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# Paternal effects on fruit characteristics of some almond cultivars

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**Abstract.** The paternal effect in fruit trees is exhibited by differences among fruits borne on the same cultivar but developed from different source of pollen. The effect of pollinator on nut and kernel characteristics of almond was studied by measuring the nuts and kernels obtained from 12 crosses between self-incompatible and self-compatible almond cultivars. Three domestic self-incompatible cultivars ('Gulcan 1', 'Gulcan 2' and 'Akbadem') were hand-pollinated with four male self-compatible cultivars: 'Guara', 'Lauranne', 'Felisia' and 'Moncayo'. Quality characteristics were determined as nut weight (g), kernel weight (g), shelling percentage, double kernels, and nut and kernel dimensions (length, width and thickness). Nut and kernel characteristics showed differences according to the pollen sources.

**Keywords.** Almond – Paternal effect – Nut – Kernel characteristics.

## *Effets paternels de certains cultivars d'amandier sur les caractéristiques du fruit*

**Résumé.** Chez les arbres fruitiers l'effet paternel a donné lieu à des différences entre fruits portés par le même cultivar mais développés à partir de différentes sources de pollen. Chez l'amandier, l'effet du pollinisateur sur les caractéristiques du fruit et de l'amandon a été étudié en mesurant les fruits et les amandons obtenus à partir de 12 croisements entre cultivars d'amandiers auto-incompatibles et auto-compatibles. Trois cultivars domestiques auto-incompatibles ('Gulcan 1', 'Gulcan 2' et 'Akbadem') ont été pollinisés à la main avec quatre cultivars mâles auto-compatibles: 'Guara', 'Lauranne', 'Felisia' et 'Moncayo'. Les caractéristiques de qualité ont été déterminées comme poids du fruit (g), poids de l'amandon (g), rendement au cassage en pourcentage, amandons doubles, et dimensions du fruit et de l'amandon (longueur, largeur et épaisseur). Les caractéristiques du fruit et de l'amandon ont montré des différences selon les sources de pollen.

**Mots-clés.** Amandier – Effet paternel – Fruit – Amandon – Caractéristiques.

## I – Introduction

Although Turkey has a considerable potential in terms of almond production, it is an almond importing country. Almost all domestic almond cultivars are stone class and they are self-incompatible. According to average almond production over the last three years, Turkey's almond production is 77,650 tons and 7<sup>th</sup> in the world (FAO, 2013). The Mediterranean, Southeast Anatolia and Aegean regions have potential for modern almond growing in Turkey. The Southeast Anatolian Project (GAP) is the largest irrigation and development project of Turkey covering about two million ha of cultivated land. Recently, modern almond orchards with foreign cultivars are being established in the GAP region.

The "xenia" term covers all direct pollen effects in seeds and fruits, whether discerned in embryo, endosperm, or maternal tissues, in the period from fertilization to germination (Denney, 1992). The paternal effects on seeds may describe as "xenia".

There were different results from different researchers about the pollen source effects on fruit characteristics of almond. According to Dicenta *et al.* (2002), there is no difference between self- and

cross-pollination for several fruit traits of almond, including fruit weight, kernel weight, shelling percentage, double kernels, empty nuts, and split kernels. The artificial selfing influenced markedly the production of double kernels in almond (Palasciano *et al.*, 1994). Fruits from open pollination of self-compatible seedlings had higher values of weight in-shell, kernel weight, nut volume and kernel volume than those from self-pollination after bagging (Vargas *et al.*, 2005). Nut quality characteristics of almonds showed differences according to the years and the pollinators (Eti *et al.*, 1994).

In this study, we pollinated 'Gulcan 1', 'Gulcan 2' and 'Akbadem' almond cultivars with pollen of 'Felisia', 'Moncayo', 'Lauranne' and 'Guara', and we used the fruits to determine the paternal effects of cultivars on physical nut and kernel characteristics in almond.

## II – Materials and methods

Three domestic and self-incompatible almond cultivars ('Gulcan 1', 'Gulcan 2' and 'Akbadem') were hand-pollinated with 4 self-compatible and late flowering foreign cultivars ('Guara', 'Lauranne', 'Felisia' and 'Moncayo') in the study. Twelve controlled crosses were performed between the domestic and foreign cultivars as below:

'Gulcan 1' × 'Felisia', 'Gulcan 1' × 'Moncayo', 'Gulcan 1' × 'Lauranne', 'Gulcan 1' × 'Guara'; 'Gulcan 2' × 'Felisia', 'Gulcan 2' × 'Moncayo', 'Gulcan 2' × 'Lauranne', 'Gulcan 2' × 'Guara'; 'Akbadem' × 'Felisia', 'Akbadem' × 'Moncayo', 'Akbadem' × 'Lauranne' and 'Akbadem' × 'Guara'.

