Scientific Papers. Series B, Horticulture. Vol. LXVII, No. 2, 2023
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

ALMOND, PRESENT AND PERSPECTIVE IN ROMANIA - A REVIEW

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Abstract

The almond tree (Amygdalus communis L.) is a fruit species of great importance, which finds favourable growing conditions in certain areas in Romania and stands out due to the many properties of its fruit which have a long shelf life. Being a species that enjoys a real appreciation due to its nutritional and medicinal properties, shows interest to fruit growers, making necessary providing some varieties with late flowering and the adoption of modern culture technologies and the aim of this review is to present the current situation and to highlight the importance of relaunching the almond culture in Romania.

Key words*: Amygdalus communis, importance, late flowering varieties, cultivation technologies.*

INTRODUCTION

The almond tree (*Prunus amygdalus* L. sin. *Amygdalus communis* L.) belongs to the family *Rosaceae*, subfamily *Prunoidae*, group *Amygdaleae* and has its origins in arid mountainous regions of Central Asia (Grasselly, 1976a). Almonds were collected here in the wild 10,000 years ago, and they were among the first plants to be domesticated all over the world around the third millennium BC (Albala, 2009). Almonds are considered as one of the oldest crops (Wani et al., 2021).

It is a harsh climate-adapted species with the ability to develop a deep root system in a centrifugal manner, these characteristics allowing the almond tree to explore a wide range of ecological niches, being adapted to conditions with mild, dry winters, warm summers, typical of the Mediterranean climate (Cociu, 2011). The almond is cultivated currently in more than 50 country (Lopez-Granados et al., 2019).

Almond crop has begun to expand in countries with less favorable conditions, and this fact is due because in the last decades a series of new cultivars have been created and cultivation technologies have been improved (Cociu, 2006). This review is about the current state of almond in Romania and the benefits that this crop can bring through the introduction of late flowering varieties and the adoption of modern cultivation technologies.

Almonds became a “luxury” fruit, being exported in large quantities in most advanced countries at a great selling price (Gavăt et al., 2013). Almonds have long been known as a source of essential nutrients; at present, they are in demand as a healthy food with a growing popularity for the general population and farmers. Studies on the composition and characterization of almond macronutrients (Table 1) and micronutrients (Table 2) have shown that the almond has many nutritious ingredients (Barecca et al., 2020; Grundy et al., 2016).

Table 1. Almonds macronutrients

Macronutrients (g)	100 g Fw
Protein	16-23
Lipid	44-61
Saturated Fats	3-4
Monounsaturated Fats	31-35
Polyunsaturated Fats	11-12
Carbohydrates	100 g Fw
Total Sugars	4-6
Total dietary Fibres	11-14

Sources: Barecca et al., 2020; Grundy et al., 2016

Table 2. Almonds micronutrients

Micronutrients (mg)	100 g Fw
Calcium	264-300
Magnesium	230-268
Phosphorus	440-510
Potassium	705-730
Zinc	3.0-4.1
Copper	0.9-1.3
Manganese	1.2-1.8
Vitamins	100 g Fw
Riboflavin	1.0-1.1
Vitamin E	25-27
Total Phenolic Compounds	260-350

Sources: Barecca et al., 2020; Grundy et al., 2016

Almonds is not appreciated only for fresh consumption, but also for their numerous ways of use: in food industry; in chemical-pharmaceutical industry (extraction of a valuable oil); the endocarp, the hard shell, can be used to prepare activated charcoal, necessary for the absorption of toxic gases; the green covering the mesocarp, after drying and calcination, gives an ash that contains 40% potassium and can be used to make soaps and for chemical fertilizers.; Almond wood, due to its color, large density and bright luster after sanding, can be used to make art objects (Cociu, 2003).
The purpose of this review is to emphasize the advantages of cultivating this species in Romania, the importance of introducing new cultivars with late flowering and modern technologies.

MATERIALS AND METHODS

This review is a research based on the current situation of almond crop, the prospective of new cultivars introduction with late flowering and modern cultivation technologies namely: the right choice of planting density and the importance of pruning.

THE CURRENT SITUATION IN ROMANIA

In Romania, the almond tree spreading area is almost overposed with that of vineyard, peach and apricot trees. At the beginning, almond trees could be found intercalated around vineyards, alleys and roads and even in the vineyard because they do don't produce big shadow and doesn't affect vineyard development (Cociu, 2003).

