td>Alcohol and microbial protein production</td>
</tr>
<tr>
<td>Powder</td>
<td>Washing, drying, roasting and milling</td>
<td>Tannins as antidiarrhoea</td>
</tr>
<tr>
<td><strong>Seed</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embryo Coat</td>
<td>Grinding</td>
<td>Germ meal. Human and animal nutrition</td>
</tr>
<tr>
<td></td>
<td>Extraction</td>
<td>Tannins for leather tanning</td>
</tr>
</tbody>
</table>

Source: Battle (1997).
food and petfood industries of around 15,000 t should be supplied yearly otherwise the consumer industry will change to substitute gums with consequent loss of market. Although supply and demand of CBG show some flexibility annually (around 3,000 t), any market loss is usually hard to recover (Batlle and Tous, 1997).

RESEARCH AND DEVELOPMENT NEEDS

The carob tree has been traditionally neglected by R&D programmes so that knowledge about existing cultivars in the Mediterranean region is still poor. Cultivars of carob cultivation have given rise to a number of cultivars differing in agronomic characters and large natural populations remain untouched in countries like Morocco and Turkey. Thus surveys and a collaborative project to compare and characterize most useful cultivars and types selected from the wild are much needed. The potential inclusion of the carob in the Inter-regional Cooperative Research Network on Nut (FAO/CIHEAM) would ease the needed cooperation (Batlle, 1997).

To summarize, the research needs for carob improvement are:

- Development of a descriptor list
- Characterization and evaluation of existing collections
- Selection of promising wild types (female and hermaphrodites)
- Development of a useful method of propagation by cuttings
- Pollination studies (insects and wind)
- Tree density and potential yield
- Seed gum production and quality
- Reforestation capacity

CONCLUDING REMARKS

After assessing the current situation on carob in most Mediterranean countries, which are the main producers, there are also some weak points, there is need to carry out R&D on important subjects like: genetic resources, flower biology, propagation, orchard design, yield, CBG quality, afforestation behaviour. Most of this basic work should be better approached through joint R&D projects. Thus an important effort on R&D is needed on this species. There is also need to promote activities and exchange of information on carob R&D. It is desirable that for some of the issues raised that kibblers and CBG companies should be involved supporting R&D projects. The carob as producer of fruits suitable for human consumption is not included in any R&D Network (Batlle, 1997).

Although carobs produce pods or beans their importance in traditional low-input Mediterranean dryland production together with some temperate nut trees like almond makes their consideration in the same Network very useful as they share some common environmental conditions and farming practices. Finally, after assessing the lacks and needs of this crop its inclusion in the Inter-regional Research Network on Nuts (FAO/CIHEAM) is recommended. As one of the main carob challenges is to further know and assess the existing genetic resources, a possibility is to include this crop within the established Subnetwork on Genetic Resources. This solution would simplify the Nut Network management as already 9 Subnetworks are operating. In addition, it would make the Network more cost effective (Batlle, 1997).

REFERENCES


NOTES AND NEWS

IN MEMORIAM: FRANCESCO MONASTRA

Francesco Monasta, 58 years old, Professor of Research at the Istituto Sperimentale per la Frutticoltura di Roma, Italy, passed away on the 31st October 1997 by a heart attack. He was a real character of our FAO-CIHEAM Research Nut Network and very well known and esteemed in the nut tree sector. In this issue of the NUCIS Newsletter we would like to pay a tribute on his memory through short notes sent by different people from various countries and fields. We asked contributions to C. Fidgehelli (ISF Rome), A. Godini (R&D in Italy), Ch. Grasselly (Stay at INRA), D.A. Kester (visit to California), R. Socias i Companys and A. Felipe (involvement with GREMPA group), N. Kaska, M. Laghezali and Ö. Seçmen (involvement with GREMPA group), Efigenio García (involvement with GREMPA group), F.J. Vargas. FAO-CIHEAM Nut Network Coordinator.

His last and important contribution to our Network should be highlighted: ‘Inventory of almond research germplasm and references’. Long time ago it was agreed to carry out this work on various of the nut crops of our Network. It was a challenging but time consuming aim. Francesco ended this catalogue just after last summer and he was the first to achieve it. A few days before ending his life, in mid October we had a Nut Network Coordination Board Meeting at ISF, Rome. Monasta was the convener and it was a success. In this meeting he presented us the almond inventory just after been printed. Ciccio was very happy and thrilled with this work. He always showed a high capacity to transmit his enthusiasm to the people surrounding him. He was all the time making projects, it seemed that with the age his zest instead of diminishing was growing. This inventory has been his last contribution to the people working on almond.

In recent years, three researchers very much linked to our Network have left us. Mahmut Ayfer (former Liaison Officer of the Subnetwork on hazelnut), Efigenio Garcia (regular participant of the GREMPA meetings) and Francesco Monasta. We will miss them in the coming meetings. All three were close friends, all three closely linked to Mediterranean cooperation on nut trees, all three will be together. God will have rewarded them for their efforts to develop the nut tree sector.

