NUCIS
NEWSLETTER

Information Bulletin of the Research Network on Nuts (FAO-CIHEAM) Number 8 December 1999

CIHEAM

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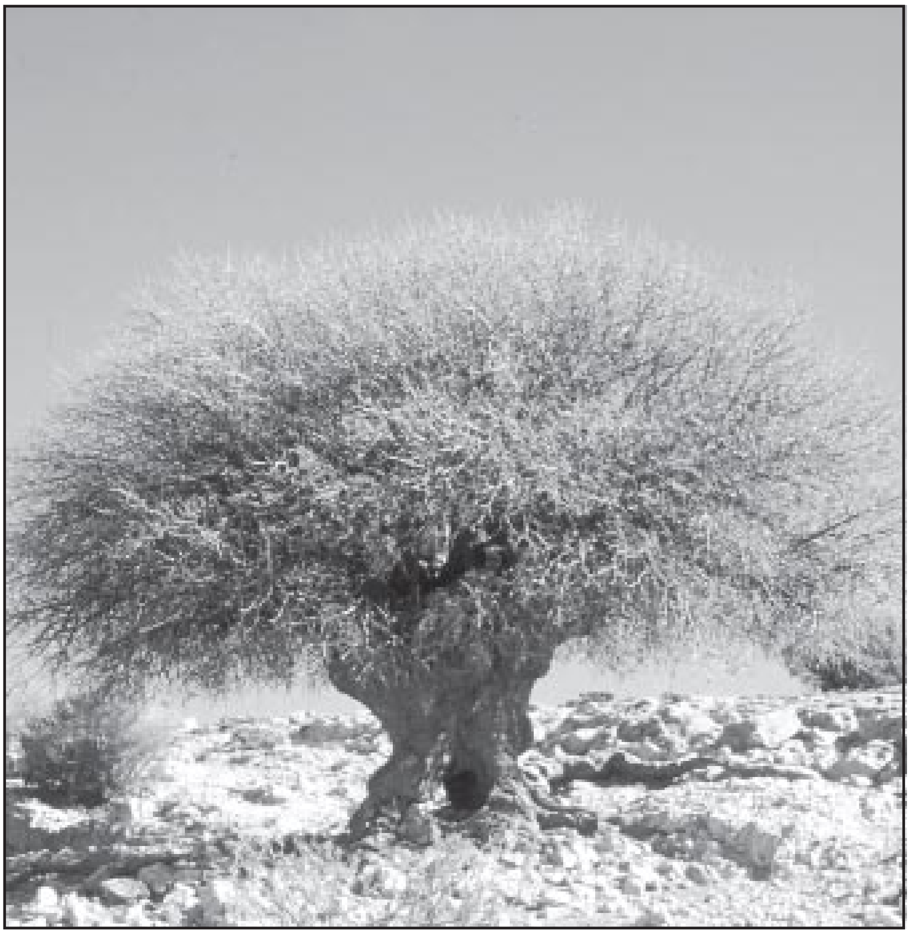
FAO CIHEAM
Nut Network

EDITORIAL



P. atlantica tree growing in Jordan

During 1999 a number of planned activities were carried out within the FAO-CIHEAM Interregional Cooperative Research Network on Nuts following the agreed programme (1997-2002). The XI GREMPA Meeting on Pistachio and Almond was held in early September in Sanliurfa, Turkey. This Meeting was organized by the University of Harran and supported by CIHEAM. The IV International Symposium on Walnut was held in Bordeaux, France, in mid September. This Symposium was organized by the Institut National de la Recherche Agronomique (INRA) under the auspices of the International Society for Horticultural Science (ISHS) and supported by the Centre technique interprofessionnele des fruites et légumes (Ctifl), FAO and CIHEAM. In each case, corresponding Subnetwork meetings took place. However, an International Congress on Stone Pine, planned to be held in Valladolid, Spain, was rescheduled for February 2000.

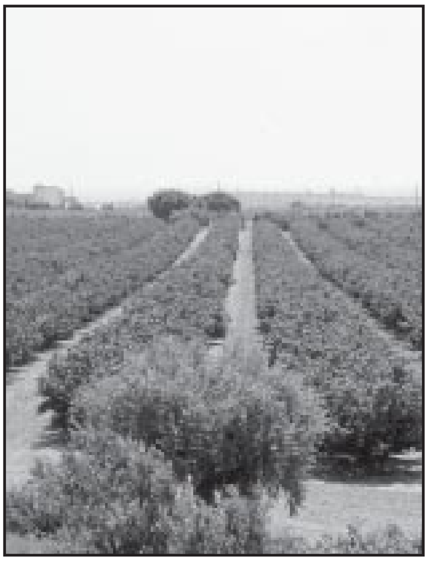
Regarding Inventories on Germplasm, Research and References, it is important to stress the work carried out collecting related information. The first Inventory on Almond, edited by F. Monastra and E. Raparelli was published and distributed in 1997. In 1999 the Inventory on Hazelnut Germplasm, Research and References was compiled and is ready for publication early next year. A.I. Köksal is the editor with the support of E. Germain, M. Rovira and I. Batlle. The FAO Regional Office for Europe and CIHEAM-IAMZ also contributed to its editing. The Inventory on Walnut Germplasm, Research and References is being collated after a new call for providing information launched during the IV International Symposium on Walnut held in Bordeaux. E. Germain, Liaison Officer of the Walnut Subnetwork, is in charge of its publication. As both publications are species germplasm related, the Subnetwork on Genetic Resources has been closely involved in the editing. We, as Coordination Centre of the Nut Network, are very grateful to all institutions and researchers who contributed by sending useful information and encouraging curators to complete it. The Inventory on Chestnut Germplasm, Research and References is being produced by G. Bounous, Liaison Officer of the Chestnut Subnetwork. The Inventory on Pistachio Germplasm, Research and References, which will be produced jointly with the International Plant Genetic Resources Institute (IPGRI), was relaunched during the XI GREMPA Meeting on Pistachio and Almond held in Sanliurfa, Turkey and now N. Kaska, Liaison Officer of the Pistachio Subnetwork and B.E. Ak are compiling the information requested via internet. All these catalogues are being funded by FAO's Regional Office for Europe (REU), the Seed and Plant Genetic Resources Service (AGPS) together with CIHEAM-IAMZ.

In addition, a special volume of Options Méditerranéennes containing the papers presented at the Economics Subnetwork Meeting held in late 1996 in CIHEAM-IAMZ, Zaragoza, to review the economic situation of the nut sector in different Mediterranean countries, has been edited. This volume will be used as a base document for calling a new meeting of the Economics Subnetwork during 2000 in Reggio Calabria, Italy.

The approach of the next century has generated many discussions and uncertainties about the future. The trend to a global economy and the new trade agreements have originated significant changes in most aspects of horticultural production and thus also on nut tree production. It seems clear that the ability to predict new trends and to adjust them to the future market efficiently will afford new opportunities for nut tree growers. It is necessary to quickly adopt changes for global competition while covering customer demands. Changes are needed at all levels: training, research and industry. Research is critical for generating new knowledge, which is then spread through training and extension to reach production practices. Combining public and private funding of agricultural research is currently the trend. However there are likely to be continued efforts towards more regional approaches and cooperation among institutions.

A large number of activities regarding scientific collaboration and training, has been carried out since the establishment of the Research Nut Network by FAO in 1990. However, an important gap is still to be filled and this is the development of joint research projects with the participation of partners from different countries. We should go further by drafting project proposals and seeking funding opportunities. There is now the EC Fifth Framework Programme for funding research projects. We should look for funding opportunities in the future if we are to strengthen collaborative work within our Nut Network.

A short version of the Newsletter (Editorial, contents and backpage) from issue number 6 onwards, is available on 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). The contents of this Newsletter can be browsed through and also copied and printed. This will further help to disburse 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).



Hazelnut orchard growing at Constantí, Spain

As in past NUCIS editorials, we stress again 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 suggest ideas or to express their opinion about the work developed by the Network (activities carried out and planned) or to publish short articles and report on relevant horticultural subjects of general interest. We receive a sufficient number of contributions from the Mediterranean basin and overseas (examples of Australia and the USA reports on almond are again in this issue) for the articles and reports section. However, the sections on news and notes and also on congresses and meetings are usually difficult to cover due to the scarce number of accounts received and thus contributions are most welcomed. Otherwise, the Editor has to report on the issues he is aware of, but certainly there are many more issues carried out throughout the year which merit reporting. Also, the place for 'grey' bibliography (references and documents which are difficult to search like Masters or Ph Theses) is scarcely filled.

IRTA Mas Bové, as Coordination Centre of the FAO-CIHEAM Interregional Cooperative Research Network on Nuts, has over the years developed a large database of Network members divided by fields of interest and it needs to be periodically updated. There is also a specific NUCIS mailing list including some 890 entries belonging to 61 different countries. We would like to update this list due to the high cost of publishing and distributing of this free bulletin, which has an edition of 1200 copies. Attached to this issue there is a simple form requesting confirmation of interest to carry on receiving the NUCIS Newsletter. In addition, to update our database there is a section to be filled with the complete address, telephone, fax and electronic mail and field of interest (almond, chestnut, economics, genetic resources, pecan, pistachio, stone pine, quality and walnut). Also there is a short questionnaire on NUCIS to assess the level of interest raised by each individual section including a place for making comments.

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 send them through Internet using the Editor's Email. The alternative is to provide them on diskette and also in printed format. Information should be sent 'in English'. The editing task in the eight NUCIS issues already published has been huge (NUCIS 1, 8 pages; 2, 20 pages; 3, 24 pages; 4, 28 pages; 5, 36 pages; 6, 52 pages, 7, 44 pages and 8, 48 pages). This time consuming major editing can no longer be provided by the Coordination Centre of our Nut Network as time and resources are limited. 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, number 9 (December 2000) by the end of November 2000. Finally we wish all Nut Network members and collaborators a creative and Happy Year 2000.

The Editor

Contributions should be written concisely in English. Please send contributions on paper and diskette (Microsoftâ Word or Word Perfectâ). Authors are responsible for the content of their papers. Reproduction of the articles is authorised, provided that the original source is clearly stated.

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AN ECONOMIC OUTLOOK OF THE NUT TREES SECTOR IN GREECE

INTRODUCTION

Tree nut crops have been traditionally cultivated in Greece mainly due to the favourable weather and soil conditions that prevail in the whole Mediterranean area, which is a major nut producing area.

Nuts are considered healthy products, being rich in fibre, vitamins, minerals and other nutrients as well as containing mostly mono-unsaturated fats which have been shown to lower cholesterol levels. Being part of the increasingly popular 'Mediterranean diet', it is possible to exploit on the growing concern on health and dietary aspects of the consumers in order to trigger consumer demand (Albisu 1995). In addition to the final consumer demand, nuts are widely used as inputs by the confectionery industry, thereby increasing final demand sources. In fact, the food processing industry is such a major outlet for nut products that for some crops special varieties have been developed and cultivated that meet distinct product and quality characteristics desirable by the industry.

PRODUCTION

Cultivated Area

Accounting for a draft delimitation of the production areas of nuts in Greece, it is noticeable that nuts are grown almost everywhere in Greece, primarily on the mainland. Principal producing regions are the districts of Thessalia (28% of total area), Peloponnese (16%) and Central Macedonia (15%). Still, there is a wide variation regarding the particular nut crop. Almonds are grown to a great extent in the north, namely Thessalia (40%) and Central Macedonia (17%). Walnuts are mostly cultivated in the southern areas of Peloponnese (38%) and West-Central Greece (26%). Hazelnuts are favoured in Central Macedonia (40%) and Eastern Macedonia & Thrace (30%), while chestnuts are grown mainly in Thessalia (29%) and Peloponnese (22%). Cultivation of pistachios on the other hand, is not as dispersed: they are grown in specific areas, Greater Athens area (45%) and nearby districts (30%) (National Statistical Service of Greece).

Orchards cultivating nuts in Greece represent only 13% of the total number of tree-cultivating farms, while the percentage of the total area is even less, namely 5.5% (National Statistical Service of Greece). Intuitively it can be argued that other crops are more favoured as cultivation alternatives among producers in Greece, namely fruits (stone and citrus fruits, apples, peaches) in the low-lands and olives in the high-lands.

It should be further stressed that the size of farms producing nuts is smaller not only compared to that of tree nuts farms in other countries, but also compared to the size of other tree crops farms in Greece. Almost two thirds of the nut orchards are less than 20 stremmas (1 str. = acre) and more than 40% do not exceed 10 stremmas (2.5 acres). This has several negative implications on the competitiveness of Greek nut products and consequently on nut producers' income, since it increases production costs and disallows for the implementation of advanced production techniques. Economies of scale cannot be achieved and even the existence of producers organisations that could alleviate this constraint is not as common in the nut sector as in other sectors; there are only three second-degree and one first-degree cooperative that are involved in the manufacturing (processing) phase of nuts and another two second-degree cooperatives that are involved in the commercial (distribution) phase (ICAP 1997).

An insight of the structure of organised nut orchards in Greece may be provided by tracing and comparing the average sizes of the five different nut crops farms, in terms of acreage (Table 1) and of the total number of trees out of which some interesting issues can be raised. Farm size is small, typical size of a farm for almonds, chestnuts and pistachios being in the range of 10 to 20 stremmas. Hazelnuts and walnuts farms are usually smaller (less than 10 stremmas and less than 5, respectively). Large farms with more than 50 stremmas represent for all crops a small fraction of the total and only in the case of pistachios they account for more than 10 percent. On the other hand, virtually all pistachios and hazelnut trees are cultivated within organised orchards. At a slightly smaller proportion but still being the overwhelming majority, this is also the case for chestnuts and almonds, while a large number of walnuts (more than 20%) is grown wild. This can be correlated with the fact that the size of walnuts farms was shown to be the smallest among all nut farms as seen in Table 1.

Production volumes

Greece is the third largest producer of nuts in the European Union, after Spain and Italy, accounting for almost 10% of the total EU production. At a world level, Greece can be characterised as a me-

Table 1. Number of orchards and total areas of tree nuts in Greece, 1991

Size (acre)	Almonds		Walnuts		Chestnuts		Hazelnuts		Pistachios	
	No. of farms (%)	Area	No. of farms (%)	Area	No. of farms (%)	Area	No. of farms (%)	Area	No. of farms (%)	Area
< 5	14.54	8327	31.64	14113	16.37	3310	27.90	2797	15.78	1625
5 - 9,9	17.97	19679	21.80	18854	16.72	6577	29.43	6252	18.30	3601
10 - 19,9	27.26	48485	21.16	26726	24.39	15384	26.58	8838	24.68	7278
20 - 29,9	16.78	44178	10.42	14481	17.51	17101	9.43	4191	15.23	6156
30 - 39,9	9.61	32302	5.89	9586	9.88	12693	3.46	1545	9.79	4901
40 - 49,9	5.18	19916	3.34	6080	5.50	8069	1.76	899	5.40	3074
> 50	8.66	46690	5.76	13555	9.62	21563	1.43	858	10.82	10435
TOTAL	**32292**	**219577**	**25647**	**103395**	**10921**	**84697**	**4251**	**25380**	**4924**	**37070**

Source: National Statistical Service of Greece - authors' compilation

dium sized producer of nuts, when compared to the output of USA (around 18%), China (8%), Middle East countries (Turkey 14%, Iran 7%) and other European countries (Spain 6.6%, Italy 6%). Nevertheless, Greece produces more than 2% of world nuts production - which is almost five million metric tonnes - and ranks ninth among the biggest nut producing countries in the world, following the above mentioned countries as well as India and Brazil (calculated from FAO's Statistical databases, 1990-1994 averages). Production had grown at a considerable rate during the period 1961 to 1981, as in 1981 the highest volumes were attained, reaching 126,595 metric tonnes. However, since then, allowing year-to-year variations, there is a downward trend, particularly during the 1990s. In 1994 the volume of production did not exceed 100,000 metric tonnes. It seems that although Greek farmers used to favour the cultivation of nut crops in the past, there is a strong tendency in the last two decades to abandon this production. The underlying reason is the small turnover, due to increased production costs and lower producer prices. Increased production costs are mainly due to the small size of farms that disallows for mechanisation and other economies of scale, while low producer prices are attributed to the intensified competition with nuts from other countries that are cheaper.

The most important nut crops in Greece are almonds, walnuts, pistachios, hazelnuts and chestnuts. Almonds account for more than half of the total production (about 55,000 t), followed by walnuts (22,000 t) and chestnuts (11,000 t). Hazelnuts (5,000 t) and pistachios (5,000 t) represent about 5% each. For all nuts but pistachios, production has been declining over the last years. The most sharp fall is exhibited by hazelnuts: output is dropping each year since 1988, while compared to the volumes produced in 1981-83 it is merely half (Table 2). Chestnuts, walnuts and almonds exhibit a similar but less dramatic pattern, as the output reduction ranges from ten to twenty percent. On the other hand, there is a distinct increase of the pistachios production that has led to a doubling of the volumes produced in 1994 compared to the period 1981-83.

Table 2. Production index of nut crops in Greece (1981/1983=100)

Year	Almonds	Walnuts	Chestnuts	Pistachios	Hazelnuts	Nuts, total
1975	68,55	89,88	116,09	55,92	39,14	76,51
1976	58,61	95,18	107,57	74,26	46,07	72,42
1977	51,22	74,68	93,05	64,13	57,69	62,71
1978	68,34	82,11	98,85	58,15	80,26	76,13
1979	49,07	80,46	93,80	85,64	70,26	64,59
1980	67,51	84,97	101,93	98,31	87,82	78,30
1981	120,50	98,75	93,92	88,10	116,97	111,11
1982	81,97	95,61	105,53	84,07	91,68	88,96
1983	97,53	105,64	100,55	127,83	91,34	99,93
1984	88,40	104,59	83,40	140,77	94,87	93,31
1985	94,13	108,36	73,74	159,03	70,33	94,31
1986	85,33	93,11	81,47	143,51	110,17	90,16
1987	56,29	67,36	76,72	170,02	77,14	65,78
1988	102,44	82,33	69,58	165,95	159,13	100,11
1989	103,20	91,83	98,28	217,06	73,51	99,89
1990	87,92	86,43	77,57	134,48	66,83	85,49
1991	92,51	83,28	92,43	195,09	64,87	90,22
1992	101,87	94,37	81,37	187,15	54,71	95,36
1993	94,22	91,92	79,12	160,32	49,90	89,41
1994	91,68	83,46	81,97	211,16	49,90	87,57

Source: FAO - authors' compilation

TRADE AND CONSUMPTION

Greece's balance of trade

Greece was a net importer of nut products until 1980 although the volumes traded were not very significant. Total imports rarely exceeded 1000 t and total exports were even smaller. The country's accession in the European Union however, led to a substantial increase of exports in the first few years, resulting to exporting volumes as high as 20,000 t in 1989. Since then, exports have dropped to half as much, whereas, imports have risen to 15,000 - 20,000 t. Perhaps this can be explained by the low world prices and the trade liberalisation of the EU that has severely affected Greek products' competitiveness, as they became more expensive than products from other countries. In addition, low volumes of production (both aggregate and by individual orchards), the lack of a well-organised promoting system (inefficient cooperatives, poor trade conducts and export management performance) and perhaps more significantly, the low homogeneity of Greek production are also accountable for small demand of the domestic production by big international confectionery industries.

Today Greece imports mainly pistachios from Iran and China, hazelnuts from Turkey, and walnuts from USA and China. It has a deficit on all particular nut crops

Almond orchard under dry conditions

apart from almonds in which self-sufficiency is achieved and some quantities are also exported.

DOMESTIC MARKET

Consumption

On the other hand, domestic market is large enough to counterbalance production. Per capita absorbency[1] of nut products in Greece is the highest in the European Union and one of the highest in the world, amounting to almost ten kg in 1994 with a distinct upwards trend. As far as final consumer consumption is concerned, Greece has the highest per capita consumption of nuts in the world, which is almost three kg per year of nuts net. If direct and indirect consumption are added, - that is, consumption of nuts net and consumption of nut products - 2.5 kg of pistachios, 1.5 kg of almonds and 0.5 kg of walnuts are annually consumed in Greece and there is an annual growth rate of 2 to 4% (Nautemporiki 1996a, 1996b). According to the Ministry of Development, pistachios represent 33% of the nut market ('Aegina' 21%, other varieties 12%), almonds account for 22%, walnuts for 14%, hazelnuts for 11% and other nuts for the remaining 20%.

Consumption of nuts in Greece exhibits heavy seasonal variations, despite the homogenous supply of the market. Nut consumption seems to be strongly correlated to feasts and it is thus at very low levels at summer, it gradually increases later on and has its peak during Christmas. After a small decline in January, it rises during February and March.

Prices

It has been said earlier, that the reason for low Greek exports is the low world prices that turned domestic products to non-competitive ones. This fact has also had an impact in the domestic market as well. In 1992 trade barriers for imported nuts in Greece were abolished and the protection of domestic production through the imposition of tariffs was relaxed. Consequently, imports from other countries increased substantially. Domestically produced nuts could not compete with the imported ones because of the latter's lower prices (due to some countries' better efficiency in production techniques, other countries' lower labour input prices) and have therefore lost market shares not only abroad but also in the Greek market.

The market deregulation that took place in 1992 resulted in stagnant or in some cases even decreasing producer prices for nuts. Retail prices of nuts have also remained stable in the last years as the average prices in the decade 1985-1995 exhibit only small fluctuations. It should be emphasised that imported nuts are generally less expensive than the domestic ones; indeed in some cases their prices can be as much as five times lower than Greek nut prices. Consequently, imported nuts are usually preferred by the consumers as they do not place any quality differentiation, at least not any significant enough to pay a premium for. Perhaps the only exemption are pistachios, for consumers strongly prefer the local cultivar 'Aegina' that has considerable price difference from other cultivars.

Structure of the chain supply

Thirty-seven percent of all domestic and imported quantities are directed towards the food industry of pastry-making and confectionery products. Apart from the food firms that use nuts with no processing as inputs for the production of final products (chocolates etc), nuts are also used by industries that create semi-final products (almond and hazelnut paste for the chocolate industry, cream paste for pastry products, croissants and snacks). Firms distributing standardised and packaged nuts account for fifteen percent excluding another ten to twelve percent that is packaged by small family-like businesses. The bulk is sold unpacked in specialised outlets. Certain quantities are also sold at street-markets, usually by the producers themselves and in large retail chains (super-markets, hyper-markets).

The number of specialised outlets has been increasing over the last years and they are becoming also more organised, expanding the range of the products sold. Today there can be as many as fourty different nut products sold, while in the past there were only ten (Nautemporiki 1996). Apart from the traditional nut crops (almonds, chestnuts, pistachios, walnuts and hazelnuts), increasingly popular are becoming cashews, macadamias, pecans and pine nuts. Nuts are sold in various forms, both shelled and unshelled, whole, halved, chopped or minced, salted or unsalted, blanched, dry-roasted or oil-roasted. In addition, various other products (beverages, alcohol etc.) have also been added in order to attract consumers. Nevertheless, considering the overall growing importance of large retail chains, it seems that the quantities marketed through these outlets could increase in the future at the expense of the traditional outlets, as a result of the consumers' effort-reducing and convenience-seeking behaviour.

Typical of the supply chain of nuts in Greece is the large number of firms involved, whose size is in most cases small. Small businesses that are active in any of the processing, packaging, and distributing (wholesaling) stage, are more than 350, as opposed to only 10 large businesses that nevertheless, own the biggest share of the market, which is in total around 35 - 40 billion Drch. (at Feb. 27, 1997: 1 US$ = 263.83 Drch.). Consequently, small businesses face several difficulties, while large firms have managed to expand, in some cases by offering differentiated products with higher added value, in other by diversifying into foreign markets. The latter is expected to increase in the future, since already for some companies, export sales constitute around 30% of their turnover, while they can be ever greater, almost 70%.

Major export destinations are Eastern European countries (Russia, Czechia, Bulgaria, Romania) and considerable bulk of exports is directed also to Western European countries (Germany, Belgium, United Kingdom). In this sense, Greece may not be exporting nuts raw, but it has managed to increase its efficiency as an intermediary and redistribution centre for the rest of Europe, as imported quantities are assigned not just for domestic consumption, but after being stored, processed, standardised and packaged, they are reexported to third countries. In some cases, future plans for certain Greek firms include investments on plant production abroad; one is already operating in Moldavia processing walnuts. Big Greek companies in the nut sector include Cardassilaris & Sons S.A. (5,360,541 thousand Drch. turnover in 1995. This company is both processor and wholesaler. Others are Vamvalis S.A. (3,191,333 Processor), Natex S.A. (2,070,896. Both), Argyrakis Bros S.A. (1,260,156. Both), Kalatheris S. & Bros S.A. (1,243,640. Processor), Xirofrout S.A. (878,177. Both), Pami S.A. (758,076. Processor), Siprima Fruits Ltd. (702,145. Wholesaler), Alco S.A. (687,151. Processor), Roupakas Ltd. (649,898. Both) (ICAP 1997).

Manufacture companies in the nut sector represent around 1.5% of total sales of food manufacturing industries in Greece, while their profitability share is similar, as opposed to milk products (16 and 8 % respectively), oil and fats products (16% and 11%), sugar products (11% and 22%), flour and bread products (10% and 12%) and meats (7% and 5%). Total advertisement expenditures of nut processing industries is in general limited, reaching in 1994 6,065,000 Drch. - approximately 37% increase over 1993 - and was allocated almost exclusively at magazines (5,994,000 Drch.). No advertising was made through television and newspapers (although for the latter, in 1993 the share was almost equivalent to that of magazines) and very small through the radio. (Hellenews 1994, 1997).

CONCLUSIONS

Tree nuts cultivation in Greece has remained stable over the last years, despite certain prosperous potentials in the world market for such products. Nuts are usually cultivated in Greece in semimountainous areas that are not properly irrigated, while average farm size is relatively small, a fact which disallows for economies of scale and the implementation of more advanced technologies. Production costs are high and this has an effect on nut prices that are higher than the world average. Consequently, foreign markets and food processing industries do not constitute a major alternative, mainly due to heavy competition from other sources with lower prices and greater exporting volumes. The competitiveness of the Greek nut sector, alike the aggregate competitiveness of all food products, seems to have declined (Mattas and Galanopoulos, 1996).

Nevertheless, nuts constitute an important element of Greek diet and domestic consumption is accordingly, quite high and adequate to absorb not only home production, but also imports as well. Per capita consumption of nuts in Greece is the highest in the world with a distinct upwards trend and therefore, if mechanisation of production techniques is intensified and nut orchards become more market-oriented, by cultivating varieties that have desirable characteristics and emphasise on quality rather than price differentiation, future prospects can be promising. Considerable gains for the producers could be generated if producers organisations become more organized in order to be eligible for EU subsidisation programmes and increase their involvement in the distribution of nuts.

In the commercial side of the nut sector, there is a big number of firms involved in processing and distribution, but the majority are small businesses. Large Greek nut processing firms have grown over the last years, increased their market share in the domestic market and have expanded their exports abroad capitalising on lower input prices of imported nuts that due to the relaxation of import barriers became easily accessible to them.

In essence, the cultivation of pistachios and walnuts appears to be more preferred since future market prospects for these two nut crops show favourable demand trends, as opposed to hazelnuts, almonds and chestnuts, whose market is saturated and production is declining. Crucial for the volumes of production of nuts remains the domestic market. Factors such as consumer and industry demand, price levels and import quantities will have an impact on the production of these commodities.

REFERENCES

Albisu, L.M. (1995). Can the Mediterranean countries afford not to be organised? Nucis Newsletter 4: 16-17.

FAO (1990). Market prospects for edible nuts. FAO Commodities and Trade Division, Rome.

Hellenews (1994). Foods and beverages. Special issue, February. (In Greek).

Hellenews (1997). Foods, beverages, wines and equipment. Special issue, February. (In Greek).

ICAP (1997). Greek Financial Directory. Vol. I (Manufacturing) and Vol. II (Commerce).

Mattas, K. and Galanopoulos, K. (1996). EU's food intra-trade: A retrospective analysis of competitiveness. Quarterly Journal of International Agriculture, Vol. 35(3): 257-268.

National Statistical Service of Greece. Various issues. (In Greek).

Nautemporiki (1996a). The market for food and beverages. Special annual issue, December. (In Greek).

Nautemporiki (1996b). The market for food and beverages. Special annual issue, February. (In Greek).

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[1] These statistics were taken from FAO's statistical database, where their relevant heading is per capita consumption, but most probably indicate absorbency, including both final consumers demand as well as industry demand. Hence, the term 'absorbency' rather than 'consumption' seems more appropriate.

THE NUT SECTOR IN TURKEY

INTRODUCTION

Nuts have been cultivated in Turkey for centuries as Turkey has favorable climatic and ecological conditions. They are also of great economic significance in Turkey. Hazelnut is the main nut in Turkey which is followed by walnut, chestnut, pistachio and almond. However only hazelnut, walnut, pistachio and almond have been selected for this study. Hazelnut is the leading nut in crop production with 74.9%. Walnut is the second in nut production with 15.5%. Pistachio and almond contribute some 5.2% and 4.4% respectively to Turkish nut production (Table 2).

The main objectives of this study are to examine development of the world and Turkish nut market; nut production, domestic consumption and world nut trade, to determine strengths and weaknesses of Turkey's domestic nut market, and to analyze opportunities and threats in the external markets.

WORLD NUT PRODUCTION AND DEVELOPMENT

World nut production has steadily increased from 1980 to 1998. World hazelnut production has almost doubled from 421,136 t in 1980 to 771,827 t in 1998[1]. Turkey has been dominant producer of hazelnut, producing around 75.1% of world hazelnut production in 1998. Italy is the second largest hazelnut producer with around 20% of world nut production. USA and Spain account for around 3.9% of the world production. The other producer countries are Greece, France and Portugal with small shares of world hazelnut production.

World walnut production went up from 795,415 t in 1980 to 1,095,041 t in 1998 with an increase of 37.7%. China and USA have contributed to the world production with 22.9%, and 18.7%, respectively, followed by Turkey and Iran.

World pistachio production has increased 4.3 times from 1980 to 1998. Iran is the leading country in pistachio production with a production ranging between 34% and 61%, recently. It is followed by USA, Turkey and Syria, respectively. These four countries produce 90% of pistachio world production.

World almond production has increased by 45.1% during 1980-1998 period and went up from 919,620 t in 1980 to 1,334,442 t in 1998. United States, especially California has been the major producer of almonds producing 30% of almond world production. Spain is the second largest producer in the world whose share varies between 15% and 25%. Italy is the other important producer country, although its production share is steadily decreasing. The other producer countries are Iran, Morocco, Greece, Syria, Tunisia, Pakistan and Turkey, but their share is very small.

TURKISH NUT PRODUCTION

The nut production in Turkey has increased notable from 1980 to 1998 due to increases in acreage and yield. However the rate of this increase varies according to the species of nuts.

In Turkey, the total number of nut trees has increased 11% from 1980-85 to 1998 (Table 1). Nevertheless, nut production during this period has increased 69% (Table 2). Within nut species; the number of pistachio trees has increased by 45.4% from 1980-85 to 1998, while pistachio production has increased two times from 1980 to 1998 due to increases in acreage. Pistachio production in Turkey has reached 40,000 t in 1998; and it has reached the highest level of 70,000 t in 1997. The total number of walnut trees follow the total number of pistachio trees with an increase of 12.1% from 1980-85 to 1998. On the other hand the number of non-bearing walnut trees (24.6% in 1998) has increased more than the number of bearing walnut trees during this period. It is noted that walnut (shelled) production has a stable declining trend between 1980-1985 and 1997 periods; and has reached 120,000 t in 1998. The total number of almond trees did not show significant changes between 1980 and 1990; but started to decline thereafter, due to new plantations. It is noted that the number of non-bearing almond trees are steadily decreasing. Taking 1996 as a base year, almond production is declining after 1997.