The almond (*Amygdalus communis* L.) being a specific plant to semi-steppe conditions, widely spread in Central Asia, it grows in Romania mainly in Banat, Dobrogea, in the area of vineyards and in many other localities with a warm climate (Ghena et al., 2004).
According to FAOSTAT in Romania there are no statistics of the areas occupied by the almond culture, this crop being included along with the other nut trees.
It should be noted that the interest in this crop is still low in Romania, while the interest shown worldwide is increasing. The almond being one of the crops that lends itself to pedoclimatic conditions in certain areas of Romania, it can be fully mechanized and is accompanied by a multitude of benefits, proving to be an adaptable and versatile species (Albala, 2009).
During the last 30 years, the almond tree has been systematically cultivated in some research stations (Gîtea, 2013).
In order to stabilize the optimal culture areas and the corresponding assortment, experimental and production plots were organized in the Fruit Research Stations in Oradea, Mehedinți, Mărculești and Constanța (Cociu, 2003).
The first cultivar collection was organized in 1951, in Mărculești and after 10-12 years it was transferred at Research Station for Fruit Growing (RSFG) Constanța. In 1975, it was reorganized and doubled at RSFG Oradea (Cociu et al., 2006).
The Romanian gene bank for almond species includes 138 genotypes of which 9 species: *Amygdalus bucharica, A. nana, A. intermedia, A. fenzliana, A. kotski, A. kuranika, A. scoparia, A. spinossa, A. webbii* (Branişte et al., 2006).
Currently, at RSFG Constanta there are 54 cultivars and selections (MADR).
The current assortment has the following autochthonous cultivars: Veronica, Mirela, Sandi, Cristi, Adela, April, Ana (created at RSFG Oradea) (Gavăt et al., 2013).

PERSPECTIVE OF INTRODUCTION OF NEW VARIETIES WITH LATE FLOWERING

At present, the growing demand on the market for nuts, places the almond culture in an interesting position in which the production of almonds with high quality organoleptic and nutritional produced will be needed to meet

growing national and global demand (Socias et al., 2017). Although this culture is widely spread in the world, the production is limited by ecological factors such as late spring frost (Melhaoui et al., 2019).
Cold resistance decreases as the trees get closer to entering the vegetation (Opriță et al., 2022).
Breeding late flowering cultivars to avoid spring frosts is one of the most important objectives of the researchers in various European almond breeding programs (Rubio et al., 2017).
Like other temperate trees, the almond tree is at rest during the winter and is generally without leaves. In these conditions, it is strong in its ability to endure very low temperatures. Nevertheless, the almond is very sensitive to cold during flowering and early fruit development. During this period, depending on many factors, in particular phenological stage, temperature and exposure time, temperatures below -1°C or -2°C can cause crop loss (Guillamon et al., 2022).
Therefore, breeders are interested in delaying the flowering time of new cultivars so that they flower when the danger of frost is minimal (Dicenta et al., 2017).
The cultivars that bloom late and ripen early are considered as being very valuable from the biological and practical point of view, because the fruit buds differentiation for the next yield performs until late autumn; having a long dormant period these cultivars are more resistant to temperatures variation arising at the end of winters and ensure high yields (Gavăt et al., 2015).
The cultivars flowering time is therefore very important and largely determines the success of commercial exploitation (Socias et al., 2017).
In present, here are currently two major genetic improvement programs: Davis University Californian program (Dale E. Kester and R. Janes) and the European programs, in which Spain (A. Felipe and R. Socias), Italy (F. Monastra and C. Fideghelli) and France (Ch. Graselly).
In the former Soviet Union breeding begun in the 1930's at Nikita Botanical Garden (Yalta, Crimea) by A. Richter and A. Yadrov who focusing on tree hardiness and frost resistance, as well as late bloom and productivity. Many cultivars were released in this program such as "Yaltinskij", "Primorsrkji", "Myagkoskolupyj" (Richter, 1972).
In the 1960's breeding work begun at INRA Bordeaux, followed later at Montfavet, France, by Ch. Graselly and later by H. Duval in the 1990's, with the aim of obtaining late flowering. The French breeding program was the most popular program in Europe for many years, with the successful introduction of "Ferragnes" and "Ferraduel" in 1967, and the late-flowering, self-incompatible cultivar "Feralise" and "Ferrastar" in 1970s (Graselly and Raynaud, 1980). In 1994 and 1997, Lauranne and Steliette cultivars were introduced to the orchards (Godini et al., 2001).
Scion breeding activity was introduced in the 1970's, lasting 20 years, in Italy (F. Monastra at ISF Rome), in Greece (D.K. Stylianides and G. Syrigianidis at Naoussa) and in Tunisia (A. El Gharbi and B. Jraidi at INRAT Ariana).
The breeding program from CEBAS-CSIC (Murcia, Spain) has its main objectives based on late bloom time (Socias et al., 2010).
The first releases in the late 1990's were the "Antoaneta" and "Marta" (Egea et al., 2000). Two more recent cultivars, "Penta" and "Tardona" are characterized by their exceptionally late blooming time (Dicenta et al., 2009).
"Tardona appears to be the latest flowering cultivar ever released (Dicenta et al., 2010).
A large number of cultivar and germplasm evaluation took place in other countries, including: Romania, Bulgaria, Morocco, Iran, India (Socias et al., 2017).
Thus, from a breeding perspective, cultivars have to fulfil many requirements to be successful, even when they are intended for a single purpose. Almond quality is determinate largely by market acceptance (Socias et al., 2008).
The most effective way to prevent damage caused by low temperatures is to use late blooming cultivars, being the best method to avoid crop damage (Imani et al., 2011).
The introduction of late flowering cultivars can bring a special economic contribution to the almond culture by increasing the productivity and quality of the fruits (Neagu, 1975).