Our most sincere sympathy to his wife Adrianna and his children Carmelo and Titti, as well as to the colleagues of the Istituto Sperimentale per la Frutticoltura of Rome.

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F.J. Vargas. FAO-CIHEAM Nut Network Coordinator.
IRTA - Mas Bové, Dept. d’Arboricultura Mediterrània
Apartat 415, 43280 Reus, Spain

CORRIGENDUM

In the article “Nut crops in Slovenia” by A. Solar, NUCIS 5: 21-22 (1996), on page 21 under Hazelnut heading the cultivar ‘Tonda Gentile delle Langhe’ should be read instead ‘Tonda Giffoni delle Langhe’.

I. Batlle
IRTA-Mas Bové, Dept. d’Arboricultura Mediterrània
Apartat 415, E-43280 Reus, Spain
Doctor Francesco Monastra died by heart attack at the end of October 1997.

After a day of activity in his office in Rome programming new working trips around the world (the following week he had to attend a meeting in Geneva and for mid November he had already fixed a visit to China) he left to his native Sicily for visiting some trials he had in that region and he was never back.

Dr. Monastra spent all his scientific life at the Fruit Tree Research Institute (Istituto Sperimentale per la Frutticolture, ISF) of Rome, since 1964, and he had an important role in the reorganization of the Institute as it is now.

His work as a researcher, that covered a wide range of different fields, from variety testing through orchard management, breeding, postharvest, testified by more than 250 papers, is indissolubly bound to his passionate battle to improve almond and more generally the nut crops.

In this field he was acknowledged as an international authority and he had covered and he still covered roles of great importance: former chairman of GREMPA (Groupe de recherche et d’étude méditerranéen pour l’amandier), Liaison Officer of the Subnetwork on almond of the FAO-CIHEAM Network on Nuts, vice-chairman of the working group Nut Crops of ISHS on almond. During the last decade he was appreciated representative of the Italian Ministry of Agriculture in the Commission ONU-CE for nut normalization of which he has been president for four years.

His last work, just printed, is, of course, related to almond and it constitutes his scientific will: “Inventory of almond research, germplasm and references”, a ponderous and very interesting volume, published jointly by FAO and CIHEAM, that crowns in the ideal way more than thirty years devoted to this species that, more than any other, he felt belonging to his Sicily.

Dr. Monastra was, since 1986, director of the Orchard Management Section of the ISF of Rome; before he was director of the Section of Caserta and of the Propagation Section.

His not common working capacity, together with his generosity and his restlessness brought him to be involved in many other initiatives and to cover important roles within the Ministry of Agriculture and the National Research Council.

He had also an extraordinary ability to get in touch with the people and particularly with youngs and he was able to transmit his enthusiasm and his pragmatism. His work will not stop with his death; many young people will put in practice his teaching.

For me he has been, first of all, a brotherly friend, but also a valued colleague and cooperator.

The witness of deep sorrow we have received from so many colleagues from all over the world express a dismay and a pain that go beyond words of circumstan-ces and show the friendship and the esti-mation of which he was surrounded everywhere.

It’s difficult to think to the coming meetings without his impetuous and showy participation, always active, attentive, constructive. We’ll miss him.

C. Fideghelli
ISF Roma
Via Fioranello, 52
Ciampino Aeroporto Roma (Italy)

CICCIO AND R&D

It is the last morning of October and the rain is incessantly pouring. I am at the work. The telephone rings and a friendly voice says: “Professor Godini, have you heard the news?”. “What news?”. “Ciccio Monastra met a sudden death”. All of a sudden the sky appeared darker and darker and the rain more violent.

Now, a month has passed since I received that tragic message. During this time memories of Francesco “Ciccio” Monastra have emerged repeatedly. Memories accumulated over thirty years of friends-

search, hip, mutual esteem and respect as well as professional collaboration. I never would have imagined that Ciccio’s death could have such a strong effect on me. The recurring image I have of Ciccio is analogous to a volcano. A volcano that is now irreversibly extinguished.

Our thirty years of scientific collaboration arose from our mutual interest in the Almonds and our shared ideas about its direction. At that time we were two young researchers among the numerous Italian Almond researchers working throughout Italy, from Pisa to Sassari, Palermo and Catania. Moreover, there was the old Apulian school which aimed at keeping its existing almond growing model and resisted new ones. Together we began to fight against those conservative views by suggesting the intriguing possibilities from the choice of selected cultivars, the use of new and more efficient rootstocks and the introduction of irrigation and honey bees as current cultural techniques. I remember our satisfaction when we were able to overcome some local problems and organize, in 1977, the third GREMPA meeting in Bari.

