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Determination of Superior Almond Genotypes in Diyarbakir Central Districts

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Abstract: This study was carried out in Diyarbakir Central districts and their villages in Turkey where there is a rich natural almond resources. In this research, it was found superior almond genotypes which had late flowering and high fruit quality were determined in years 2003 and 2004. For this purpose, natural almond populations in the area were surveyed in detail and evaluated as subjective about 500 almond trees. In these trees, 120 almond trees were labelled and determined their performances for breeding objectives. At the end of this study, 10 almond genotypes (DYB-2, DYB-11, DYB-24, DYB-40, DYB-56, DYB-64, DYB-76, DYB-86, DYB-100 and DYB-108) having superior performances were selected by using weighted ranked method. Fruit weight, fruit length, fruit width, fruit thickness, kernel weight, kernel length, kernel width and kernel thickness of the superior almond genotypes were ranged from 4.96-1.93 g, from 40.35-26.55 mm, from 24.61-16.22 mm, from 15.34-11.47 mm, from 1.23-0.56 g, from 28.56-19.98 mm, from 14.85-10.37 mm and from 7.41-5.40 mm, respectively. Protein, oil, ash and moisture contents of the genotypes were ranged from 32.90-21.18%, from 54.81-43.50%, from 4.42-2.54% and from 4.43-3.08%, respectively. First flowering, full flowering and last flowering of the genotypes were ranged from March 04-01, from March 09-06 and from March 15-10, respectively. In addition, total points were ranged from 762-735 according to flowering and from 734-710 according to quality.

Key words: Almond, weighted ranked method, late flowering, diyarbakir, oil, Turkey

INTRODUCTION

Almond (*Prunus amygdalus* L.) is a long-lived and large-sized species showing a relatively short juvenile period (Socias and Company, 1997). In addition, the almond is one of the oldest crops used by human but its exacting enviromental requirements have restricted its commercial production to specific areas of the world (Kester and Asay, 1979).

Therefore, the almond production is concentrated in some regions (Mediterranean and Asian countries and California with limited amounts in Argentina, Chile, South Africa and Australia) of the world (Kester *et al*., 1990). In Turkey, the almond culture were grown on all the areas except coast of East Black See region and high plateau (Gulcan *et al*., 1989). But now-a-days, the almond culture aree grown partly in the modern conditions.

Existing almond genotypes and cultivars differ widely from each other in many properties with respect to especially flowering time, yield, quality of the nuts and tree vigour. This variability provided an invaluable material for the selections. Almond genotypes which have late flowering, high yield and high quality have been determined in some other regions of Turkey (Dokuzoguz and Gulcan, 1979; Gulcan *et al*., 1989; Kester *et al*., 1990). As a matter of fact, a lot of researchers have directly or indirectly studied on these subjects in other regions (Kester *et al*., 1980; Kumar and Uppal, 1990; Cangi and Sen, 1991; Ledbetter and Shonnard, 1992; Kuden *et al*., 2001; Aslantas, 1993; Bostan *et al*., 1995; Simsek, 1996; Gercekcioglu and Gunes, 1999; Balta *et al*., 2001; Balta, 2002; Simsek and Kuden, 2007; Simsek, 2008; Simsek *et al*., 2010).

With hard climatic conditions, Southeast Anatolia region has mostly seedling almond populations and this region might have valuable almond genotypes and cultivars. According to currant statistical data, almond production was 4.453 tons in Southeast Anatolia region. A lot of the almond trees grown in the region are grown mostly with seed and generally grown in side of field and poly culture with the fruit species such as pistachios, olive, figs and walnuts.

No studies have been made about almond trees in Diyarbakir central districts and their villages up to now. Therefore, this study is very significant with respect to be beginning about the almond genotypes in the population.

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In this context, it was selected almond genotypes with high performance and late flowering. These genotypes may be used in plant breeding and guidance to the other studies being made in next years.

MATERIALS AND METHODS

This study was carried out during 2003-2004 on almond population naturally grown in Diyarbakir central districts and their villages which is Southeast Anatolia region of Turkey. About 120 almond genotypes were marked and evaluated in about 500 almond trees. In this context, 30 fruits were randomly taken from the each almond tree in each year. After having taken the fruit samples from the genotypes, their husts were peeled and these fruits were dried in a shade for a week.