MODERN CULTIVATION TECHNOLOGIES

The almond tree is an economically important crop. Direct benefits get generated by the adoption of new technologies in the target area (Wani et al., 2021).

In order to constantly improve the production of almonds, it is also necessary to improve the increasingly efficient and sustainable cultivation techniques by choosing optimal planting distances and suitable canopy (Maldera et al., 2021).
The application of an advanced agricultural technique, of new, perfected technologies that allow doubling, tripling of crop the same surface is conditioned by the choice of suitable cultivars (Neagu, 1975).
Planting density, which refers to the number of trees per unit area, determines numerous aspects of orchard profitability including the precocity of production, yield in the mature stage of the orchard, the initial investment, the cost and type of orchard management and the commercial life of the orchard. An increase in planting density will lead to earlier production, thus reducing the non-productive stage of the orchard (Socias et al., 2017).
A new culture system in the super high densities (SHD) one which is known as a "sustainable and efficient system" due to the optimized use of natural resources such as soil, water and agronomic inputs such as fertilizers and chemical treatments (Maldera et al., 2021).
The first crop of SHD almonds was in Spain, in 2010, and soon after several almond producing countries such as Italy, Portugal started to adopt the super intensive system of culture (Maldera et al., 2021).
The productivity of modern high density planting orchards is a function of their light interception (Grapadelli and Lasko, 2007).
The growth habits of almond trees did not evolve with farming in mind. An almond tree left to grow freely would be difficult to harvest and manage on a commercial scale. The primary goal of both training and pruning is to exploit the natural tendencies of the tree to create and maintain a habit that will produce excellent yields and facilitate cultural practices. In the first years, the tree is trained to a structure that will support future crop weight and allow for cultural practices, while minimizing cuts which could decrease early yields (Socias et al., 2017).
The implantation of these novel training systems can give a significant impact (Casanova et al., 2019).
Once the tree structure has been established, pruning principally facilitates cultural practices such as spraying and harvesting and removes dead and diseased wood. Pruning has been seen as a way to invigorate tree growth (Socias et al., 2017).
New canopy was designed, by increasing the number of three axes to two in Bibaum, Bi-axis or to three axes in Parallel Trident (Stănică, 2019).
The innovative feature of SHD almond orchards is the possibility to fully mechanize the orchard management operations (Iglesias, 2019).
The pruning is done mechanically by reducing the height and width of the fruit trees row, creating a hedgerow (Cioacă and Stănică, 2021).
A perspective of the strengths of the modern SHD culture, we have in table 3, namely the cultivars, planting distances, training and pruning.