In parallel with the decline of the Italian almond industry, the number of Italian researchers dealing with almond also decreased. In fact, at the 10th GREMPA meeting held in 1996 in Meknés (Morocco) the only two Italian researchers who presented papers on almond were Ciccio and myself. And again at the recent International Symposium on Pistachios and Almond held in 1997 in Davis (USA) the only two Italian almond papers were presented by Ciccio and myself. And now?

On Tuesday August 26, 1997, during the business meeting of the ISHS Nut Crop Working Group the “spokesman” Ciccio showed a trasparency on which he had written: “See you in 2001 in Saragoza”. With God’s help I hope, all of us will be present in Saragoza. I am firmly convinced that also Ciccio will be with us, and we will feel his presence. But it will not be as before. It will never be as before.

A. Godini
Istituto di Coltivazioni Arboree
Facoltà di Agraria
Bari, Italy

F. MONASTRA BOURSIER A L’INRA

C’est dans les années 1970 que Francesco Monastra arrive à la Station de Recherches Fruitières de la Grande Ferrade à Bordeaux et vint renforcer l’équipe qui travaillait sur les Porte-griffes du Pecher et sur l’Amandier. Dans cette équipe figu-
FRANCESCO MONASTRA AND THE GREMPA

Ciccio Monasta was one of the few founding members of the GREMPA still active, but overall he was an enthusiastic supporter of its activities, following the strength and the clear ideas of its main organizer, Jacques Souty, another researcher who passed away when many useful ideas were still expected from him.

The first GREMPA meeting was held in Zaragoza in February 1974, with four countries represented: Italy, Tunisia, France and Spain, although open, as it has been in further meetings, to researchers from all the Mediterranean countries. Its driving idea was to get together all the efforts of almond research in order to synergize them. The seed was probably born in the mind of J. Souty, in close contact with the IAMZ and the Fruit Coordinating Activities of the Ebro Valley in Spain. As early as 1972 Dr. Souty talked to us about the possibilities of experimental almond fields across the Mediterranean countries, and he did not stop until the first meeting in Zaragoza established the basis of a useful cooperating program. Unfortunately, J. Souty passed away before the end of the same year, although his enthusiasm for almond collaboration was maintained by the other participants.

The founding meeting was held at the IAMZ, and the GREMPA was considered an activity of the CIHEAM, based in its Zaragoza Institute, which gave an important backing to all the successive Colloquia, allowing the assistance of people from many different countries and funding the almond collection of Zaragoza as the reference collection of the GREMPA. The warm support of Miguel Mut, the Director of the IAMZ at that time, cannot be forgotten.

Ciccio attended all the meetings of GREMPA, until the last one in October 1996 in Meknès (Morocco), being able to see how the driving stimulus of J. Souty grew and gave important fruits. As already mentioned, almond has been probably the fruit species which endured more research changes during the last 25 years, and the activity of the GREMPA has had an important share of this success. The second meeting, held the following year in Montpellier, in order to quickly start the cooperative collaboration of all the participants, saw the presence of 23 participants from 11 different countries. Later, in some meetings, up to 14 countries were represented, showing how the GREMPA colloquia were a forum for all the almond growing countries.

Practically since its beginnings, GREMPA suffered some interference, probably because of its success. Some people tried to acquire an excessive protagonism and other organizations wanted to obtain the benefits of the collaboration among the almond researchers. It would be better to forget these situations, but we must always remember that Ciccio, however, was always a defender of the GREMPA independence, considering that it was an association of free people, of real friends, for the benefit of almond research. In this respect he maintained his head up, as a modern Quijote, far from inclining his back, as well as far from inclining GREMPA freedom. In this respect, when in the Davis Symposium of August 1997 it was decided that the next ISHS Symposium would be held in Zaragoza, he told us to organize, together but in its own, also a GREMPA meeting. We owe this to his memory, trying to follow his enthusiastic faith in almond and the GREMPA.
lost one of his founders and supporters. He helped and guided almost all the horticulturists in this region of the world. Turkey and especially the Çukurova University benefited from him a lot. In his visits to Turkey, he suggested many new and useful things, developments for the modernisation of our horticulture. Therefore we are and we will always be thankful to him.

Although he liked all the fruits I think he was in love with pistachio nut. That is why he was so happy when we proposed the next meeting of GREMPA should be held in Sanlurfa. During our last meeting in Rome between 16th and 18th of October, he was so friendly, so nice to offer us as many things as he could, including so many new publications of him. He was tied in organizing the meeting and during the wonderful dinner party he and his wife, son and daughter gave us. I was amazed that at 6 o’clock the following morning he was ready to go to Caserta for a pomological exhibition. He also took me there and along the 200 km trip I learned a lot about the Italian horticulture from him. In Caserta I saw how people loved him, how they respected him. There I understood that he was a real supporter of Italian pomology.

We will never forget Prof. Monastra, this great pomologist. He will live in our hearts with his cheerful face, jokes, friendship and love for fruit and nuts.