Controlled crosses were made in the Sekamer Station of Sutcuimam University in Kahramanmaraş. Fruits were harvested at maturity, and fruit samples collected from each cultivar pollinated with four different cultivars to determine the effect of each type of pollen on expression of the fruit characteristics.

Fruit weight, kernel weight, shelling percentage, double kernels and dimensions of fruit and kernel were determined. Length, width, and thickness of fruits were measured with a precision of 0.01 mm with a digital caliper. After measurements, nuts were cracked to obtain the kernel and determine the shelling percentage by weight using an electronic balance. Length, width, and thickness were measured in all kernels.

The results are means of three replicate samples containing 30 fruits for each replicate. The replicated values on fruit and kernel traits were analyzed using the one-way ANOVA procedure. Mean values were compared by Fisher's least-significant difference (LSD) multiple-range test at  $p \leq 0.05$ .

## III – Results and discussion

### 1. Paternal effects on fruit features of 'Gulcan 1' cultivar

All examined physical features of 'Gulcan 1' fruits were statistically affected by the pollen of 'Felisia', 'Moncayo', 'Lauranne' and 'Guara' cultivars. There was a general increasing at nut and kernel characteristics of 'Gulcan 1' almond when pollinated with 'Moncayo' and 'Lauranne'. Double kernels were observed 10% at 'Gulcan 1' × 'Felisia' fruits, while that value was 0% in the other 'Gulcan 1' crosses. 'Felisia' had a negative effect on nut and kernel traits of 'Gulcan 1' (Table 1). 'Moncayo' and 'Lauranne' can be used as pollinator for 'Gulcan 1' because of their positive effects on physical fruit traits.

Atli *et al.* (2011) had found nut weight, shelling percentage and double kernels of 'Gulcan 1' cultivar as 2.03 g, 36.4% and 10.0%, respectively. The nut weight of 'Gulcan 1' was higher in our experiment (Table 1). According to Oukabli *et al.* (2002), there was no pollination effect on the production of double kernels in 'Tuono' almond.

**Table 1. Paternal effects on physical nut and kernel characteristics of ‘Gulcan 1’ almond**

Crosses	Nut weight g	Kernel weight g	Shelling percentage %	Double kernels %	Nut dimensions mm			Kernel dimensions mm		
					Length	Width	Thick.	Length	Width	Thick.
‘Gulcan 1’ x ‘Felisia’	2.35 d	0.72 d	30.40 b	10.00 a	1.45 c	0.89 b	0.63 b	1.09 c	0.51 d	0.33 d
‘Gulcan 1’ x ‘Moncayo’	3.50 b	1.26 a	36.04 a	0.00 b	1.73 a	1.06 a	0.75 a	1.30 ab	0.58 b	0.41 a
‘Gulcan 1’ x ‘Lauranne’	3.89 a	1.20 b	30.84 b	0.00 b	1.77 a	1.07 a	0.78 a	1.36 a	0.60 a	0.39 b
‘Gulcan 1’ x ‘Guara’	2.86 c	0.87 c	30.34 b	0.00 b	1.67 b	0.89 b	0.66 b	1.21 bc	0.54 c	0.35 c
LSD ( $p \leq 0.05$ )	0.11	0.001	1.43	0.99	0.06	0.13	0.06	0.13	0.002	0.001

Letters next to numbers indicate different groups determined by LSD test ( $p \leq 0.05$ ).

## 2. Paternal effects on fruit features of ‘Gulcan 2’ cultivar

Significant differences existed for examined fruit characteristics of ‘Gulcan 2’ cultivar within pollination treatments. ‘Gulcan 2’ fruits were affected by the same pollinators. The highest physical values were obtained from the ‘Guara’ pollinated fruits, and followed by ‘Moncayo’ and ‘Lauranne’ pollinated, respectively. The lowest values were obtained from the ‘Felisia’ pollination. Similarly, double kernels were observed 5% at ‘Gulcan 2’ x ‘Felisia’ fruits, while that value was 0% in the other ‘Gulcan 2’ crosses. ‘Felisia’ had also a negative effect on fruit features of ‘Gulcan 2’ (Table 2).

Atli *et al.* (2011) reported that, nut weight, shelling percentage and double kernels of ‘Gulcan 2’ cultivar were 2.80 g, 27.7% and 3.3%, respectively. The nut weight of ‘Gulcan 2’ was higher in this experiment (Table 2).