Then, they were dried in a drying chamber at 30°C for 24 h in order to homogenise their moisture levels (Szentivanyi, 1990; Solar, 1990). According to specifications of the performances of the almond genotypes, 10 almond genotypes were selected via weighted ranked method (Table 1) of Gulcan *et al*. (1989). Flowering and pomological properties of the superior almond genotypes were made according to Gulcan (1985).

The fruit weight and the kernel weight were measured with a scale sensitive to 0.01 g. The fruit height, the fruit length, the fruit width and the fruit thickness of the genotypes were measured by a digital compass. The altitudes and coordinates of the genotypes were determined by using GPS tool. The start of flowering of the almond genotypes is getting one day late at each 35 m in altitude (Ozbek, 1977).

In addition, the moisture was determined by drying in a thermostat at 105°C (24 h) to a constant weight by using a 5±0.01 g sample for each almond genotype and it was calculated to be a dry weight and fresh weight basis (Cemeroglu, 1992).

The ash contents of the superior genotypes were determined by using a ash furnace at 200°C with 24 h and then at 560°C with 10 h (Gonul *et al*., 1988). Protein contents of the samples were determined by using kjeldahl method (Jung *et al*., 2003).

The standard method for analyzing the oil content of the samples was made by hexan extraction in a soxhlet extractor (Lee, 1981). The other matters of the samples were calculated with deriving from moisture, ash, oil the protein contents of almond samples.

Table 1: Evaluation of the almond genotypes according to the weighted ranked method

Characteristics	Classifications	Value scores	Relative scores according to flowering	Relative scores according to quality	Classifications	Value scores	Relative scores according to flowering	Relative scores according to quality
Seasonal of flower	Extremely early	1	30	20	Intermediate/late	6	30	20
(date of full flowering)	Very early	2	30	20	Late	7	30	20
	Early	3	30	20	Very late	8	30	20
	Early/intermediate	4	30	20	Extremely late	9	30	20
	Intermediate	5	30	20				
Tree habit	Extremely upright	1	3	3	Drooping	4	3	3
	Upright	2	3	3	Weeping	5	3	3
	Spreading	3	3	3				
Yield	Low	3	25	20	High	7	25	20
	Intermediate	5	25	20				
Fruit weight	Small	3	8	10	Large	7	8	10
	Medium large	5	8	10	Very large	9	8	10
Suture opening	Very wide	0	3	6	No openinig	9	3	6
of the shell	Open	5	3	6				
Shell hardness	Extremely hard	1	5	6	Soft	7	5	6
	Hard	3	5	6	Paper	9	5	6
	Intermediate	5	5	6				
Kernel colour	Extremely light	9	3	7	Dark	3	3	7
intensity	Light	7	3	7	Extremely dark	1	3	7
	Intermediate	5	3	7				
Shrivelling of kernel	Wrinkle	1	2	4	Smooth	7	2	4
	Less wrinkle	5	2	4				
Kernel hairiness	Very hairy	3	7	6	Medium hairy	7	7	6
	Hairy	5	7	6	Less hairy	9	7	6
Kernel taste	Bitter	3	11	15	Sweet	7	11	15
	Intermediate	5	11	15				
Percentage of	Low	7	2	2	High	1	2	2
double kernels	Intermediate	5	2	2	-	-	-	-
Percentage of sound kernel	-	100	1	1	-	-	-	-
Total score	100							

RESULTS AND DISCUSSION

During the study, 120 almond genotypes were labelled in about 500 almond trees. About 10 almond genotypes which had higher scores (DYB-2, DYB-11, DYB-24, DYB-40, DYB-56, DYB-64, DYB-76, DYB-86, DYB-100 and DYB-108) were selected according to the results of the weighted ranked method.

Considering 2 years mean results (2003 and 2004), the fruit weight, fruit length, fruit width, fruit thickness, kernel weight, kernel length, kernel width and kernel thickness of the almond genotypes were found to be different from each other (Table 2). The fruit weight, fruit length, fruit width, fruit thickness, kernel weight, kernel length, kernel width and kernel thickness of these genotypes were ranged from 4.96±0.697 to 1.93±0.562 g, from 40.35±0.126 to 26.55±0.255 mm, from 24.61±0.240 to 16.22±0.167 mm, from 15.34±0.481 to 1.47±0.264 mm, from 1.23±0.077 to 0.56±0.035 g, from 28.56±0.204 to 19.98±0.004 mm, from 14.85±0.428 to 10.37±0.275 mm and from 7.41±0.308 to 5.40±0.196 mm, respectively.