Table 3. Some characteristics of SHD system

Cultivars	Late to very late blooming	
Training and planting distances	Vertical Axis	4.0-4.5 x 1.5
	Parallel U	4.0-4.5 x 1.5-2.0
	Trident	4.0-4.5 x 2.5-3.0
Pruning	Mechanical	

Source: Stănică., 2019

CONCLUSIONS

The almond tree (*Amygdalus communis* L.) is a fruit species of great importance, which finds favorable growing conditions in certain areas in Romania and stands out due to the many properties of its fruit which have a long shelf life.
The popularity of almond growing demand resulting from this popularity make it necessary to provide cultivars with late flowering which correspond to the current climatic conditions and the adoption of modern cultivation technologies.
Almond cultivation offers interesting and economically sustainable prospects.

REFERENCES

Albala, K. (2009). Almonds Along the Silk Road: The Exchange and Adaptation of Ideas from West to East. *Petits Propos Culinaires*, 88, 19–34

Barreca, D., Nabavi, S.M., Sureda, A., Rasekhian, M., Raciti, R., Silva, A.S., Annunziata, G., Arnone, A., Tenore, G.C., Süntar, İ., Mandalari, G. (2020) Almonds (*Prunus dulcis* Mill. D. A. Webb): A Source of Nutrients and Health-Promoting Compounds. *Nutrients*, 12. 672.

Branişte, N., Butac M. - coordonatori (2006). *Fondul de germoplasmă la speciile pomicole, de arbuşti fructiferi şi căpşun din colecţiile din România*. Ed. Pământul, Piteşti. ISBN 973-8280-87- 7; 978-973-8280-87-8.

Casanova-Gascón, J., Figueras-Panillo, M., Iglesias-Castellarnau, I., Martín-Ramos, P. (2019) Comparison of SHD and Open-Center Training Systems in Almond Tree Orchards cv. 'Soleta'. *Agronomy*, 9(12): 874.

Cioacă, L., Stănică, F. (2021). The Evolution of the Almond Crop Technology - a Review. *Scientific Papers-Series B, Horticulture*, Vol. LXV, No.2.

Cociu, V. (2003). Culturile nucifere. Ed. Ceres Bucuresti.

Cociu, V. (2011). Nucul, alunul, migdalul. Bucuresti, RO: Ed. M.A.S.T.

Company, R. & Rubio-Cabetas, M.J. & Alonso Segura, José & Aparisi, J. (2010). An overview of almond cultivars and rootstocks: Challenges and perspectives.

Dicenta, F., Ortega, E., Martínez-Gómez, P., Sánchez-Pérez, R., Gambin, M. and Egea, J. (2009). Penta and Tardona: Two New Extra-Late Flowering Self-Compatible Almond Cultivars. *Acta Hortic*., 814, 189-192.

Dicenta, F., Ortega, E., Martínez-Gómez, P., Sánchez-Pérez, R., Martínez-García, P.J., Cremades, T., Egea, J. (2010) Almond breeding program in CEBAS-CSIC, in Murcia (Spain). In: Zakynthinos G. (ed.). *XIV GREMPA Meeting on Pistachios and Almonds*. Zaragoza: CIHEAM/FAO/AUA/TEI Kalamatas/NAGREF, 2010. p. 215-219.

Egea, J., Dicenta, F., Berenguer, T., García, J.E. (2000) 'Antoñeta' and 'Marta' Almonds. *HORTSCIENCE*, 35(7): 1358–1359.

Gavăt, C., Dumitru, L.M., Careţu, G. (2013). Present and Perspective of Almond in South-Eastern Romania. *Scientific Papers. Series B. Horticulture.*, Vol. LVII, ISSN 2285-5653, 201-204.

Gavăt, C., Militaru, M., Dumitru, L.M., Opriță, A.V., Miron, L. (2015). Productivity of some almond varieties in Dobrogea. *Fruit Growing Research*, 31. 58-64.

Ghena, N., Braniste, N., Stănică, F. (2004). Pomicultură generală. MATRIX.ROM Bucuresti.

Gîtea, M. (2013) The Analysis of Almond Cultivars Grown in Northwestern. Natural Resources and Sustainable Development.

Godini, A., Barbera, G., Catania, F., Insero, O., Mattatelli, B., Palasciano, M., Senesi E. (2001). The Italian almond evaluation project. In: Ak B.E. (ed.). *XI GREMPA Seminar on Pistachios and Almonds*. 1999/09/01-04.

