THE ALMOND AND THE CAROB TREE: DRIED FRUITS OF THE FUTURE

Josep Maria Franquet Bernis

Agricultural Engineer PhD, EUR-ING. Universidad Nacional de Educación a Distancia (UNED). Northeast Campus. Associated Center of Tortosa (Tarragona, Spain). director@tortosa.uned.es.

SUMMARY / ABSTRACT

The special capacity of adaptation to the environment of these dried fruits has allowed its use as trees colonizers in marginal lands and steep slope, where contribute significantly to the fight against water and wind erosion. On the other hand, non-perishable fruit character allows its conservation and placing on the market to the convenience of the farmer, who can play as well with the short-term vicissitudes of the market.

The results can highlight the high agronomic interest located underground irrigation in these crops, since your application produces higher yields in seed and a higher efficiency of the water applied, compared with surface localized irrigation of high frequency. This system allows cultivation to express their full productive potential, improving and complementing the response of other practices such as controlled deficit irrigation (CDI).

Key words: variety, pattern, erosion, localized irrigation, yield, vigour, bloom.

RESUMEN

La especial capacidad de adaptación al medio de estos frutos secos ha permitido su utilización como árboles colonizadores en tierras marginales y de fuerte pendiente, donde contribuyen de manera notable a la lucha contra la erosión hidráulica y eólica. Por otra parte, el carácter no perecedero de su fruto permite su conservación y puesta en el mercado a conveniencia del agricultor, que puede jugar así con los avatares coyunturales del mercado.

De los resultados obtenidos se puede destacar el alto interés agronómico del RLS (riego localizado subterráneo) en estos cultivos, ya que su aplicación produce mayores rendimientos en semilla y una más elevada eficiencia del agua aplicada, en comparación con el riego localizado superficial de alta frecuencia. Este sistema permite al cultivo expresar todo su potencial productivo, mejorando y complementando la respuesta de otras prácticas de manejo como el RDC (riego deficitario controlado).

Palabras clave*: variedad, patrón, erosión, riego localizado, rendimiento, vigor, floración.*

INTRODUCTION

The two tree species, which are the object of study in this article, have great advantages from the point of view of their food use and for other diverse purposes. Specifically, and regarding the first aspect reviewed, let's see that, in general:

- Nuts contain a large amount of fatty acids. However, they are beneficial for our body if consumed in moderate amounts and preferably without salt.
- Each type of dried fruit contains specific benefits but, in general, they have similar contributions. The best ones are walnuts, peanuts, pistachios, almonds, and cashews.
- Nuts are a good source of protein, being suitable supplements in a vegetarian diet. In addition, they help fight bad cholesterol by protecting our heart from heart disease.
- They are rich in calcium, potassium, iron and zinc. They are also a good source of energy, so consuming a portion of them a few hours before exercising is highly recommended.
- Their energizing capacity also makes them great allies for students and workers; A snack composed of dried fruits keeps the body active during the last hours of the day.
- They are one of the best sources of fiber, which improves intestinal transit.

EL ALMENDRO (*PRUNUS AMIGDALUS*, L. , BATSCH)

Almond cultivation in Spain maintains a discreet increase in surface nowadays, reaching some 615,000 ha of which 45,000 ha they are irrigated, the scattered trees being in clear retreat, which do not allow rational exploitation. Although slowly, it is a crop that improves in view of the results achieved in California, which in 20 years have doubled Spanish production, and where production takes place in excellent agronomic conditions and with a high technological level.

In our country, this crop has historically developed on almost marginal rainfed land. More than for productive purposes, it has been done for the maintenance of the land and the environment, and its survival has been linked to aid from the European Union. The drop in profitability of the almond in recent years has reduced the already scarce cultivation area below 500,000 hectares, about 17% less than in the best moments of the dried fruit. In addition, despite the fact that the yields have been increasing little by little, the average production barely reaches 80 kilos per hectare, compared to the 2,800 and 3,000 kilos that have been obtained in California.

The European surface of almonds represents around 50% of the world and Spain concentrates 77% of the European surface, after Italy with 11.7%. The

world average production is about 357,600 t, of which 73.8% corresponds to California and 9.4% to Spain.