In some other studies, the fruit weight changed from 3.45-5.86 g (Bostan *et al*., 1995), from 3.37-5.24 g (Kumar and Uppal, 1990), from 2.18-7.58 g (Gercekcioglu and Gunes, 1999), from 3.39-7.58 g (Beyhan and Simsek, 2007), from 1.21-2.75 g (Simsek and Kuden, 2007) and from 1.42-4.93 g (Simsek, 2008). Karadeniz and Erman (1996), Simsek and Kundan (2007) and Simsek (2008) determined that the kernel weight of the genotypes were changed from 1.01- 1.80 g, from 0.51-1.52 g and from 0.66-1.14 g, respectively. Simsek (1996) determined that the kernel length was changed from 18.92-33.87 mm. The fruit weight, the fruit length, the fruit width, the fruit thickness, the kernel weight, the kernel length, the kernel width and the kernel thickness can change according to the genetic characteristics, maintenance requirements and the ecological conditions. It was determined that all the almond genotypes had no open suture opening of the shell, sweet kernel taste, 100% sound kernel ratios, no twin kernel ratios, no double, intermediate yield, less hairy hairiness and medium kernel colour intensity.

In addition, some other pomological properties of the almond genotypes also were shown in Table 3. Aslantas (1993), Simsek and Kuden (2007) and Simsek (2008) determined that the double kernel ratios changed from 0.00-28.00, 0.00 and 0.00%, respectively. Kalyoncu (1990) observed that the kernel hairiness was determined to be less hairiness in 8 genotypes and medium hairiness in 4 genotypes in the almond genotypes. Simsek and Kuden determined that the sound kernel ratio was found as 100%. Simsek and Kuden determined that the suture opening of the shell was showed to be no open of 5 genotypes and open of 4 genotypes. Also, Simsek determined that the suture opening of the shell was showed to be no open of 4 genotypes and open of 2 genotypes. Simsek observed that the kernel colour

Table 2: Some pomological properties of the superior almond genotypes (average of years 2003-2004)

Code no.	Fruit weight (g)	Fruit length (mm)	Fruit width (mm)	Fruit thickness (mm)	Kernel weight (g)	Kernel length (mm)	Kernel width (mm)	Kernelthickness (mm)
DYB-2	3.36±0.097	31.48±0.245	20.41±0.330	12.19±0.598	0.83±0.034	23.11±0.495	12.21±0.541	5.47±0.106
DYB-11	2.64±0.176	28.62±0.671	16.91±0.044	11.96±0.618	0.79±0.039	20.21±0.517	10.70±0.237	7.41±0.308
DYB-24	4.08±0.322	30.38±1.112	21.29±0.229	13.10±0.332	1.07±0.053	22.28±0.176	13.46±0.357	6.51±0.247
DYB-40	4.96±0.697	40.35±0.126	23.56±0.256	13.63±0.286	1.18±0.006	28.56±0.204	13.67±0.649	5.73±0.192
DYB-56	2.85±0.126	28.04±0.381	18.24±0.248	12.16±0.147	0.71±0.066	20.73±0.688	11.73±0.631	5.40±0.196
DYB-64	2.65±0.157	27.41±1.177	17.31±0.233	12.37±0.200	0.69±0.044	19.98±0.004	11.48±0.277	6.19±0.140
DYB-76	4.48±0.114	35.05±0.268	24.61±0.240	15.34±0.481	1.23±0.077	25.48±0.265	14.85±0.428	6.29±0.542
DYB-86	3.54±0.148	31.75±0.561	21.45±0.124	14.48±0.081	0.98±0.127	23.93±0.036	12.47±0.248	6.25±0.190
DYB-100	2.12±0.161	25.93±0.580	16.22±0.167	11.47±0.264	0.56±0.035	19.03±0.611	10.37±0.275	5.52±0.259
DYB-108	1.93±0.562	26.55±0.255	18.41±0.145	14.06±0.661	0.71±0.017	19.98±1.016	10.43±0.223	6.86±0.571
LSD 5%	0.30	0.38	0.50	0.28	0.07	0.28	0.45	0.34

Table 3: Some other pomological properties of the selected almond genotypes (average of years 2003-2004)

