Recent developments of almond culture in the southeast Anatolia region of Turkey

Naska N., Ozcan Z., Ak B.E.

in

Oliveira M.M. (ed.), Cordeiro V. (ed.).
XIII GREMPA Meeting on Almonds and Pistachios

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 63

2005
pages 225-231

Recent developments of almond culture in the southeast Anatolia region of Turkey

N. Kaska*, Z. Ozcan and B.E. Ak*****
*Retired Professor of Horticulture, Adana, Turkey
**NUR-MET,Sanliurfa, Turkey
***Harran University, Sanliurfa, Turkey
nkaska@ttnet.net.tr

SUMMARY – Almond growing in South East Anatolia developed quite rapidly over the past five years. This is due to the availability of high quality irrigation water, fertile soils, productive, late flowering and early bearing cultivars, no damage from late spring frosts and high profits in comparison with field crops such as cotton, wheat and corn. With these characteristics almond is going to be an alternative nut to pistachio, which is the main nut grown in the area. Commercial almond orchard establishment started in 1999 by NUR-MET and the trees started bearing fruit at the third leaf. At the fourth leaf the yield was satisfactory. The orchards established near the Euphrates river (Bilgel, 30 ha; Atıl, 10 ha) will be at the third leaf stage in 2003 and some of the cultivars are going to bear fruits this year. Fruit buds were observed even in a new orchard (Ozbay, 12 ha) which will be at the second leaf stage in 2003. This year another 50 ha almond orchard has been established by NUR-AK in Bismil near Diyarbakir. In Sanliurfa region there are several other almond orchards covering 5 to 10 ha. Over the past 5 years the total acreage achieved about 200 ha. In all the new orchards the trees were budded on bitter almonds and all of them were irrigated using either the drip, basin or fload method, pruned and fertilized each year. This means that modern orchard management is being applied in all orchards. In this paper the results of phenological and pomological investigations of different cultivars and the recent developments of almond growing in the GAP region are presented.

Key words: Almond, GAP region, commercial orchards, phenology, pomology.

RESUME – *"Développements récents de la culture de l'amandier dans la région du sud-est de l'Anatolie, Turquie". La culture de l'amandier dans le sud-est de l'Anatolie s'est développée très rapidement lors des cinq dernières années. Ceci est dû à la disponibilité d'eau d'irrigation de bonne qualité, aux sols fertiles, aux cultivars productifs, à floraison tardive et à production précoce, ne subissant pas les dégâts des gelées de fin de printemps, et permettant une forte rentabilité par rapport aux grandes cultures telles que le coton, le blé et le maïs. Grâce à ces caractéristiques, l'amandier est en passe de devenir une culture alternative du pistachier qui est le principal fruit sec cultivé dans ces zones. L'établissement de vergers commerciaux d'amandiers a débuté en 1999 par NUR-MET et les arbres sont entrés en production lors de la troisième année. Lors de la quatrième sève, le rendement fut satisfaisant. Les vergers établis près de l'Euphrate (Bilgel, 30 ha ; Atil, 10 ha) en seront à leur troisième sève en 2003 et certains des cultivars porteront des fruits cette année. Même dans un nouveau verger (Ozbay, 12 ha) qui en sera à sa deuxième sève en 2003 on a observé des bourgeons fruitiers. Cette année, 50 hectares supplémentaires d'amandiers ont été établis à Bismil près de Diyarbakir par NUR-AK. Dans la région de Sanliurfa il y a encore d'autres vergers d'amandiers qui couvrent de 5 à 10 ha. Pendant ces cinq dernières années la surface totale a atteint environ 200 ha. Dans toutes les nouvelles plantations, les arbres ont été greffés sur des amandiers amers et tous ont été irrigués soit de façon localisée, par submersion de rangées ou déversement, et ont été taillés et fertilisés chaque année. Ceci signifie qu'une conduite moderne des vergers est en train d'être appliquée dans toutes les plantations. Cet article présente les résultats de recherches phénologiques et pomologiques sur différents cultivars, ainsi que les récents développements de la culture de l'amandier dans la région GAP.*

Mots-clés : *Amandier, région GAP, vergers commerciaux, phénologie, pomologie.*

Introduction

After about 11 years lasting experiments on almond growing revealed that, from the ecological point of view, Southeast Anatolia is quite suitable for almond growing. First experiments in this region were carried out at Koruklu in Harran Plain (Kaska *et al*., 1998), Ceylanpınar State Farm (Ak *et al*., 2003) and K. Maras (Kaska *et al*., 2002), Gaziantep and Sanliurfa with a few native and several foreign cultivars (mostly European).