World almond production, then, is concentrated in California and in the Mediterranean basin (around the remaining 26%). Spain, with a production close to 10% worldwide, is the second largest producer on the planet. But while in California the almond tree is cultivated under irrigation, in the Mediterranean basin the plantations are generally rain-fed and in areas with little rainfall. Only 7.3% of the Spanish cultivated area of almond trees is irrigated, as we have already seen, despite the fact that, in recent times, this type of cultivation has been significantly expanding. In fact, this tree has many possibilities of development with reduced and expensive endowments of the water resource, which are usually those available in most of our country.

Undoubtedly, it is in California where the new model of cultivation of this dried fruit, based on intensive farms and always irrigated, is put into practice. The area dedicated to almonds in California has increased by 50% in recent years, reaching 350,000 hectares. Thanks to this expansion, the overwhelming majority of the almonds consumed in the world are produced in the United States: 900,000 tons in the last harvest, almost 83% of the total, according to the California Institute of Almond Growers. Australia, which is in the process of adopting the American model, has become the world's second largest producer in a few years, surpassing Spain.

The almond varieties existing in Spain are indigenous for the most part, many of them locally, well adapted to the environment, free of endemic pests, with great genetic richness and "hard shell", contrary to what happens in California, which are “soft shell”. This last characteristic of the fruit implies an important advantage with respect to the American varieties, by offering greater resistance to attack by pests and diseases typical of this fruit, both in the production phase and in post-harvest. This characteristic of indigenous varieties of the Mediterranean area notoriously reduces the need to apply phytosanitary treatments and facilitates the transition to more environmentally friendly cultivation methods, such as integrated or organic production, almost impossible to carry out with the varieties soft-shell, given its need for aggressive and harmful pesticide treatments, both for human health and for the natural environment (AEOFRUSE and CCAE, 1999).

The improvement in almond production also includes a selection of modern late-flowering varieties, many of them self-compatible (which do not require entomophilic cross-pollination by bees) and which tend to exhibit good behavior in the event of late frosts such as: Tuono, Ayles, Cristomorto, Guara, Moncayo, Ferraduel, Ferragnes and others.

Recently, new Spanish varieties have appeared with very interesting characteristics, which have begun to spread rapidly in the plantations of our country. These are the following: 'Constantí', 'Marinada', 'Tarraco' and 'Vairo' (IRTA), 'Belona', 'Soleta' and very recently 'Mardía' (CITA) and 'Penta' and 'Tardona' (CEBAS – CSIC). These varieties, most of them self-fertile and all of them of late flowering, can have a favorable impact on the increase in the

productive potential of the new almond plantations that a notable increase in the prices of the grain, which occurred in the 2014 and 2015 campaigns, is promoting.

Accompanying the improvement of the varieties, the selection of one of the best existing feet at present and essential for those plantations that are susceptible to being irrigated should not be dispensed with: it is the hybrid of peach tree by almond tree INRA GF-677 and of the clone ADAFUEL. Also in recent times, numerous patterns of almond × peach trees have come to light, as well as other interspecific hybrids within the genus *Prunus*. Some of them have begun to displace the 'INRA GF – 677' pattern in peach and, to a lesser extent, almond plantations. The hybrid standards obtained by the CITA of Zaragoza, 'Garnem', 'Monegro' and 'Felinem' (Felipe, 2009), present characteristics similar to 'INRA GF – 677' and provide good tolerance to nematodes and a red color of the leaf which makes them very easy to handle in the nursery. Also, specialized companies in the Spanish nursery sector, such as Agromillora Iberia, SL (Barcelona), market new hybrids with different scales of vigor (Miarnau et al., 2010).

This dried fruit has magnificent nutritional and energy properties, in addition to having a high caloric power: 100 grams of marzipan equals 500 calories. But among other qualities, almonds contain more calcium than milk, more iron than meat, and more phosphorus than eggs. It is at the base of a diversified transformation industry that ranges from the preparation of typical sweets present in most of the towns of the Spanish geography to the snacks and appetizers industry, passing through the important sector of Christmas pastries, the cakes and the nougats (even with designation of origin). And it is that the excellent organoleptic qualities of the Spanish varieties of almonds, with a more intense flavor and a higher content in oils than California almonds, make them especially appreciated in some markets for the elaboration of certain processed products.