Code no.	Tree habit	Nut shape	Shrivelling of kernel	Kernel shape according to widthness index	Kernel shape according to thickness index	Shell hardness	Sizeness group according to 1 ons
DYB-2	Drooping	Oblong	Less wrinkle	Medium width	Oblate	Very hard	Small
DYB-11	Drooping	Cordate	Smooth	Medium width	Medium thick	Very hard	Small
DYB-24	Drooping	Cordate	Less wrinkle	Width	Oblate	Very hard	Medium large
DYB-40	Weeping	Cordate	Smooth	Narrow	Oblate	Very hard	Large
DYB-56	Weeping	Cordate	Less wrinkle	Medium width	Oblate	Very hard	Small
DYB-64	Drooping	Cordate	Less wrinkle	Medium width	Medium thick	Very hard	Small
DYB-76	Weeping	Oblong	Less wrinkle	Medium width	Oblate	Very hard	Large
DYB-86	Drooping	Oblong	Less wrinkle	Medium width	Oblate	Very hard	Medium large
DYB-100	Drooping	Cordate	Less wrinkle	Medium width	Oblate	Very hard	Small
DYB-108	Drooping	Oblong	Less wrinkle	Medium width	Medium thick	Intermediate	Small

intensity was determined to be light in 1 genotype, medium in 3 genotypes and dark in 2 genotypes. Simsek and Kuden (2007) and Simsek (2008) determined that the kernel tastes of all the almond genotypes were observed as sweet. Simsek determined that the yield was shown to be high in 3 genotypes and medium in other 3 genotypes. The double kernel ratio is desired not to excess 5% (Ozbek, 1977). The suture opening having very wide is an undesirable properties. The twin kernel ratio, the sound kernel ratio, the kernel colour intensity and the suture opening of the shell can change according to the genetic properties of almond genotypes and cultivars.

But, the kernel colour intensity can accessible from light density. Kernel hairiness is an undesire because it does not welcome to the mouth and does not create a better image. In addition, hairiness is negatively effect the roast of kernels. The state in kernel taste can change according to the purpose of research. Although, the yield is an inherited property, it can change according to the pollination, maintenance requirements and the ecological conditions. The widthness and thickness indexes of the superior almond genotypes were shown in Fig. 1. The kernel ratios and the kernel numbers in 1 ons of the almond genotypes were shown in Fig. 2 and 3,

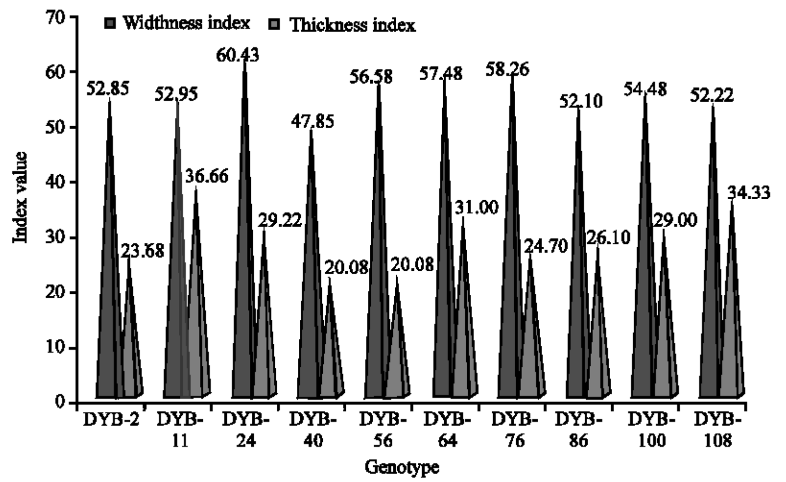

Fig.1: The widthness and the thickness indexes of the almond genotypes (average of years 2003-2004)