The total number of hazelnut trees has also increased 7.5% from 1980-1985 to

Table 1. Number of Nut Trees in Turkey (000)

Years	Hazelnut			Walnut			Pistachio			Almond			Total		
	Fruit bearing	Non-fruit bearing	Total	Fruit bearing	Non-fruit bearing	Total	Fruit bearing	Non-fruit bearing	Total	Fruit bearing	Non-fruit bearing	Total	Fruit bearing	Non-fruit bearing	Total
1980-85	247383	23675	271058	3215	927	4142	17342	12609	29951	3871	828	4699	271811	38039	309850
1986-90	258116	18919	277035	3259	988	4247	19482	14878	34361	4042	773	4814	284899	35558	320457
1991-95	254239	21627	275866	3407	1097	4504	22644	17507	40151	3947	731	4678	284237	40962	325199
1996	270295	20390	290685	3447	1047	4494	24480	19600	44080	3825	677	4502	302047	41714	343761
1997	271730	23200	294930	3445	1050	4495	25340	19200	44540	3775	640	4415	304290	44090	348380
1998	273980	17450	291430	3490	1155	4645	26050	17500	43550	3680	608	4288	307200	36713	343913
Index															
1980-85	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1986-90	104.3	79.9	102.2	101.4	106.6	102.5	112.3	118.0	114.7	104.4	93.4	102.4	103.4	93.5	103.4
1991-95	102.8	91.3	101.8	106.0	118.3	108.7	130.6	138.8	134.1	102.0	88.3	99.6	105.0	107.7	105.0
1996	109.3	86.1	107.2	107.2	112.9	108.5	141.2	155.4	147.2	98.8	81.8	95.8	110.9	109.7	110.9
1997	109.8	98.0	108.8	107.2	113.3	108.5	146.1	152.3	148.7	97.5	77.3	94.0	112.4	115.9	112.4
1998	110.8	73.7	107.5	108.6	124.6	112.1	150.2	138.8	145.4	95.1	73.4	91.3	113.0	96.5	111.0
%															
1980-85	91.0	62.2	87.5	1.2	2.4	1.3	6.4	33.1	9.7	1.4	2.2	1.5	100.0	100.0	100.0
1986-90	90.6	53.2	86.4	1.1	2.8	1.3	6.8	41.8	10.7	1.4	2.2	1.5	100.0	100.0	100.0
1991-95	89.4	52.8	84.8	1.2	2.7	1.4	8.0	42.7	12.3	1.4	1.8	1.4	100.0	100.0	100.0
1996	89.5	48.9	84.6	1.1	2.5	1.3	8.1	47.0	12.8	1.3	1.6	1.3	100.0	100.0	100.0
1997	89.3	52.6	84.7	1.1	2.4	1.3	8.3	43.5	12.8	1.2	1.5	1.3	100.0	100.0	100.0
1998	89.2	47.5	84.7	1.1	3.1	1.4	8.5	47.7	12.7	1.2	1.7	1.2	100.0	100.0	100.0

Source: SIS. 1999. The summary of agricultural statistics 1998. Ankara

Table 2. Nut production in Turkey (t)

Years	Hazelnut	Walnut shelled	Pistachio	Almond shelled	Total Nut
1980-1985	282500	118500	21417	35666	458083
1986-1990	381400	111600	25800	41400	560200
1991-1995	417000	117400	43800	45000	623200
1996	446000	115000	60000	43000	664000
1997	410000	115000	70000	33000	628000
1998	580000	120000	40000	34000	774000
		Índex			
1980-1985	100.0	100.0	100.0	100.0	100.0
1986-1990	135.0	94.2	120.5	116.1	122.3
1991-1995	147.6	99.1	204.5	126.2	136.0
1996	157.9	97.0	280.2	120.6	145.0
1997	145.1	97.0	326.8	92.5	137.1
1998	205.3	101.3	186.8	95.3	169.0
		%			
1980-1985	61.7	25.9	4.7	7.8	100.0
1986-1990	68.1	19.9	4.6	7.4	100.0
1991-1995	66.9	18.8	7.0	7.2	100.0
1996	67.2	17.3	9.0	6.5	100.0
1997	65.3	18.3	11.1	5.3	100.0
1998	74.9	15.5	5.2	4.4	100.0

Source: SIS. 1999. The summary of agricultural statistics 1998. Ankara.

1998, although hazelnut production has increased by two times from 1980 to 1998. Therefore, the number of non-bearing hazelnut trees has decreased 73.5% from 1980-1985 to 1998 due to limitation of hazelnut acreage by government. However the number of bearing hazelnut trees has increased 10.8% during this period.

The largest number of nut trees are hazelnuts with 84.7%. Pistachio is the second with 12.7% in number of nut trees. Nevertheless it is noted that the share of 47.7% pistachio non bearing trees is bigger than the part of pistachio bearing trees. The number of almond trees is almost the same as the share of walnut trees.

Concerning nut production, most part of it in Turkey is taken by hazelnut production as well as the total number of hazelnut trees. The second place is taken by walnut production, but walnut production is decreasing and walnut share has also decreased from 25.9% in 1980-1985 to 15.5% in 1998. The pistachio share in nut production is 5.2% in 1998. Pistachio share had an increasing trend until 1997; and it has reached maximum level with 11.1% in 1997. However, pistachio nut production has decreased from 11.1% in 1997 to 5.2% in 1998.

Almond had a stable trend with around 7.4% until 1991-1995 but after this period it took a declining trend which reached 4.4% in 1998.

WORLD AND TURKEY NUT TRADE

World hazelnut export has increased steadily during 1980-1997 period. World hazelnut export has risen from 129,570 t in 1980 to 178,997 t in 1997 with an increase of 38 %. Turkey is a leading country in hazelnut export. During 1980-1997 period, Turkey's situation in world export has increased from 75% in 1980 to over 77.2%. Italy's position in world export is quite stable during this period and were 15,560 t in 1980 with 12 % in the world export, 18,193 t in 1997 with 10% in the world export. United States reached 2% to 4% with an increasing trend.

Germany has been the main hazelnut importer reaching 43% of world imports in 1997. More than half of the world hazelnut export goes to European countries.

World walnut export (shelled) went up from 12,796 t in 1980 to 65,150 t in 1997. United States is the largest exporter accounting for around 50% of total world exports. China is the second largest exporter. France is the other important exporter in the world and the largest exporter in the Mediterranean Area. Turkey's share is negligible in the world walnut export, while the United Kingdom, France and Germany are the main walnut importers.

World pistachios export went up from 5,660 t in 1980 to 148,481 t in 1997. Iran is the largest producer and exporter and it contributes to 52.5% of pistachio exports. The United States and Syria are the other exporter countries with a participation of 7.6% and 7.0%, in world pistachio exports, in 1997, respectively. Turkey has relatively a low level export compared to the other producer countries. Some other countries such as Germany, Belgium, Luxembourg and England import pistachio in order to re-export it to other countries. Germany, for example, contributes 11.4% of world pistachio export by the re-exporting process. Turkey's pistachio export shares in world trade ranged from 15% to 30% during the first half of 1980's, this percentage decreased considerably since 1986. Turkey's pistachio export share is 2,9% of world pistachio export in 1997. Germany was also the leading country in importing pistachios with 27.4%. Germany is followed by Italy, Russia, France, Spain, Belgium, Luxembourg and China.

World shelled almond export increased twice during 1980-1997 and reached from 105,616 t in 1980 to 216,286 in 1997 doubling the increasement. United States is the largest exporter and producer with 70.3% in world almond export in 1997. Spain is the second almond exporter with 20.4% of world almond exports. Spain is also the largest almond exporter among other Mediterranean Countries. Turkey started to export almond in 1981, but its export volume is lower (0.1% of world export in 1997).

The European Union is the main importer with more than 50 % of total world almond imports. Germany accounted for 27% of world imports in 1997 and is followed by France and Japon. Italy, which was the net exporter until the early 1980's, is now a net importer. Turkey started exporting almonds in 1981. Turkey's export which has reached 142 t in 1981 and 267 t in 1997, is still very negligible with 0.1% of world almond export in 1997.

Most of Turkey's nut production except hazelnut is consumed at the home market. However, domestic consumption and export level per capita in Turkey is lower than in other producer countries.

Nuts have beneficial effects on heart and cardiac vascular diseases. The generic advertising and promotion activities, which are regularly carried out in USA and European Countries, can also be carried out in Turkey for increasing and promoting nut consumption. In addition, nuts can be utilized as 500 to 1,000 different products in the nut related industry. However, industrial use of nuts is not as high as it could be regarding the existing potential. Measures must be taken to increase the industrial use of nuts in Turkey. Processing facilities with modern technologies should be established in the main producing areas. Consumers can be informed about the positive influence of nuts on health and nutrition, these two elements are of most importance for today's consumers. Expected nut export level in Turkey could be reached by doing research about the product development according to the needs of the target consumer in external markets and improvements made in the export market system (in production, processing and marketing phase) developing the marketing strategies in order to enter Central Asia and Eastern European countries which have similar consumer structures and nutrition habits to Turkey (Sengül and Emeksiz, 1999).

Government intervenes in the hazelnut and pistachio prices; however it does not intervene in almond and walnut prices. Almond and walnut prices are determined in open market conditions. Pistachio is sometimes purchased by the Southeast Agricultural Sale Cooperatives at support price level in the name of the Turkish State but recently they have started buying pistachio by themselves. Hazelnut is purchased by the Union of Hazelnut Sale Cooperative (FISKOBIRLIK) (Yavuz, 1998). Hazelnut is also purchased by the private export sector which are the union of black sea region's hazelnut exporter and the union of Istanbul's hazelnut exporter.

The increase in hazelnut production brought serious problems in exports. The Government decided to limit hazelnut growing areas. On the other hand, the problem mostly lies in the inefficient export system. Most exporters are small- and inefficient on the international markets.

Turkey's nut export value and export volume have increased during 1980-1997 period. However, Turkey's nut export value is very low compared to the volume of other producer countries except for hazelnut export. Turkey's hazelnut export value is 78.5% of the total world hazelnut export value.

Pistachio orchard growing in southern Anatolia, Turkey

ANALYSIS OF TURKEY'S NUT SECTOR

Turkey's strengths and weaknesses in nut production and domestic market as well as opportunities and threats on international markets are listed below using SWOT analysis.

Strengths

I.Nuts are produced in almost every region of Turkey. Hazelnut production in Turkey is mainly concentrated in the Blacksea region. It is followed by West Anatolia (Aegean and Marmara Agricultural Region) and Central Anatolia Region. Pistachios production is concentrated mainly in the Southeastern Anatolia and Mediterranean region. Walnut production is spread out almost in every part of Turkey. Central Anatolia region holds the first place, followed by West Anatolia, East Anatolia and Blacksea region. Almond production is concentrated mainly in the Aegean and Mediterranean region of Turkey.

II. Hazelnuts are grown in areas and in soils considered unsuitable for most other crop plants, and on very steeply sloped terrain. An additional benefit for the hazelnut cultivating areas which particularly experience a high rainfall is the crop's ability to prevent soil erosion (Köksal, 1995).

III. Turkey is one of the biggest nut producing countries in the world. Turkey produces around 74.9% of hazelnut, 15.5% of walnut, 5.2% of pistachio and 4.4% of almond world production in 1998.

IV. Nuts are considered luxury goods and price elasticity is high. Due to the increasement of production and income level, prices can come down, and consumption may increase. Nuts have also changed their consumption appearance in the snack industry as well as the processing industry.

V. Pistachio production may be improved by grafting pistachio-scions on to wild pistachio species commonly found (such as *P.Terebinthust* L.) in the wilderness.

VI. Nut has an important place in Turkish economy. Many farmers earn their living producing hazelnuts and pistachios. In addition, hazelnut and pistachio are widely used in the nut processing, especially in the industry, more than walnut and almond.

VII. There is no labor shortage in nut production, labor fees are cheap in Turkey.

Weaknesses

I. Turkish nut production per area is relatively low compared to other producer countries due to lack of water, inadequate fertilizer use (in 1998; hazelnut yield is; 1,381 kg/ha, pistachio yield; 1,144 kg/ha, almond yield; 1,790 kg/ha, walnut yield; 2,089 kg/ha.

II. There are either lackness or weakness in producer and export organizations in the domestic and international market.

III. There is no direct product and export strategy for nut at the national level.

IV. Research and development activities for nut marketing are inadequate.

V. Distribution channels and storage facilities of nuts are inadequate at the national and international level.

VI. There is no clear and stable government policy on both national and international markets.

VII. The product line is very limited compared to other producer countries.

Opportunities

I. There is a common opinion that nuts have positive effects on heart and cardiac vascular diseases.

II. Nuts'market is one of the fastest growing markets in the international trade.

III. Turkey's vicinity to those potential buyer-countries such as Central Asian Countries and Eastern European Countries.

IV. Liberalization of trade through the GATT agreements will have positive effects on nuts trade.

V. The product line is very limited compared to other exporter countries.

Threats

I. High quality and quantity of pistachios that meet the needs of international markets are not available. The main characteristics of Turkish pistachios are: green-like colouring inside; delicious and aromatic taste, with small or medium sized grains, and with limited cracking ability. Iranian species do not have the natural green-like colouring, they are not delicious and aromatic, but their grain size is large to crack. The "Kerman" species, which are grown mainly in the United States, have the medium sized grains and have high natural cracking ability. These species which do not have a good taste and aroma but have large grains and high cracking-ability are sold at premium prices (Emeksiz and Sengül, 1999).

II. There is too much bureaucracy in exporting procedure.

III. Consumer tasts and preferences towards products are constantly changing in international markets.

IV. There are few exporting organizations which have been working independently without proper cooperation.

V. Exporting organizations are unable to collect satisfactory and rapid information about international markets and their activities and spending on research and development on foreign market is very limited.

VI. Disadvantages exist compared with other countries in production techniques and variety.

VII. There is not an efficient international marketing organization.

VIII. Economic crises that occur often in Turkey have negative effects on the nut sector.

CONCLUSION

Turkish nut has a great production potential in Turkey. Due to favorable climatic and ecological conditions nuts have been cultivated in Turkey for centuries but they have not reached a desired and stable export structure. SWOT analysis show that Turkish nut production and export could considerably be increased when compared to actual export levels. However, this goal could only be reached by taking implements that will eliminate weakness and threats, and by taking into account the opportunities and strengths.

REFERENCES

Emeksiz, F., Sengül S., 1999. Determining production and Export Potential of Pistachio in Turkey. XI. G.R.E.M.P.A. Meeting on Pistachios and Almonds. 1-4 September, Sanliurfa, Turkey.

FAO, Different Years. FAO web Page. (Http:// www. Fao.Org).

Köksal, A., 1995. Hazelnut Production in Turkey. FAO-Nucis-Newsletter, number 3, January.

SIS. 1999. The Summary of Agricultural Statistics 1998, Ankara.

Sengül, S., Emeksiz, F., 1999. Potential almond production and Development Possibility of Domestic Consumption and Export in Turkey. XI. G.R.E.M.P.A. Meeting on Pistachios and Almonds .1-4 September, Sanliurfa, Turkey.

Yavuz, F., 1998. An Overview of Nut Market in Turkey, Advanced Course Production and Economics of Nut Crops. CIHEAM. 18-29 may 1998. Adana, Turkey.

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(1) All figures in this study have been taken from FAO for different years from Web Page (Http:// www. Fao.Org)

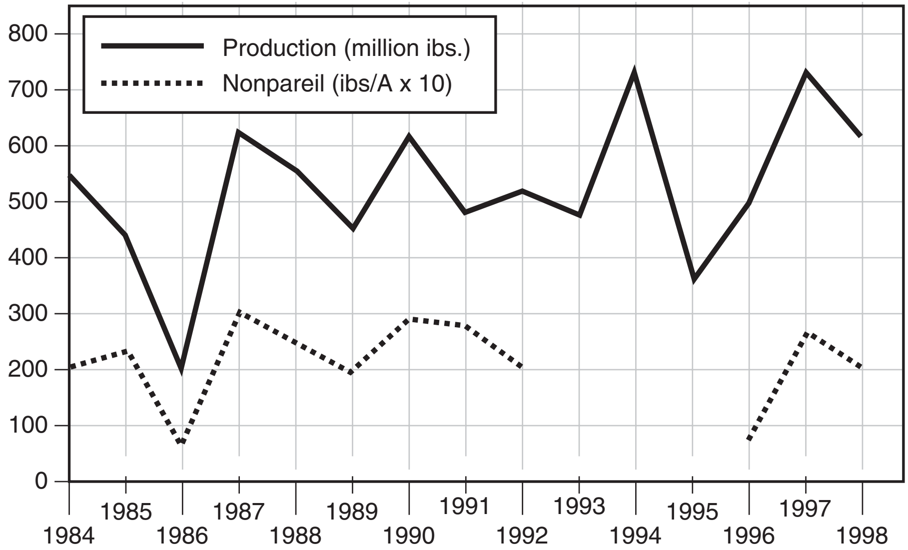
THE UNIVERSITY OF CALIFORNIA ALMOND BREEDING PROGRAMME: II. BREEDING OBJECTIVES AND PROJECTS

California has become a world leader in the production of almond [*Prunus dulcis* (Mill.) D.A.Webb, syn. *P. amygdalus* Batsch] primarily through the optimization of cultural and management inputs for the current soft-shelled varieties utilized (Kester and Gradziel, 1998). Continued high production, which exceeded 370,000 metric tons of nutmeats in 1999, is presently threatened by the losses in traditional pesticides and honeybee pollinators. Poor cross-pollination conditions often result in insufficient crop to meet established demand. At the same time, new opportunities have developed to expand almond markets by improving phytonutrient benefits in new varieties while minimizing potential health and marketing risks such as aflatoxins and kernel allergins. Thus, continued viability of this industry relies upon dependable production with reduced inputs. The breeding of improved self-fruitful and disease and pest resistant varieties adapted to the local conditions, offers opportunities to meet these demands while remaining both ecologically and economically acceptable. Breeding success will depend upon the successful identification of useful germplasm, the efficient indexing, testing and transfer of selected genes through controlled crosses, and the generation of large numbers of progeny from controlled crosses to ensure recovery of the rare, horticulturally superior individuals (Kester and Gradziel, 1996; Bartolozzi et al., 1998). Given these considerations, the primary breeding objectives of the almond breeding program at the University of California at Davis include the development of improved pollenizers for the principle California variety 'Nonpareil', and the development of the next generation of California almond variety possessing self-compatibility, improved insect and disease resistance, and improved phytonutrient quality. Attainment of these goals would reduce grower inputs and so costs, reduce pesticide levels in orchards and nut products, and reduce the current year-to-year fluctuations in California production (Fig. 1).

DEVELOPMENT OF IMPROVED POLLENIZERS FOR 'NONPAREIL'.

Despite recent increases in almond acreage, year-to-year production continues to fluctuate widely. Cross-pollination failures at flowering are widely believed to be a major cause of yield fluctuations. A comparison of statewide production shows good agreement with fluctuations in Regional Variety Trials (RVT) as shown in Fig 1. These fluctuations thus reflect inherent limitations within the varieties, especially their need for cross-pollination in the winter season when weather and honeybee foraging patterns are erratic. Particularly vulnerable is the early-to-mid bloom of the major California variety 'Nonpareil'. 'Carmel', which is the principle pollinizer for 'Nonpareil', has often flowered after 'Nonpareil', leaving the most critical early to mid-bloom incompletely

Figure 1. Fluctuations in California almond production from 1984 to 1993, with average yields for 'Nonpareil' at the San Joaquin County RVT (1984-1992) and younger RVT at Kern Co. (1996-1998) provided for comparison.



cross-pollinated. A high incidence of noninfectious bud-failure in 'Carmel' has also resulted in large reductions in the new plantings of this variety by growers. To meet these cross-pollination needs we have bred a pollinizer for the early 'Nonpareil' bloom (designated as UCD,13-1; final naming and release is expected in 2000) and have tested and released a low bud-failure souce of the 'Carmel' variety (see Kester et al., 1994; 1997). In California Regional Variety Trials (RVTs; see Micke et al. 1997) UCD13-1 has consistently flowered during the targeted early 'Nonpareil' bloom despite the occurrence of unusual patterns in Winter chill and Spring heat units which have often pushed 'Carmel' bloom concurrent to or later than 'Nonpareil'. Tree production and nut quality have been comparable or superior to 'Carmel'. While 13-1 had originally shown some resistance to Alternaria leaf spot *(Alternaria alternata)*, this disease has recently been observed in this genotype. In addition, damage from anthracnose *(Colletotrichum acutatum)* has been observed on this selection in the Butte County RVT following the cool, wet Spring of 1998. The thin shell, while contributing to a high crack-out, has also led to moderate levels of susceptibility to Navel orangeworm *(Amyelois transitella)* and peach twig borer *(Anarsia lineatella)* damage which are comparable to 'Nonpareil' and 'Carmel'. Kernel quality is good, with low numbers of doubles, twins, or other nut distortions. Early processing evaluations (i.e. blanching, dicing, etc.) have also been favorable in larger scale industry evaluations.

DEVELOPING LOWER INPUT VARIETIES: SELF-COMPATIBILITY

All commercially important California almond cultivars are self-incompatible (Kester et al., 1994). The resulting self-sterility has necessitated the interplanting of cross-compatible pollinizer cultivars and the bringing of large numbers of honeybee pollinators into the orchard during flowering to transfer compatible pollen between trees. Often, two to three pollinizer cultivars having overlapping bloom periods relative to the main cultivar, are interplanted in the same orchard to maximize cross-pollination with the main cultivar. Despite these efforts, seed-set at bloom remains the most important determinant of final crop yield (Kester and Gradziel, 1996). While poor weather at bloom results in some flower loss to disease, the suppression of honeybee cross-pollination flights is believed to be the most important limitation. Thus, the development of self-fruitful cultivars may both stabilize production and reduce field management complications resulting from the differing needs of different pollinizer cultivars. Highly self-compatible and/or self-fruitful varieties might also allow single variety orchards with their inherent savings in orchard management costs.

Important components of self-fertility include self-compatibility and either the capacity for self-pollination (autogamy) or suitable attractiveness to bee pollinators. Self and cross-incompatibility has now been fairly well characterized for all important California cultivars at the field-performance, genetic and molecular level (Kester et al., 1994; Tao et al., 1997; Ushijima et al., 1998). Self-compatibility, as with self-incompatibility is inherited as a single, multi-allelic gene, though modifier genes also appear to be important (Dicenta and Garcia, 1993; Godini 1996; Socias i Company, 1990).

As previously reported by Gradziel and Kester (1997), hybrids have been obtained between California almond cultivars, including 'Nonpareil' and 'Mission', and the related species *Prunus persica, P. mira, P. webbii, P. argentia,* and *P. fenzliana,* using standard methods as described by Kester et al. (1991) and Kester and Gradziel (1996). Promising selections have now been backcrossed for one to three additional generations with recurrent selection for desired traits. Trees were selected for vigor and desired tree and nut shape and for self-fruitfulness. Self-compatibility and self-pollinating ability were tested by bagging individual branches of trees with insect-proof, mesh bags. Separate bags on each tree were either hand crossed with self-pollen, hand crossed with cross-compatible pollen, or left unpollinated to evaluate natural selfing. Viability of donor pollen is also verified through in-vitro germination and/or vital staining tests. Fruit set is typically recorded 8 weeks following pollination to allow for late drop of abortive nuts. Fruit set following self-pollination is compared with sets from outcrossing to assess level of self-compatibility. In general, self-sets greater than 20% are considered self-compatible, and sets of less than 10% considered self-incompatible. Similarly, sets in unpollinated bags of greater than 20% or which approximate sets from adjacent limbs which are allowed to out-cross normally, were considered self-pollinating.

Trees exhibiting promising levels of self-compatibility and self-pollination as well as good agronomic characteristics are selected and propagated on 'Nemaguard' or 'Lovell' rootstocks. Once into production, data is again collected on self-compatibility and capacity for self-pollination, tree size and shape relative to '*Nonpareil*', crop size (yield relative to tree size), time of bloom, the percent of predominantly soft-shelled nuts exhibiting a complete shell seal, the percent of total nuts having double nuts, the ratio of kernel meat weight to whole nut (kernel meat plus shell) weight and kernel weight. In this way a series of advanced breeding selections which incorporate new genes from wild and related species has been developed and the breeding value of these introgressed genes evaluated. As expected, the horticultural value of differeing interspecific germplasm source varies greatly, with each species offering unique potentials as summarized below.

P. argentea. Parents were medium to large trees with the characteristic silvery, pubescent leaves. Nuts are small with very hard shells having shallow pits to slight exterior grooves. Hybrids tend to show the complete range of shell mar-

Almond orchard in California being harvested using a trunk shaker

kings but most having roughly equal proportions of pits and grooves. Kernel shapes range from long narrow to short plump. Trees are often large, almond-like, ranging in shape from spreading to upright and of good quality though fruit quality is often poor. Many progeny are late blooming and late leafing, often with varying levels of leaf pubescence conferring the silvery appearance of the leaves as previously reported (Gradziel and Kester, 1997).

P. persica. Peach parents used include 'Lukens Honey', 'J.H. Hale', 'Fay Elberta', the very early flowering and nematode resistant breeding line '40A-17, and the brachytic dwarf breeding line '54P455'. Hybrids were very vigorous with large trees, and leaf and fruit morphology intermediate to parents. Backcrossing to almond resulted in moderately vigorous and productive trees, often with single, pink, narrow-petaled and showy flowers. Other phenotypes recovered include double flowered, very late flowering, and pistil sterile types. Fruiting habit ranged from predominantly spurs to terminal shoot bearing habits, with the specific almond backcross parent showing strong influence on final predominance of spur production. F_2 populations segregating for the brachytic dwarf gene appeared to show some incomplete dominance for this trait rather than the complete dominance observed in peach. Up to 30% of the progeny showed degrees of pistil sterility though remaining individuals demonstrated appreciable self-compatibility. Approximately half of the self-compatible trees also exhibited some capacity for self-fertilization as well.

P. mira. Parents were very peach-like, though with small, poor-quality fruit and small, somewhat smooth, and flattened seed. Kernels tended to be bitter. Hybrids and backcrosses were very similar to peach populations though with smoother pits. Both parent and progeny trees tend to be smaller, often with a weepy or willowy growth habit.

P. fenzliana. Parents were bushy and small. Nuts were small, flat and hard shelled with the shell surface showing sparse, shallow holes. Kernels were often bitter. Hybrid nuts are intermediate to parents in size and shape. Trees tend to be upright and vigorous with nut production on both spurs and terminal shoots.

P. webbii. The parent is a small, thorny bush with small leaves. Bloom is very late with dense flowering occurring on many spurs and short lateral branches. Nuts are hard shelled and small with bitter kernels. Hybrids are upright, varying in size, with flowering on long flowering shoots and many lateral shoots. Flowers are almond-like; appearing pink in buds then becoming white. Anther length varies from short to long. Backcrosses to almond often retained the characteristic bearing habit on many short, lateral branches.

Expression of both self-compatibility and (when present) self-pollination varied from year-to-year indicating a strong environmental effect. Similarly, the level of self-compatibility varies within sibling groups from the same cross. Since previous work has shown self-compatibility to be controlled by a single dominant gene (Socias i Company, 1990), all self-compatible progeny have probably inherited this gene with the level of its expression being strongly affected by the genetic background. To be commercially viable, self-sets need to be close to 30-40% and stable from year to year. Thus, strong selection needs to be applied not only to the presence of self-compatibility but for high and consistent levels of self-compatibility and/or self-fruitfullness. Factors controlling the level and stability of self-compatibility are presently poorly understood (Gradziel and Weinbaum, 1999). For the development of consistently high yielding self-compatible cultivars, a better understanding of both the fertilization process as well as honeybee pollination behavior in almond is needed. The diverse genetic origins of these interspecific selections may allow important insights into the influence of genetic background for this trait. While most parent species were hard shelled with low meat-to-nut crack-out ratios, backcross progeny were fairly easily selected for relatively high crack-out ratios and the softer and often less well sealed California-type shells. Kernel size, though, consistently smaller than the 'Nonpareil' standard was often in the range of other commercially acceptable cultivars. Blooming time ranged from early to very late.

Only one of these advanced self-compatible selections possesses a high capacity for self-pollination, demonstrating the continued need for insect pollinators for most future self-compatible cultivars. Previous reports have also indicated that self-pollinating cultivars will produce higher sets when cross pollen was available (Godini, 1996; Socias i Company, 1990). Self-compatible cultivars in the absence of self-pollination could, however, be an important first step in improving almond production by both allowing production on the more easily managed single cultivar orchards as well as by allowing improved efficiency of the honeybee pollinator. Self-compatibility also appears to be readily transferred to almond from its wild relatives. While agronomic quality suffered in hybrids and first generation backcrosses, quality approached commercial levels by only the second backcross, due in part to the greater phenotypic variation acceptable in nut trees in relation to other crops. In addition to self-compatibility, other novel tree and nut traits were transferred including self-pollinating flower type, denser bearing habits, disease and insect resistance, and improved kernel fatty acid composition.

PEST RESISTANCE AND DISEASE RESISTANCE

The need for pest resistance in the next generation of California almond varieties has been given added impetus by the increasing threats from both old and new diseases at a time when access to effective traditional pesticides is becoming increasingly restricted. Preliminary disease screenings at Davis have identified potential resistance sources for several important diseases including anthracnose, shot-hole and blossom blight diseases *(Monilinia spp).* Resistance is also being pursued for aflatoxin causing *Aspergillus spp.* infection of almond kernels (Gradziel and Dechun Wang; 1994; Gradziel et al., in-press). While several potential sources of aflatoxin resistance have been identified the most promising appears to be the control of the insect pests, particularly navel orangeworm (NOW) which predispose the nuts to infection (Gradziel and Kester, 1994).

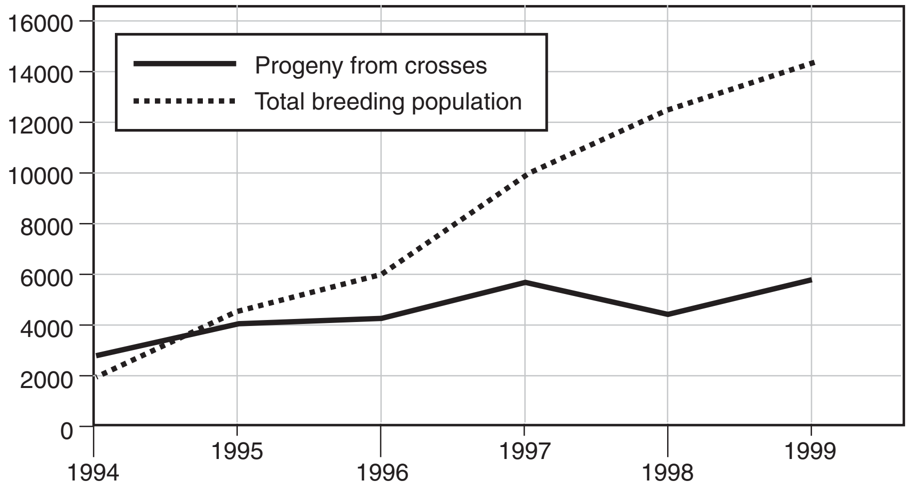
INSECT RESISTANCE

Pest targeted are those damaging the almond kernel, and include navel orangeworm (NOW), peach twig borer (PTB), and more recently ants. Opportunities for NOW control have been identified in genotypes which either prove toxic or repellant to initial NOW feeding on almond hulls and/or nuts, or which are prevented from damaging the kernel by an impregnable shell barrier. The development of an impregnable shell barrier has the added benefits of not involving toxic plant chemicals, and since it is a physical barrier, may be effective for a broad range of insects and diseases which damage the kernel. Our research has identified two key components of a well-sealed paper shell or endocarp: a strong and continuous inner shell, and a well-formed and completely sealed suture such as that found in many European varieties and the California variety 'Mission'. Both good shell structure and complete suture seal require higher levels of the high density plant biochemical lignin, which, in turn, has been associated with lower yield potentials since it has been believed that the plant must divert energy away from kernel to lignin production. Our recent findings, however, refute these assumption by showing that no clear relation exists between yield of California varieties and the amount of lignin produced in the hulls and/or shell. An improved understanding of almond shell or endocarp development may allow the development of new varieties with a 'Nonpareil'-type kernel and yield in a 'Mission' type shell with its relatively high crack-out and resistance to NOW, PTB, ants, and *Aspergillus* infection. We are, therefore, currently developing a more complete understanding of the critical components of shell structure and integrity. However, the process of shell sealing and cementing (lignification) appears to respond to several independent environmental and genetic variables, and so defies an easy and consistent predictive model.