In Turkey, almond is produced from rain-fed seedling trees. In the Southeast Anatolia (GAP Region) our aim was to grow almond with productive, late flowering cultivars suitable for the demands of markets under irrigated conditions. Because almond is the most expensive nut in the markets, and, on the other hand, the State was intending to build 22 dams on the 2 big rivers (Euphrates and Tigris) for irrigation of 1.7 million ha and to produce hydroelectric power. Presently these goals have come to reality in a reasonable extent. Construction of dams and hydroelectric power stations, giant irrigation channels are still going on. Especially Harran Plain in Sanliurfa became a new irrigated cotton, corn and wheat growing area of Turkey. Our intention was to introduce some fruit trees (especially almond) in this region.

In this region there are 9 provinces. Their almond productions are shown in Table 1. As it can be seen in this table, all of these provinces are producing almond. All the trees are seedling trees and they are being grown without irrigation. Among these provinces Mardin and Diyarbakir are ranking first with more than 1000 tons and they are followed by Adiyaman, Sirnak and Batman with more than 400 tons in shell production. An important point here is the yield per tree. It is the highest in Sirnak and it is followed by Batman and Adiyaman with 25.0, 17.7 and 14.5 kg in-shell almond per tree, respectively. In Sanliurfa both production and yield per tree are very low.

Table 1. Number of trees and production of almond in the GAP Provinces

Provinces	Number of trees			Production		Yield/tree
	Total (000)	Bearing (000)	%	Tons	%	(kg)
Mardin	122	108	88.1	1317	3.06	12.2
Diyarbakir	192	146	76.2	1218	2.83	8.3
Adıyaman	50	40	79.4	580	1.35	14.5
Sirnak	42	21	49.2	528	1.29	25.0
Batman	33	23	68.9	409	0.95	17.7
Siirt	41	37	91.8	220	0.52	5.9
G. Antep	15	12	84.5	82	0.19	6.7
S. Urfa	12	10	83.6	48	0.11	4.7
Kilis	5	3	60.0	30	0.96	10.0
Others	3999	3424	85.8	38,568	89.69	11.3
Turkey	4502	3825	85.0	43,000	100.00	11.2

After getting these very valuable experiences in almond growing in the GAP Region at 1999, we decided to establish commercial almond orchards in the region (Table 2). In 2003 the almond acreage of new commercial orchards in the GAP region reached about 200 ha. In this paper the results obtained from the first orchard (NUR-MET) will be presented and discussed.

Table 2. Recently established commercial almond orchards in the GAP Region

Year	Size (ha)	Province
1999	17.5	Sanliurfa
2000	42.0	Sanliurfa
2001	36.0	Sanliurfa
2002	30.0	Sanliurfa
2003	66.0	Diyarbakır
Total	191.5	

Materials and methods

In the experiments two types of rootstocks were used: (i) GF-677; and (ii) bitter almond. On GF-

677 there are 3 cvs from Spain ['Masbovera', 'Glorieta' (Vargas and Romero,1993) and 'Guara' (Felipe and Socias,1987)] and 3 cvs from France ['Ferragnès', 'Ferraduel' and 'Lauranne' (Graselly and Duval, 1997)]. All the plants were imported from Spain in January 1999 and planted in NUR-MET orchard in February. The cvs grafted on bitter almond were: 2 Spanish ('D. Largueta' and 'Garrigues'), 3 from USA ('Drake', 'Nonpareil' and 'Texas'), 4 Russian ('Nikitski', 'Picantili', 'Primorski' and 'Yaltinski'), 2 Italian ('Tuono' and 'Cristomorto') and 3 Turkish cvs selected by Dokuzoguz and Gulcan, (1973) ('101/13', '101/23' and '300/1'). All the trees of the second group were prepared in Sanliurfa by Prof. Dr. B. E. Ak.

In all the experimental trees, phenological observations were done during 2001, 2002 and 2003 growing periods and pomological analysis of nuts (such as the dimensions and weights of kernels, and shelling percentages) were performed. All the trees were drip irrigated, each season, from April to October when the irrigation water was delivered through the channels. All P and K fertilizers were supplied in winter and N was given in spring as broadcasting. During the growing period fertigation was continued as a complementary nutrition. By weighing separately the nuts of 13 replicates of GF-677 budded 6 cvs and 5 replicates of bitter almond budded 14 cvs, the yield and yield efficiency per tree were calculated.