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**A LA MEMOIRE DE NOTRE FIDEL AMI MONASTRA**

La disparition brutale de notre cher regrétté Monastra laisse un profond chagrin au sein de la communauté scientifique œuvrant dans le domaine de l’arboriculture fruitière des pays de l’ensemble du bassin méditerranéen. Le défunt Monastra avait largement contribué à faire adhérer les pays du sud de la méditerranée aux activités de recherche et développement de la partie nord de ce bassin. Son dynamisme, sa compétence et son dévouement lui ont valu d’être l’un des principaux fondateurs du GREMPA.

Grace à son encouragement pour l’échange du matériel végétal et de l’information entre les membres du groupe, une harmonisation des travaux de recherches s’est concrétisée. Son esprit coopératif a permis l’extention de ces échanges à d’autres espèces fruitières ; à chaque fois que le besoin se faisait exprimer par ses collègues d’Afrique du Nord. Il a également oeuvré pour faciliter ce travail coopératif visant à résoudre certains problèmes de la culture d’amandier dans les pays méditerranéens.

Sa présence distinguée dans toutes les réunions et son amabilité permanente ont contribué à créer un cadre d’amitié, d’entente et de coopération entre les chercheurs de nos différents pays, ceci a permis l’obtention de résultats pour lesquels une collaboration étroite était nécessaire.

Tous les chercheurs qui ont participé à la dixième réunion du GREMPA et à la consultation technique du Reseau Coopératif Inter Régional sur les Fruits Secs, tenues à Meknès (Maroc), en Octobre 1996, et qui ont constitué les dernières manifestations qui nous ont réunis avec notre regrétté Monastra, se souviendront de son dévouement de son dynamisme.

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**MY LAST HOMAGE TO THE MEMORY OF MY FRIEND CICCIO**

Since my first contact with him, I had the feeling that he was always very busy in his office. He was always dealing with several matters, projects, meetings, some times professional politics and particularly exchange of genetic materials but without losing his friendly smile on his face. He had a kind of humanitarian humor which was reflected in the decoration and arrangement of his office. I observed several times his human approach to his environment which I would like to remain with us. This is the main reason why I always kept in touch with him. Now in the parsimmon, pecan, almond, apricot and kiwi collections of my Department he is alive among his donations. He believed germplasm exchanges improve personal relationships at universal level. Cultivars sent by him are also spread over different collections without even knowing the real curator.

He was a very active member of our ‘Nut Board’ and he stimulated all the time new projects and activities for the success of our Group. Sometimes he got angry and defended his point of view right away to the end but without losing his very deep friendships. He was always constructive and reconciling for the collaboration at Mediterranean level.

I will remember him at the end of my work in the University of Çukurova and he will be living through his new fruit varieties as growing trees greeting his presence.

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**CHANGE OF FAO ESCORENA COORDINATION**

In May 1997, Dr. J. Boyazoglu resigned as Senior Officer for Research and Technology of the FAO’s Regional Office for Europe. J. Boyazoglu, as coordinator of European System of Cooperative Research Networks in Agriculture (ESCORENA), coordinated during four years (1993-1997) all activities on research and technology relating to sustainable agriculture, development, production and environmental matters of the programme FAO in Europe. As responsible of promoting and monitoring the development of scientific and technical cooperation among the European countries and between European and developing countries in the Mediterranean basin and Central and Eastern Europe and Middle East Countries he made an outstanding contribution. His always straightforward manners and easy going relationship has much eased our work at IRTA Mas Bové as Coordination Centre of the Nut Network. In addition his
Cartesian thinking was neatly shown through his managerial skills. This was very useful to plan and develop programmes with him. We thank J. Boyazoglu his sound advice and enthusiasm to coordinate efforts on nut tree research and development in the Mediterranean basin and Central and Eastern Europe. We also wish his successor all the best on the important task ahead.

FAO CIHEAM

NUT NETWORK LOGO

The Nut Network Logo contest launched in the NUCIS Newsletter 5 under the slogan "The Interregional Research Nut Network needs a sharp logo!" was not very successful as no entrants were received. Perhaps the motto was insufficiently catchy or maybe the intellectual prize was not rewarding enough. Finally, the logo adopted has been the presented at the Coordination Board Meeting held in Meknes (Morocco) in October 1996. This logo (a nut tree enclosed in an inverted triangle) was designed by I. Batlle and developed by M.A. Pollino from Caracter Grafico, S.L. Reus, Spain.

The logo will facilitate the Nut Network identification and will be used in documents.

II INTERNATIONAL COURSE ON PRODUCTION AND ECONOMICS OF NUT CROPS

As announced in the last NUCIS issue, the Second International Course on Production and Economics of Nut Crops will be held next Spring (18 to 29 May 1998) at the University of Çukurova, Adana, Turkey. This course ensures the continuity of the succesful First Course held in 1994 at the Centre de Formación i Estudis Agrorurals in Reus, Spain.