**Table 2. Paternal effects on physical nut and kernel characteristics of ‘Gulcan 2’ almond**

Crosses	Nut weight g	Kernel weight g	Shelling percentage %	Double kernels %	Nut dimensions mm			Kernel dimensions mm		
					Length	Width	Thick.	Length	Width	Thick.
‘Gulcan 2’ x ‘Felisia’	4.72 d	1.16 d	24.60 a	5.00 a	1.71 b	1.11 b	0.75	1.29	0.69 b	0.36 a
‘Gulcan 2’ x ‘Moncayo’	5.74 b	1.31 b	22.77 b	0.00 b	1.87 a	1.26 a	0.78	1.37	0.79 a	0.30 d
‘Gulcan 2’ x ‘Lauranne’	5.28 c	1.30 c	24.64 a	0.00 b	1.81 ab	1.27 a	0.78	1.30	0.80 a	0.34 b
‘Gulcan 2’ x ‘Guara’	6.12 a	1.32 a	21.56 b	0.00 b	1.88 a	1.30 a	0.79	1.33	0.84 a	0.33 c
LSD ( $p \leq 0.05$ )	0.24	0.002	1.25	0.99	0.11	0.11	N.S.	N.S.	0.06	0.002

Letters next to numbers indicate different groups determined by LSD test ( $p \leq 0.05$ ).

## 3. Paternal effects on fruit features of ‘Akbadem’ cultivar

Domestic ‘Akbadem’ cultivar was pollinated with same almond cultivars. Significant differences existed for fruit and kernel weight, shelling percentage, double kernels, nut length and nut width of ‘Akbadem’ almond within pollination treatments. There was a positive effect on nut and kernel characteristics of ‘Akbadem’ when pollinated with ‘Moncayo’ and ‘Lauranne’. Double kernels of ‘Akbadem’ were higher than the other cultivars, and had high value when pollinated with ‘Felisia’ and ‘Moncayo’. ‘Felisia’ and ‘Guara’ had negative effects on nut and kernel characteristics of ‘Akbadem’ (Table 3).

According to Atli *et al.* (2011), nut weight, shelling percentage and double kernels of ‘Akbadem’ cultivar were 2.65 g, 45.9% and 65.0%, respectively. Kuden and Kuden (2000) were reported double kernels of ‘Akbadem’ as 26.6%. Our results were between those of Atli *et al.* (2011), and Kuden and Kuden (2000).

Dicenta *et al.* (2002) found no difference between self- and cross-pollination for several fruit traits, including fruit weight, kernel weight, shelling percentage, double kernels, empty nuts, and split ker-

nels. According to Vargas *et al.* (2005), fruits from open pollination of 34 self-compatible seedlings had higher values of weight in-shell, kernel weight, nut volume and kernel volume than those from self-pollination after bagging. Eti *et al.* (1994) reported that, nut quality characteristics of 4 selected almond types showed differences according to the years and the pollinators. Our results agreed with those of Vargas *et al.* (2005), and Eti *et al.* (1994).

**Table 3. Paternal effects on physical nut and kernel characteristics of 'Akbadem' almond**

Crosses	Nut weight g	Kernel weight g	Shelling percentage %	Double kernels %	Nut dimensions mm			Kernel dimensions mm		
					Length	Width	Thick.	Length	Width	Thick.
'Akbadem' x 'Felisia'	4.41 b	1.99 d	45.41 c	40.00 a	2.36 a	1.16 b	0.77	1.62	0.78	0.39
'Akbadem' x 'Moncayo'	4.32 c	2.28 a	52.79 a	40.00 a	2.30 ab	1.18 ab	0.79	1.56	0.84	0.41
'Akbadem' x 'Lauranne'	4.96 a	2.22 b	44.77 d	19.33 b	2.44 a	1.24 a	0.87	1.68	0.85	0.38
'Akbadem' x 'Guara'	4.02 d	2.02 c	49.83 b	20.00 b	2.15 b	1.14 b	0.78	1.61	0.79	0.38
LSD ( $p \leq 0.05$ )	0.006	0.006	0.35	2.88	0.15	0.06	N.S.	N.S.	N.S.	N.S.

Letters next to numbers indicate different groups determined by LSD test ( $p \leq 0.05$ ), NS: Not significant.

## IV – Conclusions

The paternal effect in fruit trees is exhibited by differences among fruits borne on the same cultivar but developed from different source of pollen. We conclude that pollen of different almond cultivars has effect on fruit characteristics of 'Gulcan 1', 'Gulcan 2' and 'Akbadem' cultivars.

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