Grappadelli, L., Lakso, A. (2007). Is maximizing orchard light interception always the best choice? *Acta Horticulturae*, 732. 507-518.

Grasely C., Crossa-Raynaud, P., (1980). L'Amandier. Techniques Agricoles et Productions Mediterraneennes. G.P. Maison neuve et Larose, Paris, XII.

Grasselly, C. (1976). Origine et évolution de l'amandier cultivé. Options Méditerr 32: 45–50.

Grundy, M.M., Lapsley, K., Ellis, P.R. (2016). A review of the impact of processing on nutrient bioaccessibility and digestion of almonds. *Int J Food Sci Technol*.1937-1946.

Guillamón, J.G., Egea, J., Mañas, F., Egea, J.A., Dicenta, F. (2022). Risk of Extreme Early Frosts in Almond. *Horticulturae*, 8, 687.

Iglesias, I. (2019). Costes de producción, sistemas de formación y mecanización en frutales, con especial referencia al melocotonero. *Rev. Fruticult.*, 69, 50– 59.

Imani, A., Mahamadkhani, Y. (2011). Characteristics of almond selections in relation to late frost spring. 31-34.

López-Granados, F., Torres-Sánchez, J., Jiménez-Brenes, F., Arquero, O., Lovera, M., De Castro, A. (2019). An efficient RGB-UAV-based platform for field almond tree phenotyping: 3-D architecture and flowering traits. *Plant Methods*, 15. 10.1186/s13007-019-0547-0.

Maldera, F., Vivaldi, G.A., Iglesias-Castellarnau, I., Camposeo, S. (2021). Row Orientation and Canopy Position Affect Bud Differentiation, Leaf Area Index and Some Agronomical Traits of a Super High-Density Almond Orchard. *Agronomy*, 11(2):251.

Maldera, F., Vivaldi, G.A., Castellarnau, I., Camposeo, S. (2021). Two Almond Cultivars Trained in a Super-High-density Orchard Show Different Growth, Yeld Efficiencies and Damages by Mechanical Harvesting. *Agronomy*, 3, 949.

Martínez-Gómez, P., Sánchez-Pérez, R.., Dicenta, F., Howad, W., Arús, P., Gradziel, T: M. (2007). *Fruits and Nuts, Volume 4*. ISBN: 978-3-540-34531-2.

Melhaoui, R., Addi, M., Houmy, N., Abid, M., Mihamou, A., Serghini-Caid H., Sindic, M., Elamrani, A. (2019). Pomological Characterization of Main Almond Cultivars from the North Eastern Morocco. *International Journal of Fruit Science*, 19(4), 413-422.

Neagu, I.M. (1975). *Ameliorarea plantelor horticole*. Ed. Ceres, Bucuresti.

Opriță, V. A., Gavăt, C., Septar, L., Moale, C., Caplan, I., Lămureanu, G., Mazilu, C., Nicolae, S., Sturzeanu, M., Dumitru, M., Băluță, M., Balcan, A., Bocioroagă, L. (2022). *Sortimentul de cais, piersic, migdal și alte sâmburoase înmulțit la Stațiunea de Cercetare-Dezvoltare pentru Pomicultură Constanța*. Iași: PIM, 2022. ISBN 978-606-13-7129-7.

Rikhter, A.A. 1972. Biological bases for the creation of almond cultivars and commercial orchards [in Russian]. Glavny Botanical Garden, Moscow, Russia.

Rubio, M., Martínez-García, P.J., Cremades, T., Dicenta, F. (2017). Early selection for flowering time in almond breeding programs. *Scientia Horticulturae*, 220. 1-3. 10.1016.

Socias, R., Kodad, O., Segura, J.M.A., Gradziel, T.M. (2008). Almond Quality: A breeding Perspective. *Horticultural Reviews*, Volume 34 (pp. 197-238).

Socias R., Gradziel T.M. (2017). *Almonds: botany, production and uses*. Boston. CCABI.

Stănică, F. (2019). New tendencies in fruit trees training and orchard planting systems. *Scientific Papers-Series B, Horticulture*, 63.2: 25-34.
Wani, M., Bhat, A. (2021). Economics of Medium Density Almond Cultivation in Kashmir Valley of Jammu and Kashmir. *Sarhad Journal of Agriculture*. 37. 10.17582
https://www.fao.org/faostat/en/#home
https://www.madr.ro