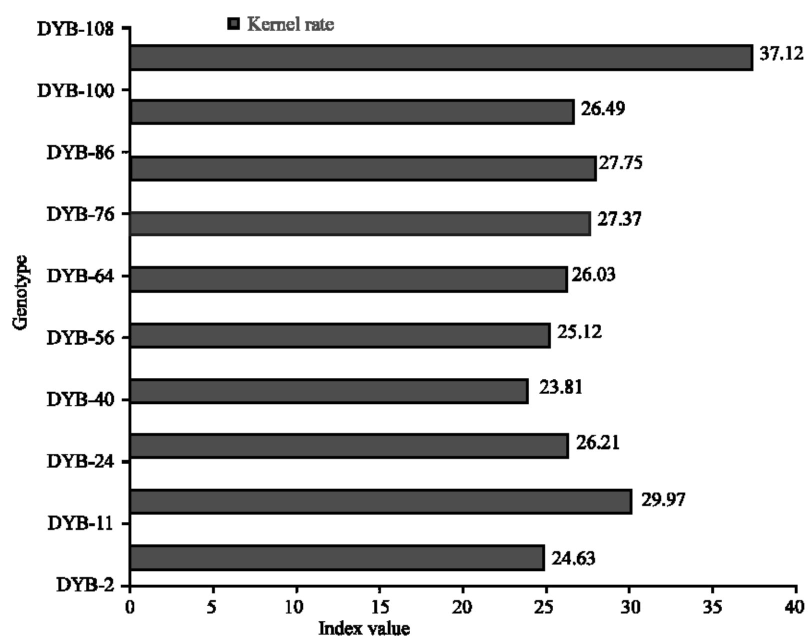

Fig. 2: The kernel ratio of the almond genotypes (average of years 2003-2004)

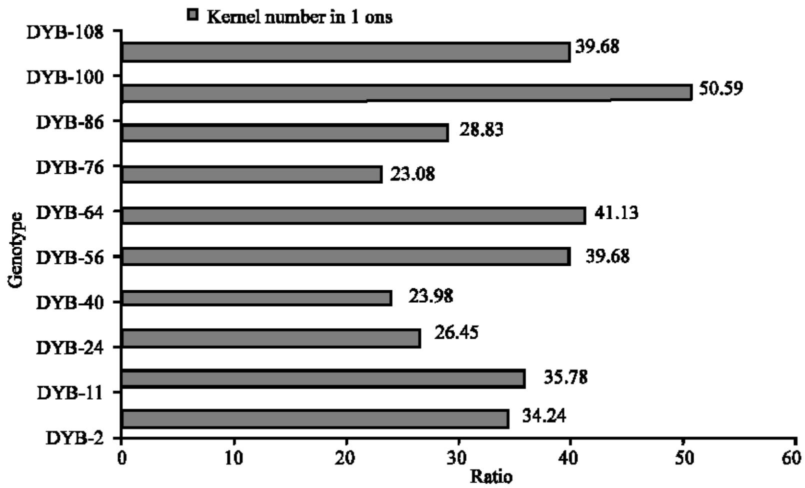

Fig. 3: The kernel number in 1 ons of the almond genotypes (average of years 2003-2004)

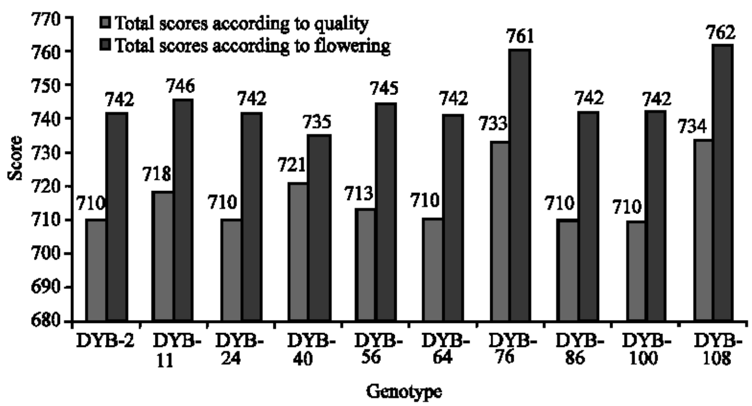

Fig. 4: The total scores according to flowering and quality of the almond genotypes (average of years 2003-2004)

respectively. The total scores according to the flowering and the quality of the selected almond genotypes were shown in Fig. 4.

The widthness and the thickness indexes of the almond genotypes were ranged from 60.43-47.85 and from 36.66-20.08, respectively.

In addition, the kernel ratio and the kernel numbers of the almond genotypes were ranged from 37.12-23.81% and from 50.59-23.08%, respectively. Balta *et al.* (2001) determined that kernel ratio was changed from 29.20-18.40%. Simsek (2008) determined that the widthness and thickness indexes was changed from 55.23-50.19 and from 44.32-22.37, respectively.

Simsek determined that the kernel number in 1 ons changed from 41.92-26.57. In addition, the total scores according to the flowering and the quality of the almond genotypes were ranged from 762-735 and from 734-710, respectively. Simsek determined that the total scores according to the quality changed from 884-787. Kernel ratio, kernel number, widthness and thickness indexes in 1 ons can change according to the genetic characteristics. The scores with respect to almond genotypes and cultivars can change according to the genetic characteristics, maintenance requirements and the ecological conditions.