Objective of the course

A large part of the world nut production is concentrated in the Mediterranean region. Some nut tree species like almond, hazelnut, walnut, pistachio have been cultivated for centuries. Most countries in this region have important economic activities related to nut crop production, trade and industry. These activities depend on several factors which need to be integrated in order to succeed. Some of these factors evolve quickly and it is necessary to adapt them to the changing conditions. The ability to adapt can make the difference between profit and loss.

The objective of the course is to review the current situation and problems, focusing on the most recent advances made in the production and economics of nuts which lead to a reduction in production costs and an improvement in the profitability of these crops. The course not only concentrates on the most widely grown nut crops in the Mediterranean region but also on potentially important alternative species.

Although most Mediterranean countries have important nut growing areas, the number of specialized training courses focused on nut crops has been scarce. This course is a significant coordinated effort of several institutions to gather a major group of scientists and industry professionals from the nut sector to cover the wide range of topics on the programme. The course is designed for graduates working in R&D and professionals in the sector directly involved in the production and economics of nut crops.

Adana is on the Mediterranean coastline of Turkey, and is very near pistachio, almond and walnut important growing centres. The University of Çukurova has collection orchards of nut species, being the Department of Horticulture one of the R&D centres for all these nuts in Turkey.

Organization

The course is jointly organized by the CIHEAM, through the Mediterranean Agricultural Institute of Zaragoza (IAMZ), the University of Çukurova, through the Faculty of Agriculture, and the Food and Agriculture Organization of the United Nations (FAO), with the collaboration of the Pistachio Research Institute of Turkey, and with the contribution of the Commission of the European Union (DG I).

The course will take place at the University of Çukurova headquarters, in Adana, and will be given by well qualified lecturers from research centres and universities.

The course will be held over a period of 2 weeks, from 18 to 29 May 1998, in morning and afternoon sessions.

Admission

The course caters for a maximum of 30 professionals with a university degree already directly involved in the subject matter of the course. The official language of the course will be English.

Registration

Application forms may be obtained from:
Instituto Agronómico Mediterráneo de Zaragoza
Apartado 202, 50080 Zaragoza (Spain)
Tel: +34-976 57 60 13
Fax: +34-976 57 63 77
e-mail: iamz@ciheam.mizar.csic.es

Candidates should send the completed application form to the above address, accompanied by a detailed curriculum vitae, stating degree, diplomas, experience, professional activities, language knowledge and reasons for applying to the course. Copies of certificates should be enclosed with the application. The deadline for the submission of applications is 15 February 1998.

Applications from those candidates who cannot present their complete records when applying, or those requiring authorization to attend the course, may be accepted provisionally.

Registration fees for the course amount to 500 US$. This sum covers tuition fees only.

Scholarships

Candidates from CIHEAM member countries (Albania, Algeria, Egypt, France, Greece, Italy, Lebanon, Malta, Morocco, Portugal, Spain, Tunisia and Turkey) may apply for scholarships covering registration fees, and for scholarships covering the cost of travel and full board accommodation during the course.

Candidates from other countries who require financial support should apply directly to other national or international institutions such as FAO, European Commission, World Bank, etc.

Insurance

It is compulsory for participants to have medical insurance valid for Turkey. Proof of insurance cover must be given at the beginning of the course.

Teaching organization

The course requires personal work and interaction among participants and with lecturers. The international characteristics of the course favour the exchange of experiences and points of view. Formal lectures are complemented by round table discussions and technical visits.

Programme

Course presentation (1 hour)
A world outlook of the nut sector (2 hours)
- Technical aspects
Economical aspects

Economics (9 hours)
- Economic issues in the Mediterranean basin
- Agricultural policies
- Economic situation of the Turkish nut sector
- A comparative analysis of the nut sector organization in the Mediterranean and the USA
- Nut trade in the world
- Round table discussion on market prospects for nuts

Almond (8 hours)
- Crop situation and problems. Important aspects of R&D
- Plant material
- Choice and breeding of varieties
- Choice and breeding of rootstocks
- Propagation and nursery management

Pistachio (10 hours)
- Crop situation and problems. Important aspects of R&D
- Pistachios in California
- The pistachio in its traditional growing areas
- Reproduction physiology
- Plant material
- Choice and breeding of varieties
- Choice and breeding of rootstocks
- Propagation and nursery management

Walnut (6 hours)
- Crop situation and problems. Important aspects of R&D
- Walnut in Turkey
- Plant material
- Choice and breeding of varieties
- Choice and breeding of rootstocks
- Propagation

Hazelnut (4 hours)
- Crop situation and problems. Important aspects of R&D
- Reproduction physiology
- Plant material: Choice and breeding

Other nuts of potential importance in the Mediterranean region (2 hours)

Nut diseases and pests of economic importance (5 hours). Nut virosis (1 hour)