IMPROVEMENT OF THE PHYTONUTRIENT CONTENT OF ALMOND

Related breeding approaches targeting the control of kernel pests and diseases by modifying kernel fatty acid composition are creating opportunities for improving the nutritional, (phytonutrient) value of almond to the consumer. Continued studies in this area have identified interspecific breeding lines having significantly lower linoleic/oleic fatty acid ratios (Abdallah et al. 1998). This is desirable as it improves both the nutritional value and storability of the almonds and products made from them. In addition, these studies have verified the linear relation between linoleic and oleic acid (Abdallah et al. 1998), supporting their close biochemical relationship. Further research in this area, particularly concerning the genetic control of this putative biochemical pathway, may offer opportunities in the future to fine tune this pathway and the resultant fatty-acid composition of the kernel. These opportunities are currently being pursued through both genetic engineering and the more traditional controlled genetic recombination strategies. Genetic engineering strategies have targeted the transformation/regeneration of established varieties, particularly 'Nonpareil'. Transformation using *Agrobacterium tumefaciens* is readily achieved though subsequent plant regeneration occurs only in low frequencies. Improved plant regeneration is being pursued through the optimizing of tissue culture practices for each targeted variety.

Figure 2. Summary of progeny size from crosses by year and consequent total number of seedling trees in the almond evaluation trials



BREEDING PROGRAMME

Self-compatible selections have now been used as parents to generate the next generation of breeding lines combining self-compatibility with improved resistance, kernel quality and tree yields. This work involves the making of large numbers of controlled crosses between selected parents and the planting and evaluation of the resulting progeny. Very large numbers of crosses are required to generate the large progeny populations, which, in turn, are needed to insure recovery of the rare genetic recombinant containing the full complement of desired traits (for kernel quality, yield, resistance, tree structure, etc.). In 1999, roughly 20,000 controlled crosses were made in over 300 different crossing combinations, with approximately 6,000 seed harvested, stratified and, germinated for transplanting to the field. Approximately 2000 of these seedlings will be rouged out before or within the first year of transplanting based on undesirable plant structure. Four years of vegetative growth are often required before flowering, fruiting and nut evaluation are possible (Kester and Gradziel, 1996). The first crosses in this project were made in 1993 with approximately 2,000 seedlings being field transplanted in 1994. We have harvested an average of approximately 5,000 seed from controlled crosses in each of the last 4 years resulting in a rapid growth of the breeding program size (Fig. 2). In 1999, nut characteristics, including self-compatibility, were evaluated from seedling trees from the earlier plantings. Approximately 40 individuals were selected for further evaluation with the remainder discarded. An analysis of the lineage of selected items revealed that most resulted from crosses with only 7 parents, even though over 20 different parents were used in the initial crosses. Even within these elite parents, the proper choice of the specific crossing combination was crucial to success. Information developed from these evaluations is being used to develop future crossing plans. Thus, a cycle of genetic improvement has begun, which involves the generation and evaluation of a large population of seedling progeny leading to the identification of elite progeny, and, in parallel, elite parental combinations. This information, in turn, leads to improvements in the quality of the parents utilized, which, in turn, leads to improvements in both the overall quality of the progeny populations as well as our understanding of the inherent strengths and weaknesses (and heritability) of the parental germplasm used.

The relatively long period of vegetative growth before fruiting can occur means that the results of these efforts are only starting to be realized. The number of progeny selected from early plantings is particularly satisfying since many of the sources of self-compatibility and pest resistance utilized in those crosses were still fairly wild in their characteristics, and which are commonly transmitted to many, though not all of the progeny. The relative speed with which this very rich and extensive wild germplasm has been transferred to a commercial almond background is partly the consequence of the greater variability in plant and seed characteristics tolerated in tree crops as compared to vegetable and grain crops. Thus, despite the emerging challenges in almond production, pest management and marketing, the genetic materials and breeding methods to meet these challenges appear available. The ultimate challenge, perhaps, is to adequately predict and prioritize the most important needs of the evolving almond situation into the next Century.

LITERATURE CITED

Abdallah, A., M.H. Ahumada and T.M. Gradziel. 1988 Oil content and fatty acid composition of almond kernels from different genotypes and from different California production regions. J Amer Soc Hort Sci 123:633-437.

Bartolozzi, F., M.L. Warburton, S. Arulsekar, and T.M. Gradziel. 1998. Genetic characterization and relatedness among California almond cultivars and breeding lines detected by randomly amplified polymorphic DNA (RAPD) analysis. J. Amer. Soc. Hort. Sci. 123(3):381-387.

Dicenta F and J.E. Garcia. 1993. Inheritance of self-compatibility in almond. Heredity 70: 313-317.

Godini A. 1996. Current understanding of self fertility in almond. Rivista di Frutticoltura e di Ortofloricoltura. 58: 70-75.

Gradziel, Thomas M. and Dechun Wang. 1994. Susceptibility of California almond cultivars to aflatoxigenic *Aspergillus flavus*. HortScience 29(1):33-35.

Gradziel, T.M. and D.E. Kester. 1994. Breeding for resistance to *Aspergillus flavus* in almond. Acta Horticulturae 373:111-117.

Gradziel, Thomas M. and Dale E. Kester. 1997. Breeding for self-fertility in California almond cultivars. Acta Horticulturae 470:109-117.

Gradziel, T.M. and S. A. Weinbaum. 1999. High Relative Humidity Reduces Anther Dehiscence in Apricot, Peach and Almond. HortScience 34:322-325.

Gradziel, T., N. Mahoney and A. Abdallah. (in press). Aflatoxin production among almond genotypes is unrelated to either kernel oil composition or *Aspergillus flavus* growth rate. HortScience 35:xxx-xxx.

Kester, D.E., T.M. Gradziel, and W.C. Micke. 1994. Identifying pollen incompatibility groups in California almond cultivars. Journal of the American Society for Horticultural Science 119(1):106-109.

Kester, D.E., W.C. Micke, T.M. Gradziel, S. Arulsekar, K. Pelletreau, K. Shackel, M. Viveros, and R. Asay. 1994. Solving the problem of noninfectious bud-failure in California almond. Acta Horticulturae 373:35-39.

Kester, D.E. and T.M. Gradziel. 1996. Almonds, p. 1-97. In: Fruit Breeding, Vol. III: Nuts, ed. J. Janick and J.N. Moore. John Wiley & Sons, Inc.

Kester, D.E., K.A. Shackel, W.C. Micke, T.M. Gradziel, and M. Viveros. 1997. Variability in potential and expression of noninfectious bud-failure among nursery propagules of 'Carmel' almond. Acta Horticulturae 470:268-272.

Kester, D.E. and T.M.Gradziel. 1998. The University of California Almond Breeding Project: I. Historical Aspect. Nucis: 7:8-10.

Micke, W.C., D.E. Kester, T.M. Gradziel, J.T. Yeager, M.A. Thorpe, J.H. Connell, P.S.Verdegaal, and M. Viveros. 1997. Almond cultivar evaluation using regional trials. Acta Horticulturae 470:91-94.

Socias i Company R. 1990. Breeding self-compatible almonds. Plant-Breeding-Reviews 8:313-318.

Tao, R., H. Yamane, H. Sassa, H. Mori, T.M. Gradziel, A.M. Dandekar and A. Sugiura. 1997. Identification of stylar Rnases associated with gametophytic self-incompatibility in almond (*Prunus dulcis*). Plant Cell Physiol. 38:304-311.

Ushijima, K., H. Sassa, R. Tao,H. Yamane,A.M. Dandekar, T.M. Gradziel and H. Hirano. 1998. Cloning and characterization of cDNAs encoding the Rnases in almond (*Prunus dulcis*): primary structural features and sequence diversity of the S-RNases in Rosaceous. Mol Gen Genet 260:261-268.

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BIOTECHNOLOGICAL IMPROVEMENT OF ALMOND IN PORTUGAL

INTRODUCTION

Almond is a Portuguese traditional culture that finds, in the regions of Algarve (South) and Trás-os-Montes (North), particularly good edaphic and climatic conditions. In the fifties, almond was one of the main dry fruits produced in this country however it lost some importance in the following 30 years. Recently, more attention has been paid to this culture and new research programmes are being conducted. New orchards have also been established, using modern management techniques, but these rely on foreign varieties, most of French ('Ferragnes', 'Ferraduel' and 'Ferrastar') and some Spanish ('Guara', 'Ayles') origin. One of the disadvantages of Portuguese cultivars is their precocity, which may account for important losses if frost arises at bloom. Problems like early flowering, old type orchard management, insufficient fertilisation or irrigation and lack of identified good pollinators, all contribute to a low productivity in orchards of Portuguese varieties (Cordeiro, 1998).

Part of the Portuguese almond germplasm was recently studied in terms of production and nut quality. From these studies, some cultivars have been identified joining important agronomic characteristics and high organoleptic quality (Cordeiro, personal communication,1999).

To improve the quality of Portuguese almond varieties, making them competitive for high quality almond production, a breeding programme will start in the year 2000.

BIOTECHNOLOGY OF ALMOND

We started our research in almond a few years ago, first at the Faculty of Sciences of Lisboa (Department of Plant Biology) and, since late 1996, at the Institute for Biological and Experimental Technology (IBET), in Oeiras. Initial studies allowed us to identify several general problems in almond orchards: (1) spread of virus infection, a problem already identified by Nolasco *et al.* (1991); (2) absence of knowledge about the cross-compatibility of the Portuguese cultivars (the only studies are from Almeida, 1945); (3) absence of efficient strategies for cultivar identification; (4) lack of knowledge of the genetic relationships existing among cultivars. Moreover, the fact that there was only reduced knowledge about *in vitro* manipulation of almond and no report of a transformation protocol, led to the gradual implementation of various research programmes aiming to study and contribute to solve some of the identified problems (Miguel et al., 1998).

SELF-INCOMPATIBILITY AND FERTILIZATION

Almond is a species where the problem of self-incompatibility reaches higher levels as most cultivars are self-incompatible. Almond self-incompatibility is of gametophytic type and controlled by a single multiallelic locus, called the *S*-locus. This locus expresses in pistils with the production of basic glycoproteins with RNase activity (*S*-RNases), that recognise and block the growth of pollen tubes sharing the same allelic composition. The knowledge of the *S*-allele composition of two cultivars, together with the knowledge about their flowering periods, may allow predicting their cross-compatibility and possible use of such combination in an orchard.

Together with colleagues from the Faculty of Sciences of Lisboa (FCUL, Portugal ,J. Feijó), the Katholieke University of Leuven (Belgium - W. Broothaerts), and the Horticultural Research International of East Malling (UK - K. Tobutt and R. Boskovic), we have started work in this area. Pollen/pistil interaction was evaluated in compatible and incompatible crosses, using light, fluorescence and confocal microscopy of whole pistils and cryo-sections (Feijó et al., 1999). Pollen tube progression along the style was followed by aniline blue staining and the expression of S-proteins is being studied by confocal microscopy analysis of pistil cryosections after immunolocalisation with antibodies raised against a conserved region of almond S_8 or apple S-proteins. S-proteins distribution in the pistil is being evaluated and related to their function in preventing incompatible pollen tubes from fertilising the ovule.

The study conducted with HRI collaboration included S-protein analyses in unfertilised pistils, using isoelectric focusing techniques for protein separation and detection of RNase activity (Boskovic et al., 1997). The samples were run in various conditions, together with standards for all the known *S*-alleles. From these studies 3 putatively new *S*-alleles were recently identified. Moreover, the distribution of *S*-alleles among the two populations studied (Algarve and Trás-os-Montes) seems to indicate that the two groups are quite different.

Research is also being conducted in order to identify and characterise *S*-alleles, aiming to develop a molecular strategy through which the identification of *S*-allele combination can be made on vegetative tissue. Five *S*-alleles were already isolated and cloned, and their genomic sequence was investigated. The data from the molecular analyses of *S*-allele sequences, confirmed S-protein analyses. During this research, two *S*-like genes were identified (PD1, Van Nerum *et al.*, unpublished, and PD2, Ma Rongcai and Oliveira, in preparation).

VIRUS DIAGNOSIS AND ELIMINATION

Almond trees are often strongly infected with viruses of the ilargroup. In studies conducted in the Algarve region, the presence of Prune Dwarf virus (PDV) and *Prunus* Necrotic Ringspot virus (PNRSV) was a constant (Raquel, 1998). These two viruses appear often as almond pathogens, in orchards located as far as in California (Slaughter, personal communication, 1999), Australia (Bertozzi et al., 1999) or the Mediterranean basin (Nolasco et al., 1991, Savino et al., 1995). It is known that these viruses may spread vegetatively, not only through grafting, but also through pollen, which makes their eradication a difficult task.

We have developed a programme for virus elimination, using meristem culture, thermotherapy and chemotherapy (Raquel, 1998). This programme aimed to establish virus-free *in vitro* material, and define a protocol for virus elimination.

We are presently studying, along the year the evolution of PDV and PNRSV in infected trees. Samples are being collected from three regions in the country (North, centre and South), at least once every month, for diagnosis. The strategies used for virus detection depend on the level of infection. For a high infection level ELISA (enzyme-linked immunosorbent assay) was enough, while IC-RT/PCR (immunocapture, reverse transcription, polymerase chain reaction) was used for lower virus titre, a technique developed with the collaboration of the University of Algarve (Portugal, G. Nolasco) (Raquel et al., 1999b). In the second case, the amplified PCR products were detected on ethidium bromide stained agarose gels or, when the concentration of virus particles was very low, Southern was performed with a homologous probe. A technique for *in situ* RT-PCR, using paraffin embedded samples, was developed (Tereso, 1999) and is being optimised aiming to study virus distribution in apical meristems.

TISSUE CULTURE AND TRANSFORMATION

The development of a highly effective adventitious regeneration or somatic embryogenesis protocol is essential for the application of genetic transformation strategies. A protocol for adventitious regeneration from *in vitro* micropropagated adult material (cv. 'Boa Casta') was published by our team, in collaboration with P. Druart from the Station des Cultures Fruitières et Maraichères, in Gembloux, Belgium (Miguel et al., 1996). In the same report, a protocol for optimised regeneration from juvenile material was also described. Several almond varieties grown in Portugal are presently being propagated *in vitro* and studied for their potential for adventitious regeneration. Several modifications are being tested in order to overcome the recalcitrance of adult genotypes, a negative characteristic shared by most *Prunus* species.

In vitro rooting through the application of a hormone shock (indol butyric acid), followed by its removal, was shown to efficiently induce rooting in some genotypes that could be successfully transferred to soil (Miguel, 1998, Tereso, 1999), however the strategy needs further improvements for recalcitrant clones.

The regeneration of transgenic plants was already achieved for juvenile material (Miguel and Oliveira, 1999). The recovery of transgenic plants was achieved using *Agrobacterium*-mediated transformation of leaves excised from *in vitro* propagated shoots. The supervirulent EHA105 strain was chosen (with p35SGUSINT plasmid, carrying kanamycin resistance as selection marker and -glucuronidase as reporter gene) and applied to incomplete sections made across the leaf mid-vein, the region where regeneration events usually occur. The use of the biolistic method (performed with the collaboration of P. Christou from John Innes Institute, UK) has still not led to transgenic plant recovery, eventually due to insufficient penetration in the leaf tissue, not reaching the inner regeneration-competent cells. This strategy, however, can still not be excluded and needs further testing.

From histology studies conducted on the regenerating leaf samples, the difficulty in recovering transgenic plants was interpreted as a consequence of the regeneration pattern available (Miguel, 1998). Changes in the regeneration protocol, leading to a change in the regeneration pattern, might overcome recalcitrancy and are presently under study.

INTRODUCTION OF VIRUS DISEASE RESISTANCE

The use of virus-free almond trees in the establishment of new orchards is not sufficient to ensure medium/long-term healthy conditions. The plantation of a healthy almond orchard near an infected one leads to the infection of the new orchard in less than 3 years (Slaughter, 1999, personal communication). This problem is recognised in several almond-producing countries and strategies aiming to introduce virus-disease resistance are therefore desirable. Until now, the coat protein strategy is the only which has provided cases of success and it was chosen for research in our case. The coat protein sequence of PDV was isolated from leaves collected from infected trees, using the IC-RT/PCR strategy. The isolated sequence was cloned in an intermediate vector and, after sequencing, it was inserted in pBI121, under the regulation of the 35SCaMV promoter, in substitution of the *uid* A (a-glucuronidase) coding region. This construction was transferred to *Agrobacterium* by triparental matting, and was tested in *Nicotiana* transformation and shown to express a protein detectable by ELISA (Raquel *et al.*, 1999a). The same strategy was used to prepare and test, a construct coding for the *Prunus* necrotic ringspot coat protein gene. Presently new constructions are being prepared and tested in *Nicotiana* for optimised efficiency in preventing virus infection.

MOLECULAR CHARACTERIZATION

The molecular characterisation programme was the last one we started. RAPD (random amplified polymorphic DNA), RFLP (restriction fragment length polymorphism), AFLP (amplified fragment length polymorphism) and mp-PCR (microsatellite-primed PCR) have been tested and are being evaluated for different purposes. P. Arús (from IRTA, Cabrils, Spain) kindly provided probes for RFLP. For this programme we count with the advice of R. Tenreiro, from the Faculty of Sciences of Lisboa, Centre of Genetics.

Varieties maintained in collections established in Algarve and Trás-os-Montes are being studied and compared with cultivars obtained from farmers or collected from the wild. The data collected are now being analysed in order to: (1) establish relationships among Portuguese varieties, (2) relate them with foreign varieties already characterised and (3) identify good candidates for the breeding programme. This work is being conducted with the close collaboration of the Regional Agricultural Services of Trás-os-Montes (with A. Monteiro and V. Cordeiro, from Direcção Regional de Agricultura de Trás-os-Montes in Mirandela), where the breeding programme will start next year, and Algarve (with E. L. Ferreira, from Direcção Regional de Agricultura do Algarve). The molecular strategies will also be used to assist the breeding programme. The data collected from S-RNases and *S*-like gene analyses are also being used to help the molecular characterisation.

CONCLUSIONS

The absence of an extension service in Portugal makes more difficult the contact of research units with the farmers and the industry, complicating an integrated evaluation of problems, research, dissemination of results and application. Nevertheless, we expect that the close contact of our research unit with the regional agricultural services may result in co-ordinated work with practical application, allowing, with our mutual motivation, to recover a culture that has strong traditions in Portugal, while studying scientific problems of broader interest.

The research we are developing is being funded by national projects supported by the Foundation for Science and Technology. Researchers and Master and PhD students have also obtained their fellowships through this Foundation.

The present team includes: Ma Rongcai (invited scientist since June/98 - *S*-allele molecular characterisation), A. C. Certal (researcher – pollen-pistil interaction/ S-protein analyses), M. Martins and A. P. Farinha (PhD student and researcher, respectively - molecular characterisation), H. Raquel (PhD student – strategies to introduce resistance to ilarviruses), C. Silva and R. Batista (researchers - virus diagnosis/*in situ* RT/PCR/ rooting), M. Santos (diploma student - regeneration/transformation systems). C. Miguel (PostDoc) and S. Tereso (Master) have completed their thesis and, as IBET researchers, still collaborate with our team.

REFERENCES

Almeida, C. R. M., 1945. Acerca da improdutividade na amendoeira. Anais Inst. Sup. Agron. 15, 1-184.

Boskovic, R., Russell, K. and Tobutt, K. R., 1997. Inheritance of stylar ribonucleases in cherry progenies, and reassignment of incompatibility allelels to two incompatibility groups. Euphytica 95, 221-228

Bertozzi T., Bennett, C. and Sedgley, M. 1998. Almond improvement in Australia. FAO - Nucis-Newsletter 7, 10-11.

Feijó, J. A., Certal, A. C., Boavida, L., Van Nerum, I., Valdivieso, T., Oliveira, M. M. and Broothaerts, W. 1999. Advances on the study of sexual reproduction the cork-tree (*Quercus suber*), chestnut (*Castanea sativa*) and in Rosaceae (apple and almond). *In:* "Fertilization in Higher Plants – Molecular and Cytological Aspects" (M. Cresti, G. Cai, A. Moscatelli, eds.), Chap. 26, pp:377-396. Springer-Verlag, Berlin.

Miguel, C. M., 1998. Adventitious regeneration and genetic transformation of almond (*Prunus dulcis* Mill.). PhD. Thesis, Faculty of Sciences of Lisboa, Lisboa, Portugal.

Miguel, C., Druart, Ph. and Oliveira, M. M., 1996. Shoot regeneration from adventitious buds induced on juvenile and adult almond (*Prunus dulcis* Mill.) explants. In Vitro Cellular and Developmental Biology - Plant vol. 32, 148-153.

Miguel, C., Raquel, M. H., Sánchez, A., Martins, M., Nolasco, G., Ferreira, E. L. and Oliveira, M. M., 1998. In vitro culture and improvement of Portuguese almond genotypes. (Proceedings of the International Symposium on Pistachios and Almonds (24-29 de Agosto), Univ. California.). Acta Horticulturae 470, 562-569.

Miguel, C. M. and Oliveira, M. M., 1999. Transgenic almond (*Prunus dulcis* Mill.) plants obtained by *Agrobacterium*-mediated transformation of leaf explants. Plant Cell Reports 18, 387-393.

Nolasco, G., Neves, M. A. and Faria, E. A., 1991. Distribuição no Algarve de vírua do grupo Illavírus em amendoeira e suas consequências na produção, 1ª aproximação. Rev. de Ciências Agrárias 15, 33-37.

Raquel, M. H., 1998. Diagnose de infecções virais, saneamento de cultivares Portuguesas de amendoeira e pesquisa de estratégias para introdução de resistência a vírus. Master Thesis, Faculty of Sciences of Lisboa, Lisboa, Portugal

Raquel, M. H., Miguel, C., Nolasco, G. and Oliveira, M. M., 1999a. Construction and testing of a transformation vector to introduce PDV resistance in almond. (*Proceedings of the World Congress of the International Society for Horticultural Science. Brussels*, 3-8 August 1998). Acta Horticulturae (*in press*).

Raquel, M. H., Tereso, S., Oliveira, M. M. and Nolasco, G., 1999b. Establishing a protocol for IC/RT-PCR detection of Prune Dwarf Virus in almond (*Prunus dulcis* Mill.). (Proceedings of the COST 823 Meeting: "Mass scale diagnosis of plant pathogens by nucleic acids amplification methodology" (9-10Jul/98) Faro). Petria, Ispave, Roma (*in press*).

Savino, V., Terlizzi, B. D., Digiaro, M., Catalano, L. and Murolo, O., 1995. The sanitary status of stone fruits in Apulia. (The Fruit Tree Virus Diseases XVI). Acta Horticulturae, 386, 169-175.

Tereso, S. 1999. Estudos de saneamento de viroses e de detecção do Ilarvírus 'Prune Dwarf Virus' em amendoeira, e introdução à técnica de transcrição inversa 'polymerase chain reaction' *in situ*. Master Thesis, Universidade de Évora, Évora, Portugal.

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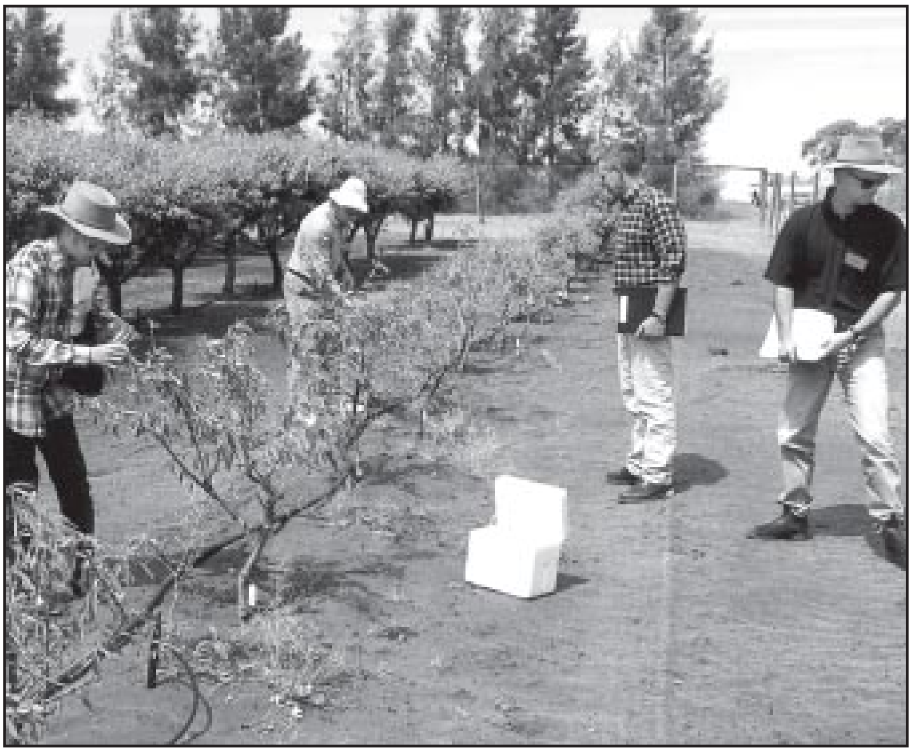
ALMOND INDUSTRY PROFILE IN AUSTRALIA



Central budwood Repository. New varieties just released from quarantine

INTRODUCTION

Commercial almond growing in Australia originally began in the State of South Australia, and was initially centred around the capital city, Adelaide. Most of these plantings have since disappeared under urban expansion with a few still existing to the South and North.

By the mid to late 1960's plantings had expanded east along the Murray River into the North-western areas of the State of Victoria. By 1993/94, production had grown to 5,000 t kernel and was worth US$21m annually, with Victoria producing 57%, South Australia 41% (US$ 8.7m) and New South Wales 1% (US$ 0.13m).

The industry has continued to expand at a steady rate of 12-13% per year with production in 1998/99 reaching 8,000 t. Expansion at this rate is expected for at least the next six to eight years. However, suitable soils and water are becoming difficult to find and are limiting expansion. Total area of almond production is approximately 4,000 ha.

MAIN PRODUCTION REGIONS

The industry can be categorised into two distinct production groups. The first is the relatively smaller grower, primarily based in the more traditional growing areas centred around Adelaide and the second is the new, usually larger, holdings along the Murray River and to the east into Victoria and to a minor extent, New South Wales.

TRADITIONAL AREAS

In this group are the areas to the North and South of Adelaide. There are approximately 100 growers in these areas and they have an average orchard of 1,850 trees or 7.5 ha. The unavailability of good quality water will limit further expansion in these areas and is, in fact, already severely impacting on the productivity of the holdings in these areas.

The natural rainfall of 450-500 mm is supplemented by irrigation, usually by bore water. This water is limited in supply and has relatively low quality, with an average salt level of 1,200 ppm. Coupled with relatively heavy and difficult soils, the trees regularly show the symptoms of chloride toxicity, especially those on peach and almond rootstock. The productivity of the trees in these areas reflects these problems and averages 3.5 kg kernel.

MORE RECENT DEVELOPMENTS

These areas form a narrow belt along the Murray River in South Australia and Victoria. Growing conditions are generally more favourable in these areas, with adequate good quality water and a hot dry Mediterranean climate. Soils, while fertile and generally well drained, can be relatively shallow, with a calcareous subsoil of high pH which can cause problems of lime induced chlorosis. For this reason, Nemaguard is not a favoured rootstock in these conditions. Productivity in these areas tends to be relatively high, with an average of 6.9 kg per tree being produced in 1994.

The orchards in these areas tend to be larger and highly mechanised. Many are owned by consortiums of investors, with the properties being professionally managed. Productivity on these properties compares very favourably with that being achieved in California, and the better growers regularly achieve in excess of 2.5 t of kernel per ha. Typical property sizes range from 40 ha to 1,000 ha.

Unfortunately, future development will be limited since the suitable growing area is a narrow strip along the Murray River. This river system is already overcommitted, providing for the majority of Australia's irrigated horticultural crops as well as towns and cities adjacent to it. Adelaide, South Australia's State Capital, is situated at the end of the river and depends on the Murray for 90% of it's water. South Australia is well known as the "driest state in the driest continent", so the limitations are of great concern.

INDUSTRY STRUCTURE

While early plantings were based on a number of Australian hard-shell varieties thought to have originated from material brought from South Africa, plantings since the late 1960's have been based on the Californian varieties.

A number of these varieties have proven susceptible to diseases which have become widespread in recent years such as bacterial spot, (*Xanthomonas campestris* pv *pruni*) and anthracnose, (*Colletotrichum acutatum*).

All current plantings are based on 'Nonpareil' with 'Carmel' as the preferred pollinator. Either 'Price' or 'Peerless' are also included. Early plantings were on almond rootstock with these trees proving to be long-lived. All later plantings are either on Nemaguard or a locally selected peach x almond hybrid, which is propagated in vitro.

All orchards are irrigated, with around 80% by sprinklers and the balance by drip. There is a trend towards either mini sprinklers or drip. The majority of orchards use electronic soil moisture monitoring. However, in our hot dry conditions with sandy soils water usage is high. The typical orchard uses 11-12 megalitres of water per hectare per year to obtain maximum production. In particularly hot years, mature orchards can use 14 megalitres which is of concern with our limited water. Harvesting is by Californian shakers, sweepers and pick-up machines. Smaller pro-

Seedling evaluation in the breeding programme
(14 months old seedlings, planted 1m apart and rows separeated 4,5 m)

perties either use second-hand machinery or employ a contractor.

INDUSTRY ASSOCIATIONS

As the industry grew there was an awareness that in order to ensure long-term success, the industry must be efficient and develop to suit Australian growing and marketing conditions. In a move to coordinate the industry on a national level, the Australian Almond Grower's Association was formed in June 1995.

In 1997 the Association applied to the Federal Government to levy a special tax on growers to help fund an extensive research and development programme. This was granted in 1998, with the funds raised being matched by the Government. These funds now provide for the majority of almond research in Australia.

There is a dedicated Research and Development Committee which works hard to ensure the industry progresses technically. A programme has been developed which maps out the areas of research to be undertaken over the next five years.

THE RESEARCH PROGRAMME

The industry has undertaken many small research projects in the past as problems or needs arose. However, now with guaranteed funding and a keen interest in developing technical expertise, a long-term programme has been developed.

Central to this programme is the almond improvement programme. Part of this programme was discussed recently (Bertozzi et al., 1999). in the last edition of Nucis. It is extensive, covering the breeding and evaluation programme; micropropagation of varieties and rootstocks; the development of genetic transformation systems; germplasm repositories including cryopreservation; evaluating virus indexing techniques; developing virus elimination techniques for use in almonds; sourcing and evaluating superior varieties from around the world; evaluating rootstocks for Australian conditions and identifying superior performing clones of major varieties.

Other areas of research either currently being undertaken or are soon to begin include:

- Improved orchard canopy management.
- Developing a control programme for anthracnose.
- Genetic mapping and marker aided selection techniques.
- Detection and identification of viroids affecting almonds (other than prune dwarf and prunus necrotic ring spot).
- A 'visiting scientist' programme to promote the regular exchange of scientists on sabbatical or study tours.
- Improved nutrient and irrigation management techniques.

THE FUTURE

The Australian industry is beginning to change to more closely address the climatic and growing conditions in our country. The current emulation of the Californian technologies, while successful, will need to be adjusted so that varieties, rootstocks and agronomic techniques better suit our unique, and quite different, conditions.

Our dry conditions, shallow soils of high pH and limited, often saline water has much in common with the Mediterranean region. We will be moving away from the current varieties to those which are more productive, self-fertile, drought tolerant and disease resistant. We will be using superior rootstocks that are productive; drought, pH and rematode resistant; tolerant of saline soils and easy to propagate.