According to ALMENDRAVE, the Association of Exporters of Almonds and Hazelnuts in Spain, the average annual production of almonds in our country is 60,000 t of kernel almonds (about 240,000 t in shell). It should be borne in mind that, from the seventies of the last century, world consumption of this product begins to grow at a much higher rate due to various factors: the increase in the standard of living of consumers, its incorporation into a growing number of food products (chocolates, breakfast cereals, bars, etc.), public awareness of the health benefits of the Mediterranean diet (for its content in proteins, fibrous materials, essential fatty acids, minerals and vitamins) and the important promotional campaigns carried out by sectoral organizations. Very especially, it is necessary to highlight its high content of vitamin E, with antioxidant and anticancer effects, and whose physiological effect lies in preventing the oxidation of LDL cholesterol in the blood, reducing the risk of arteriosclerosis.

Also in the future, research on drought tolerance through ecophysiological characterization and genetic improvement of varieties and patterns will undoubtedly optimize the selection and use of improved varieties that will adapt well to the conditions of the Mediterranean climate (Vargas and Romero, 1999). Likewise, for some thirty years, several Spanish research centers (mainly Mas

Bové-IRTA, Aula Dei-Zaragoza and the Center for Edaphology and Applied Biology of Segura in Murcia) have been successfully working on the genetic improvement of the almond tree with the objective to obtain varieties that add to the indisputable organoleptic qualities of traditional local varieties, in particular the "Marcona" and the "Desmayo Largueta", some characteristics that improve their productive capacity and their resistance to adverse environmental conditions, especially to low temperatures (as those are early flowering) and drought, achieving good economic profitability. Self-fertility, ease of handling, pruning and regularity of the fruit are other qualities that researchers have sought to promote through crosses between varieties and genetic selection. In this way, satisfactory results have been obtained that we should all take advantage of and that have already been introduced in the varietal reconversions carried out thanks to the Quality Improvement and Marketing Plans, promoted by European Union, that have produced such excellent results in Spain.

THE CAROB TREE (*CERATONIA SILIQUA*, L.)

Spain, with an average annual harvest of more than 100,000 tons, is the world's leading producer and exporter of the fruit of this tree: the carob. It is a trio species, with male, female (the most widespread) and hermaphrodite varieties.

The carob tree presents a series of interesting characteristics for the Mediterranean coastal zone that constitutes its natural habitat (from Tarragona to Huelva, including especially the Balearic Islands in the Mediterranean Sea), such as: its high rusticity, resistance to limestone and drought (chronic and cyclical in our country), tolerance to salinity, few cultural demands (labor, fertilizers, treatments, irrigation, pruning, ...), and fruit preservability. Alternatively, it has an excellent response to good agricultural practices and, in particular, to the application of occasional or support irrigation. Due to its agronomic characteristics, therefore, this species constitutes a clear alternative to other traditional crops (olive trees, cereals, vines, sweet and citrus fruit trees) that already currently experience problems of surplus production and/or low prices perceived by the farmer (Tous and Batlle, 1990).

From a phytoecological point of view, it is a xerophytic and sclerophilic plant, which constitutes a characteristic element of the Mediterranean coastal flora. Due to its physiological and adaptive potential, it can be used in plant restoration and revaluation of degraded areas that are difficult to exploit. It is an important plant resource against desertification and has undoubted interest in visual-landscape and environmental modeling. Similarly, in some areas of the Mediterranean ecosystem, its agroforestry use could be seriously considered, as well as being used as a windbreak and even as an ornamental tree in the streets, squares and gardens that make up the urban landscape.

It is very possible that the future evolution of the markets will result in an improvement in the world demand for the seed or locust bean, which could also contribute to the revaluation of the carob bean pulp and its derivatives (flour, chopped) for its use food, both human and animal.