Harvest and post-harvest (6 hours)
- Harvest systems
- The case of California
- The case of the Mediterranean countries
- Pistachio harvest in Turkey and Iran
- Post-harvest management
- The case of California
- The case of the Mediterranean countries
- Post-harvest quality control

Irrigation (2 hours)
- Irrigation control and water status of the plant
- Optimization of limited water resources and low quality waters

Prospects offered by molecular and cellular techniques (2 hours)
- In vitro micropropagation
- Molecular markers
- Genetic engineering

Round table discussion on the future of nut production in the Mediterranean region (2 hours)
Participants’ presentations on their own experience (3 hours)

GUEST LECTURERS

B.E. AK, Haman Univ., Sanliurfa (Turkey)
L.M. ALBISU, SIA-DGA, Zaragoza (Spain)
G. ANANIA, Università degli Studi della Calabria, Reggio Calabria (Italy)
S. ÇAGLAR, KSU, Kahramanmaras (Turkey)
S. ÇETİNER, Univ. Çukurova, Adana (Turkey)
O. ERKAN, Univ. Çukurova, Adana (Turkey)
S. ETI, Univ. Çukurova, Adana (Turkey)
A. FELIPE, SIA-DGA, Zaragoza (Spain)
L. FERGUSON, Univ. California, Parlier (USA)
E. GERMAIN, INRA, Villeneuve d’Omon (France)
N. KASKA, KSU, Kahramanmaras (Turkey)
A.B. KÜDEN, Univ. Çukurova, Adana (Turkey)
T. MICHALIDES, Univ. California, Parlier (USA)
A.I. ÖZGÜVEN, Univ. Çukurova, Adana (Turkey)
S. PAYDAS, Univ. Çukurova, Adana (Turkey)
S.M. SEN, Univ. 100 Yil, Van (Turkey)
O. TEKİNEL, KSU, Kahramanmaras (Turkey)
F. VARGAS, IRTA, Reus (Spain)
F. YAVUZ, Atatürk Univ., Erzurum (Turkey)
M.A. YILMAZ, Univ. Çukurova, Adana (Turkey)

PISTACIA RESEARCH
IN ISRAEL AT BEN-GURION UNIVERSITY OF THE NEGEV

The adaptability of some Pistacia species to the Negev desert of Israel and the increasing interest in its unique developmental biology made this taxon an ideal candidate for our studies. The only large woody tree found growing naturally on the Negev highland, where the average yearly rainfall is 95 mm, is the Pistacia atlantica. There are a few trees several hundreds years old.

The research has taken 2 major directions:
1. Molecular work to identify and characterize proteins and their genes, involved in flower bud development and sexual expression.

Splendid P. atlantica, 15 years old growing in dry conditions at IRTA Mas Bové, Reus, Spain

2. Establishment of a germplasm collection of the genus Pistacia.

We have identified and purified a 32 kDa protein (lbp27) from pistachio male inflorescence buds. It accumulates during floral induction, remains in the buds during the dormancy period and disappears during flowering. Using antibodies produced against this protein, we detected an immunologically related protein of 27 kDa (lbp27) in female buds. This protein was present in about 70% of the female trees tested (37 trees). None of the eight male trees tested so far contained the lbp27 in its inflorescence buds. This may have a potential in early sex determination in pistachio. A fragment of lbp27 cDNA was cloned. Sequence analysis and the deduced amino acid sequence revealed homology to dehydrins, a
family of proteins induced by environmental stresses, such as water, salt and cold.

A Mediterranean *Pistacia* germplasm collection is being established at the Jacob Blaustein Institute for desert Research, Sede Boker Campus. This project was initiated as a cooperation between the Israeli group and an Egyptian and Belgian groups. The collection consists of a live seedlings collection and a seed collection. Seeds of *Pistacia* species growing around the Mediterranean basin have been collected since 1995. The collection is planned to host the species, subspecies and hybrids of the genus *Pistacia*. So far, we have collected over 300 accessions of 8 species from Tunisia, Spain, Greece, Cyprus, Israel, Turkmenistan, Jordan, Turkey, Syria and Egypt. Of each accession 5 to 10 seedlings will be planted in the live collection. Seeds of each accession are also stored as a seed gene bank for future use. The broad objective of this germplasm collection is to evaluate the accessions in the collection at macroscopic, molecular and biotechnological levels. Preparation of a descriptor identification list of each accession in our collection at the botanical, phenological and molecular levels is underway.

Acknowledgments: I thank Prof. P. Van Damme, Prof. N. A. M. Saleh and Mr. P. Van Mele for their cooperation in this project and in seed collection and to Mr. P. Cherksamy and his team at JNF Gilat Nursery for seed germination. We thank greatly all our colleagues around the Mediterranean basin and around the world who assisted in seed collection in their countries. The germplasm collection establishment was carried out with the support of the European Commission.