Clearly, the objectives and aspirations of our industry are very similar to those of a number of countries. The Australian growers and researchers would like to think they could make a significant contribution to the pool of knowledge and research currently being undertaken by organisations and groups within GREMPA.

REFERENCES

Bertozzi, T.; Bennett, C.; Sedgley, M., 1998. Almond improvement in Australia. FAO-Nucis Newsletter, (7): 10-11.

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QUALITATIVE TRAITS IN ALMOND TREES

INTRODUCTION

The paucity of genetical studies in almond (*Prunus amygdalus* Batsch) has been previously stressed both for qualitative traits (Socias i Company, 1997a) and for quantitative traits in fruits (Socias i Company, 1998). However, the results observed along the breeding programmes can furnish useful information about the transmission of interesting traits.

The traits studied so far in almond trees are those considered the most important from an agronomical point of view and refer mostly to the phenological stages of tree development. The most important phenological traits are blooming time, duration and intensity of bloom, as well as the ripening season. Also production intensity, disease and frost resistance and other physiological and morphological characters have received some attention, although no real measurements on their heritability have been made.

BLOOMING TIME

Blooming time is considered to be inherited quantitatively in most fruit species (Anderson and Seeley, 1993). In almond, blooming date may change from year to year depending on the winter weather conditions. Although the blooming sequence of different cultivars is relatively constant over the years, small variations in the order of blooming may occur (Felipe, 1977), due to differences in the chilling requirements (Tabuenca, 1972) and heat requirements before bloom (Tabuenca et al., 1972). Thus, blooming scales have been developed in order to classify the almond cultivars independently of the year (Gülcan, 1985) and scales have been applied when studying the heritability of almond blooming (Kester et al., 1973). However, the presence of very late blooming seedlings in some progenies (Grasselly and Olivier, 1985; Socias i Company et al., 1996a) made unapplicable this scale rate of blooming and it has been decided to change it at the X GREMPA (Group de Recherches et d'Études Mediterranéen pour l'Amandier) Colloquium in Meknès (Morocco) in October 1996.

Most of the results on the transmission of blooming time in almond show that this trait is inherited quantitatively (Grasselly, 1972; Grasselly and Gall, 1967; Kester, 1965; Vargas and Romero, 1988). However, only in a few cases has this heritability been estimated. The first approach was that of Kester et al. (1973), establishing a heritability of 0.804. The same authors (Kester et al., 1977) later confirmed the value of this heritability, which was based on observations of 13 different parents, 20 families and 490 offspring. Dicenta et al. (1993) used a similar number of parents but a larger number of families and offspring and decreased this value to 0.67, probably due to the wider genetic basis of the parents involved in the later study. In fact, cultivars from different geographical regions may possess different quantitative loci related to blooming time, since the use of late blooming cultivars from different regions has probably allowed the accumulation of different quantitative genes retarding almond blooming much more than in other fruit species (Socias i Company et al., 1996b).

Although blooming time is considered at full bloom, several different measures can be taken to record blooming time, estimating different percentages of open flowers and defining first, full and final blooming times (Dicenta et al., 1993; Socias i Company et al., 1996a). Dicenta et al. (1993) estimated the values for these different phenological stages: first (0.73), full (0.78) and final (0.67) blooming time, although there is a high correlation among these stages which cannot be considered independent.

Leafing time is highly correlated with blooming time, although there are differences among the almond cultivars for the time of leafing in relation to the time of blooming, with a bloom-leaf index variable or even negative (Buyukyilmaz and Kester, 1976). However, the heritability of leafing times was even higher than blooming time (0.829 as compared to 0.804) for the same families (Kester et al., 1977).

BLOOMING DURATION

Differences in blooming duration are associated with the climatic conditions, mainly temperature, at the time of bloom (Bernad and Socias i Company, 1995; Dicenta et al., 1993). Its importance is only related to the climatic conditions during bloom, as a long bloom can avoid the negative effects of a frost at the beginning of bloom or to bad weather conditions disturbing the bee pollination work. Dicenta et al. (1993) have found a very high year x family interaction for blooming duration due to this temperature effect, but do not rule out a small genetic interaction, although the heritability of this trait (0.20) was considered somewhat uncertain.

BLOOMING INTENSITY

Blooming intensity is considered a primary requirement for a good productivity of an almond clone. Bloom density was considered as a trait transmissible to the offspring (Grasselly, 1972), thus opening the possibility of selection for this character, although no heritability of this trait was estimated until Dicenta et al. (1993) with a value of 0.54.

Grasselly (1972) related bloom intensity to production precocity, with a possible correlation of the juvenile period of the seedlings and the unproductive period of the young orchard. Obviously the juvenility of the seedlings does not allow to make the evaluation of this trait to occur until the forth or fifth year (Kester and Asay, 1975).

RIPENING SEASON

The date of ripening is also highly affected by the year, but as for blooming time, the ripening sequence of different cultivars is highly constant. The importance of an early ripening season is due to the need of harvesting before fall rains and, consequently, of offering the new crop to industry before the Christmas marketing orders, both of which are very important factors in some countries. Early harvest is also very important in non irrigated conditions, before drought is too severe. Both Grasselly (1972) and Kester and Asay (1975) observed that ripening season was quantitatively inherited. While heritability has been estimated as 0.69 (Dicenta et al., 1993) the presence of non-additive variance has been suggested.

Dicenta et al. (1993) also considered the duration of maturity, with a heritability of 0.61. Although this trait was not previously considered in almond, a simultaneous ripening, thus a short ripening season, would be interesting for facilitating harvesting.

PRODUCTION INTENSITY

Production intensity is highly correlated with bloom intensity, but it also depends on the conditions of fruit setting. A medium bloom density with a high set can reach a higher production than a high bloom density with a low set (Bernad and Socias i Company, 1997). Thus, although production intensity was considered to be quantitatively inherited (Grasselly, 1972; Kester and Asay, 1975), when its heritability was estimated, it was lower than for bloom intensity (0.45 vs 0.54) (Dicenta et al., 1993).

DISEASE AND FROST RESISTANCE

Although almond has been considered to be a species resistant to some pests and diseases as well as to abiotic factors, not much attention has been paid to evaluate specific resistances and to estimate their heritability. Only Grasselly (1972) reported the transmission of resistance to fungal diseases to the offspring of 'Ardéchoise', but he did not evaluate its transmission rate. Grasselly (1981) also reported that there is a general resistance or susceptibility to different fungal diseases in the same cultivars, thus implicating some correlation among these traits. El Gharbi (1981) reported the transmission of Taphrina deformans (Berk.) Tul. susceptibility from 'Tuono' to its offspring. Similarly, Felipe (1988) has suggested that frost resistance could also be a quantitative factor to be transmitted to the offspring as observed in 'Tuono' and its progenies.

OTHER MORPHOLOGICAL AND PHYSIOLOGICAL CHARACTERS

A quantitative transmission has been suggested for several other traits in almond, but difficulty in their measurement or the low level of quantitative observations in a reduced number of offspring have not allowed the estimation of their heritability. Among these traits, Grasselly (1972) pointed out that growth habit is a complex trait, with an apparent dominance in some offspring probably due to the parents used in the crosses, but quantitatively inherited. Kester and Asay (1975) also reported that the different morphological types of tree structure are evidently polygenic in nature, transmitted to the offspring and highly heritable.

The colour and linear dimensions of the leaf are also traits with a possible quantitative transmission, although they are not of great agronomical interest (Grasselly, 1972). This fact possibly explains the similarities among seedlings coming from the same cross for leaf traits (Bernad and Socias i Company, 1994). These same conclusions can also be applied to the flower dimensions (Bernad and Socias i Company, 1994; Grasselly, 1972) and to the stamen number (Grasselly, 1972).

Almond is a species with a very difficult propagation by hardwood cuttings. However, Felipe (1984) identified an almond cultivar having a very good rate of hardwood propagation and has shown that this ability can be transmitted to the offspring (Felipe, 1992). Although this transmission has not been quantified, it is another example of a quantitative trait.

CONCLUSION

The traits related to almond tree morphology and physiology are very difficult to consider because of the paucity of precise measurements of many of these traits, as it happens in most of other fruit trees. Only the blooming season has really received enough attention due to the incidence of spring frosts at bloom in many almond regions and the possibility to measure precisely the actual dates of almond blooming. However, with the other almond traits (Socias i Company, 1997b) it is only possible to have a general overview of the possibilities of almond selection in the breeding programme.

ACKNOWLEDGEMENTS

Review conducted under project AGF98-0211-C03-01 (Spanish CICYT). Comments by A.J. Felipe and C. Grasselly are highly appreciated.

LITERATURE CITED

Anderson, J.L.; Seeley, S.D., 1993. Bloom delay in deciduous fruits. Hort. Rev. 15: 97-144.

Bernad, D.; Socias i Company, R., 1994. Caracterización morfológica y bioquímica de algunas selecciones autocompatibles de almendro. Inf. Técn. Econ. Agrar. 90V: 103-110.

Bernad, D.; Socias i Company, R., 1995. Characterization of some self-compatible almonds. II. Flower phenology and morphology. HortScience 30: 321-324.

Bernad, D.; Socias i Company, R., 1997. Bud density and shoot morphology of some self-compatible almond selections. II International Symposium on Pistachios and Almonds, Davis, California, 24-29 August 1997.

Buyukyilmaz, M.; Kester, D.E., 1976. Comparative hardiness of flower buds and blossoms of some almond genotypes in relation to time of bloom and leafing. J. Amer. Soc. Hort. Sci. 101: 344-347.

Dicenta, F.; García, J.E.; Carbonell, E.A., 1993. Heritability of flowering, productivity and maturity in almond. J. Hort. Sci. 68: 113-120.

El Gharbi, A., 1981. Résultats préliminaires des croisements intervariétaux d'amandier réalisés en Tunisie. Options Méditerr. CIHEAM/IAMZ 81/I: 23-35.

Felipe, A., 1977. Epocas de floración de variedades de almendro. An. Inst. Nat. Invest. Agrar., Ser. Prod. Veg. 7: 105-112.

Felipe, A.J., 1984. Enrancinement de l'amandier par bouturage ligneux. Options Méditerr. CIHEAM/IAMZ 84/II: 97-100.

Felipe, A.J., 1988. Observaciones sobre comportamiento frente a heladas tardías en almendro. Rap. EUR 11557: 123-130.

Felipe, A.J., 1992. Aptitude pour la propagation chez l'amandier 'Garrigues' et sa descendance. Rap. EUR 14081: 73-79.

Grasselly, C., 1972. L'amandier: caractères morphologiques et physiologiques des variétés, modalité de leurs transmissions chez les hybrides de première génération. Thesis Univ. Bordeaux, 156 pp.

Grasselly, C., 1981. Existe-t-il des corrélations de sensibilité des semis d'amandier à diverses maladies cryptogamiques? Options Méditerr. CIHEAM/IAMZ 81/I: 57-58.

Grasselly, C.; Gall, H., 1967. Étude sur la possibilité de combinaison de quelques caractères agronomiques chez l'amandier Cristomorto hybridé par trois autres variétés. Ann. Amélior. Plant. 17: 83-91.

Grasselly, C.; Olivier, G., 1985. Avancement du programme «tardivité de floraison» chez l'amandier. Options Méditerr. CIHEAM/IAMZ 85/I: 47-54.

Güllcan, R., 1985. Almond descriptors (revised). IBPGR, Rome, 30 pp.

Kester, D.E., 1965. Inheritance of time of bloom in certain progenies of almond. Proc. Amer. Soc. Hort. Sci. 87: 214-221.

Kester, D.E.; Asay, R., 1975. Almonds. In: Janick, J.; Moore, J.N. (eds): Advances in fruit breeding. Purdue Univ Press, West Lafayette, Indiana, pp. 387-419.

Kester, D.E.; Raddi, P.; Asay, R., 1973. Correlation among chilling requirements for germination, blooming and leafing in almond (*Prunus amygdalus* Batsch). Genetics 74 (2,2): s135.

Kester, D.E.; Raddi, P.; Asay, R., 1977. Correlation of chilling requirements for germination, blooming and leafing within and among seedling populations in almond. J. Amer. Soc. Hort. Sci. 102: 145-148.

Socias i Company, R., 1997a. Qualitative traits in almond. Nucis 6: 6-9.

Socias i Company, R., 1997b. Fruit tree genetics at a turning point: the almond example. Theor. Appl. Genet. 96: 588-601.

Socias i Company, R., 1998. Quantitative traits in almond fruits. Nucis 7: 12-14.

Socias i Company, R.; Felipe, A.J.; Gómez Aparisi, J., 1996a. Genetics of late blooming in almond. Eucarpia Symposium on Fruit Breeding & Genetics, Oxford, England, 1-6 September 1996.

Socias i Company, R.; Felipe, A.J.; Gómez Aparisi, J., 1996b. Approche génétique à la floraison tardive chez l'amandier. Cah. Options Méditerr.

Tabuenca, M.C., 1972. Necesidades de frío invernal en almendro. An. Estac. Exper. Aula Dei 11: 325-329.

Tabuenca, M.C.; Mut, M.; Herrero, J., 1972. Influencia de la temperatura en la época de floración de almendro. An. Estac. Exper. Aula Dei 11: 378-395.

Vargas, F.J.; Romero, M.A., 1988. Comparación entre descendencias de cruzamientos intervarietales de almendro en relación con la época de floración y la calidad del fruto. Rap. EUR 11557: 59-72.

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POLLEN SUPPLEMENTATION IN ALMOND AND PISTACHIO ORCHARDS USING ELECTROSTATIC TECHNIQUES

INTRODUCTION

In recent years, insufficient pollination has been found to be one of the important limiting factors for low yield in many field and orchard species (Shivanna & Sawhney 1997). Some species require management of pollinating agents, while others need artificial means of pollination, one of which is pollen supplementation (Hopping and Jerram 1980a 1980b), involving three major steps: (1) pollen collection; (2) pollen storage; (3) pollen deposition on receptive stigmas.

Several methods of pollen supplementation have been used on almonds (*Amygdalus communis* L.) and pistachios (*Pistacia vera* L.) over the years when conditions in the orchards were less than ideal. In almonds, beehive inserts containing compatible pollen through which outgoing honeybees have to pass (Griggs *et al*. 1952; Free 1993), and the application of pollen by using ground blowers (Thorp *et al*. 1967), have failed to increase yields in almond orchards with adequate plantings of compatible cultivars. Hand pollination has been used successfully but was too expensive to use commercially (Free 1993). Bouquets of almond flowers placed in or near trees of compatible cultivars, in orchards with inadequate plantings of compatible cultivars, increased fruit set but their effect was only local (Briggs *et al.* 1983). In pistachios, however, fewer attempts were made at supplementing pollen and most results were inconclusive (Oltman, 1997).

Electrostatic forces have been tested in numerous technologies, over the past 35 years, including printing, and the transportation, collection, or separation of material in the form of powder or small droplets. These electrostatic forces were employed by using three particle charging methods: (1) electrostatic induction of charge onto a conductive liquid dispersion medium with suspended pollen grains (Banerjee and Law 1996); (2) triboelectrification (i.e., frictional charging) of pollen grains (Banerjee and Law 1995); and (3) ionized-field particle charging or corona charging of the pollen grains (Bright et al., 1978).

Several researchers have tried to use supplementary pollination techniques using electrostatic forces: in apples (Legge 1975; cited by Williams and Legge 1979); in dates (Bechar, 1996; Bechar et al., 1999); in almonds, plums, apples, olives, walnuts, and pistachios (Oltman, 1997); and in Larch (Philippe and Baldet, 1997).

The aim of this study was to test the effects of electrostatically assisted pollen supplementation on yield and nut quality in insect pollinated almonds and wind pollinated pistachios.

MATERIALS AND METHODS

The electrostatic pollination device

In an ongoing project, since 1994, we developed a powder-coating device especially designed for electrostatic pollination. Our method of pollen application was an ionized-field particle charging (corona charging) of the pollen grains (Bright et al., 1978). As the mass of negatively charged pollen grains approach the targeted plant, they induce charging by creating an electron flow inside the plant thus keeping the earthed plant close to zero potential. The electrons flow down into the soil, leaving the exposed plant surfaces with a temporary positive charge. The resulting electric field forces the charged pollen grains towards the charged plant parts.

So far we have used this device successfully on almonds, pistachios, dates, sweet cherries and tomatoes for hybrid seeds.

Pollen supplementation in a Californian pistachio orchard

Electrostatic pollination of almond

We conducted the experiment at Kibbutz Yizreel in Israel, during the 1998 season. In this ranch the trees of cv. 'Um El Phahem' and 'NePlus Ultra' were interplanted in four adjacent rows of each cultivar alternatively and two rows of the pollenizer 'M.D' were planted in the middle of the ranch.

The experiment was conducted on the cv. 'Ne Plus Ultra' and compatible pollen of cv. 'Butte' was used for the pollination treatments. The treatments were:

1) Electrostatic pollination of the trees in three applications of 1 g and open (honey bee) pollination; 2) Non-electrostatic pollination of the trees and open pollination; 3) open honey bee pollination as control. We applied 1 g pollen per tree per application, three times throughout the blooming period. At harvest we weighed yield per tree and nut weight was calculated per each tree separately.

Electrostatic pollination of pistachio

We conducted The experiment at San Joaquin Valley, California, USA, during the 1998 season (Vaknin et al., 1999). In this ranch the trees were planted in 130 rows (from east to west), 84 trees in each row. The female trees were of cv. 'Kerman', grafted onto 'Pioneer Gold' rootstock, and the male trees of cv. 'Peters' were interplanted in the orchard at a proportion of one male per 24 females (4%).

The trees were 5-years old and coming into production for the first time. Most males were not blooming and a few which bloomed were not fully overlapped with the females. Therefore, pollen was in certain limitation during the female bloom.

The experiment consisted of two treatments:
1) Electrostatic pollination of the trees in two applications of 0.2 g pollen per tree per application throughout the blooming period;
2) Open wind pollination as control.

Because of restrictions imposed on us by the growers, we limited the control to the 12 most northern rows and electrostatically pollinated the other 118 rows. Fruitlet count took place about 30 days after the blooming period ended. During harvest we weighed the yield of the 12 untreated rows together as well as the adjacent 12 rows of the electrostatic pollination treatment. Each treatment was also tested for nut quality, i.e. percentages of split nuts (endocarp dehiscence) and percentages of blank nuts.

Analysis

Statistical analysis were carried out using SPSS 7.5.1 SPSS Inc., 1989-1996.

Almond - data were analyzed by ANOVA and Post Hoc Fisher's PLSD tests. Prior to statistical analysis cubic root transformation was applied on yield weight. Average nut weight was not transformed prior to the statistical analysis.

Pistachio - data were analyzed by t-test. Square root transformation was applied on counts of fruitlets per cluster prior to the statistical analysis.

Table 1. Effects of electrostatic pollination of almond (means±S.E) on yield per tree and on nut weight. Statistical analysis was done for each measurement separately. Means followed by different letters are significantly different

Treatment	Yield (kg)	n	Nut (g)	n
Electrostatic pollination	21.7 ± 0.53 a	70	3.7 ± 0.03 B	69
Non-electrostatic pollination	19.2 ± 1.52 b	10	3.5 ± 0.11 C	9
Open pollination	19.2 ± 0.74 b	39	3.9 ± 0.06 A	40

Table 2. Results of electrostatic pollination of pistachio

Treatment	# fruitlets	Yield (kg)	Split nuts (%)	Blank nuts (%)
Electrostatic pollination	15.4 ± 0.49 a	7.9	57.5	4.3
Control	13.3 ± 0.64 b	7.1	48.8	10.9

Values in the table describe the following: 1) mean (±S.E) number of fruitlets per cluster (n=50); 2) mean yield per tree (n=986 for the electrostatically pollinated trees and n=954 for the control);

3) percentage of split nuts; 4) percentage of blank nuts.

t-test was only performed for the number of fruitlets. Mean number of fruitlets followed by different letters are significantly different.

RESULTS AND DISCUSSION

Almond - electrostatic pollination of individual trees resulted in significantly higher yield compared to the control (ANOVA, $F_{(2, 116)}$=4.432, P=0.0140). By electrostatically pollinating the trees we gained a significant improvement of 13% in yield compared to the control and the treatment of non-electrostatic pollination with open pollination (Table 1).

Data on the average yield per tree in Kibbutz Yizreel, during the 1997-1998 seasons, which was provided to us by the growers, suggested that the orchard was alternate bearing. 1997 was probably an off year with about 11 kg per tree and 1998 was probably an on year with about 20 kg per tree. The increase in yield due to electrostatic pollination occurred in 1998 when the trees were already bearing many more nuts than 1997. We suggest that even if pollen were limited in 1997, the trees were probably not able to produce more nuts due to reasons unnecessarily related to pollination such as environmental or physiological constraints (see also, Sedgley and Griffin 1989). In 1998, however, when the trees were probably much stronger they were able to carry the extra load resulting from electrostatic pollination.

Results of nut weight per tree have shown an opposite trend to the one we found in yield per tree. Nut weight per tree was 5% lower for the electrostatically pollinated trees than for the control (ANOVA, $F_{(2, 114)}$=8.097, P<0.001). Therefore, the increase in the number of flowers that were pollinated and produced mature nuts, as a result of electrostatic pollination, was even bigger than 13% as it reached 13.7%.

Pistachio - The electrostatically pollinated trees showed a significant increase of 16.2% in fruitlet number per cluster compared to the control (t-test, t_{248}=-3.491, P<0.001). Due to electrostatic pollination yield was improved by 11.3%, percentage of split nuts was improved by 18%, and percentage of blank nuts was reduced by 60% (Table 2).

The control treatment produced a fair amount of nuts; however, application of pollen with our technique dramatically improved all aspects of nut set and nut quality. As electrostatic pollination was so effective we can safely determine that the addition of electrostatically charged pollen probably reached many non-pollinated flowers and supplied them with a high quality of pollen which resulted not only in more nuts per cluster therefore with higher yield, but also with more split nuts and fewer blank nuts.

CONCLUSIONS

In conclusion, our results clearly show that electrostatic pollination has a significant role in fruit set both in insect pollinated plants such as almond and in wind pollinated plants such as pistachio. It is suggested that in almond electrostatic pollination could be an important technique for pollen supplementation in orchards with inadequate plantings of compatible cultivars and where honeybee pollination is insufficient. In pistachio it is suggested that in extreme cases of pollen limitation, electrostatic pollination could replace natural pollination and ensure high yields with high nut quality.

Practical commercial use

The electrostatic pollination device is now in the final stages of development. For the past two years (1998-1999) it had been used commercially on pistachio orchards in California USA and on an almond orchard in Israel. The acquired knowledge by the authors of this paper on pollen harvest, pollen storage and pollen application of both pistachio and almond, enables the growers to use electrostatically assisted pollen supplementation on vast areas with minimum investment and hopefully with maximum gain.

Acknowledgements
The study was funded by grant no. US-1996-91 from the United States - Israel Binational Agricultural Research and Development Fund (BARD). The study was also partially funded by Paramount Farming Company, USA.

REFERENCES

Banerjee, S. and Law, S. E. 1995. Characterization of chargeability of biological particulates by triboelectrification. IEEE/IAS Conference. 2: 1295-1301.

Banerjee, S. and Law, S. E. 1996. Electrostatic induction charging of pollen suspensions. IEEE/IAS Conference. (In press).

Bechar, A. 1996. Pollen deposition in electrostatic field. (in Hebrew) MSc thesis. The Faculty of Agricultural Engineering, The Technion - Israel Institute of Technology.

Bechar, A. Shmulevich, I. Eisikowitch, D. Vaknin, Y. Ronen, B. and Gan-Mor, S. 1999. "Modeling and experiment analysis of electrostatic date pollination". Transaction of the ASAE. (In press).

Briggs, D. Thorp, R. and Klungness, M. 1983. Artificial pollination of almonds, *Prunus dulcis*, with bouquets monitored by fruit set and pollen germination. Journal of Horticultural Science. 58: 237-240.

Bright, A. W. Corbett, R. P. and Hughes, J. F. 1978. Electrostatics - Electrostatic engineering design guide no. 30. Oxford University Press. Oxford.

Free, J. B. 1993. Insect Pollination of Crops. Academic Press, London, pp. 11, 68.

Griggs, W. H. Vansell, G. H. and Iwakiri, B. T. 1952. The use of beehive pollen dispensers in the pollination of almonds and sweet cherries. Proceedings of the American Society for Horticultural Science. 60: 146-150.

Hopping, M. E. and Jerram, E. M. 1980a. Supplementary pollination of tree fruits. I. Development of suspension media. New Zealand Journal of Agricultural Research. 23: 517-521.

Hopping, M. E. and Jerram, E. M. 1980b. Supplementary pollination of tree fruits. II. Field trials on kiwifruit and

Japanese plums. New Zealand Journal of Agricultural Research. 23: 517-521.

Legge, A. P. 1975. Artificial supplementary pollination of European fruit crops. Ph.D. Thesis, University of Bath.

Oltman, D. 1997. Gaining an edge - supplementing the amount of pollen normally distributed in an orchard is proving to be an effective form of crop insurance for many commodities. California farmer. April, pp. 8-9, 18, 47, 76.

Philippe, G. and Baldet, P. 1997. Electrostatic dusting: an efficient technique of pollination in lach. Annales des Sciences Forestieres. 54: 301-310.

Sedgley, M. Griffin, A. R. 1989. Sexual reproduction of tree crops. Academic Press. London. pp. 149.

Shivanna, K. R. and Sawhney, V. K. 1997. Pollen biology and pollen biotechnology: an introduction. Pollen Biotechnology for Crop Production and Improvement In: Shivanna KR Sawhney VK (eds), Cambridge University Press, Cambridge. pp. 1-12.

Thorp, R.W. Stanger, W. and Aldrich, T. 1967. Effects of Artificial pollination on yield of Nonpareil almond trees. California Agriculture. 21: 14-15.

Vaknin, Y. Gan-Mor, S. Bechar, A. Ronen, B. and Eisikowitch, D. 1999. Electrostatic pollination of pistachio (*Pistacia vera* L.) – a novel technique of pollen supplementation in agriculture. The XI G.R.E.M.P.A meeting on pistachio and almond. Harran University, Sanliurfa, Turkey.

Williams, R. R. and Legge, A. P. 1979. Pollen application by mechanical dusting in English apple orchards. Journal of Horticultural Science. 54: 67-74.

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EVALUATION OF THE POSSIBILITY TO SELECT WALNUT (*J. regia*) TREES FOR HYPOXIC SOIL RESISTANCE

INTRODUCTION

Woody plants vary markedly in their tolerance and response to flooding (Pereira and Kozlowski 1977, Tang and Kozlowski 1982, Pezeshki and Chambers 1985) and water stress (Ranney et al. 1990, Ni and Pallardy 1991). Flooding causes rapid depletion of oxygen in soil which induces soil chemical changes (Kozlowski 1984), affects solubility of mineral compounds, and leads to the formation of phytotoxic substances (Janiesch 1991).

Differences in tolerance to anaerobic conditions among types of rootstock used or of potential use have been established. *Juglans* species (*J. hindsii* and *J. regia*) or their hybrids ("Paradox") are considered very sensitive to soil aeration (Catlin et al., 1977).

The relative response of *J. nigra* to excessive soil moisture is not clear. From field observation, *J. nigra* has been described as tolerant (White, 1973), somewhat tolerant (Bell et al., 1974), moderately sensitive (Lindsey et al., 1961), and very sensitive (Loucks et al., 1973). In a comparison with *J. regia*, *J. nigra* appeared to be more tolerant to waterlogging (Solignat, 1974). In all these works, however, sometimes only few seedlings per treatment were employed and epinasty and chlorosis, wilting, and necrosis of leaves were normally used as indicators of root damage and tolerance degree of plants.

As already mentioned *Juglans* species are reported to be highly sensitive to root anaerobiosis, however, studies on the morphological, physiological and biochemical modifications occurred to walnut plants in flooded soil are lacking.

In the overall objective of the UE project "Walnut - Basic research for agroforestry and Industry" the enhancement of knowledge in physiology and genetic of walnut trees mainly devoted to wood production is taken in consideration, together with the aim to develop a new extensive cultural model suggesting solutions for agricultural overproduction and waste lands.

The aim of this research is to contribute to cover the lacking knowledge on this topic and to take part in the study of genetic variability and molecular markers that may help in the selection programme for *Juglans* sp. or interspecies hybrid plants better adaptable to different climatic regions and environmental stresses.

The comparison of the physiological responses to the soil flooding of *J. regia* trees of different European countries provenance, and of interspecific hybrids, *J. nigra* x *J. regia* and *J. major* x *J. regia,* has been investigated to give indication of the possibility to select plant material more suitable for different environmental conditions.

MATERIALS AND METHODS

Two years old trees of *J. regia*, varieties 'Lozeronne' from France, 'Sorrento', 'Feltre' and 'Soraloviner' (a progeny of selected Feltre trees indicated with the locality name where trees grow) from Italy, the clone MBT-31 from Spain and 'Colbitz' and 'Templin' from Germany as well as *J. nigra* x *J. regia* (NG23 x RA) and *J. major* x *J. regia* (MJ209 x RA) hybrids obtained from French nursery, were planted into plastic pots (50 cm in diameter and 40 cm in height, about 75 l volume, one plant per pot) containing soil for horticultural use, and were grown under natural conditions with fertiliser and water added as needed.

In July twenty plants of similar size and appearance of each genotype were selected for flooding treatment. Pots with plants were immersed in larger pots (65 cm in diameter), filled with tap water maintained at about 2.5 cm above the soil level. Some plants were maintained in freely drained conditions, watered every day, and considered as control plants. After different times of flooding, stressed tree plants were drained and treated similarly to the control plants.

Measurement of leaf gas exchange was made daily. Considering that the experiments were carried out in open field, the measures were collected always in the morning between 8:30 am to 10:30 am. Raining days were not considered for measurement.

The carbon dioxide and water exchange rates of fully expanded leaves were measured using an LCA3 portable photosynthesis system (Analytical Development Co., Hoddeston, U. K.). Five separate measurements taken on each plant were used to calculate average and statistical analysis between plants of the same treatment.

Leaflets were collected at interval days after beginning of treatment and from control plants and used for ethylene analysis. Ethylene was measured by GC according to Kimmerer et al. (1982).

The density of stomata on leaves surface has been calculated from silicon image obtained by polymerisation of silicon paste directly on the leaves. Silicon was then stripped out and microscopically observed.

The dissolved oxygen was measured with Oxi325 oximeter (WTW, Weilheim, Germany). The measures were taken in the water layer above the soil and at 20 cm deep in flooded soil.

RESULTS

To evaluate the soil hypoxia condition the measure of dissolved oxygen was collec-

Table 1.
Comparison of the stomatal density on leaf abaxial face of several walnut genotypes (± SE n 10)

Genotypes	stomata / mm^2 of leaf surface
'Feltre'	237.38±51.64
'Lozeronne'	187.58±26.88
'Colbitz'	138.61±25.37
'Saraloviner'	129.48±37.97
'Templin'	122.01±25.97
NG23 x RA	103.75±35.48
MBT-31	92.96±21.71
MJ209 x RA	88.81±22.83

ted at an interval of 1 h the first day and controlled twice per day in the following period. The tap water contained 6.2 mg/l of oxygen. In flooded soil in 12-18 h, at 20 cm deep intermediate pot height, it decreased to 1-1.2 mg/l and after one day it was at 0.5-0.8 mg/l and remained at this concentration for all the following soil flooding time. On the water layer above the soil the oxygen concentration was lower, but after one day it never reached more than 1.2 mg/l. Those measures indicated that the hypoxia condition started to affect the root system few hours after soil submersion.