The main traditional varieties of carob bean have as their main characteristic their high pulp content, normally used for animal consumption. However, the current market demand is based on the seed of the fruit called “locust bean”, identified as E-410 and recommended by environmental and consumer organizations as a natural additive, from which a gum or galactomannan used as a thickener is extracted, stabilizer, emulsifier and natural gelling agent for food uses: ice creams, sauces, sorbets, soups, creams, mayonnaises and baby food. It is also used in the manufacture of capsules for medicines, laxatives, toothpaste, as a special glue in cutting-edge technology for application in the space industry, in cosmetics (shaving cream), in the textile industry (dressings, prints) and in chemistry (paints and bitumens).

THE WATER NEEDS OF BOTH SPECIES

Without a doubt, irrigation is one of the key factors determining the increases in production of these fruit trees. In the case of the almond tree, the possibilities offered by localized irrigation applying controlled deficit-dose strategies allow grain yields of 2,200 kg/ha to be achieved with contributions of 2,800 m^3/ha applied from budding in mid-June and reducing watering to a minimum until after harvest, which is when they should be reinforced again. In deep soils, it is advisable to carry out winter irrigation to recover the capacity of soil water reserves. In the carob tree, the simple application of possible irrigations produces spectacular increases in vegetative development and harvest.

These characteristics of rusticity of the almond tree have made it to be considered as a purely rainfed crop, but its response to irrigation is also spectacular and this allows it to go from medium-sized dryland productions of around 160 kg grain/ha at the average irrigated production close to 1,600 kg grain/ha, that is, 10 times greater.

However, the availability of water resources for agriculture in the Mediterranean area, as is well known, is very limited and with an uncertain future due to the increasing demand of urban and industrial areas and the recurrent drought cycles, typical of the country. All this makes it necessary to put more emphasis on the rationalization of the distribution and consumption of irrigation water and on the improvement and development of irrigation techniques that allow obtaining sufficiently high yields with limited contributions of irrigation water.

The start-up of irrigation located in almond trees, superficial and underground, is being the great novelty in a traditionally rain-fed crop, and, in fact, it can be considered that, at present, 10 percent of the entire surface of almond trees existing in Spain already has this high frequency irrigation system. The yields obtained are significantly higher than the traditional irrigation system (by flood or aspersion), since one hectare of crop can go from having a production of 500-1,000 kilograms to 3,000-5,000 kilograms of almond in shell.

Given that the initial reductions in irrigation water (for example 60% of evapotranspiration throughout the annual cycle) produce significant productive

drops (Hutmacher *et alt*, 1994), it seems more correct to use other strategies such as those of controlled deficit irrigation (RDC), based on the restriction of irrigation water at those times of the annual cycle when the almond tree is less sensitive to the fearsome water deficit.

From the results obtained, it can be highlighted, in addition, the high agronomic interest of RLS (underground localized irrigation) in almond cultivation, since its application produces higher seed yields and a higher efficiency of applied water, compared to irrigation superficial localized. This system allows the crop to express its full productive potential, improving and complementing the response of other management practices such as the RDC (Franquet, 2003).

CONCLUSIONS

The cultivation of nuts, synthesizing the aforementioned advantages, has considerable socio-economic and environmental importance, since it produces public goods that are not strictly valued by the market but increasingly by 21st century society. These socio-environmental benefits are as follows:

- Its usefulness in fighting forest fires, by acting as a firewall.
- Its role as a bastion against erosion and desertification.
- Its enhancement of the existence of a very diverse entomofauna and avifauna, given the scarcity of phytosanitary treatments and chemical fertilizers.
- Its inseparable nature from the Mediterranean landscape.
- Their promotion of employment in rural areas.
- Their independence (that of the European market) from third-country suppliers, which could lead to a certain monopoly on production with its logical consequences on prices.
- Its moderate water requirements in a time and a country where the supply of irrigation water is a serious present and future problem.

The European, central and regional administrations, in short, should take into account all the favorable characteristics related to these crops that we have just reviewed, not losing sight, at any time, that they have an important genetic heritage spread over large areas that it is necessary to evaluate and preserve. The organization of the producer sector in OPFH, which has provided such good results for all purposes, has also allowed the research and use of this natural resource to be promoted, both from an ecological and agri-food point of view.

We sincerely believe that the Spanish farmer and other countries have, in these nuts, a frankly profitable and intelligent bet for the coming years.

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