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CONGRESSES AND MEETINGS

SECOND SUCCESSFUL ALMOND AND PISTACHIO SYMPOSIUM HELD AT DAVIS, CALIFORNIA

Davis California, USA was the site of the International Society of Horticultural Science Second International Symposium on Pistachio and Almond convened by Drs. Dale Kester and Louise Ferguson. The 93 papers presented and the networking roster of attendees, with direct E-mail links, are now listed online at http://pom44.ucdavis.edu.ishsnet.html. Proceedings will be available January, 1998 through ISHS headquarters. The next symposium will be convened in Zaragoza, Spain by Dr. R. Socias I Company in 2001.

V MEETING OF THE EUROPEAN PRUNUS GENOME MAPPING PROJECT

The fifth meeting of the collaborative EU *Prunus* Genome Mapping Project (AIR3-CT3-1585) was held at HRI-East Malling, England, on 31 October and 1 November, 1997. It was attended by the staff from the various institutes involved, IRTA Cabrils and Mas Bové, Spain, CIm Arkaute, Spain, INRA Bordeaux and Orleans, France, ISF Rome, Italy, and HRI-East Malling, together with several students currently working at East Malling, and Richard Hardwick from the European Commission. Progress in the development of molecular markers in the crops studied in the project was reported, including cherry, peach and plum, as well as almond.

An important achievement in almond, by IRTA, was the elaboration of a genetic map in the progeny ‘Ferragnes’ x ‘Tuono’ of 183 markers (120 RFLPs, 56 RAPDs and 7 isoenzymes). Various major genes have been mapped in this or other progenies, including genes for incompatibility and kernel bitterness, and Quantitative Trait Loci have been detected for kernel size, shell hardness and flowering time. Mapping of these characters paves the way for marker-assis-
SESSION ON THE ALMOND TREE IN THE MEMORY OF EFGENIO GARCÍA

On February 18, 1997 a “Session on the almond tree” was held in the Centro de Edafología y Biología Aplicada del Suelo (CEBAS-CSIC) in Murcia, in the memory of Efigenio García García, Scientific Researcher of the CSIC, Head of the Department of Breeding and Plant Pathology of this Center, unfortunately dead last December. His wife, María and their two daughters, María and Marta, as well as numerous personalities of the scientific and agrarian environment, friends and colleagues of the Researcher attended the act.

The Session was inaugurated by the Director of the CEBAS, A. Cerdà and consisted of two parts:
The first part was directed to remember the professional career of Efigenio García from its beginning in the Course of Horticulture of the CIHEAM that he developed in Zaragoza, his stay in the INRA in Bordeaux, his teaching experience in the Escuela de Ingenieros in Orihuela and, finally, his longer and more important period, in the Grupo de Mejora de Frutales of the CEBAS. In this part, which developed in a very emotive way, T. Berenguer, Ch. Grasselly, F. Riquelme, J. Egea, A. Martínez and F. Dicenta took part. All the participants emphasized the scientific profile and the human values of Efigenio García.

After a short coffee break, the second part of the homage began. This had a more scientific content on a species to which E. García devoted his life: the almond tree.

Firstly, Ch. Grasselly of the Station of Recherches Fruitières Méditerranéenes of the INRA in Avignon, spoke about the huge variability that almond tree presents for the most important traits and its possibilities of use in the breeding programs.

F.J. Vargas, Head of the Departament d’Arboricultura Mediterrània of the Centro Mas Bové of the IRTA in Reus, centered his speech on the utilization of the early selection as a very useful tool in the almond tree breeding programs, giving rise to a high number of descendants on which to carry out a rapid selection. This increases notably the possibilities of obtaining an improved variety in less time.

R. Socias i Company, Head of the Unidad de Fruticultura of the SIA in Zaragoza, stated a very important topic in almond tree and to which he has dedicated a long part of his scientific career: the self-compatibility. The obtaining of new self-compatible almond varieties has become a common objective of the breeding programs over the world.

A. Felippe researcher of the Unidad de Fruticultura of the SIA in Zaragoza, brought us up to date on the rootstocks obtaining for the almond tree and their utilization depending on the characteristics of the soil.

The session finished with the speech of J.L. Albacete, Representative of Nuts of the Federación de Cooperativas Agrarias of Murcia, that introduced us to the economic aspects of the almond market in Spain.

The organizers sincerely thank the lecturers and the wide audience for their participation in this act, a token of our friendship for Efigenio.

F. Dicenta
CEBAS-CSIC, Apartado 4195
30080 Murcia, Spain

WORKSHOP ON WALNUT IN LOGROÑO, LA RIOJA, SPAIN

The Department of Agriculture, Livestock and Rural Development of La Rioja in collaboration with the ‘Foundation Caja Rioja’ and the European Social Fund organised a one day workshop on walnut both for fruit and timber, in Logroño on the 26th of November, 1997.