Results and discussion

Blooming dates of the experimental almond cvs are shown in Table 3 and 4. In 2002 spring, first and full bloom dates were about 1 month earlier in all cvs regardless of their rootstocks. 'Guara' was the first flowered cv. both in 2002 (21 Feb.) and 2003 (20 March). The latest flowering cvs. were 'Ferraduel' and 'Lauranne' in both years (3 March 2002 and 31 March 2003). Full bloom dates were corresponding to first blooming patterns. Among the cvs on bitter almond rootstock, '101/23' was the first flowering cv. (12 March 2003) and it was followed by 'D. Largueta' (17 March 2003), 'Tuono' (20 March 2003) and 'Nonpareil' (28 March 2003) (Table 4). The latest flowering cvs were 'Drake' and 'Picantili' (4 April 2003).

Table 3. Blooming dates of almond cvs budded on GF-577 rootstocks during 2002 and 2003 springs (Planting: February 1999)

Cultivars	Fırst bloom		Full bloom	
	2002	2003	2002	2003
'Ferraduel'	03/03	31/03	08/03	06/04
'Ferragnès'	02/03	30/03	07/03	05/04
'Lauranne'	03/03	31/03	08/03	06/04
'Guara'	21/02	20/03	02/03	01/04
'Glorieta'	25/02	26/03	04/03	02/04
'Masbovera'	28/02	25/03	05/03	03/04
'Marcona'	-	20/03	-	29/03
'Francolí'	-	29/03	-	05/04
'Cristomorto'	-	29/03	-	04/04

In 2002 spring, no frost damage was observed in the flowers, but in 2003 the air temperatures dropped down to –6ºC in February at the time of flower bud swelling and even in the bud-burst stages of 'D. Largueta' and 'Tuono'. These low temperatures seemed to cause slight damages in 'Ferragnès', 'Guara', 'Marcona', 'Tuono' and 'D. Largueta'. However, the crop on these cvs looked rather satisfactory. It is interesting to note that among the 4 apricot cvs ('Katy', 'Castelbrite', 'Bella D'Imola' and 'Goldrich') grown in the same orchard, the flowers of 'Katy' were completely frozen and almost no fruit was obtained. The other 3 apricot cvs have given quite a good yield. So, it seems almond is at least more frost tolerant than the low-chill apricot cvs.

In relation to growth and yields of trees Table 5 and 6 were prepared for all the experimental trees.

Generally, stem thickness of almond trees on GF-677 rootstock were grown rather faster in comparison to the ones on bitter almond. However, 'Tuono' on this latter rootstock was grown as much as 'Guara' and 'Glorieta' and more than 'Masbovera'. These growth rates are higher in Sanliurfa than in Adana and K. Maras (Kaska and Kuden, 1996; Kaska *et al.*, 2002).

Table 4. Blooming dates of almond cvs budded on bitter almond rootstock (Planting: February 1999)

Cultivars	First blooming	Full blooming
'Tuono'	14/03	20/03
'Drake'	26/03	04/04
'Nonpareil'	16/03	28/03
'D. Largueta'	09/03	17/03
'Garrigues'	26/03	03/04
'Pıcantili'	26/03	04/04
'Nikitski'	13/03	20/03
'Primorski'	19/03	02/04
'101/13'	27/03	03/04
'101/23'	16/03	12/03
'300/1'	24/03	03/04

Table 5. Growth of stem diameter (cm), yield and yield efficiencies of experimental almond cvs budded on GF-677 rootstock (2001 and 2002)

Cultivars	Stem diameter (cm)	TCSA (cm^2)†	Yield/tree (kg)	Yield efficiency††
'Ferraduel'				
2001	6.2	30.99	1.529	46.82
2002	9.6	72.38	7.200	98.12
Diff.	3.4	41.39	5.671	51.30
'Lauranne'				
2001	5.9	27.63	1.033	39.02
2002	9.1	65.04	7.000	107.63
Diff.	3.2	37.41	5.967	68.61
'Glorieta'				
2001			0.450	
2002	8.5	56.75	3.500	61.67
'Ferragnès'				
2001	6.00	29.80	0.562	18.480
2002	9.58	70.87	4.500	63.496
Diff.	3.50	41.07	3.938	45.016
'Guara'				
2001	5.2	21.16	1.623	76.700
2002	8.07	59.45	5.000	84.104
Diff.	2.87	38.29	3.377	7.404
'Masbovera'				
2001			0.253	
2002	7.3	41.85	2.000	47.789

†TCSA: Total cross sectional area of stem.
††Yield efficiency: yield per cm^2 of TCSA.