To compare the response to soil hypoxia of the different walnut genotypes the gas exchange parameters were collected. The net CO_2 assimilation characteristics of walnut leaves has shown high sensitivity to temperature (Tombesi et al., 1983), with an optimum temperature between 25-30°C. At higher temperature the CO_2 assimilation rapidly decreased. Considering that July-August weather condition, in Milan, may oscillate between 20°C at dawn to 37°C afternoon with high relative humidity values, to reduce the inconvenience of temperature and humidity fluctuations, the measures were collected in a short period during the morning. In this interval the temperature fluctuation did not exceed 3-4°C, and the photosynthetic photon flux density was at saturation value already.

The carbon dioxide assimilation measurements on leaves of *J. regia* v. 'Lozeronne' trees subjected to flooding were shown in Figure 1. The flooding caused a rapid decrease in net CO_2 assimilation, with wilting leaf symptoms immediately visible. The leaves of 'Lozeronne' plants rapidly recovered CO_2 assimilation if soil was drained after 1 day. When trees were put in drained condition after 3 days the leaves, with a one day delay and slowly, were again in condition to recover CO_2 assimilation. If the flooding condition was longer (4 days) the leaves were chlorotic and wilted and no recovery attempt was visible (Fig. 1) and leaves began to shed on the 8th day from the start of the experiment and 4 days after drainage. The data obtained on the 'Lozeronne' trees are given in Figure 1 indicating the high sensitivity of walnut root apparatus to soil oxygen deficiency. However, the different *J. regia* genotypes showed time differences in the capacity to recover CO_2 assimilation and the Figure 2 shows the time limit for each *J. regia* genotype after which no recovery from root hypoxia damages were observed.

In experiments with the NG23 x RA hybrid trees, the soil flooding was continued till 12 days. Also for these plants a rapid decrease of CO_2 assimilation was the evident consequence of the stress (Fig. 3) without wilting symptoms. At different times of flooding treatment when water excess was removed the CO_2 assimilation recovered and went back to standard level (Fig. 3), indicating that trees remained alive for at least 12 days. The data obtained with NG23 x RA hybrid trees and here presented are comparable to the measure collected from MJ209 x RA trees. However, the hybrid plants, both NG23 x RA and MJ209 x RA, showed higher variability in the physiological responses respect to the *J. regia* plants. The hybrid trees were obtained from seeds. Walnuts are heterozygous, the heterozygosity can explain the observed variability in the response to flooding stress of plants within the same hybrid species. "In vitro" micropropagation of hybrid plants can produce clones with higher homogeneity and solve the problem.

The data of the stomatal conductance and water transpiration for each genotype here considered followed the curves of the carbon dioxide assimilation reported for each one (data not shown). To attempt an explanation of the different leaves capacity in resistance to flooding stress leaf morphology has been examined and on Table 1 the density of the stomata of the genotypes is reported. The less resistant genotypes, 'Lozeronne' and 'Feltre', showed the highest stomata density and the leaves of MJ209 x RA hybrid, the most resistant, showed the lowest density. However, the stomata density can explain only partially the degree of genotype stress resistance. Indeed, for the other genotypes there is a spread distribution between stomatal number and days after which genotypes remain able to recover from the root hypoxia stress.

Searching for a possible indicator of hypoxia stress resistance the measure of ethylene formed in leaves during stress period has been investigated. The 1-aminocyclopropane-1-carboxylic acid (ACC), the precursor in ethylene biosynthesis, is considered as a positive signal, moving from root to shoot as consequence of root hypoxia (Vartapetian and Jackson, 1997). The ACC is converted to ethylene in leaves and ethylene role in control of leaf gas exchange and leaf epinasty has been well described in vegetables, and cereals (English et al., 1995, Vartapetian and Jackson, 1997).

Analysis of ethylene in the walnut leaves for some of studied genotypes are presented in Table 2. In highly flooding sensitive trees the ethylene increase was observable after two days. In the 'Soraloviner' plants the ethylene increase occurred later and rose to a dramatic concentration before flooding damage effect became visible on leaves. In leaves of interspecific hybrids NG23 x RA (and for MJ209 x RA not presented on this table) no significant changes were measurable during all the 12 days of soil flooding. The data give indication that ethylene, or its precursor ACC, may have an important role also in walnut tree response to root hypoxia. If in more resistant walnut trees there is no accumulation of ACC in root or absence of ACC convertion to ethylene in leaves remain an open question, considering that also in more studied model plants (tomato and rice) the presence and activation of ACC synthase in root and of ACC oxidase in leaves is not totally defined.

Our data obtained on *J. regia* trees seem in disagreement with the results reported by Aletà et al. (1994). Those authors flooded plants of two derivatives of *J. regia*, one from 'Serr' and another from 'MB-T-31'. In their work, after 17 days of flooding the lea-

Table 2. Ethylene formed in leaves of walnut genotypes during soil flooding treatment (μg/g leaf fresh weight ± SE n 5-7)

Genotypes		Days from start of flooding condition				
		2	4	6	11	12
'Feltre'	control	0.10±0.02	0.10±0.02	0.10±0.01		
	flooded	1.99±0.36	3.75±1.12	2.28±0.88		
'Lozzeronne'	control	0.08±0.02		0.11±0.04		
	flooded	1.17±0.33		3.12±0.92		
'Soraloviner'	control	0.28±0.06	0.25±0.07	0.35±0.07	0.30±0.11	
	flooded	0.31±0.11	4.22±1.15	31.7±4.65	23.48±3.21	
NG23 x RA	control	0.10±0.01			0.11±0.01	0.12±0.06
	flooded	0.12±0.08			0.85±0.07	0.62±0.10

Figure 1 Effect of soil flooding on the net carbon dioxide assimilation measured in leaves of *J. regia* 'Lozeronne' trees. Dashed lines show the gas assimilation when the soil is drained after 1, 3 or 4 days. Each data is the mean of measures carried out at least on three leaves of three different plants and 5 measures on each leaf

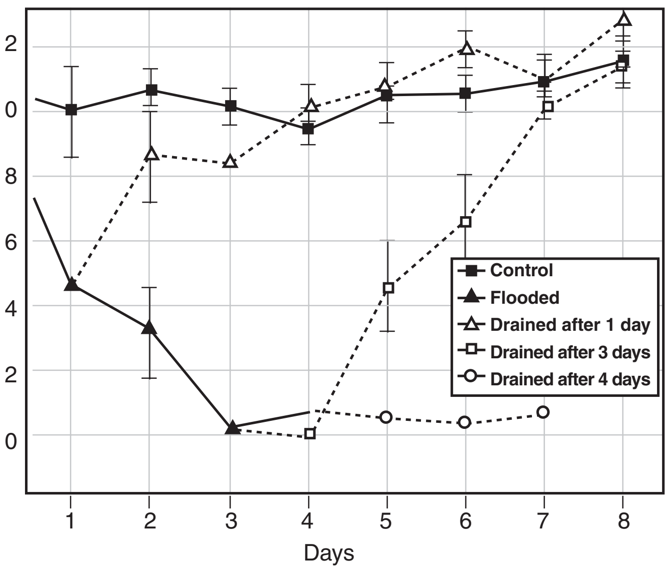


Figure 2 - Cumulative percentage of trees showing leaf damages. A tree is considered damaged when at least two leaves show visible symptom of leaf wilting and/or chlorosis

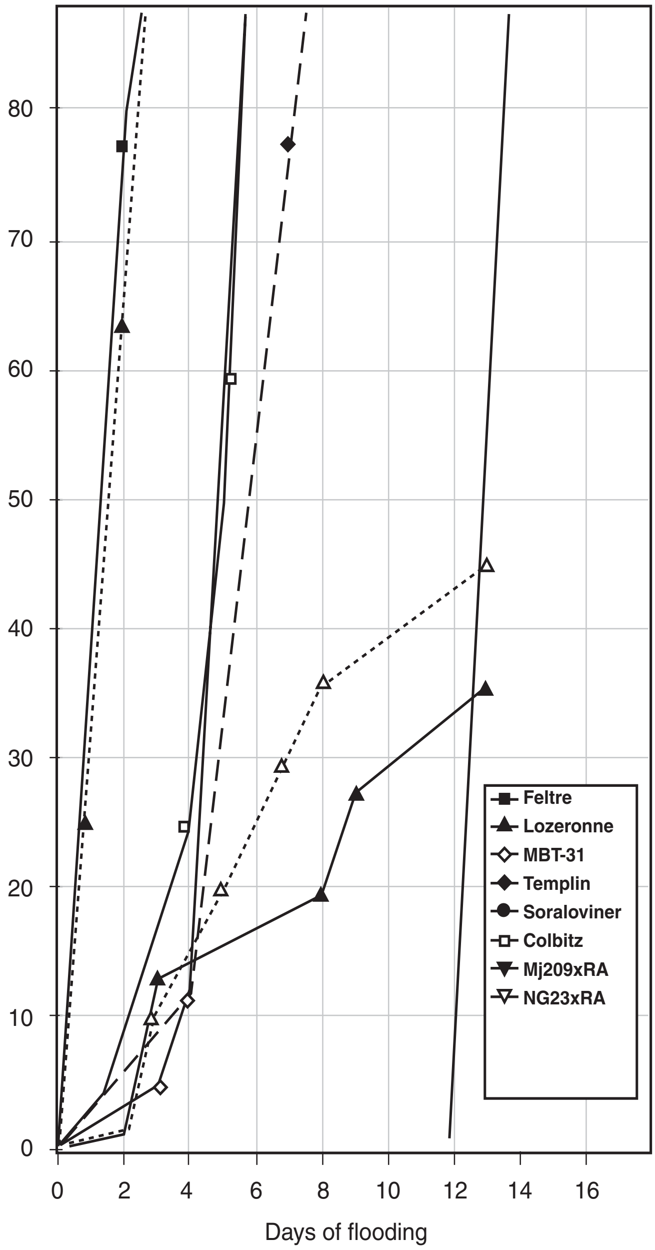
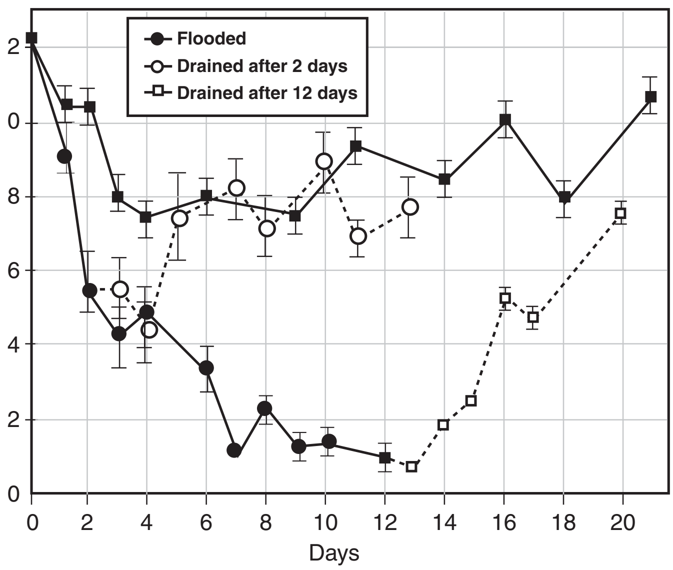


Figure 3 - Change of net carbon dioxide assimilation in control and flooded *Juglans nigra* x *Juglans regia* (NG23 x RA) hybrid plants. Each point is the mean of measures carried out at least on three leaves of three different plants and 5 measures on each leaf



ves were not chlorotic or shed and they had the capacity to recovery, also if not to initial values, the stomatal resistance.

We tried as preliminary experiment with *J. regia* 'Lozeronne' plants subjected to root hypoxia stress in a different system. Plants were flooded in conditions where water percolation through the pots was continuously present at a flux of 5 l/h. This system can mimics the natural water movement in the soil due to water table or to river fluctuation. In these conditions the rapid decrease of CO_2 assimilation was observed again, but after 15 days of flooding, when plants were transferred to drained soil conditions, the assimilation began to recover to reach the control level. Only few leaves showed senescence symptoms; in general the plants subjected to hypoxia condition remained indistinguishable from the control. The difference observed between flooding, and percolated water stress system on 'Lozeronne' could explain the different responses, changing from tolerant to very sensitive, reported for *Juglans* by previous works (White, 1973, Loucks et al., 1973, Solignat, 1974, Shaybany and Martin., 1977, Catlin et al., 1977). The different responses of 'Lozeronne' trees to soil hypoxia stress here indicated can be attributed only partially to different soil hypoxia levels (the oxygen at 20 cm deep in soil with percolating water never rises over 1.3 mg/l). The presence of substances with toxic action that are removed or diluted from the soil by water percolation can be a possible answer. This aspect was in the past suggested by Catlin and co-workers (Catlin and Shaybany, 1976, Catlin et al., 1977) and our recent observations. Working to attempt for hydroponical culture of walnut seedlings we observed that the continuous air flux in water was not enough for seedling survival. The presence of active absorbing compounds (carbon or polyvinylpirrolidone) or frequent changes of water were conditions for seedling survival.

CONCLUSIONS AND PROSPECTS

The comparison of *J. regia* genotypes for root hypoxia stress resistance indicates the presence of a different resistance degree to the stress. The data obtained are encouraging in searching tree germplasm with higher resistance to flooding stress as well as other environmental conditions. The *Juglans regia* cultivars ('Feltre', 'Sorrento' and 'Lozeronne') have shown to be highly sensitive to soil anoxia. The hybrid plants show higher capacity to survive in flooding soil condition, but the presence of intraspecific variation seems to be a limit of their use in soils where flooding can occurr for longer period. The possibility to select a more stress resistant walnut progeny also in *J. regia* species, however, seems possible from the data of the 'Soraloviner' and 'Templin' trees.

The hybrids and *J. regia* trees with apparent higher degree of tolerance to flooding could be used, also with biotechnological procedure of "in vitro" micropropagation or cell and tissue culture, in order to assess the real degree of stress tolerance, to investigate genetic and biochemical aspects and to propagate new walnut clones suitable for growth in environmental limiting conditions and with faster growing rate.

ACKNOWLEDGEMENTS
We are indebted to European research Institutes (IRTA Spain, INRA France, NFV Germany) for having provided us the seeds or the tree seedlings needed for the research. The research was developed in the frame of the program W-Brains, financed by the European Union (Contract FAIR III CT 96-1887).

LITERATURE CITED

Aletà, N. and Ninot, A. 1994. *In*: Développement de la culture extensive des noyers a bois et a fruits en Europe - Quatrième rapport d'activités, UE Contract AIR3 CT92-0142.

Bell, D. T. and Johnson, F. L. 1974. Flood-caused tree mortality around Illinois reservoirs. Trans. Ill. State Acad. Sci., 67: 28-36.

Catlin, P. B., Martin, G. C. and Olson, E. A. 1977. Differential sensitivity of *Juglans hindsii*, *J. regia*, Paradox hybrid, and *Pterocarya stenoptera* to waterlogging. J. Amer. Soc. Hort. Sci., 102: 101-104.

Catlin, P. B. and Shaybany, B. 1976. Phenolic compounds as toxins in hypersensitivity of *Juglans* seedlings to waterlogging. HortScience, 11: 306.

English, P. J., Lycett, G. W., Roberts, J. A., and Jackson, M. B. 1995. Increased 1-aminocyclopropane-1-carboxylic acid oxidase activity in shoots of flooded tomato plants raises ethylene production to physiologically active levels. Plant Physiol., 109: 1435-1440.

Janiesch, P. 1991. Ecophysiological adaptations of higher plants in natural communities to waterlogging. *In* Ecological Responses to Environmental Stresses. Eds. Rozema, J. and Verkleij, J. A. C.. Kluwer Academic Publishers, The Netherlands, pp 50-60.

Kimmerer, T. W., and Kozlowski, T. T. 1982. Ethylene, ethane, acetaldehyde, and ethanol production by plants and stress. Plant Physiol., 69: 840-847.

Kozlowski, T. T. 1984. Plant responses to flooding of soil. BioScience, 34: 162-167.

Lindsey, A. A., Petty, R. D., Sterling, D. K. and Van Asdall, W. 1961. Vegetation and environment along the Wabash and Tippecanoe rivers. Ecol. Monogr., 31: 105-154.

Loucks, W. L. and Keen, R. A. 1973. Submersion tolerance of selected seedling trees. J. For., 71: 496-497.

Ni, B. R. and Pallardy, S. G. 1991. Response of gas exchange to water stress in seedlings of woody angiosperms. Tree Physiol., 8: 1-9.

Perreira, J. S. and Kozlowski, T. T. 1977. Variations among woody angiosperms in relation to flooding. Physiol. Plant., 41: 184-192.

Pezeshki, S. R. and Chambers, J. L. 1985. Stomatal and photosynthesis response of sweet gum *Liquidambar styraciflua* to flooding. Can. J. For. Res., 15: 371-375.

Ranney, T. G., Whitlow, T. H. and Bassuk, N. L. 1990. Response of five temperate deciduous tree species to water stress. Tree Physiol., 6: 439-448.

Tang, Z. C: and Kozlowski, T. T. 1982. Some physiological and morphological responses of *Quercus macrocarpa* seedlings to flooding. Can. J. For. Res., 12: 196-202.

Shaybany, B. and Martin, G. C. 1977. Abscisic acid identification and its quantitation in leaves of *Juglans* seedlings during waterlogging. J. Amer. Soc. Hort. Sci., 102: 300-302.

Solignat, G. 1974. Note sur le comportement a l'asphyxie radiculaire de port-greffes du noyer *J. regia*. Pomol. Franc., 16: 75-77.

Tombesi, A., De Jong, T. M. and Ryugo, K. 1983. Net CO_2 assimilation characteristics of walnut leaves under field and laboratory conditions. J. Amer. Soc. Hort. Sci., 108: 558-561.

Vartapetian, B. B. and Jackson, M. B. 1997. Plant adaptation to anaerobic stress. Ann. Bot., 79 (suppl A) 3-20.

White, P. M. 1973. Plant tolerance for standing water: an assessment. Cornell Plantations, 28: 50-52.

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PISTACHIOS: PAST, CURRENT SITUATION AND PROSPECTS

SOME INSIDES ON PISTACHIO

All through history, the pistachio nut was highly valued and desired, but only those living close to its native range of distribution of *P. vera* trees, or those from afar, that had the opportunity and or the means, could enjoy it. Within the last century (in the process of becoming one big village world) the dispersion of these trees, on one hand and, the importation of the nuts, on the other, reached all the corners of earth.

Like with other valued commodities and crops, that became known and desired, an economical demand of pistachios has started to grow up and incited both the increase of importation and the production of this crop in new regions having suitable environmental conditions. A positive economical process of a rising supply, further urged the demand and vice versa. This trend is now high and, probably, will continue so for some time to come, as demand is still growing faster than supply.

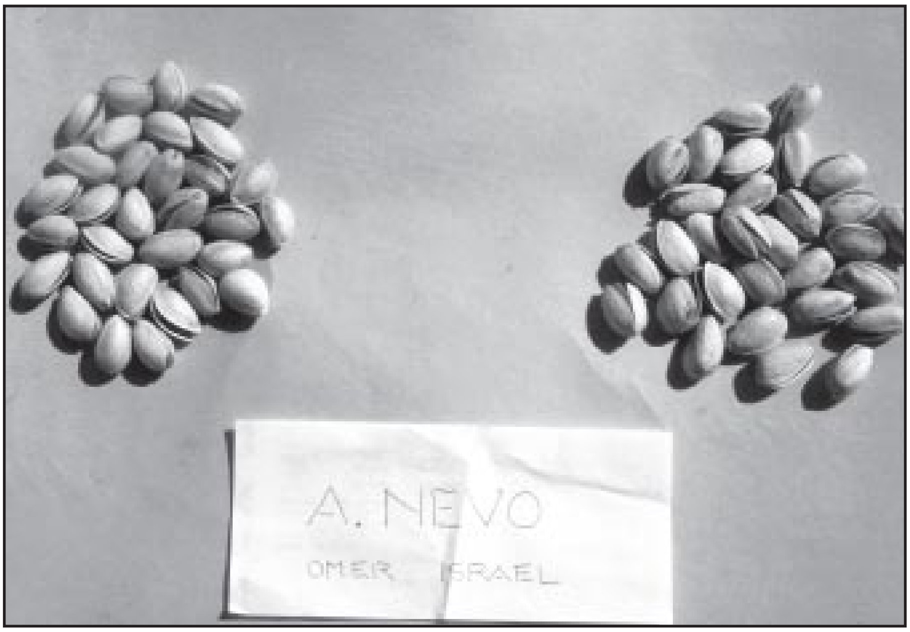
There is no need to go into details of pistachios production and marketing in the far past. It is enough to know, understand and analyse the relevant records of the last 25 years and the most outstanding issue that more and more people in the world are exploring this nut and can allow themselves to taste it. And, as it is well known, when people taste something nice, they will try again and again to perceive the same sensation.

This process of growing demand is further strengthened as pistachio nuts are coming more and more into an increasing number of commodities (confectionary, bakery, cooking etc.) in addition to the main "classical" use of the nuts as a high quality snack.

The total world trade in pistachio-nuts (according to common definitions and data from customary sources) is constantly increasing inspite of their high price:

Year	World production (t) (dry in shell pistachios)
1975	50.000
1985	125.000
1990	190.000
1995	360.000
2000	410.000

Based on these data, it is expected that demand will continue to rise above the already forseeable increase of production from the still young, unbearing yet, orchardss and, from the already planned new plantations.



Pistachio nuts from two A. Nevo's selections

It is important to consider that these records are relevant to the world market, in which it is the largest, heaviest and the most beautiful nut. In my opinion, pistachio nut is the "star" (falling into the categories of Large + Extra Large, that is - up to 25 nuts per 1 ounce). The cultivars bearing this size nuts, have usually high winter chilling requirements (900-1200 hours). Not much free arable land, with that level of chilling combined with hot and dry summers is currently available in many countries.

A possible solution to enhance the production of these, large first class nuts is by finding or breeding new varieties bearing such a nut size but under much lower chilling requirement conditions. Some work has been done on it in different places. Practically, there are already two new such varieties, which are now in the first stages of commercial planting. These two varieties require only 600 hours of chilling which means that availability of land (with all other environmental conditions needed) is not much a problem.

It should be considered that the prevailing concept of the standards, definitions of quality and price of the commodity in the world market, is misleading, in a way. This market, now is practically limited to the upper 2 or 3 tenths, socio-economic level of the population, who can easily afford to buy pistachios. If we assume that the lowest 2 or 3 tenths are practically deprived of this luxury, there are still about 4 to 6 tenths, the middle socio-economical levels, huge masses of people that are not in poverty and could become eager consumers of pistachios if they can get them, in one or another shape or form, at a lower price. It is worth for every pistachio grower, in practice or potentially, to aim at this sector of the world market, in general and, within his own country in particular.

Everybody wishes to drive a Cadillac... or a Mercedes, or a Jaguar, etc., but those who can afford it are numbered. Yet, very many people indeed, including those of the middle tenths, do drive and travel, much and well in far more modest and smaller cars and they are quite content with them. The world market for these modest cars bustles and develops. Moreover, the manufacturers of these cars are doing very well.... These big masses, of the middle tenths, are looking out for their modest pistachios. Only a meagre supply of these modest nuts reach now this sector.

The production of pistachios for the middle tenths of the market, whether defined as the local market or as part of the world market, can be worthy and of a large scale. Especially around the Mediterranean basin, where winter chilling is low (300-600 hours) but summers are rather hot and dry; in which are large tracts of marginal lands that are either empty, or are used for some traditional crops which are doing poorly but could be fit for pistachios. Especially so that pistachios require much less water and can withstand brackish water more than many other crops.

Pistachios production can be added to, or integrated with existing agricultural setups, down to the level of a «family farm». In practice, if possible, large scale operation may be preferable. But in the reality of the Mediterranean basin, this option is rather remote. The benefits of large scale operation, though, can be reached by a proper organisational set up, of small farms, like a cooperative, and thus securing many of those benefits.

There are a few pistachio cultivars which bear fine nuts and are very tasty too (in categories Medium + Small = 26-32 nuts per ounce). With proper agrotechniques (including dormancy breaking, irrigation and fertilizers schemes, pollination, etc.) the yields can be very high at relatively modest inputs.

A FEW COMPLEMENTARY REMARKS:

1. There is no contradiction between the possibility /feasibility of producing pistachios, of the big first class nuts, by "large-scale operation" and the production of the "modest" ones. These are two complementary options, each directed to a rather specific sector of the market. The decision as towards which option to follow or how to integrate both, have to be reached by weighing the environmental conditions and all other, relevant, elements and compulsions.

2. The average consumption of pistachio-nuts, by country, (kg of dry-in-shell / per capita, per annum) is quite distint in different countries. It goes all the way from 0 to 6 kg. In most countries, in which pistachios are produced or/and marketed, it is in the range of 0.5 to 2 kg. An increase of these figures depends mainly on nuts availability. The more the nuts are available the more they will be consumed. Both by new consumers and by the old ones. So far, there is no data or solid indication as to what the maximum consumption could be.

3. The positive prospects for pistachios may cause some allurements to new investors: be cautious!. This is not a routine, easy crop. It has some bothering, "built in" complications and difficulties. It is recommended, to those considering going into pistachio production, to start with a serious feasibility survey, done by an expert on the subject, in which all relevant conditions, factors, parameters etc. will be examined and assessed followed by clear recomendations. There is a cost for it, of course, but this cost might be found to be the best and wisest investment, disregarding the final recommendation is positive or negative.

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BEHAVIOR OF MEIOTIC CHROMOSOMES IN *Pistacia vera* L. (*Anacardiaceae*)

INTRODUCTION

P. vera (2n=30) is the only species in this genus, successfully grown in orchards, which produces edible nuts large enough to be commercially acceptable. Other species and sub-species, producing smaller nuts, which are mainly used as rootstocks or for oil, agro-forestry, timber production and carpentry (Barghchi and Alderson, 1989). Pistachio cultivation plays an important role in the agricultural economy of arid and semi-arid countries such as Iran, a country that leads the world in the production of these nuts. The largest genetic diversity of pistachio is found in Iran and the most valuable quality of pistachio in the world is originated from Iran.

Although the chromosome number of *P. vera* has been previously reported (Zohary, 1952; Bochantseva, 1972; Fasihi Harandi, 1996a,b) this is the first time work on the meiotic behavior in *P. vera* is reported independently.

MATERIALS AND METHODS

Chromosome studies carried out on material collected from Rafsanjan (Kerman province, Iran). Flower buds were sampled at the stage, which meiotic division occur in the microsporocytes and immediately fixed in the field in the Piennar's fixing fluid (6 ethanol 96% : 3 chloroform : 2 propionic acid v/v) for 24 hours at room temperature. They were then washed and preserved in 70% ethanol and stored at 4C in the refrigerator. Anther dissected out from bud flowers were squashed and stained with 2 percent acetocarmin. All slides were made permanent by the Ventian Turpentien (Wilson, 1945). Photographs were taken from permanent preparation using an Olympus photomicroscope at initial magnification of 330X.

RESULTS AND DISCUSSIONS

Pistacia vera belongs to the *Anacardiaceae* family and it is native from Central Asia (Whitehouse, 1957; Joley, 1969; Rechinger, 1969). Existing documents show that pistachio has been cultivated since 3000-4000 years ago in Iran and was introduced into Mediterranean Europe at approximately the beginning of the Christian Era (Crane, 1978). Previous chromosome countings in this species was 2n=30 (Zohary, 1952; Bochantseva, 1972; Fasihi Harandi, 1996 a,b).

Meiosis studies in pollen mother cells showed that in leptotene, chromosomes gathered around the nucleolus like a synizetic knob (Fig. 1). This stage is necessary for the pairing of homologous chromosomes, and it will produce 15 bivalents in zygotene. In pachytene, diplotene and diakinesis nucleolus was clearly visible and one to five pairs of chromosomes were attached to it (Fig. 2 and 3).

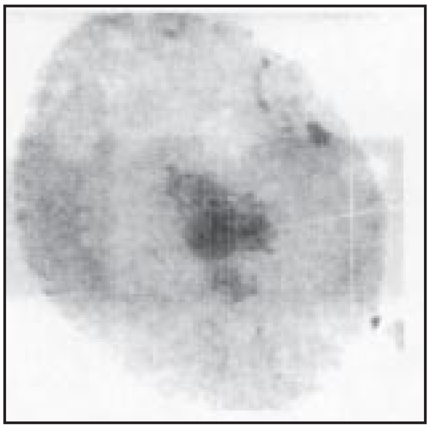

Fig. 1. Leptotene: chromosomes are clumped around nucleolus like a synizetic knob

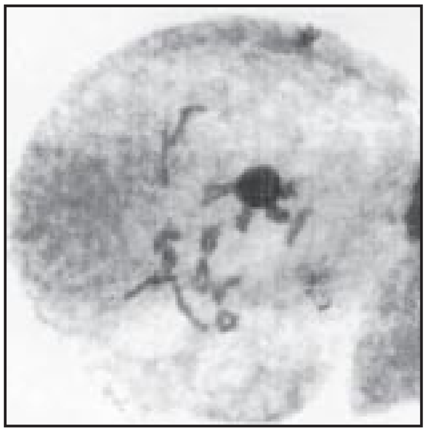

Fig. 2. Diplotene: showing 15 bivalents, four of them are associated with nucleolus

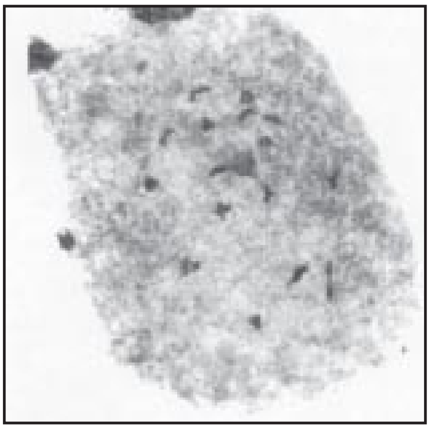

Fig. 3. Diakinesis: showing 15 bivalents, two of them are associated with nucleolus

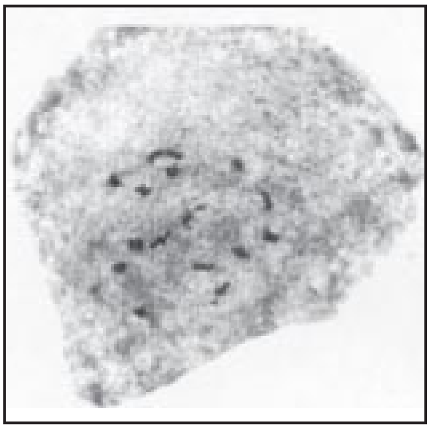

Fig. 4. Metaphase I

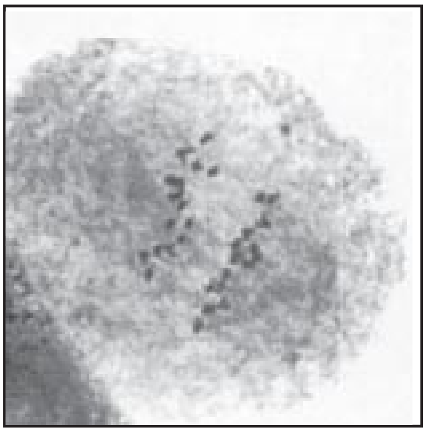

Fig. 5. Anaphase I. Showing (15-15) segregation

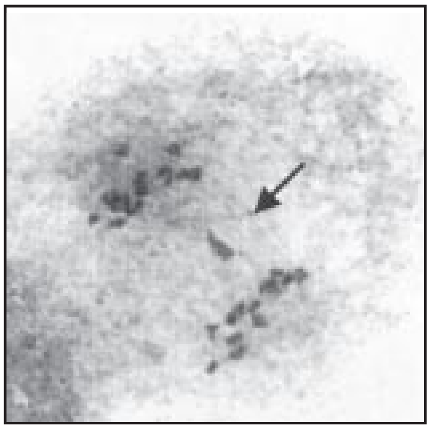

Fig. 6. Anaphase I. Showing laggard chromosomes (arrow)

Chromosome coiling in this species is considerably fast, thus the morphology of bivalents in diakinesis and first metaphase is so similar that only by presence of nucleolus, the difference of these two stages could be distinguished (Fig. 3 and 4).