The topics presented and discussed were:

The different subjects were developed by researchers of the Dept. d’Arboricultura Mediterrània of IRTA-Mas Bové (N. Aleťà, A. Ninot and M.A. Romero). The number of participants was over 100 people between advisors, extensionists, technicians and farmers. There were open discussions and the Workshop was a success.
TO BE HELD:

**Fruit and nut trees**

**XI Colloque sur les Recherches Fruitières**

**Architecture et Modélisation en Arboriculture Fruitière (INRA-Ctifl)**

Date: 5-6 March 1998

Place: Montpellier, France

Convener: P.E. Lauri

Laboratoire d’Arboriculture Fruitière

INRA-AGRO Montpellier

2, Place P. Viala

34060 Montpellier cedex 1 (France)

**VI World Tree Nut Convention**

Date: 22-24 May 1998

Place: Charleston (South Carolina) USA

Convener: J. Swink / G. Guasch

International Nut Council (INC)

C/ Boule, 4

E-43201 Reus, Spain

Tel: +34-977 33 14 16

Fax: +34-977 31 50 28

E-mail: inc@readysoft.es

**Almond and Pistachio**

**XI GREMPA - Almond and Pistachio Meeting**

Date: September 1999

Place: Sanliurfa, Turkey

Convener: B.E. Ak

Harran University

Faculty of Agriculture

63200 - Sanliurfa (Turkey)

Tel.: +90 (414) 247 03 83

Fax: +90 (414) 247 03 85

or +90 (414) 312 81 44

**III ISHS-FAO International Congress on Pistachio and Almond**

Date: 2001

Place: Zaragoza, Spain

Convener: R. Socias i Company

SIA-DGA, Unidad de Fruticultura

Apartado. 727 - 50080 Zaragoza

Tel.: +34-976 57 63 11

Fax: +34-976 57 55 01

E-mail: rsc@mizar.csis.es

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**Chestnut**

**II ISHS-FAO International Congress on Chestnut**

Date: 19-24 October 1998

Place: Bordeaux (France)

Convener: G. Salesses

INRA, Station de Recherches Fruitières

BP 81, 33883 Villenave d’Ornon CEDEX. France

Tel.: +33-56843277

Fax: +33-56843083

**Walnut**

**ISHS-FAO IV International Walnut Congress**

Date: September 1999

Place: Bordeaux (France)

Convener: E. Germain

INRA, Station de Recherches Fruitières de Bordeaux

BP 81, 33883 Villenave d’Ornon (France)

Tel: +33 - 56.843277

Fax: +33 - 56.843083

E-mail: urefv@bordeaux.inra.fr

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**MEETING OF THE SPANISH NUT AND CAROB INDUSTRY WITH ALMOND BREEDERS.**

The “Asociación Española de OPAS de Frutos Secos y algarrobos” (AEOFRUSE) (the Spanish Association grouping producers of nuts and carobs) will hold a Meeting next 17th of March at IRITA-Mas Bovié, Reus, Spain with Spanish almond breeders. Breeders from the three institutes developing breeding programmes on almond: CEBAS-CSIC, IRITA Mas Bovié and Cabrilis, and Murcia, SIA - DGA Zaragoza will participate. The meeting will start by visiting Mas Bovié premises. The almond collection and selecting plots will be visited. After this field visit participants will gather for 2 hours to hear main R&D lines about the three Spanish breeding programmes from project leaders of each Institute. Finally a round table to discuss about the possibilities to breed late flowering cultivars is planned. This type of meetings are very useful to ensure that research projects are aimed towards solving growers’ needs.
The ‘ideal’ references on nut trees to be included in the NUCIS bibliographic section should be those of recent work produced in countries of the Network: Europe, North Africa and the Near East. However, now that this Network is being extended to interested countries outside the Mediterranean Region and as the ISHS Newsletter on Nuts is no longer published, this bibliographic section has expanded the range of references. Thus references broadly related to nut tree growing and economics are most welcomed. References of work published in journals of limited circulation or documents (Master and PhD theses and reports) which are difficult to search due to their limited diffusion would be the most interesting. This is why we ask readers to send this type of references (known as ‘grey literature’) to the Editor for coming issues of the newsletter. In addition, bibliography on nut tree crops appeared in referred journals can also be included.

ALMOND


FAO - Nucis-Newsletter, Number 6 December 1997
CAROB


CHESTNUT


ECONOMY


HAZELNUT


**PECAN**


**PISTACHIO**


**WALNUT**


**NUTS**


**PROCEEDINGS**


**REPORTS**


**MASTERS**


**THESES**

Acar, I., 1997. A study on the morphological and biological features of the selected male pistachio types at Ceylanpinar state farm (in Turkish with summary in English). Harran University, Faculty of Agriculture, Sanlurfa, Turkey. 92 pp.


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<td>Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria INIA Centro</td>
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