Among the yield values the yields/tree are interesting. The yields were very low in 2001 (3rd leaf stage) but rather high in 2002 (4th leaf stage) (Table 5). In fact the average yield/tree reached to 7.2 kg in 'Ferraduel' and 7.0 kg in 'Lauranne' in 2002. For trees of 4th leaf stage these values seem quite satisfactory. In parallel to yield, the yield efficiencies were quite high in 'Lauranne' (107.63) and 'Ferraduel' (98.12). 'Glorieta' and 'Masbovera' started bearing a bit late in comparison to the other 4 cvs. In fact their average yield/tree in the 4th leaf stage were 3.5 and 2.0 kg, respectively.

Among the bitter almond budded trees, 'Tuono', 'D. Largueta' and 'Garrigues' have taken the first ranks with 4.925, 4.200 and 3.800 kg per tree, respectively (Table 6). Yield efficiency of 'D. Largueta' was the highest (121.31) among all the experimental cvs and the lowest in '300/1' (29.868).

When the kernel yields of trees are compared, it can be seen that 'Lauranne' is ranking first with 2664 g/tree (Table 7). It is followed by 'Guara' (1855 g/tree), 'Ferraduel' (1835 g/tree), 'Ferragnès' (1611 g/tree). 'Tuono', 'Garrigues' and 'D. Largueta' appeared to be the high kernel yielding cvs.

Table 6. Growth of stem diameter (cm), yields and yield efficiencies of experimental cvs budded on bitter almond (2002)

Cultivars	Stem diameter (cm)	TCSA (cm^2)†	Yield/ tree (kg)	Yield efficiency††
'Tuono'	8.1	51.53	4.975	96.54
'D. Largueta'	6.64	34.62	4.200	121.31
'Picantili'	7.65	45.96	3.000	65.27
'Primorski'	7.03	38.82	1.100	28.335
'101/13'	6.48	32.98	1.850	56.09
'300/1'	7.30	41.85	1.250	29.868
'Drake'	6.20	30.19	2.400	79.496
'Garrigues'	6.82	36.53	3.800	104.02
'Nikitski'	5.20	21.23	2.000	94.206
'Nonpareil'	6.96	38.05	1.200	31.537
'101/23'	7.94	49.51	1.800	36.356

†TCSA: Total cross sectional area of stem.
††Yield efficiency: yield per cm^2 of TCSA.

Table 7. Yield, shelling percentages and kernel yields of the experimental trees

Cultivars	Yield/tree (kg)	Shelling (%)	Yield in kernel/tree (g)
'Lauranne'	7.0	35.2	2464
'Guara'	5.0	37.1	1855
'Ferraduel'	7.2	25.5	1836
'Ferragnès'	4.5	35.8	1611
'Tuono'	5.0	30.5	1517
'Garrigues'	3.8	36.3	1379
'D. Largueta'	4.2	27.4	1150
'Drake'	2.4	45.0	1080
'Nikitski'	2.0	50.6	1012
'Glorieta'	3.5	26.4	924
'Nonpareil'	1.3	66.2	794
'Masbovera'	2.0	27.9	558
'101/13'	1.9	29.8	551

Pomological characteristics of the experimental cvs are shown in Table 8. The heaviest nuts were

obtained from 'Glorieta' (5.2 g) and 'D. Largueta' (5.1 g). They were followed by 'Ferraduel' (4.9 g), 'Masbovera' (4.8 g), etc. The smallest nuts were obtained from 'Nonpareil' (1.5 g). The kernels of 'Ferragnès' and 'Garrigues' were the heaviest (1.6 g) and they are followed by 'Nikitski' (1.5 g), 'D. Largueta' and 'Glorieta' (1.4 g). The smallest kernels were obtained from '300/1', 'Drake', 'Lauranne' and 'Nonpareil' (1.1 g). The nut sizes are quite similar to those stated by Monastra *et al.* (1982) and either similar or a bit higher than those of K. Maras (Caglar *et al.*, 2003) and Adana (Kaska and Kuden,1996).