The progress of terminalization of chiasmata from the end of zygotene to first metaphase showed 15 pairs of bivalents, which most of them appeared in a ring conformation and with two terminal chiasmata. Interstitial chiasmata were observed with a low frequency. The mean number of chiasmata in 110 cells was estimated 1.35 for each bivalent at first metaphase. In some cells the repulsion force followed by chiasmata terminalization causes the segregation of bivalents and therefore the appearance of univalents.

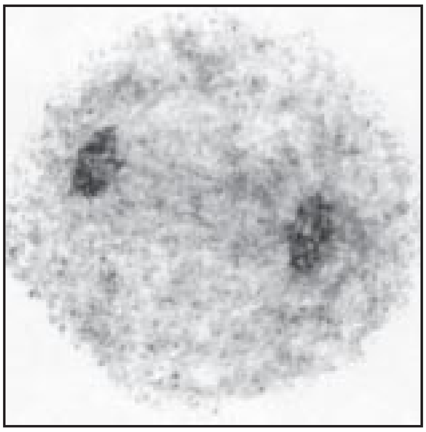

Fig. 7. Telophase I

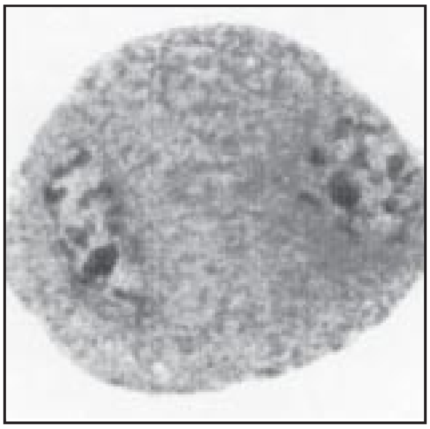

Fig. 8. Prophase II

Fig. 9. Metaphase II

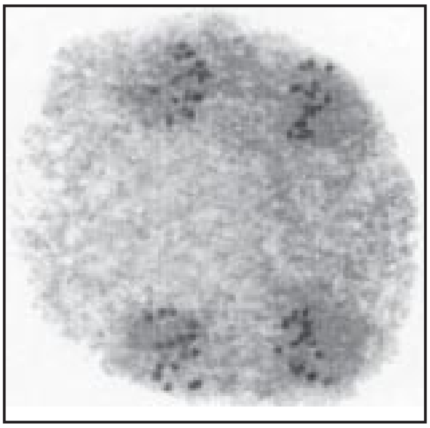

Fig. 10. Anaphase II. Showing (15-15) segregation of monads

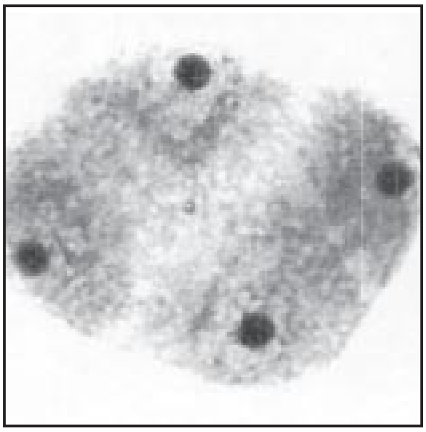

Fig. 11. End of Telophase II

Fig. 12. End of tetrad stage with four microsporocites

Meiosis in this species was regular and showed (15-15) segregation of diads and monads in first and second anaphase respectively (Fig. 5 and 10). Occasionally in some cells laggard chromosomes at first anaphase were observed (Fig. 6). First division of meiosis is completed in Telophase I (Fig. 7). Second division of meiosis begins by Prophase II (Fig. 8), and continues by second metaphase, anaphase, telophase and tetrad (Fig. 9, 10, 11 and 12). Meiotic behavior of this species is reported here for the first time.

ACKNOWLEDGEMENTS

This work was supported by a grant (Project No. 5) from Research Council, University of Tehran. The authors would like to thank Mr. Hossein Fasihi Harandi, Mrs. Fakhrieh Harandi Rabbani Poor and Mr. Abbas Fasihi Harandi for providing us Pistachio flower buds and seeds from Rafsanjan. We are also grateful to Mrs. Parisa Kalantari and Mr. Gholam Reza Sharifi for their help and encouragements during this study.

REFERENCES

Abrishami, M., 1995. Persian Pistachio, a comprehensive history. Iran University Press. Tehran.

Barghchi, M. and Alderson, P.G., 1989. Pistachio (*Pistacia vera* L.). In Biotechnology in Agriculture and Forestry, 1989, Bajaj YPS (ed). Springer-Verlag, Berlin, Heidelburg, New York, Vol. 5: 68-98.

Bochantseva, Z.P., 1972. Ochislakh chromosom. Introd. Akkli. Rasteny Akad, Nauk. UZ. SSR: 44-53.

Bolotov, S., 1979. Best forms of Pistachio in southern Kirgizia. Bioekkol. Issled. v orekhovoplod, Isakh Yuzhn. Kirgizii, Frunze, Kirgizssr. Referativnyi Zhurnal, 6. 55. 747. (in Russian).

Chernova, G.M. and Olekhnovich, G.S., 1977. Breeding *Pistacia vera* in Tajikistan. Subtropicheskie Kul'tury, 5: 168-170.

Crane, J.C., 1978. Pistachio tree nuts. Avipublishing Co. Westport, USA.

Fasihi Harandi, O., 1996a. Genetic studies of wild and cultivated Pistachio in Iran. M.Sc Thesis in plant breeding. College of agriculture, Azad University of Karaj, Karaj, Iran.

Fasihi Harandi, O., Behboodi, B., Abd-mishani, C. and Ghaffari, M., 1996b. The cytogenetic studies and Isozyme analysis of Iranian Pistachio. Proc. 5th Iranian Biology Congress, 28-30 August, College of Sciences, University of Tabriz, Tabriz, Iran.

Fasihi Harandi, O. and Shahsavan Behboodi, B., 1997. Botany, distribution and ecology of *Pistacia* genus in Iran. Proc. 6th Iranian Biology Congress, 25-27 August, College of Sciences, University of Kerman, Kerman, Iran.

Joley, L.E., 1969. Pistachio. In Handbook of North American nut trees. Jaynes RA (ed). Northern Nut Grower Assoc., Knoxville: 348-361.

Popov, K.K., 1979. Variability of Pistachio fruits on the Apsheron peninsula. Rastitel'nye Resurty, 15: 127-131.

Raven, P.H., 1975. The bases of angiosperm phylogeny, cytology. Ann. Missouri Bot., 724-764.

Rechinger, K.H., 1969. Flora Des Iranischen Hochlandes Und Der Umrahmenden Gebirge, Graz, Austria. No. 63.

Stuessy, T.F., 1990. Plant Taxonomy. New York.

Whitehouse, W.E., 1957. The Pistachio nut – A new crop for the Western United States. Econ. Botany, 11(4): 281-321.

Wilson, G.B., 1945. The Venetian turpentine mounting medium. Stain Technology, 20: 133-135.

Zohary, M., 1952. A morphological study of the genus *Pistacia*. Palestine J. Bot., Jerusalem Ser. 5: 187-228.

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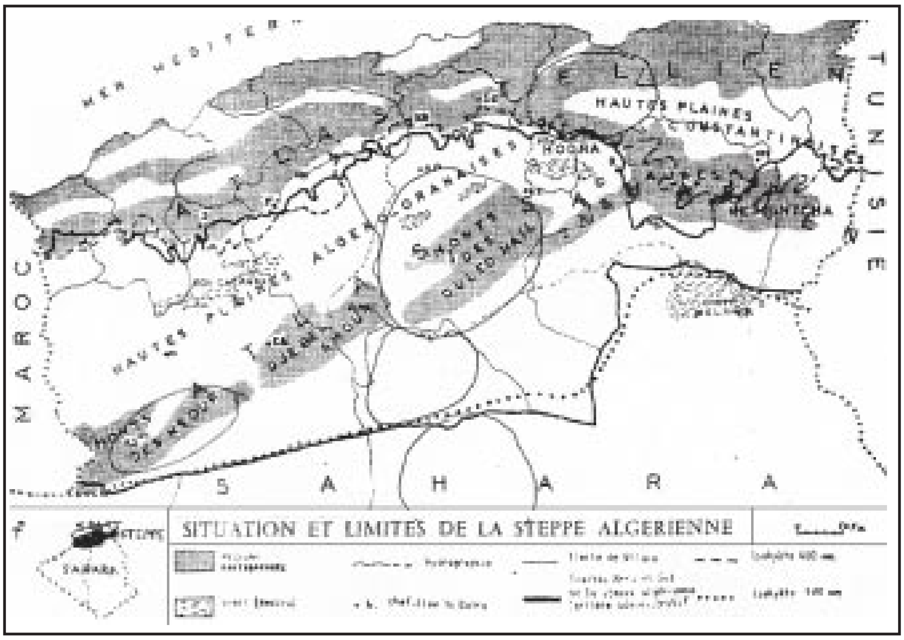
Scattered wild *P. atlantica* trees growing in Algeria

P. atlantica trees growing on bare regions of Algeria

PISTACHIO SITUATION IN ALGERIA

Pistacia atlantica Desf. also called Elbetoum, Botma, Betouma ou Btouma in local Arabic language and Iggh in Berberian language. The nuts are called Elkhodiri. It is widespread in the semi arid and arid region. Several endemic species of *Pistacia* are native and common of the Algerian territory as follows (map):



Distribution map of *Pistacia* species in Algeria

P. lentiscus associatiated to *Pinus halepensis* and *Quercus* species in the northern part (basin of the Soumam)

P. therebintus associatiated to *Pinus halepensis* and *Quercus* species in the northern part (basin of the Soumam and basin of 'El Kseur')

P. atlantica associatiated to *Ziziphus lotus* and *Pinus halepensis* in the semi arid and arid regions (high plateaux and Saharian Atlas).

The nuts of *P. atlantica* contain an energetic oil which is usually mixed with dates and can be eaten all day along with milk. The seeds are dried, mouled and mixed with sweet water as small sweets can be made. They can be eaten dried as nuts as they have an aromatic taste. The bark produces a resin-mastic that exudes naturally under hot weather. The local population uses this mastic as medicine. The tree gives an artisanal wood and all the leaves of pistachio species are source of food for animals and specially in autumn.

Pistacia atlantica is located specially in the semi arid and arid regions, the trees grow in a wild population, that can stand strong winds and very poor soils and long periods of drought. The approximative age of the trees can reach easily 1000 years old. The size of the tree can reach 5m and 20m height. The weight of the seeds is about 97 mg. *Pistacia atlantica* is always associated to *Ziziphus lotus*, Rhamnaceae family and known as Cedra in Arabic language.

In Algeria, this crop is underutilized inspite of its potential of adaptation to the arid conditions. The climatic conditions of most of the mountainous and semi arid regions of our country are favourable to its extension. Several studies will be conducted on the biodiversity intra and inter-populations to assess the variability of the traditional local species and the spontaneous subspecies of the genus *Pistacia* in Algeria, by using morphological and molecular markers. The wild ecotypes are subjected to a genetic erosion caused by forest fires, deforestation, desertification, pollution, climatic changes, animal action and finally the human action.

A few new *P. vera* orchards are being grown in some parts, with new introduced cultivars from Syria, Turkey and Iran.

REFERENCES

Monjauze, A., 1965. Etude de la mise en valeur du bassin de la Soummam. Rapport final, pp: Végétation forestière.

Monjauze, A., 1980. Connaissance du Bétoum. Revue Forestière Française,

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DISTRIBUTION OF WILD *Pistacia* spp. IN LEBANON

ABSTRACT

In response to the priority tree list put forth by the WANANET Horticultural Working Group, studies were initiated to survey the distribution of wild and cultivated pistachio. Field collections were conducted throughout the country. The current distribution of pistachio species was determined and field samples were collected and characterized for further selection and conservation purposes. Results of these studies are presented.

Keywords: *Pistacia palaestina* (Boiss.), *Pistacia lentiscus* (L.), *Pistacia atlantica* (Desf.), *Pistacia vera* (L.)

INTRODUCTION

The genetic diversity of Lebanon has resulted in the formation of diverse ecosystems in which a wide variety of fruit trees thrive. That same ecological diversity however, has allowed growers to import and cultivate exotic fruits and/or varieties with commercial importance (Lebanese Agricultural Research Strategy, 1996). As a result, there has been no interest in native or naturalized fruit trees until recently following an awareness of the importance of plant genetic resources (Barkoudah et al, 1995; Abi-Saleh et al., 1996).

During its meetings, the Horticultural Working Group of the WANA region recommended the inclusion of Pistachio (*Pistacia spp)* in a priority list of native fruit trees to be assessed, studied, and conserved (WANANET, 1992). In light of this recommendation, projects were initiated at the American University of Beirut, with the aim of surveying, characterizing and documenting pistachio germplasm in Lebanon.

MATERIALS AND METHODS

Collection expeditions were initiated in 1996 and 1997 throughout Lebanon. Vegetative material was collected for characterization. Samples were taken from wild and cultivated habitats. Plant identification was confirmed by comparing the collected material with herbarium specimens from the Post Herbarium at the American University of Beirut. Morphological characterization of the samples was performed based on descriptors provided by IPGRI as well as other sources (Post et al, 1932).

RESULTS AND DISCUSSION

Pistachio in Lebanon was found at latitudes between 33'11 N and 34'35 N and at longitudes between 35'25 E and 36'25 E at precipitation varying from 250 to 1200 mm. The survey revealed that all Pistacia species previously cited are still prevalent in Lebanon. These are *Pistacia palaestina* Boiss, *Pistacia lentiscus* L., *Pistacia palaestina x lentiscus, Pistacia atlantica* Desf. (Post et al, 1932, Mouterde, 1966; Zohary, 1995; Zohary, 1952). The current field collections however revealed that many sites that were visited were subjected to significant degradation by urbanization, extensive cutting, or by the extension of agricultural lands.

P. palaestina Boiss. is the major species found mainly along the Lebanese western mountains at elevation from 0-1500m. The distribution of *P. lentiscus* L. is limited to coastal areas (0-500m elevation), while *P. atlantica* Desf. was found as scattered trees in the anti-Lebanon mountain (1000-1500m). The surveyed sites rarely contained more than one *Pistacia* species in the same habitat, and the only association was between *P. palaestina* and *P. lentiscus* and was found in only four sites. The tree species associated with *P. palaestina are Pinus spp, Quercus spp, Crataegus spp, Cupressus spp, Juniperus spp, Ceratonia spp, Olea spp, Amygdalus spp* and *Vitis spp*. The main threats to this species, which is mainly located in Mount Lebanon, is the extensive urban expansion in that part of the country. The expansion agricultural lands threaten populations found on higher lands, where urbanization is less pronounced.

The distribution of *P. lentiscus* is limited to the northern coastal sites of Lebanon and in Mount Lebanon. Trees associated with this species are *Pinus spp, Quercus spp, Ceratonia spp, Olea spp* and *Amygdalus spp*. Since *P. lentiscus* is located near urban regions, the major threat to the species is urban expansion. Many populations which were previously reported to be present could no longer be found.

The distribution of *P. atlantica* was limited to the region of Arsal which is a semi arid highland located in the Northern part of the Western side of the Anti-Lebanon mountain chain. Only three scattered populations comprising very few large-sized trees were found in that area. A rapid appraisal of the situation with the local elderly revealed that extensive tree cutting occurred in the early 1900's as fuel source for the Turkish railway (as tax in the form of wood coal) or for the native inhabitant during the winter. This region is subjected to desertification and soil erosion problems. Tree species associated with *P. atlantica* are *Crataegus spp, Pyrus spp, Prunus spp, Juniperus spp, Amygdalus spp.*

Pistachio cultivation in Lebanon is minimal, accordingly *P. vera* L. was found in a limited number of orchards that were composed of grafted varieties which were most likely imported from Syria.

Work has been initiated to assess the genetic diversity of *Pistacia* germplasm in Lebanon both at the morphological and molecular levels.

ACKNOWLEDGEMENTS

This work is supported by the International Plant Genetic Resource Institute, and the Lebanese National Council for Scientific Research.

LITERATURE CITED

Lebanese Agricultural Research Strategy. 1996. Prepared for the Lebanese Agricultural Institute. Project supported by Canada's International Development Research Center.

Barkoudah Y., Y. Adham, and M. Abi Antoun. (eds). 1995. First National Symposium on Plant Genetic Resources in Lebanon.

Abi-Saleh B., Nassar N., Rami H., Safi N., Safi S. and, Tohme H.,1996. Etude de La Diversite Biologique du Liban. La FloraTerrestre. Project GF/6105-92-72. Publication No.3, Lebanon. p.p.: 147.

West Asia and North Africa plant Genetic Resources Network, WANANET, Phase 1, 1992

Post G. E. and Dinsmore, 1932. Flora of Syria, Palestine and Sinai. Vol. 1. Publications of the Faculty of Arts and Sciences, American University of Beirut, Lebanon. 658 p.

Mouterde, S.J. 1966. Nouvell Flore du Liban et de la Syrie. Tome premier. Ed. de l'imprimerie catholique. Beyrouth.

Zohary D., 1995. The genus *Pistacia* L. , p. 1-11. In: Padulosi S., Caruso T. and Barone E., eds. Taxonomy, distribution, conservation and uses of *Pistacia* genetic resources. International Plant Genetic Resources Institute.

Zohary M, 1952. A monographic study of the genus *Pistacia*. Palestine J. Bot. Jerusalem series 5(4):187-228

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SPANISH SCHEME IN CHESTNUT IMPROVEMENT FOR NUT AND TIMBER PRODUCTION

INTRODUCTION

After natural spread of *Castanea sativa* species, local selections have provided nut and timber during centuries. At the beginning of this century, introductions of Asiatic species have provided resistance to the ink disease (*Phytophthora* spp.). As these new species were not suitable for nut and timber production, interespecific hybrids were obtained. Some of them produce nuts good enough for human consumption, other hybrid clones are suitable for timber production, and some of them are compatible with European species as rootstocks.

From 1989 we have studied interespecific hybrid clones resistant to the ink disease (*Phytophthora* spp.) and local cultivars of European chestnut in order to facilitate selected cultivars to the growers. After ten years we are encouraging private nurseries to propagating them under contract. Here we present the chestnut cultivars that can be initially promoted and how this material is organized.

UP TO DATE IN OUR RESEARCH AND TRANSFERENCE OF TECHNOLOGY

After cultivar studies, most of the descriptions have been published on international journals (Pereira *et al.*, 1996a and b, Pereira and Fernández, 1997a) and national books (Fernández and Pereira, 1994; Pereira and Fernández, 1997b).

Individual contracts with private and state institutions will be signed in the near future to use this material with the aim of improving the culture in the chestnut area without changing cultivar distribution when it is possible, because clonal selection recommended here come from the same orchards where nut production is more interesting. In the coast area, below 500 m over sea level, a new kind of material can be used to produce early nuts: interespecific hybrid clones. These hybrids are propagated by layering, or more recently by cuttings or "in vitro" culture.

Nuclear stock

A four years old plantation with two repetitions by cultivar with the best clonal selections has been established in the Centro de Investigaciones Forestales de Lourizán, Pontevedra, in order to produce scions from *C. sativa* cultivars to graft over ink resistant rootstocks HS (Pereira and Fernández, 1997c).

Germplasm Bank

A second plantation exists with other *C. sativa* cultivars which will not be used in direct transference but they will be conserved as germplasm with genetic variability origins, and maybe in the future they could be useful for breeding programmes. This plantation is six years old and it is grafted also on HS with two replicates by clone.

RECOMMENDATIONS

Twelve Galician cultivars are recommended in the chestnut areas of this region (Table 1). All of them are marron type, some of them good for the fresh market, others for nut and timber production and some of them can be used with both pur-

Table 1. Clones of *Castanea sativa* (Cs) recommend in Galicia, Spain.

Cultivar	Bud break (dates)	Ripening time (dates)	Male flowering type	Nut size (g)	Percentage of doubles (%)	Pellicle adhesion	Utilisation
'Amarelante1'	23Apr-7May	26Oct->11Nov	M	12	1	Medium	Fresh, purée
'Famosa'	21Apr-7May	26Oct->11Nov	B	13	0	Low	Industry, fresh and purée
'Garrida'	15Apr-7May	26Oct->11Nov	B	14	2	Low	Industry, fresh, purée and timber
'Inxerta1'	10Apr-30Apr	26Oct->11Nov	M	12	1	Low	Industry, fresh and purée
'Longal'	14Apr-7May	26Oct->11Nov	B	8	0	Low	Industry, fresh and purée
'Loura'	10Apr-30Apr	26Oct->11Nov	M	14	1	High	Fresh, purée
'Luguesa1'	21Apr-30Apr	26Oct->11Nov	M	11	1	Medium	Purée
'Negral1'	27Mar-30Apr	10Oct-10Nov	L	9	1	Low	Fresh, purée, pollinizer
'Parede'	10Apr-14May	26Oct->11Nov	M	6	0	Low	Purée, timber
'Raigona 2'	21Apr-30Apr	26Oct->11Nov	B	8	5	Low	Purée
'Rapada'	3Apr-7May	26Oct->11Nov	M	10	4	Low	Purée
'Ventura'	17MAR-7May	26Oct-10Nov	M	11	0	Low	Industry, fresh and purée

M: mesostaminate catkin, B: brachystaminate catkin, L: longistaminate

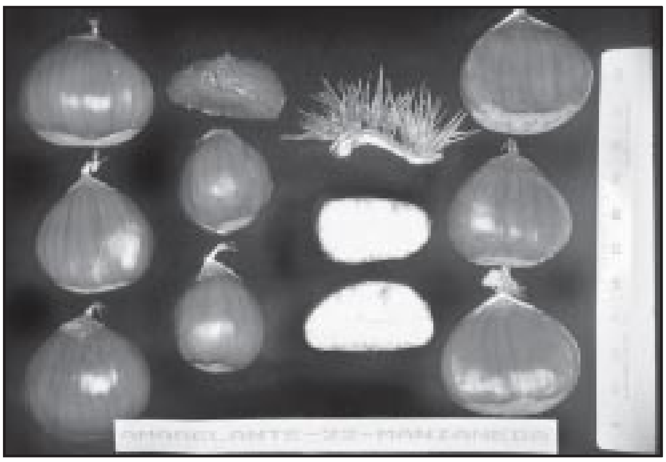

Fig. 1. Clonal selection 'Amarelante1'

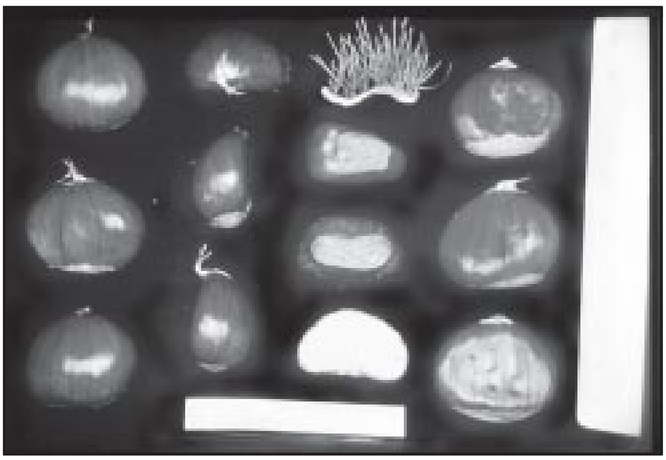

Fig. 2. Clonal selection 'Famosa'

Fig. 3. Clonal selection 'Garrida'

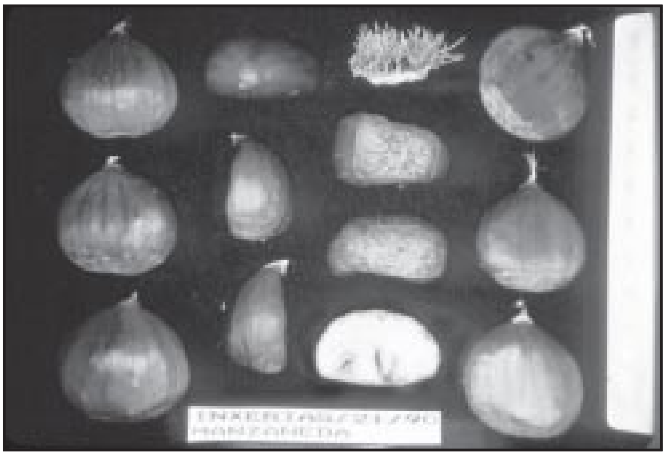

Fig. 4. Clonal selection 'Inxerta1'

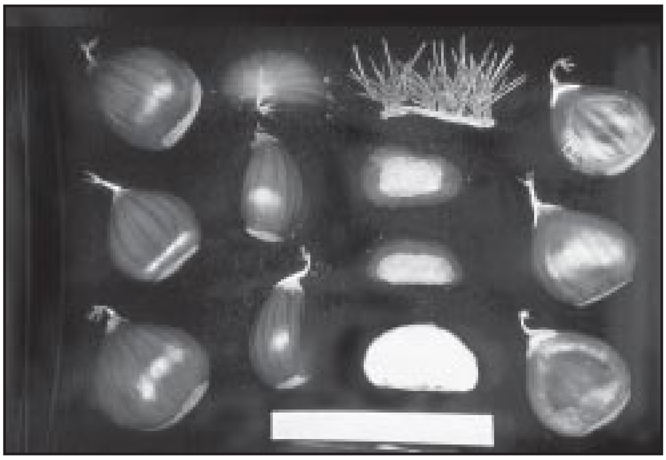

Fig. 5. Clonal selection 'Longal'

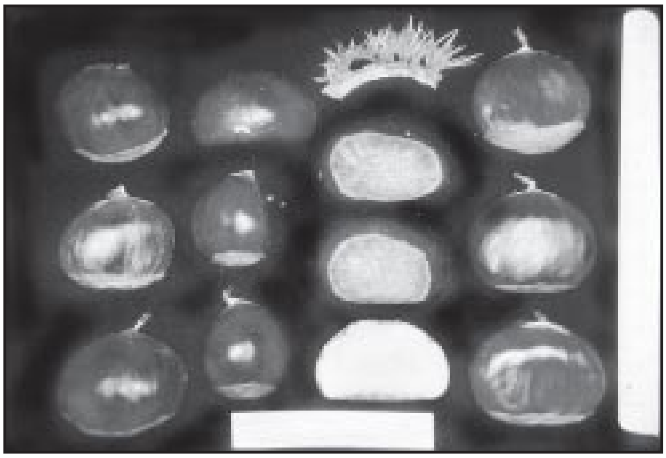

Fig. 6. Clonal selection 'Loura'

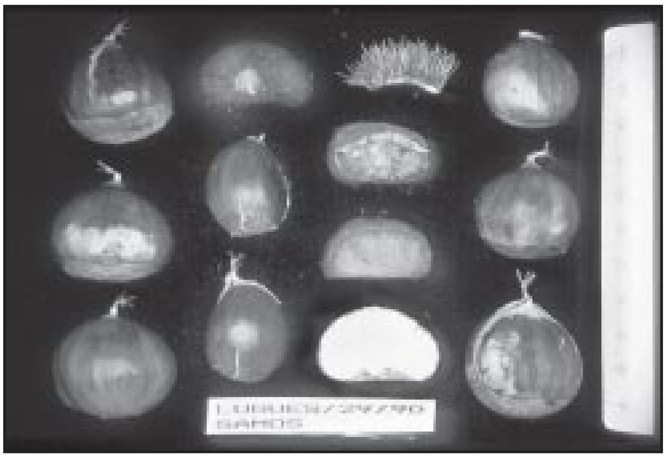

Fig. 7. Clonal selection 'Luguesa1'

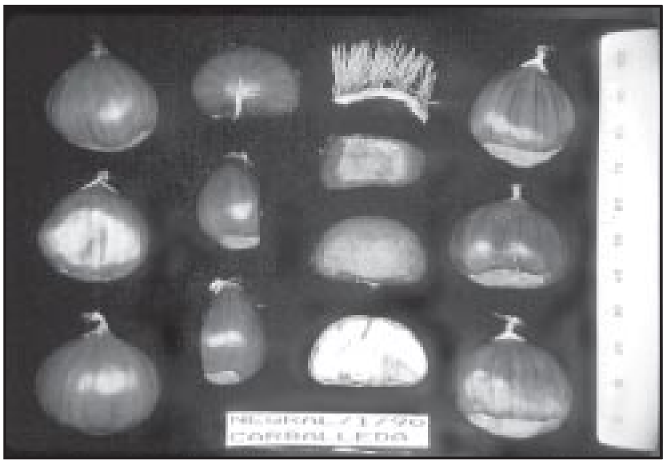

Fig. 8. Clonal selection 'Negral1'

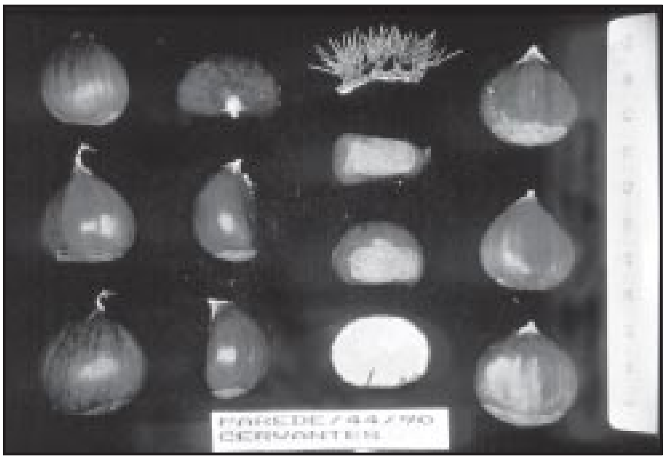

Fig. 9. Clonal selection 'Parede'

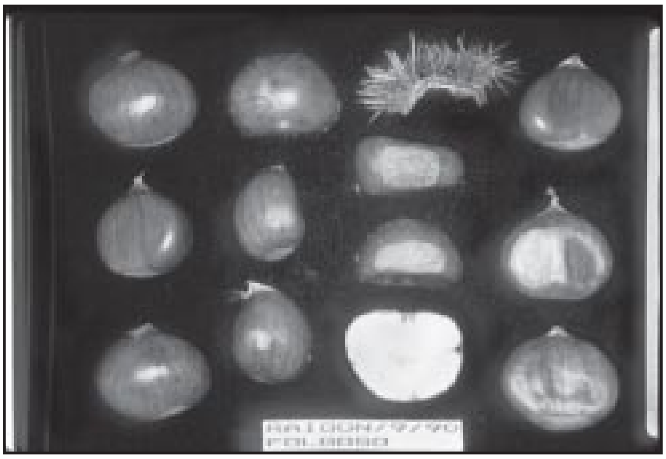

Fig. 10. Clonal selection 'Raigona 2'

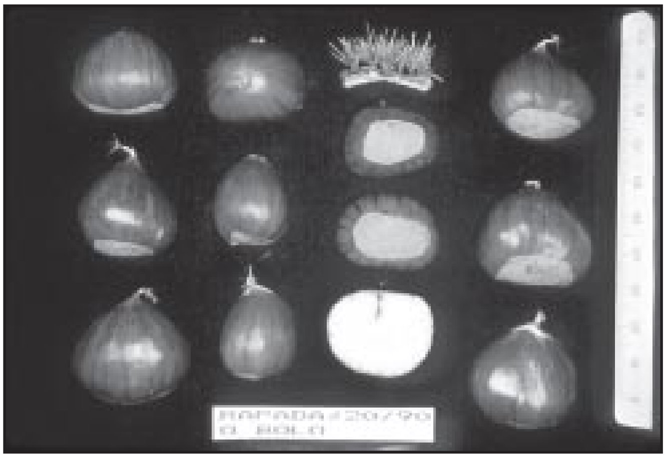

Fig. 11. Clonal selection 'Rapada'

Fig. 12. Clonal selection 'Ventura'

poses. 'Negral' [z] will be used like pollinizer, because it is the only one with longistaminate catkins. All these cultivars can be propagated on HS hybrid rootstock (Pereira and Fernández, 1997c).