According to the means values of years 2003-2004, the chemical properties of the selected almond genotypes were shown in Table 4. The protein, oil, ash and moisture contents of the superior genotypes were ranged from 32.90-21.18%, from 54.81-43.50%, from 4.42-2.54% and from 4.43-3.08%, respectively. Yildirim *et al.* (2008) determined that oil, protein, ash and moisture contents of the selected genotypes were ranged from 44.25-54.68%, from 21.23-35.2%, from 2.75-3.81% and from 3.41-4.52%, respectively. It was shown to be the variations with respect to protein, oil, ash and moisture contents of 10 superior genotypes in Diyarbakir central districts and their villages. Chemical

Table 4: Some chemical properties of the almond genotypes (average of years 2003-2004)

Code no.	Protein (%)	Oil (%)	Moisture (%)	Ash (%)	Other matters (%)
DYB-2	21.18	50.69	3.60	2.76	21.77
DYB-11	22.12	54.81	3.60	3.61	15.86
DYB-24	26.10	47.23	3.68	3.67	19.32
DYB-40	23.60	49.30	4.15	3.78	19.17
DYB-56	30.11	47.80	3.19	4.11	14.79
DYB-64	22.44	51.80	3.84	2.90	19.02
DYB-76	24.20	50.66	4.43	4.19	16.52
DYB-86	32.90	43.50	4.08	3.15	16.37
DYB-100	24.50	49.66	3.08	2.54	20.22
DYB-108	21.23	50.42	3.90	4.42	20.03

Table 5: The flowering times and the periods, the altitudes and the coordinates of the superior almond genotypes in 2004

						Coordinates	
Code no.	First flowering	Full flowering	Last flowering	Flowering period (days)	Altitudes (m)	East	North
DYB-2	01 March	06 March	11 March	11	610	37610026	4200324
DYB-11	01 March	06 March	10 March	10	607	37610034	4200336
DYB-24	01 March	06 March	11 March	11	599	37610039	4200348
DYB-40	02 March	06 March	10 March	9	598	37610043	4200359
DYB-56	01 March	06 March	11 March	11	592	37610051	4200366
DYB-64	03 March	08 March	12 March	10	595	37610066	4200367
DYB-76	04 March	09 March	15 March	12	662	37607224	4191741
DYB-86	03 March	08 March	13 March	11	654	37607279	4191697
DYB-100	03 March	08 March	14 March	12	656	37607298	4191686
DYB-108	04 March	09 March	14 March	11	657	37607368	4191630

properties of almond genotypes and cultivars can change according to the genetic properties, the maintenance requirements and the ecological conditions.

The flowering times and the periods, the altitudes and the coordinates of the superior almond genotypes were shown in Table 5. The first flowering, the full flowering, the last flowering, average flowering period of the superior almond genotypes were ranged from March 01-04, from March 06-09, from March 10-15 and from 9-12 days, respectively.

In addition, the altitudes of the almond genotypes were ranged from 592-662 m. The coordinates of the almond genotypes were found to be 37610051 E-4200366 N for DYB-56 genotype which had lowest altitude and 37607224 E-4191741 N for DYB-76 type which had highest altitudes. Simsek (1996) determined that first flowering started from 25 February to 05 March.

Aslantas (1993) determined that the flowering occured from 11 April to 4 May in 1992 and from 5 April to 3 May in 1993 and determined the the flowering lasted 9- 10 and 8-12 days in the same as years, respectively. In addition, Kuden *et al.* (2001) determined that the flowering occured from 25 February to 26 March in 1999 and from 10 March to 24 March in 2000.

In temperate climate fruits, almond is earliest flowering species. Therefore, it is affected more according to the other temperate climate fruits from late spring freezes. To select the almond species which are late flowering and higher performance is very important commercially. In general, almond types and cultivars can change according to the altitude, the ecological conditions and the genetic characteristics.

CONCLUSION

During this research, the superior almond genotypes in Diyarbakir central districts and their villages in Turkey were seen their outperform in point of almost properties. However, there are need the determination of variety candidates or varieties which have more suitable for the region.

In addition, these almond genotypes should be made their adaptations in the same ecological condition with other almond genotypes and cultivars which are domestic and wild. At the end of the adaptation work, the almond genotypes and cultivars which have higher performances should be grown for the contribution to Turkey and world's economy.

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