Table 8. Comparison of almond cultivars on a kernel basis

Cultivars	In-shell nuts				Kernel				Shelling %
	Length (mm)	Height (mm)	Width (mm)	Weight (g)	Length (mm)	Height (mm)	Width (mm)	Weight (g)	
'101/13'	34.2	15.7	22.7	4.5	24.7	8.11	14.6	1.3	29.8
'300/1'	29.4	15.9	20.7	2.6	22.1	9.11	12.5	1.1	44.3
'D. Largueta'	35.3	15.5	23.9	5.1	26.8	7.84	13.4	1.4	27.4
'Drake'	28.7	15.3	20.2	2.5	21.4	9.21	12.3	1.1	45.1
'Ferraduel'	34.4	16.6	25.2	4.9	23.9	7.96	15.2	1.2	25.5
'Ferragnès'	35.1	16.3	23.3	4.4	25.6	8.7	13.9	1.6	35.8
'Garrigues'	36.8	17.8	26.2	4.4	26.1	8.5	16.5	1.6	36.3
'Glorieta'	39.1	17.5	25.7	5.2	26.5	7.8	14.8	1.4	26.4
'Guara'	34.4	16.5	24.1	3.3	24.8	7.93	14.6	1.2	37.1
'Lauranne'	33.1	14.4	22.1	2.9	23.5	7.24	13.3	1.1	35.2
'Marcona'	28.8	17.4	24.9	4.6	21.1	8.62	15.3	1.3	27.5
'Masbovera'	32.3	17.6	25.6	4.8	25.9	7.84	14.1	1.3	27.9
'Nikitski'	38.4	15.9	21.8	3.1	27.7	9.31	13.1	1.5	50.6
'Nonpareil'	29.6	11.8	18.7	1.5	22.5	7.81	12.1	1.1	66.2
'Picantili'	39.4	18.1	24.3	4.4	29.6	10.57	15.1	1.9	44.4
'Primorski'	37.6	17.5	24.1	4.1	28.6	9.8	15.2	1.7	43.1
'Tuono'	27.9	16.8	22.5	3.8	22.6	7.52	14.1	1.2	30.5

Harvest was performed at the end of August in 2001 and in the first week of September in 2002. 'Guara' was harvested at about the same dates in both years, but 1 week delayed in 2002.

Conclusions

Due to: (i) availability of high quality of irrigation water; (ii) existence of fertile and deep soils; (iii) productive late flowering and early bearing cvs; (iv) dry and hot summers with no rains at harvest times; (v) almost no frost damage; and (vi) high profits in comparison to field crops (cotton, corn, wheat, lentil, etc.), almond is going to be the major alternative nut to field crops in the GAP Region of Turkey. If modern almond growing techniques such as pruning, harvesting, cracking, etc. are applied, Turkey can be at least self-sufficient in almond. It appeared that 'Lauranne', 'Guara', 'Ferragnès' and 'Ferraduel' are the most promising cvs for the region.

References

Ak, B.E., Kuzdere, H. and Kaska, N. (2003). An investigation on phenological and pomological traits of some almond cultivars grown at Ceylanpinar State Farm in Turkey. XIII GREMPA Meeting. Mirandela (Portugal), 1-5 June 2003 (Publication pending).

Caglar, S., Kaska, N. and Yilmaz, K.U. (2003). Adaptation of some foreign almond cultivars in the ecological condition of Kahramanmaras province in Turkey. In: XIII GREMPA Meeting. Mirandela (Portugal), 1-5 June 2003 (Publication pending).

Dokuzoguz, M. and Gulcan, R. (1973). *Breeding of Aegian region almond by selection and their adaptation work*.TUBITAK Pub., 22, 26 pp.
Felipe, A.I. and Socias i Compani, R. (1987). 'Ayles', 'Guara' and 'Moncayo' almonds. *HortScience,* 22: 961-962.
Grassely, C. and Duval, H. (1997). *L'Amandier.* CTIFL. Paris.
Kaska, N., Yesilirmak, B. and Yilmaz, K.U. (2002). Comparison of growth, flowering periods, bloom and small fruit densities of some late flowering Turkish and foreign almond cultivars under irrigated conditions in the Kahramanmaras region. In: Proceedings of the III International Symposium on Pistachios and Almonds, Zaragoza (Spain), Nov. 2002, Battle, I., Hormoza, I. and Espiau, M.T. (eds). *Acta Horticulturae,* 591: 465-472.
Kaska, N., Kuden, A.B. and Kuden, A. (1996). Studies on the growing of some late flowering foreign and local almond cultivars in Adana and Pozanti. *Tr. J. Agriculture Forestry,* 20: 115-119.
Kaska, N., Kuden, A.B. and Kuden, A. (1998). Performance of some local and foreign almond cvs in South East Anatolia. In: Proceedings of the X GREMPA Seminar. Meknes (Morocco), 14-17 October 1997. *Options Mediterraneennes, Series Cahiers,* 33: 181-183.
Monastra, F., Crisafulli, A., Marchese. F., Ondradu, G., Pavia, R. and Rivalta, L. (1982). *Monografia di Cultivar di Mandorlo*. Instituto Sperimentale Per la Frutticoltura, Ministero Agricoltura e Foreste, Roma, 93 pp.
Vargas, F.J. and Romero, M. (1993). 'Masbovera', 'Glorieta' and 'Francoli', three new almond varieties from IRTA. *Acta Horticulturae,* 22: 961-962.