WORKS IN PROGRESS

Chestnut cultivars are being studied in Andalusia (Pereira, S., in preparation), Extremadura, El Bierzo and Asturias. These works will provide new clonal selections adapted to each producing area. Up to now, we can say that in South Spain early ripening cultivars with big nuts exist, quite different to the North ones. In El Bierzo, province of León, growers cultivate the same cultivars as in the Galicia border. In Asturias, also some of the Galician cultivars are grown in the West side, but in the Central and West part, new interesting cultivars appear. Some of them have very nice appearance to be sold in the market.

To promote the crop in the different chestnut areas we have in Spain we propose that more than one Germplasm Bank should be established to allow each major producing region the development of their own capacities. That means, apart of the national Germplasm Bank located in Galicia, a regional Bank with its own local cultivars will be planted in Asturias and in Andalusia, where local governments are encouraged to support them.

REFERENCES

Fernández, J.; Pereira, S. 1994. Inventario y Distribución de los Cultivares Tradicionales de Castaño (*Castanea sativa* Mill.) en Galicia. MAPA, Monografía I.N.I.A., 87, 271 pp. ISBN: 84-7498-424-6.

Pereira, S.; Fernández, J. 1997a. Description of 80 cultivars and 36 clonal selections of chestnut (*Castanea sativa* Mill.) from North-western Spain. Fruit Varieties Journal, 51(1), 13-27.

Pereira, S.; Fernández, J. 1997b. Los cultivares autóctonos de castaño (*Castanea sativa* Mill.) en Galicia. Monografías INIA, 99, 533 pp. ISBN: 84-7498-461-0.

Pereira, S.; Fernández, J. 1997c. Propagation of chestnut cultivars by grafting: Methods, rootstocks and plant quality. The Journal of Horticultural Science, 72(5), 731-739.

Pereira, S.; Fernández, J.; Moreno, J. 1996a. Variability and grouping of Northwestern Spanish Chestnut Cultivars (*Castanea sativa*). I. Morphological traits. J. Amer. Soc. Hort. Sci., 121(2), 183-189.

Pereira, S.; Fernández, J.; Moreno, J. 1996b. Variability and grouping of Northwestern Spanish Chestnut Cultivars (*Castanea sativa*). II. Isoenzyme traits. J. Amer. Soc. Hort. Sci., 121(2), 190-197.

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CAROB DISTRIBUTION IN LEBANON

CULTIVATION OF CAROB IN LEBANON

Carob (*Ceratonia siliqua* L.) has been cultivated for centuries in Lebanon and still represents an important source of additional revenue for many local farmers. The tree has low input requirements. It needs occasionally pruning in winter and sometimes fertilisation in late winter. Insecticides and fungicides are rarely used. The fruits are harvested in September while grafting is done in April. The main carob products in Lebanon are the molasses, made out of the pods, which are sold for human consumption. Most of the molasses production is for the local market, while export is rather limited. Other products are the seeds, mainly for export and used for e.g., pharmaceutics and cosmetic products, confectionery, and fodder. Furthermore, there is an increasing interest to use the species in reforestation and afforestation (Bernadette et al., 1996)

In Lebanon, carob is cultivated in different agricultural systems. It can be found in olive and almond orchards, where carob is mainly planted and grafted. It is also cultivated along borders of agricultural lands or in mixed cereal-grazing systems. These are mostly wild trees that have been maintained and grafted. Furthermore, carob is planted in monoculture orchards. Among the grafted varieties, at least four different cultivars are distinguished by the farmers. A major challen-

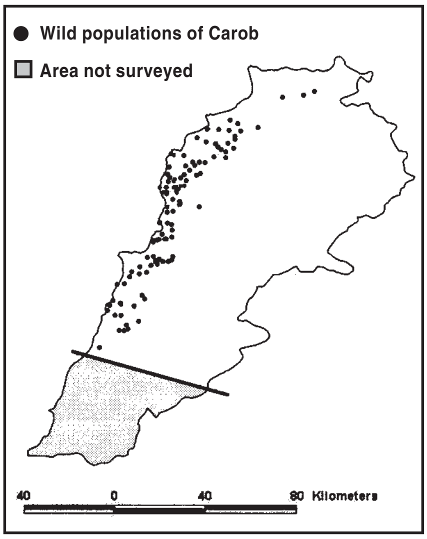

Figure 1. Distribution of wild populations of *Ceratonia siliqua* in Lebanon

ge in the identification of these varieties is represented by a degree of confusion about their names. Not only the names differ in each region, but also similar names are given to different varieties. The 'Ahmar' variety, also known as 'Makdissi' or 'Sandali', has small curved pods, which can provide up to 25% of sirop of good quality. Another variety, also named 'Makdissi', has small straight pods that can provide up to 40-45% of sirop of good quality. A third variety, also known as 'Makdissi' or 'Sandali', has long, straight, thick pods, which can provide up to 35-45% of sirop of good quality. A fourth variety, known as 'Khachabi', 'Barri', or 'Mar Abda', has long, straight, thin pods that can provide up to 45% of sirop of lower quality.

Wild carob tree growing on slopes in Lebanon

WILD POPULATIONS OF CAROB IN LEBANON

Carob is a typical Mediterranean tree species that can be found in the coastal area of Lebanon up to 800 m. It thrives on calcareous soils while it is rarely found on sandy or acid soils. It is an important species in the *Ceratonia-Lentiscus* climax community where it is always present, but generally sparse because it is very sensitive to human activities. Furthermore, it grows as an understory species in *Pinus brutia* and *Pinus halepensis* forests and in forest/scrub-lands dominated by *Quercus calliprinus* or *Quercus infectoria* (Bernadette et al., 1996).

In 1999, the International Plant Genetic Resources Institute (IPGRI), in collaboration with Saint Joseph University and the Ministry of Agriculture of Lebanon conducted a survey to map the distribution of wild carob populations in the country. The southern part of the country was not covered due to security reasons (Figure 1). Variations in population size, density and structure were found, mostly related to altitude, slope aspect and human activities. Both between and within the populations, a high variation in tree growth, form and leave size was observed. Altitude, slope aspect and stress factors again seem to be important.

In large part of its distribution range, *Ceratonia siliqua* is under increasing pressure, mainly because of urbanisation and conversion of areas to agricultural land. This degradation of carob populations seems to be symptomatic of the decline of the whole natural vegetation of the coastal region.

CAROB GENETIC RESOURCES

As was reported by Batlle and Tous (1997), carob cultivars show a high diversity, both between and within the cultivars, in morphologic characteristics. However, low polymorphism of cultivars

Old carob tree from Lebanon showing cauliflory

of different and the same origin was found using isoenzyme and DNA analyses. This may suggest a narrow origin of cultivars (Batlle and Tous, 1997). In Lebanon, both wild and cultivated populations can be found, often close to each other or even mixed. Although the influence of centuries of cultivation of carob in Lebanon is not known, we have seen that wild populations can be found under very different environmental conditions showing different growth characteristics. Given the change in interest from cultivars selected for high pulp content to high seed yielding varieties and varieties suitable for afforestation and reforestation, it is important to conserve and evaluate Lebanon's carob genetic resources, including wild populations, to identify useful sources for future improvement. A first step in such an assessment was done by the IPGRI and the American University of Beirut and with support from the Ministry of Agriculture. They are currently carrying out a joined study to the genetic diversity within and between wild populations of *Ceratonia siliqua*. The results will support the identification of priority populations for conservation and research. In the meantime, IPGRI and the Saint Joseph University are carrying out a survey to identify the varieties that are used in Lebanon. Further efforts will focus on the evaluation of important traits e.g., pod quality and growth requirements, of these varieties and wild populations.

REFERENCES

Batlle, I.; J. Tous. 1997. Carob tree. *Cerationia siliqua* L. Promoting the conservation and use of underutilized and neglected crops. 17. Institute of Plant Genetics and Crop Plant Research, Gatersleben / International Plant Genetic Resources Institute, Rome, Italy. 92 pp.

Bernadette, A-S.; Nasser, N.; Rami, H.; Safi, N.; and H. Tohme. 1996. Etude de la diversity biologique du Liban. 3. Flore terrestre. Minister of Agriculture of Lebanon / United Nations Environment Programme.150 pp.

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NOTES AND NEWS

‘MANDALINE’ ®, A NEW FRENCH ALMOND VARIETY

‘Mandaline’ is a self-fertile, late flowering variety resulting from the INRA’s almond breeding programme. It could be used in a single cultivar orchard or in combination with ‘Lauranne’.

Origin
‘Mandaline’ originated from the cross ‘Ferralise’ x ‘Tuono’, made in 1979 which gave a population of 40 seedlings. Seedlings were observed between 1981 and 1989 in the experimental field of INRA in Manduel near Nîmes in the South-east of France. Two hybrids were selected for their high productivity and kernel quality: hybrid 16 (cloned as R998) and hybrid 18 (cloned as R974). Both were then grafted and observed in different orchards (Duval and Grasselly, 1994). Hybrid 16 (R998) was released in 1999, for its nice kernel and medium susceptibility to diseases. In addition clone R974 was kept as genitor for its good resistance to frost.

Description
The tree is not large in size, medium to upright in shape and bears fruits on spurs (Figure 1). It is easy to train as a young tree and also to prune. Time of bloom is the same as the cultivar ‘Ferragnés’, with one or two days earlier, some years. The variety is self-fertile and was genotyped S_1S_f for the gene *S*. It does not need pollinators. Fruits mature at the beginning of September, one to two weeks before Lauranne in Nîmes.

Its shell is hard and the shelling percentage (Kernel weight/in-shell weight) is about 32-35 %. There are not double-kernels. The kernels have a small size (1g-1.1g) and an ovate-pointed shape. It has a smooth aspect and a light brown colour.

Fig 1. ‘Mandaline’ tree close to its breeder, H.Duval

Use
Mandaline kernels are comparable to the Californian variety and can be used for the praline (burnt almond). They have a good sweet flavour. In France, they can replace the kernels of the old variety ‘Ai’.

Performance
‘Mandaline’ is productive, but it is particularly remarkable by its early bearing. In an orchard located in St Gilles (Gard) and managed by the growers’ cooperative Sud-Amandes, the kernel yield from the third year to the ninth year are represented in the Figure 1 and Table 1 in comparison to the other INRA’s obtentions ‘Ferragnès’, ‘Ferraduel’ and ‘Lauranne’. ‘Mandaline’ has the best total kernel yield with 6 tonnes per hectare. The trees are grafted on GF677 and the planting space is 7m x 5m. The vigour of ‘Mandaline’ is medium and it could be possible to plant the trees with a higher density (6 m x 5 m, 5 m x 5 m).

Table 1. Annual kernel yield (t/ha) of ‘Mandaline’, ‘Ferragnès’, ‘Ferraduel’ and ‘Lauranne’ in an orchard located in St Gilles. Trees planted in 1991 on GF677.

Years	1993	1994	1995	1996	1997	1998	1999	Total Yield (t/ha)
‘Ferragnès’	0,15	0,46	0,64	0,77	0,96	0,53	1,65	5,16
‘Ferraduel’	0,25	0,56	0,82	0,72	0,94	0,76	1,15	5,19
‘Lauranne’	0,25	0,53	0,70	0,77	0,86	0,44	1,08	4,61
‘Mandaline’	0,25	0,72	0,77	0,89	1,22	0,95	1,16	5,95

Source: P. Froment (Sud Amandes).

‘Mandaline’ is slightly susceptible to *Fusicoccum amygdali*, at the same level as ‘Lauranne’ but less than ‘Ferragnès’.

REFERENCES

Duval, H.; Grasselly, Ch., 1994. Behaviour of some self-fertile almond selections in the south-east of France. Acta Horticulturae, 373: 69-74.

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‘ANTOÑETA’ AND ‘MARTA’ TWO NEW SELF-COMPATIBLE AND LATE FLOWERING ALMOND VARIETIES

In mid December 1999 two new almond cultivars were officially presented in Murcia by the Centro de Edafología y Biología Aplicada del Segura (CEBAS) belonging to the Spanish Consejo Superior de Investigaciones Científicas (CSIC): ‘Antoñeta’ and ‘Marta’ both derived from the same cross ‘Ferragnes’ x ‘Tuono’ which was made in 1985.

These two cultivars have been bred and obtained by J. Egea, F. Dicenta and T. Berenguer who are breeders from the Dept. Mejora y Patología Vegetal. Plant variety rights have been asked and grafted trees will be available in the near future from Spanish nurseries. A broad description of both cultivars will appear in the Germplasm section of a forthcoming issue of HortScience.

ALMOND TRIALLING IN ANDALUSIA, SPAIN

The autochthonous regional government of Andalusia, Spain, Junta of Andalusia, through its Consejería de Agricultura y Pesca, apart from two almond trials (in dry and irrigated conditions) established in 1994 in Malaga, has recently started to trial other almond cultivars in different sites of Andalusia. Within the trialling network, known as Red Andaluza de Experimentación Agraria (RAEA), two new groups of trials are planned: late blooming and early blooming cultivars. Each group comprises plots in different places. In addition, some rootstocks:

‘Garrigues’, ‘Montclar’, GF 677, GN 9 (‘Monegros’), GN 15, GN 22 , ‘Mayor’ and ‘Cadaman’ will be trialled. All trials, except those sited in Córdoba, will be planted on orchards of collaborating farmers. O. Arquero from the Department of Olive and Nut trees, CIFA “Alameda del Obispo” of Córdoba is the coordinator with the support of S. Rodríguez. This note is based on the information provided by him: oarquero@cifa.org.

Late flowering cultivars trial. The first experimental trial planned for 1999 and 2000 is based on 12 late flowering cultivars placed in six sites (Almería (2), Córdoba (CIFA), Granada, Huelva and Málaga). The six sites were selected regarding their almond past and potential. In addition several considerations were made as: environment, soil characteristics, water availability (one trial is under dry conditions, other with water deficiency and the other without irrigation limitations). The 12 cultivars chosen were: ‘Ferragnes’, ‘Ferraduel’ and ‘Lauranne’ from INRA Avignon, France; ‘Masbovera’ and ‘Glorieta’ from IRTA Reus, Spain; ‘Guara’ and ‘Cambra’ from SIA Zaragoza, Spain; ‘Antoñeta’ and ‘Marta’ from CEBAS Murcia, Spain; ‘Supernova’ from ISF Rome and ‘Tuono’ and ‘Cristomorto’ from the Apulian region, Italy. The rootstock used is the hybrid INRA GF 677 and the planting space is 7m x 6m. The design is randomized blocks with 6 (Córdoba) or 2 (Almeria, Granada, Huelva and Málaga) replications and 2 or 10 trees per block respectively.

Early flowering cultivars trial. The second experimental trial planned for the year 2000 considers three sites: Córdoba (CIFA), Huelva and Málaga with two main Spanish traditional and high quality cultivars: ‘Marcona’ and ‘Desmayo Largueta’ and a number of pollinating cultivars for both. For ‘Marcona’ (‘Garrigues’, ‘Atocha’ and ‘Blanquerna’) and for ‘Desmayo Largueta’ (‘Ramillete’, ‘Atascada Tardía’, ‘Asperilla’, ‘Achaak’ from Tunisia and ‘Chellastone’ from ‘Australia’). This trial also encloses ‘Guara’. The experimental design is randomized blocks with two plots and 10 trees per repetition. The trials will be planted under irrigated conditions and on a tree spacing of 7m x 6m. Each plot will occupy a surface of 1,2 ha.

P. atlantica tree growing at the Golan Heights

COLLECTING *Pistacia* GERMPLASM IN ISRAEL

A *Pistacia* species seed collecting expedition to Mediterranean Coastal area of Israel, Mount Carmel, Upper and Lower Galilee and Golan Heights was undertaken during three days, 20-22 October 1999. *P. lentiscus* seeds were collected in the Sharon Plain, near Hadera, in the maquis where it is the leading species of the *Ceratonia-Pistacia* plant community. In Upper Galilee, *P. palaestina* specimens were found associated with *Quercus calliprinos* in the maquis near Amirin where seeds were collected. A reduced number of *P. palaestina* seeds were obtained from wild isolated trees growing on the slopes of Nachal Oren in the Mt. Carmel, near Bet Oren. In Upper Galileee, *P. atlantica* seeds were collected from relict trees at Chanion Ha’ela, near Kadesh Naphtali. In the Golan Heights widespread *P. atlantica* trees were observed mostly in steppe areas of the hills, most trees were fruitless (most of the seeds were empty or shells bored by insects) and shedding the leaves at this time of the year. No stands of *P. palaestina*, were met.

The seeds collected were divided into two batches per each of the three species (BIDR Sede Boker and IRTA Mas Bové) for later germination and planting in both *Pistacia* collections. This *Pistacia* seed collecting expedition complements the currently existing genetic resources of the three species at both sites.

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STONEPINE NEEDLE GRAFTING

The needle graft technique on pine species was started to be developed in Spain in the early 1970’s by Balguerias and collaborators and also by Parra (1980). It has been used both for massive grafting onto Aleppo pine stands (*Pinus halepensis* Miller) as rootstocks of selected stone

P. pinea needle grafted onto *P. halepensis* pine (*P. pinea* L.) and for the establishment of clonal genebanks in Spain. Aleppo pine is more tolerant to calcareous soils than other pine species. This technique was described by Gil et al. (1986) and Palomar et al. (1993). G. Catalán, as Liaison Officer of the Subnetwork on Stone pine, has presented and shown this technique on several meetings. Recently, R. Furneaux from Kanangra Propagators, Douglas Park, New South Wales, Australia, based on these two publications successfully tried this needle graft technique using some pine species and has it now available. He referred to it as a «quite neat technique». This is a clear example of technology transfer.

REFERENCES

Parra, J.L., 1980. Creación de huertos semilleros de pino carrasco e injertos de pino piñonero sobre carrasco, en la provincia de Murcia. Bol. Estación Central de Ecología (ICONA), 9 (18): 15-23.

Gil, L.; Pérez, V.; Palomar, J., 1986. El injerto en los pinos (in Spanish). Ministerio de Agricultura, Pesca y Alimentación. Hojas Divulgadoras, (20): 1-23.

Palomar, J.; García, J.; Gil, L., 1993. El injerto en los pinos: una nueva variante (in Spanish). Montes (32): 27-31.

FUNDACIÓN
NUCIS
SALUD Y FRUTOS SECOS

FOUNDATION NUCIS, HEALTH AND TREE NUTS

The past 30th April 1999 was formally established in Reus, Spain the private Foundation Nucis, Health and Tree Nuts, a non-profit organization which main objective is to increase awareness about health benefits of tree nuts by studying, researching and divulging the nutritional and dietetic characteristics of tree nuts as a basic component for a balanced and healthy diet.

Nucis, Health and Nut trees is formed by chief representatives and main companies of the Spanish tree nut sector and it is also represented by some European companies. The Foundation enjoys in its Master Members the collaboration of important personalities of the scientific, academic and economic field, being the president G. Ferraté.

In order to achieve the objectives above, the Foundation Nucis will promote scientific research to increase understanding, and will hold seminars, discussion forums and congresses, to exchange scientific and dietary information nationally and internationally, as well as to divulge knowledge through the society.

The Foundation recently participated in the XV Healthy Heart Week, that was held in Madrid last October. The prevention of the cardiovascular diseases as one of the most frequent causes of mortality in the European countries was the main objective of that Week. Inside an appropriate nourishment to prevent this type of diseases, nuts were recommended as a very complete and beneficial food for a balanced and healthy diet.

Also, last November was formally constituted the Scientific Committee of the Foundation Nucis whose main objective is to endorse and contrast scientifically all the existing information that the Foundation seeks to divulge. The Scientific Committee is formed by the following members: L. Masana, R. Solà, M. de Oya, G. Lloberas, R. Segura, E. Ros and J. Salas.

In this sense, the Foundation is studying the possibility to promote new studies and research by the establishment of an annual grant that will increase evidences about the healthy benefits of nuts intake. The participation in European congresses will be also important in order to divulge and increase awareness among the scientific community about the important role of tree nuts in our diet.

The private Foundation was named after the same noun which was chosen in 1991 for the NUCIS Newsletter by the Coordination Board of the Inter-regional Cooperative Research Network on Nuts, the Information Bulletin of the Research Network on Nuts (FAO-CIHEAM). However both are completely independent, apart from being interested in the same commodities. The name originally derives from the Latin genetive nucis (of the nuts).

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CONGRESSES AND MEETINGS

XI GREMPA MEETING ON PISTACHIOS AND ALMONDS HELD IN SANLIURFA, TURKEY

Almond and pistachio scientists met for XI GREMPA Meeting on Pistachios and Almonds in Sanliurfa during four days, 1-4 September 1999. The meeting was supported by CIHEAM and the University of Harran. The venue was the DSI (Regional Directorate of State Hydraulic Works) Meeting hall in Sanliurfa and B.E. Ak was the convener.

The Meeting was attended by some 124 participants from 17 different countries: Algeria (1), Australia (6), Belgium (1), Greece (1), Iran (4), Israel (2), Italy (1), Portugal (4), South Africa (1), Spain (4), Turkey (30 with papers, 68 as listeners), USA (1) and Uzbekistan (1). Participants included scientists, students, growers, exporters, managers and some bureaucrats.

The aim of this meeting was to present, review and discuss recent scientific achievements regarding pistachio and almond nut trees. The scientific programme featured seven sessions chaired by prominent researchers on different fields: Physiology, Biology, Pollination and Fruit set; Propagation and Orchard Management; Cultivars, Rootstocks and Breeding, Pest and Diseases, Harvesting, Post-harvest and Economics. During the meeting a total of 78 papers were presented; 38 of which were oral (2 invited papers, 19 on pistachio and 17 on almond) and 40 posters (21 on pistachio and 19 on almond) presented research results obtained from all over the world. The Abstract Book of the meeting was published and given to the participants. The proceedings will be edited in a special volume of Cahiers Options Méditerranéennes of CIHEAM-IAMZ. At the end of the Meeting the Attendance Certificate and a copper plate, as a present in the memory of the XI GREMPA Meeting, were delivered to the participants.

In the afternoon of the second day of the meeting a Pistachio processing plant (URFASAN AS) was visited. Dehulling and drying systems were shown in the plant by its Director. In the third day's afternoon the Harran plain was visited and the newly established irrigated fields observed. Also the ruins of the considered as the first University of the world, which

Participants of the XI GREMPA Meeting on Pistachios and Almonds

was founded in the IX Century, were visited. And the typical Harran Houses were seen at Harran town. Later in the afternoon greenhouses producing ornamental potted plants, which are heated by geothermal energy, were visited.

An additional full day (on Saturday) a technical visit was organized. In the morning, the Atatürk Dam, some pistachio orchards and wild almond species were seen. In the afternoon, Ceylanpinar State Farm placed some 150 km from Sanliurfa and bordering Syria was visited. At the State Farm pistachio orchards and the experimental Station were visited. Pistachio harvesting season was underway. Information was provided about the running experiment on pistachios and almond.

The Meeting runned on a very good atmosphere allowed very interesting scientific discussions. The first day dinner was provided by the governor of Sanliurfa. Second day's dinner was given by the Mayor of Sanliurfa, under traditional Turkish conditions, near the Holly lake. After the dinner the sacred fish pool, the cave in which Abraham was born and the Mosque were visited. The gala dinner was organised by the Rector in the garden of the University as a garden party.

The next XII GREMPA Meeting will be organized in Zaragoza, Spain jointly with III International Symposium on Pistachios and Almonds of the ISHS by R. Socias i Company (Spain) from SIA, Zaragoza.

IV INTERNATIONAL WALNUT SYMPOSIUM HELD IN BORDEAUX, FRANCE

The Fourth International Walnut Symposium was organized by the INRA, Fruit and Wine Research Station, Center of Bordeaux, from 12th to 16th September 1999 under the auspices of ISHS. E. Germain, Chair of the ISHS Working Group on Walnut was the convener. During the Symposium, a meeting of the FAO-CIHEAM Subnetwork of Walnut was also organized by E. Germain (Liaison Officer) and F.J. Vargas (Nut Network Coordinator). During this meeting, the publication of an inventory of walnut researches, germplasms and references was discussed and planned for the next year.

The symposium was attended by 117 scientists from 23 countries representing the 5 continents. France, Italy, Romania, Spain, Turkey, and the USA were represented by important delegations. The attendance of scientists coming from distant countries of the Southern hemisphere : Australia, Chili, New Zealand, South Africa, is interesting to report.

The scientific programme included seven sessions related to the following topics : genetic resources, breeding, varieties, propagation and rootstocks, molecular biology, biotechnologies, biology, physiology, plant protection, orchard management, nut quality and economy. These scientific sessions took up 3 days. 49 oral communications and 48 posters concerning the research results obtained from all over the world were presented. Thanks to the simultaneous translation this bilingual symposium (French and English) promoted understanding and interesting discussions. A technical visit was organized during an additional full day in the Garonne Valley. After the visit of the INRA Experimental Farm of Les Jarres near Bordeaux where E. Germain explained his variety and rootstock walnut breeding programme, the congressists had the opportunity to see the mechanical harvesting of fresh nuts in a hedgerow orchard and to visit an important walnut and hazel-


Participants of the IV International Symposium on Walnut

nut cooperative. The gala diner took place in «Château Giscours» one of the reknown « Château » located in the heart of the famous Medoc wine-growing area. During the closing session, N. Aletà (IRTA, Spain) was elected as the new chair of the ISHS Walnut Working Group in the place of E. GERMAIN (INRA-France) who will be retired the next year. Three countries were candidate for the next ISHS Walnut Symposium : Australia, Chili and Italy. Italy was choosen to organize this Congress in 2004. The place and the convener are to be determined. A two day post-congress trip allowed more than thirty participants to visit the Dordogne Valley, one of the main French walnut growing areas and also famous for its touristic sites.

The proceedings of this symposium will be available by the middle of the next year through ISHS Secretariat, K. Mercierlaan 92, 3001 Leuven, Belgium, Fax (32) 16.22.94.50.

WORKSHOP ON GENETIC RESOURCES AND SYLVICULTURE OF CHESTNUT HELD IN NITRA, SLOVACK REPUBLIC

The annual workshop of the work groups Genetic Resources and Silviculture of COST G4 “Multidisciplinary Chestnut Research” was held in Nitra (Slovak Republic), 29 September-2 October 1999. The local organisation was done by M. Bolvansky, F. Tokar and G. Juhásova of the Institute of Forest Ecology, Slovak Academy of Sciences. 42 researchers from 16 different countries attended to the meeting.

Invited keynote speakers were G. Eriksson (Dept. Forest Genetics, the Swedish University of Agricultural Sciences, co-ordinator of Noble Hardwoods Network of EUFORGEN) with a conference on Forest tree gene conservation with an emphasis on Southern European tree species and F.V. Hebbard (American Chestnut Foundation) with a conference on Use of molecular markers in backcrossing blight resistance of *Castanea mollissima to Castanea dentata.*

Presentations to the work group of Genetic Resources (Coordinator J. Fernández-López and F.Villani) dealt with: New descriptor list for chestnut genetic resources (M. Bolvansky and L. Mendel); Methods for collecting cultivars for conservation considering intracultivar variation (S. Pereira, J. Ascasibar, A.M. Ramos, J. Fernández); Some considerations on the establishment of an European Chestnut Provenance test (W.D. Maurer and J. Fernández); Guidelines for chestnut conservation (J. Fernández); Plus trees selection of *Castanea sativa* for timber production (K. Russel); Microsatellite markers for the study of chestnut germplasm (R. Botta, D. Marinoni, A. Akkak, P. Boccaci, S. Kampfer, G. Bounous); Isoenzyme polymorphism in two populations of chestnut in Slovaquia (A. Kormutak; M. Bolvansky, F. Tokar); Genetic variation of different types of Chestnut in Slovenia (A. Podjavorsek, F. Stampar, A. Solar); British Hardwood Improvement Programme the sweet chestnut working group (K. Warwick).

Presentations to the working group of Silviculture (Coordinators F. Giudici and F. Romane): implications of different soil management practices in chestnut groves of northern Portugal (A. Martins, I. Linhares and F. Raimundo), A biochemical characterisation of local sweet chestnut varieties in northern Portugal); J. L. Carvalho, O. Borges and A. Monteiro; Dynamic changes of selected bioelements in different stands types of C. sativa (Konôpková); Consequences of the tree cuttings technics on the plants diversity (F. Romane, H. Gondard); Utilisation of Chestnut Timber in Construction (N. Braden); Management of a chestnut coppice in the north-east of Portugal (M. do Loreto Monteiro, M. do Sameiro Patrício); Growth and silviculture in chestnut coppices without thinning (E. Sevrin); Growth of young Chestnut plantations (A. Oosterbaan, C. Wan der Berg); Growth, wood and fruit production in progenies of C.sativa (F. Tokár, M. Bolvansky, Z. Perháová); The chestnut in Europe in the last 50 years: role, evolution and new perspectives for timber production (M. C. Manetti, E. Amorini); Inventory of the chestnut resource in Spain for fruit and timber production J.G. Lancho); The sweet chestnut in Germany (V. Bouffier); Sweet chestnut in Albania (Maxhun Dida); Key about common word used in the research on chestnut silviculture (M. Pividori, F. Giudici, M. C. Manetti, A. Zingg).

WG discussion topics and planned activities were as follows:

- A Survey on Chestnut resource in Europe (questionnaire and recent distribution map);

- Standardisation of the data (definitions, criteria and indicators);

- Common bibliography on chestnut silviculture.

TO BE HELD:

Almond and Pistachio

III ISHS International Symposium on Pistachios and Almonds and XII GREMPA - Pistachio and Almond Meeting
Date: 20-24 May 2001
Place: Zaragoza (Spain)
Conveners: R. Socias i Company
Unidad de Fruticultura SIA-DGA
Apartado 727, 50080 Zaragoza, Spain
Montañana 176, 50016 Zaragoza, Spain
Tel: +34-976-576436
Fax: +34-976-575501
E-mail: rsc@mizar.csic.es

Hazelnut

V ISHS International Symposium on Hazelnut
Date: 27-31 August 2000
Place: Corvallis, Oregon
Convener: S.A. Mehlenbacher
Oregon State University
Department of Horticulture
4017 Agricultural and Life Sciences Building
97331 - 7304 Corvallis, OR, USA
Tel: 1 503 737 5467
Fax: 1 503 737 - 3479
E-mail: mehlenbs@bcc.orst.edu

Stonepine orchard at Torrebesses, Spain

Stonepine

International Symposium
on Stonepine
Date: 22-24 February 2000
Place: Valladolid, Spain
Convener: G. Catalán
Address:
Centro de Recursos Forestales - INIA
Av. Padre Huidobro, s/n
28040 - Madrid, Spain
Tel: + 34 -91 3476772
Fax: + 34 -91 3573107
E-mail: catalan@inia.es

Almond orchard at La Granadella, Spain

BIBLIOGRAPHY

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

Antoniou, P.P.; Tjamos, E.C.; Tokalis, N., 1997. Serious fungal and bacterial diseases of almond in Greece. Bulletin OEPP, 27: 507-510.

Asíns, M.J.; Monforte, A.J.; Mestre, P.F.; Carbonell, E.A., 1999. Citrus and *Prunus* copia-like retrotransposons. Theor Appl Genet, 99: 503-510.

Azery, T.; ÇyÇek, Y., 1997. Detection of virus diseases affecting almond nursery trees in western Anatolia (Turkey). Bulletin OEPP, 27: 547-550.

Barbera, G., 1999. Tutela e valorizzazione della biodiversità del mandorlo in Sicilia. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 44-48.

Batlle, I.; Romero, M.A.; Vargas, F.J., 1999. Aplicación de las ribonucleasas (RNasas) estilares al cultivo y mejora genética del almendro. Fruticultura Profesional, (104) Especial Frutos Secos II: 54-59.

Benjama, A., 1997. Les maladies cryptogamiques et bactériennes de l'amandier au Maroc: importance et perspectives de lutte. Bulletin OEPP, 27: 521-522.

Bennett, C., 1999. Almond Research & Development Plan adopted. Australian Nutgrower, 12 (4): 28-29.

Boskovic, R.; Tobutt, K.R.; Duval, H.; Batlle, I.; Dicenta, F.; Vargas, F.J., 1999. A stylar ribonuclease assay to detect self-compatible seedlings in almond progenies. Theor Appl Genet 99: 800-810.

Crawford, M. (editor), 1998. Nut profile: Almonds. Agroforestry News, 6 (4): 12-27.

Dallot, S.; Bousalem, M.; Boeglin, M.; Renaud, L.Y.; Quiot, J.B., 1997. Potential role of almond in sharka epidemics: susceptibility under controlled conditions to the main types of plum pox potyvirus and survey for natural infections in France. Bulletin OEPP, 27: 539-546.

Del Amor Saavedra, F.M.; Del Amor García, F., 1999. Riego por goteo subterráneo en almendro. Aspectos de manejo y respuesta del cultivo. Fruticultura Profesional, (104) Especial Frutos Secos II: 61-66.

De Salvador, F.R.; Di Tommaso, G., 1999. Comportamento agronomico di due selezioni di portinnesti franchi clonati di mandorlo. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 77-78.

Egea, J.; Dicenta, F.; Berenguer, T., 1999. Antoñeta y Marta: dos nuevas variedades de almendro autocompatibles y de floración tardía. Fruticultura Profesional, (104) Especial Frutos Secos II: 48-53.

Ekinci; S.; Albisu, L.M.; Ameur, M.; Salem, T. Ait; Cohen, G.V.; Gómez García, J.C.; Nuñez Pastori, R.J.; Tekelioglu, I., 1998. Modelización de los precios de la almendra en España. ITEA, 94 (2): 89-103.

Fahmy, E.M.; Abou-El-Nasr, N.M., 1998. Physical and biochemical genetic identification of some selected almond trees. Arab Universities Journal of Agricultural Sciences, 6 (2): 481-508.

Förster, H.; Adaskaveg, J.E., 1999. Identification of Subpopulations of *Colletotrichum acutatum* and Epidemiology of Almond Anthracnose in California. Phytopathology, 89 (11): 1056-1065.

Godini, A., 1999. Mandorlo. Liste varietali dei fruttiferi 1999. Frutticoltura (7/8): 45-47.

Jacas, J.A.; Hermoso de Mendoza, A.; Cambra, M.; Balduque, R., 1997. *Asymmetrasca decedens*: a new pest of almond in Spain. Bulletin OEPP, 27: 523-524.

Katan, T.; Shabi, E., 1996. Vegetative compatibility among isolates of *Colletotrichum gloeosporioides* from almond in Israel. European Journal of Plant Pathology, 102 (6): 597-600.

López, M.M.; Cubero, J.; Vicedo, B.; Piquer, J.; Peñalver, R., 1997. Detection of

Agrobacterium tumefaciens and biological control of crown gall in almond rootstocks. Bulletin OEPP, 27: 519.

Martelli, G.P.; Savino, V., 1997. Infectious diseases of almond with special reference to the Mediterranean area. Bulletin OEPP, 27: 525-534.

McMichael, P.; Robinson, S., 1999. Almond 'anthracnose' this season in Australia. Australian Nutgrower, 12 (4): 12.

Miguel, C., Druart, Ph. & Oliveira, M.M., 1996. Shoot regeneration from adventitious buds induced on juvenile and adult almond (*Prunus dulcis* Mill.) explants. In Vitro Cellular and Developmental Biology - Plant, vol. 32: 148-153.

Miguel, C., Raquel, M.H., Sánchez, A., Martins, M., Nolasco, G., Ferreira, E.L. & Oliveira, M.M., 1998. In vitro culture and improvement of Portuguese almond genotypes. (*Proceedings of the International Symposium on Pistachios and Almonds (24-29 de Agosto), Univ. California.*). Acta Horticulturae, 470: 562-569.

Miguel, C.M. & Oliveira, M.M., 1999. Transgenic almond (*Prunus dulcis* Mill.) plants obtained by *Agrobacterium*-mediated transformation of leaf explants. Plant Cell Reports, 18: 387-393.

Pancaldi, M.; Kaçar, Y.; Küden, A.B.; Sansavini, S., 1999. Impiego di microsatelliti sequenziati nel pesco per il «fingerprinting» e l'analisi genealogica del mandorlo. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 70-73.

Pocock, D.R., 1999. Comparative analysis of almond production in Southern Australia. Technical report number TR 270. Primary Industries and Resources SA - Government of South Australia: 47 pages.

Psallidas, P.G., 1997. Hyperplastic canker - a perennial disease of almond caused by *Pseudomonas amygdali*. Bulletin OEPP, 27: 511-517.

Rumbos, I.C., 1997. Eutypa canker and dieback of almonds. Bulletin OEPP, 27: 463-468.

Saad, A.T.; Masannat, K., 1997. Economic importance and cycle of *Polystigma ochraceum*, causing red leaf blotch disease of almond, in Lebanon. Bulletin OEPP, 27: 481-485.

Shabi, E., 1997. Decline of verticillium wilt incidence in almond. Bulletin OEPP, 27: 487.

Shibli, R.A.; Shatnawi, M.A.; Ajlouni, M.M.; Jaradat, A.; Adham, Y., 1999. Slow growth *in vitro* conservation of bitter almond (*Amygdalus communis* L.). Adv. Hort. Sci., (13): 133-134.

Smith, I.M., 1997. Almond protection in relation to good plant protection practice. Bulletin OEPP, 27: 443-447.

Socias R., 1999. Situación actual del cultivo del almendro en España. Vida Rural, 56-60.

Socias i Company, R.; Felipe, A.J.; Gómez Aparisi, J., 1998. Genetics of late blooming in almond. Proceedings of the Eucarpia Symposium on Fruit Breeding and Genetics. Acta Horticulturae (484): 261-265.

Socias i Company, R.; Felipe, A.J., 1999. 'Blanquerna', 'Cambra' y 'Felisia'. Tres nuevos cultivares autógamos de almendro (in Spanish with summary in English). Invest. Técnica y Económica Agraria (ITEA), 95 (2): 111-117.

Socias i Company, R.; Felipe, A.J.; Gómez Aparisi, J., 1999. A major gene for flowering time in almond. Plant Breeding, 118: 443-448.

Stapleton,J.J., 1997. Verticillium wilt of almond in California. Bulletin OEPP, 27: 489-492.

Talaie, A.R.; Imani, A., 1995. Selection of the best pollinizers for late flowering almond cultivars. Iranian Journal of Agricultural Sciences, 26 (2): 83-89.

Teviotdale, B.; Goodell, N.; Harper, D., 1997. Effect of infection by the shot-hole fungus, Wilsonomyces carpophilus, on drop and quality of almond fruit. Bulletin OEPP, 27: 493-500.

Teviotdale, B.; Goodell, N.; Harper, D., 1999. Shot hole encourages almond drop, doesn't harm kernels. California Agriculture, 53 (1): 16-18.

Tsopelas, P.; Tjamos, E.C., 1997. Occurence and pathogenicity of *Armillaria tabescens* on almond in Greece. Bulletin OEPP, 27: 455-461.

Ushijima, K.; Sassa, H.; Tao, R.; Yamane, H.; Dandekar, A.M.; Gradziel, T.M.; Hirano, H., 1998. Cloning and characterization of cDNAs encoding S-RNases from almond (*Prunus dulcis*): primary structural features and sequence diversity of the S-RNases in Rosaceae. Mol Gen Genet, 260: 261-268.

Uyemoto, J.K.; Asai, W.K.; Kirkpatrick, B.C., 1999. Etiology of almond shriveled kernel disease. New Zealand Journal of Crop and Horticultural Science, 27: 225-228.

Vaknin, Y.; Gan-Mor, S.; Bechar, A.; Ronen, B.; Eisikowitch, D., 1999. Effects of desiccation and dilution on germinability of almond pollen. J. of Horticultural Science & Biotechnology, 74 (3): 321-327.

Vargas, F.J., 1999. Situación del almendro en los países mediterráneos. Fruticultura Profesional, (104) Especial Frutos Secos II: 31-40.

Vargas, F.J.; Romero, M.A., 1999. Ensayo de variedades de almendro de floración tardía en Tarragona. Fruticultura Profesional, (104) Especial Frutos Secos II: 43-47.

Wicks, T.J.; Lee, T.C.; Scott, E.S., 1997. Phytophthora crown rot of almonds in Australia. Bulletin OEPP, 27: 501-506.

CAROB

Aguado, M.T. et al, 1997. Semilleros de algarrobo y pino en substratos de turba y corcho compostado. Acta del II Congreso Forestal Español. Tomo III: 15-20.

Cantalejo, M.J., 1999. Sensor analyses of volatile components derived from earth-almond *Cyperus esculentus* L. and carob *Ceratonia siliqua* L. Z Lebensm Unters Forsch A, 208: 373-378.

Navarro, R.M.; Campo, A.; Alejano, R.; Alvarez, L., 1998. Caracterización de calidad final de planta de encina (*Quercus ilex* L.), alcornoque (*Quercus suber* L.), algarrobo (*Ceratonia siliqua* L.) y acebuche (*Olea europaea* var. *sylvestris* L.) en cinco viveros en Andalucía. Comunidad Europea. Junta de Andalucía. Servicios de Publicaciones y Divulgación. Informaciones Técnicas 53: 60 pages.

Priolo, A.; Lanza, M.; Biondi, L.; Pappalardo, P.; Young, O.A., 1999. Effect of partially replacing dietary barley with 20% carob pulp on post-weaning growth, and carcass and meat characteristics of Comisana lambs. Meat Science, 50 (3): 355-363.

Race, D.; Curtis, A.; Booth, W., 1999. Carob agroforestry industry: an assessment of its potential for the low-medium rainfall Murray Valley region. Australian Journal of Experimental Agriculture, 39 (3): 325-334.

Roukas, T., 1998. Carob pod: A new substrate for citric acid production by Aspergillus niger. Applied Biochemistry and Biotechnology, 74 (1): 43-53.

Tous, J.; Plana, J.; Romero, A.; Batlle, I., 1999. Situación actual del material vegetal de algarrobo. Fruticultura Profesional, (104) Especial Frutos Secos II: 26-30.

CHESTNUT

Berrocal del Brío, M., 1998. Enfermedades del castaño de carácter secundario. Agricultura, LXVII (796): 928-930.

Bounous, G.; de Guarda Bounous, A., 1999. Among the chestnut trees in Cuneo province.

Benzo, M.; Parola, F.; Borsotto, M., 1999. La produzione di castagne secche e farina di castagne in provincia di Cuneo. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 54-58.

Del Giudice, F., 1999. La situazione della castanicoltura campana. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 50-53.

Feijó, J.A., Certal, A.C., Boavida, L., Van Nerum, I., Valdivieso, T., Oliveira, M.M., Broothaerts, W., 1999. Advances on the study of sexual reproduction the cork-tree (*Quercus suber*), chestnut (*Castanea sativa*) and in Rosaceae (apple and almond). *In:* "Fertilization in Higher Plants – Molecular and Cytological Aspects" (M. Cresti, G. Cai, A. Moscatelli, eds.), Cap. 26, pp:377-396. Springer-Verlag, Berlin.

Liu, L., 1997. Nut Quality in Chinese Chestnut Cultivars. 88th Annual Report of the Northern Nut Growers Association: 11-13.

Mansilla, P.; Pérez, R.; Salinero, C., 1999. Agusanado de la castaña producido por *Curculio elephas* Gyll (in Spanish). Excma. Diputación Provincial de Pontevedra, 1 (EFA 14/99: Curculio): 4 pages.

Mansilla, P.; Pérez, R.; Salinero, C., 1999. Agusanado de la castaña producido por *Cydia fagiglandana Zel* y *Laspeyresia splendada* Hb. (in Spanish). Excma. Diputación Provincial de Pontevedra, 1 (EFA 13/99: Cidyas): 4 pages.

Mansilla, P.; Pérez, R.; Salinero, C., 1999. Agusanado de la castaña producido por *Pammene fasciana* L. (in Spanish). Excma. Diputación Provincial de Pontevedra, 1 (EFA 12/99: P. fasciana): 4 pages.

Mancuso, S.; Ferrini, F.; Nicese, F.P., 1999. Chestnut (*Castanea sativa* Mill.) genotype identification: An artificial neural network approach. The Journal of Horticultural Science & Biotechnology, 74 (6): 777-784.

Portela, E.; Ferreira-Cardoso, J.; Roboredo, M.; Pimentel-Pereira, M., 1999. Influence of magnesium deficiency on chestnut (*castanea sativa* mill.) yield and nut quality. Chapter 35 of the book «Improved Crop Quality by Nutrient Management: 153-157. Kluwer Academic Publishers, P.O. Box 322, 3300 AH Dordrecht, The Netherlands.

Rubio, A.; Elena, R.; Sánchez, O.; Blanco, A.; Sánchez, F.; Gómez, V., 1999. Autoecología de los castañares catalanes. Invest.Agri: Prod.Prot.Veg., 8 (2): 387-405.

HAZELNUT

Baldwin, B., 1999. Turkish Hazelnut Types. Australian Nutgrower, 12 (4): 34-35.

Bignami, C.; De Salvador, F.R.; Strabbioli, G., 1999. Aspetti agronomici e prospettive di valorizzazione della corilicoltura italiana. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 16-27.

Game, M., 1999. In a nutshell. The history of Kentish cobnuts. 56 pages.

Grinnell, S., 1997. What's New in Filberts. 88th Annual Report of the Northern Nut Growers Association: 14.

Romero, A.; Tous, J.; Guerrero, L.; Gou, P.; Guardia, M.D., 1999. Aplicaciones del análisis sensorial en el tostado industrial de avellana en grano. Fruticultura Profesional, (104) Especial Frutos Secos II: 71-67.

Santos, A.; Silva, A.P., 1999. Comportamiento agronómico de once cultivares de avellano. Fruticultura Profesional, (104) Especial Frutos Secos II: 67-70.

Roversi, A., 1999. Indagini sulle asportazioni minerali del nocciolo. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 32-34.

Scortichini, M., 1999. La «moria» del nocciolo. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 40-42.

Strabbioli, G.; Coramusi, A.; Avanzato, D., 1999. Ricerche sull'inerbimento del nocciolo finalizzato ad un minor impatto ambientale della corilicoltura. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 29-31.

Valentini, N.; Me, G., 1999. Nuove selezioni di nocciolo per usi industriali. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 36-38.

PECAN

Campbell, R.D., 1997. Kernel Quality in Northern Pecans. 88th Annual Report of the Northern Nut Growers Association: 69-70.

Gordon, Jr. J.H., 1997. Comparing Pecan to Hickory in Northern Erie County, New York. 88th Annual Report of the Northern Nut Growers Association: 78-80.

Grauke, L.J.; Thompson, T.E.; Reid, B.; Gustafson, W.A., 1999. Verification of the True 'Witte' Pecan and Naming of the 'Martzahn' Cultivar. Fruit Varieties Journal, 53 (4): 208-214.

Johnson, D.G., 1997. The Collection and Handling of Dormant Scion Wood of Pecan, Hickory and Walnut. 88th Annual Report of the Northern Nut Growers Association: 71-77.

Lagarda, A.; Medina, M.C.; Arreola, J., 1998. Efecto de la poda y aclareo de árboles adultos sobre la producción de nuez del nogal pacanero. ITEA, 94 V (3): 148-157.

Loebel, M.R., 1999. Training young pecan trees. Australian Nutgrower, 12 (4): 36-37.

Loebel, M.R., 1999. Pecan nut development. Australian Nutgrower, 12 (4): 27.

Rice, W., 1997. Pecan Rootstocks - Observations & Uncertainties. 88th Annual Report of the Northern Nut Growers Association: 65-68.

Smith, M.W.; Cheary, B.S.; Carroll, B.L., 1999. Growth characteristics of selected pecan rootstocks prior to grafting. Fruit Varieties Journal, 53: 40-43.

STONEPINE

Cañellas, I.; Finat, L.; Bachiller, A.; Montero, G., 1999. Comportamiento de planta de *Pinus pinea* en vivero y campo: Ensayos de técnicas de cultivo de planta, fertilización y aplicación de herbicidas. Invest.Agri: Prod.Prot.Veg., 8 (2): 335-359.

García Güemes, C.; Montero, G., 1998. Influencia de ciertas variables selvícolas en la pudrición provocada por *Phellinus pini* sobre *Pinus pinea*. Investigación Agraria, Sistemas y Recursos Forestales, vol. 7: 203-217.

PISTACHIO

Golan, A.; Peri, I.; Birk, Y.; Smirnoff, P., 1998. Inflorescence Bud Proteins of *Pistacia Vera*. Trees Structure and Function, 12: 415-419.

Couceiro, J.F.; Coronado, J.M.; Mendiola, M.A., 1998. Experiencias sobre el injerto de pistachero (*Pistacia vera* L.) en Castilla-La Mancha (2a y última parte) (in Spanish). Fruticultura Profesional, 97: 36-49.

Couceiro, J.F.; Mendiola, Mª A.; Menchén, Mª T., 1999. Estados de desarrollo de las yemas de pistachero (*Pistacia vera* L.). Fruticultura Profesional, (104) Especial Frutos Secos II: 106-111.

Díaz Barradas, M.C.; Correia, O., 1999. Sexual dimorphism, sex ratio and spatial distribution of male and female shrubs in the dioecious *Pistacia lentiscus* L. Folia Geobotanica 34: 163-174.

Peri, I.; Matusova, R.; Smirnoff, P.; Birk, Y.; Golan, A., 1999. Inflorescence bud protease(s) against dehydrin-like inflorescence bud proteins of *Pistacia vera*. Plant Physiol. Biochem., 37 (1): 51-56.

Polito, V.S., 1999. Seedlessness and parthenocarpy in *Pistacia vera* L. (*Anacardiaceae*): Temporal changes in patterns of vascular transport to ovules. Annals of Botany, 83: 363-368.

Vargas, F.J.; Romero, M.A.; Batlle, I., 1999. Aspectos básicos del cultivo del pistachero: situación, problemática y perspectivas. Fruticultura Profesional, (104) Especial Frutos Secos II: 98-105.

Vemmos, S.N., 1999. Carbohydrate content of inflorescent buds of defruited and fruiting pistachio (*Pistacia vera* L) branches in relation to biennial bearing. J. of Horticultural Science & Biotechnology, 74 (1): 94-100.

White, I.; Joyce, C., 1999. Fresh pistachios - a reminder of market standards. A guide to «Fresh» marketing of pistachio nuts. Australian Nutgrower, 12 (4): 22.

WALNUT

Aletà, N.; Ninot, A.; Romero, M., 1999. La poda de formación y de producción en el nogal. Fruticultura Profesional, (104) Especial Frutos Secos II: 85-91.

Avanzato D., 1999. Un sistema mobile di riscaldamento localizzato del punto d'innesto applicato *in situ* su semenzali di noce. Riv. di Fruttic. 61(11) : 74-76

Belisario A., Forti E., Balmas V., Valier A., Corazza L., 1999. La fusariosi del frutto, una malattia del noce commune. Inform. Agrar. 21/99 : 51-52

Germain E., Lespinasse J.M., Delort F., Reynet P., 1998. Mise au point de modes de conduite adaptés aux variétés de noyer à fructification sur brindilles latérales. Actes du 11ème Colloque Recherches Fruitières, INRA Ctifl « Architecture et modélisaiton en arboriculture fruitière, 5-6 mars 1998, Montpellier (France) : 195-200

Gispert, J.R., 1999. Uso eficiente del riego y la fertirrigación en el nogal, aplicación práctica de diseño. Fruticultura Profesional, (104) Especial Frutos Secos II: 92-97.

Leroux X., Grand S., Dreyer E., Daudet F.A., 1999. Parameterization and testing of a biochemically based photosynthesis model for walnut (*Juglans regia*) trees and seedlings. Tree physiology, 19(8) : 481-492

Lugli S., Fanigliulo G., 1998. Il noce in Italia: coltura in ripresa. Riv. di Fruttic. 1(98) : 7-14

Maillard P., Deleens E., Castell F., Daudet F.A., 1999. Source sink relationships for carbon and nitrogen during early growth of *Juglans regia* L. seedlings : analysis at two elevated CO_2 concentrations. Ann. For. Sci. 56 : 59-69

Mitrovic, M.; Nikolic, M.; Ogasanovic, D., 1998. Selection of walnuts. Proceedings of the Eucarpia Symposium on Fruit Breeding and Genetics. Acta Horticulturae (484): 203-205.

Muncharaz, M., 1999. La variedad ideal de nogal, características exigibles a variedades de nogal para producción de frutos. Fruticultura Profesional, (104) Especial Frutos Secos II: 78-84.

Nicese F., Hormaza J.I., MCGranahan G.H., 1998. Molecular characterization and genetic relatedness among walnut *(Juglans regia* L.) genotypes based on RAPD markers. Euphylica, 101(2) : 199-206

Prunet J.P., Garcin A., Germain E., 1998. De nouveaux porte-greffes adaptés aux variétés à fructification latérale. Infos Ctifl, 147 : 34-37

Prunet J.P., 1998. La nocicoltura californiana alle soglie del 2000. Riv di Fruttic. 1(98): 17-20

Radix P., Bastien C., Jay-Allemand C., Charlot G., Seigle-Murandi F., 1998. The influence of soil nature on polyphenols in walnut tissues. A possible explanation of differences in the expression of walnut blight. Agronomie, 18 : 627-637

Reil, W.; Ramos, D., 1999. Hedgerow walnut cultivars on Paradox and Northern California Black rootstocks. Australian Nutgrower, 12 (4): 32-33.

Sabatier S., Barthelemy D., Ducousso I., Germain E., 1998. Elongation modes and morphology of annual growth in walnut tree, *Juglans regia* L. « Lara » *(Juglandaceae).* Canadian Journal of Botany, 76(7) : 1253-1264

Sabatier S., Ducousso I., Guedon Y., Barthelemy D., Germain E., 1998 Structure de scions d'un an de noyer commun, *Juglans regia,* variété Lara greffés sur trois porte-greffe *(Juglans nigra, Juglans regia, J. nigra x J. regia).* Acte du 11ème Colloque Recherches Fruitières INRA-Ctifl : « architecture et modélisation en arboriculture fruitière, 5-6 mars 1998, Montpellier (France) : 75-80

Sharma S.D., Sharma O.C., 1998. Studies on the variability in nuts of seedlings walnut *(Juglans regia* L.) in relation to the tree age. Fruit Varieties Journal, 52(1) : 20-23

Sinesio F., Moneta E., 1999. Analisi del profilo sensoriale : un metodo per discrivere la qualita delle noci. Riv. di Fruttic. 61(11) : 65-68

Weinbaum S., Van Kessel C., 1998. Quantitative estimates of uptake and internal cycling of 14N-labeled fertilizer in mature walnut trees. Tree physiology, 18(12) : 795-801

Woeste K., McGranahan G., 1998. Low correlation between genomic and morphological introgression estimates in a walnut backcross. J. Amer. Soc. Hort. Sci. 123(2) : 258-263

BOOKS

Frutos de cáscara y algarroba: un sector amenazado. Documento de reflexión, 1999. Edita AEOFRUSE and CCAE (in Spanish): 105 pp.

Aletà, N.; Kishore, D.K.; Sharma, Y.P.; Pramanik, K.K., 1999. The Persian walnut *J. regia* L. In: A textbook on Pomology devoted to Temperate Fruits. IV Volume: 169-193. Prof. T.K. Chattopadhyay, Editor. Kalyani Publishers. New Delhi.

Bounous, G.; de Guarda, A., 1999. Among the chestnut trees in Cuneo province. 79 pages. Associazione «Il Tempo delle Castagne». Via Vittorio Amedeo, 13 - 12100 Cuneo, Italy.

Game, M., 1999. In a nutshell. The history of Kentish cobnuts. Meg Game. 50 Partmouth Park Road, London NW5 ISN. England: 56 pages.

Ramos D., 1998. Walnut production manual. Publ 3373 University of California, 320 pp

Germain E., Prunet J.P., Garcin A., 1999. Le noyer. Ctifl Paris ed, 279 pp

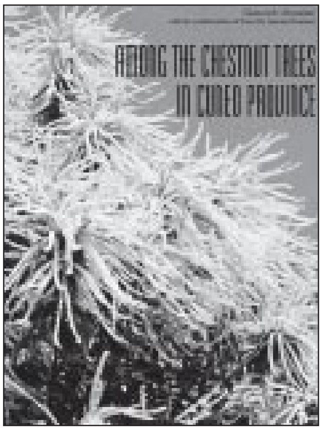
Vahdati, K., and Kashi, A., 1998. Apomixis and its importance in walnut (in Persian). Nashr Amoozesh Keshavarzi Press. Karaj, Iran. 98 pp.

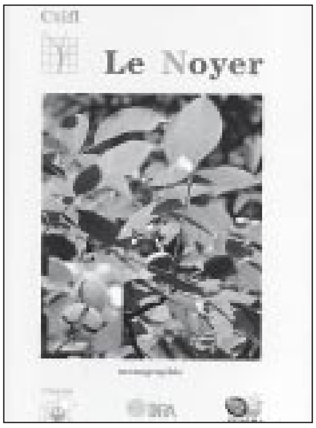
NUTS

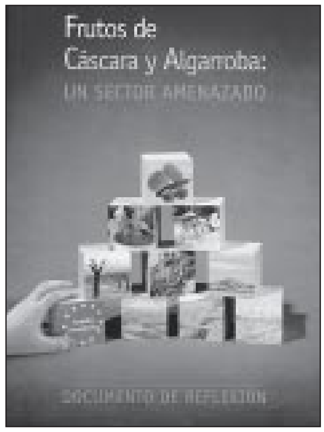
Batlle, I.; Aletà, N.; Clavé, J.; Ninot, M.A.; Plana, J.; Romero, M.; Rovira, M.; Tous, J.; Vargas, F.J., 1999. Bancos de germoplasma de especies de frutos secos y desecados: avellano, nogal, pistachero y algarrobo. Fruticultura Profesional, (104) Especial Frutos Secos II: 6-12.

Batlle, I.; Monastra, F.; Köksal, A.I.; Germain, E.; Kaska, N.; Tuzcu, Ö.; Gomes Pereira, J.A.; Catalán, G.; Vargas, F.J., 1999. Nut trees genetic resources conservation and documentation in Europe and the Mediterranean region. Implementation of the Global Plan of Action in Europe- Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture. Proceedings of the European Symposium, July 1998 Braunschweig, Germany. Part II - Posters: Utilization of PGR: 343.

Cantalejo, M.J., 1999. Sensor analyses of volatile components derived from earth-al-







mond *Cyperus esculentus* L. and carob *Ceratonia siliqua* L. Zeitschrift für Lebensmittel - Untersuchung und - Forschung A - Food Research and Technology, 208 (5-6): 373-378.

DAP, 1999. Frutos secos de cáscara y algarroba. Un sector amenazado. Documento de reflexión.

Degenbeck M., 1999. Regeneration of old fruit trees: expenditure and costs. Proceedings of a Conference "Structural elements in the agricultural landscape: interrelations with land use", in Veitshochheim bei Wurzburg. Germany.

Dirk, L.M.A.; Van der krol, A.R.; Vreugdenhil, D.; Hilhorst, H.W.M.; Bewley, J.D., 1999. Galactomannan, soluble sugar and starch mobilization following germination of Trigonella foenum-graecum seeds. Plant Physiology and Biochemistry, 37 (1): 41-50.

Fideghelli, C., 1999. La produzione italiana di frutta in guscio nel contesto internazionale. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 7-8.

Kok, M.S.; Hill, S.E.; Mitchell, J.R., 1999. A comparison of the rheological behaviour of crude and refined locust bean gum preparations during thermal processing. Carbohydrate Polymers, 38 (3): 261-265.

Maluenda, Mª J., 1999. El sector exterior de los frutos secos. Fruticultura Profesional, (104) Especial Frutos Secos II: 21-25.

Manning, R., 1998. Beetubes revolutionise pollination in modern orchards. Good Fruits Vegetables, 8 (10): March: 1 page.

Palara, U.; Calcagni, G., 1999. Trend produttivi e commerciali della frutta in guscio nel mondo. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 10-14.

Rovira, M., 1999. Biología floral y polinización en frutos secos y desecados. Fruticultura Profesional, (104) Especial Frutos Secos II: 13-20.

Sinesio, F.; Moneta, E., 1999. Analisi del profilo sensoriale: un metodo per descrivere la qualità delle noci. Rivista di Frutticoltura e di Ortofloricoltura, LXI (11): 65-68.

MASTERS

El Hassani, 1998 Contribution à l'étude de la variabilité génétique chez le noyer cultivé *(Juglans regia)* à l'aide de marqueurs morphologiques, dans les populations de semis de Ourika, Amezmiz, Midelt et Rich. Mémoire 3ème cycle en Agronomie, ENA Meknès (Maroc) : 79 pp (in French with summary in English and Arabic).

Gholipour, Y., 1999. Primary Investigation of Drought Resistance in Some Pistachio Rootstocks (in Persian). Tehran University, Iran.

Nabil D., 1999. Etude de la variété morphologique et des variations interannuelles observées dans les populations de noyers de semis du Rif, du Moyen Atlas et du Haut Atlas. Mémoire 3ème cycle en Agronomie, ENA Meknès (Maroc) : 92 pp (in French with summary in English and Arabic)

Raquel, H., 1998. Diagnosis of viral infections by immunological and molecular methods, sanitation of portuguese varieties of almond and search for strategies to introduce virus resistance. (Master thesis) Faculdade de Ciências de Lisboa, Lisboa Portugal. (written in Portuguese with abstract in English). pp: 113.

Tereso, S., 1999. Studies for virus sanitation and detection of the ilarvirus "Prune Dwarf Virus" in almond, and introduction to the technique of *in situ* reverse transcription PCR. (Master thesis), Universidade de Évora, Évora, Portugal. (written in Portuguese). pp: 161.

PROCEEDINGS

Proceedings of the Second International Symposium on Chestnut. ISHS-INRA. Editor: G. Salesses. Acta Horticultura (494): 528 pages.

REPORTS

Boutard, A., 1999. Détection et transmission alllélique des ribonucléases stylaires impliquées dans l'incompatibilité pollinique chez différentes espèces de *Prunus* (in French with summary in English). Ecole nationale supérieure agronomique de Rennes. Memoire de fin d'etudes: 37 pages.

Gil-Albert, C., 1999. El almendro (*Prunus amygdalus* Batsch): Estado actual y necesidades de mejora (in Spanish with Summary in English and French). CIHEAM, Zaragoza. 43 pages.

THESES

Abdellatif, C., 1999. Les différentes potentialités de régéneration in vitro du pistachier (*Pistacia vera*) cv. 'Mateur'. 179 pages. Université de Tunis II. Fac. Sciences de Tunis.

Burtin-Grandieu P., 1999. Origine biochimique de la couleur du bois de noyer *(Juglans sp.)* (in French). Université Henri Poincaré, Nancy I, France : 245 pp

Miguel, C., 1998. Adventitious regeneration and genetic transformation of almond (*Prunus dulcis*. (Ph D. Thesis), Faculdade de Ciências da Universidade de Lisboa. (written in English). pp: 177.

Campalans, A., 1999. Identificació, clonatge i caracterització de gens implicats en la tolerància a la sequera a l'ametller (*Prunus amygdalus*, Batsch) (in Catalan). Universitat de Barcelona, Spain, 197 pages.

Vahdati, K., 1996. An investigation on different aspects of asexual propagation of Persian walnut (in Persian or Farsi with summary in English). MSc. thesis. University of Tehran, Faculty of Agriculture, Karaj, Iran. 72 pp.

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Network Coordinator: F.J. Vargas
Editor: I. Batlle
Editorial staff: M. Lannoye
Typeset by: Carácter Gráfico, S.L.
E-mail:cg@ediho.es
ISSN 1020-0797