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Evaluation of alternate bearing intensity in Iranian pistachio cultivars

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SUMMARY – This project was undertaken in Rafsanjan area in order to determine alternate bearing on 12-year-old pistachio trees for four years. Six trees from each cultivar were selected at a suitable harvest time and fresh and dry yield rates, splitting and blanking percentage, nut size (ounce) and nut/kernel ratio were measured. This experiment was conducted and analysed in a randomised complete block design in 4 replications, and means were compared using the Duncan test. Results showed that different cultivars have different alternate bearing intensity and this was significant in some cultivars. Alternate bearing intensity in 'Ahmad-Aghaii', 'Safid pesteh-Nough' and 'Fandoghi-zodras' cultivars was high and it was low in 'Jandaghi', 'Shahpasand' and 'Italiaii' cultivars. Percentage of blanking nuts was significant in some cultivars and that range varied between 4.9% and 39.1%.

Key words: Pistachio, alternate bearing, cultivars, Iran pistachio, alternate bearing intensity.

RESUME – *"Evaluation de l'intensité d'alternance de production chez des cultivars iraniens de pistachier". Ce projet a été conduit dans la zone de Rafsanjan pour déterminer l'alternance de production sur des pistachiers de 12 ans d'âge pendant quatre ans. Six arbres de chaque cultivar ont été sélectionnés à une période de récolte adéquate, en mesurant le taux de rendement en vert et en sec, pourcentage de fruits ouverts et vides, taille du fruit (en onces) et rapport fruit/amandon. Cette expérience a été menée et analysée selon un dispositif aléatoire en blocs complets, avec 4 répétitions, et les moyennes ont été comparées selon le test de Duncan. Les résultats ont montré que des cultivars différents avaient une intensité différente d'alternance de production et que ceci était significatif chez certains cultivars. L'intensité d'alternance était élevée chez les cultivars 'Ahmad-aghaii', 'Safid pesteh-Nough' et 'Fandoghi-zodras', et faible chez les cultivars 'Jandaghi', 'Shahpasand' et 'Italiaii'. Le pourcentage de fruits vides était significatif chez certains cultivars, variant de 4,9 à 39,1%.*

Mots-clés : *Pistachier, alternance de production, cultivars, pistachier iranien, intensité d'alternance de production.*

Introduction

Pistachio nuts are one of the important Iranian export products between agricultural crops. In Iran, pistachio plantation area is about 380,000 hectares and of that, 270,000 hectares are mature and productive. Diversity among Iranian pistachio cultivars is high, but the number of commercial cultivars is only six, which are budded on *Pistacia vera* cv. Badami as a rootstock. The mean of annual production rates is about 220,000 tons.

Pistachio is an alternate bearer physiologically, but its mechanism differs from other alternate bearing fruit tree species (Joley, 1969; Crane and Nelson, 1972). Biennial bearing in other fruit tree species is usually the result of greatly reduced flower bud formation during the year of a heavy crop. In pistachio, abundant floral buds are initiated every year but abscise in large numbers during the summer of a heavy crop. Therefore, bienniality in pistachio is caused by abscission of floral buds during a heavy crop year rather than lack of bud formation (Crane, 1984).

Alternate bearing intensity is affected by the kind of rootstock, for some the production in *off year* represents 75% of the production observed in *on year*, while for others this value is only of 25% (Crane and Nelson, 1972). Role of genetic factors in alternate bearing production was determined between different family, genus and species (Monselise and Goldschmidt, 1988). This study was done for determination of alternate bearing intensity in different commercial pistachio cultivars.

Materials and methods

The experiment was conducted in a collection of Iranian Pistachio Research Institute in Rafsanjan area. This project was done for four years on 12-year-old trees. All cultivars were budded on *Pistacia vera* cv. 'Badami' rootstocks with a distance of 4 m on rows and 7 m between rows. Six trees from each cultivar were selected and in the harvesting time, different factors such as fresh and dry yield per tree (g), alternate bearing intensity, percentage of blanking and unsplit nuts, nuts per ounce (nut size) and nut/kernel ratio were measured.

Yield was calculated for each tree harvested separately, both hulled and dried for calculation of percentage of blanks and unsplit nuts. 250 g of hulled fresh yield per trees were used and then the number of blank and unsplit nuts was counted. In order to determine the nut size, the number of nuts per 28.3 grams was counted. Also, for each cultivar, the weight of kernel in 100 g of nuts was determined.

The alternate bearing index (I), which defines the yield intensity of yield deviation for the four successive experimental periods was calculated for each cultivar as follows:

$$I = \frac{1}{n-1}\left(\frac{a2-a1}{a2+a1}+\frac{a3-a2}{a3+a2}+\frac{a4-a3}{a4+a3}+\ldots+\frac{an-an-1}{an+an-1}\right)$$

An evaluation of intensity of deviation in yield in four successive years:

Where a = yield in corresponding years, and n = number of years.

If I = 0, there is no alternate bearing. If I = 1.0, there is total alternate bearing (Wood, 1989).

This experiment was done and analysed in a complete randomised design in six replication (tree) and for four years. Mean of separation was performed using Duncan test in P<5%.

Results

Results of this project on fresh yield showed that there are significant statistical differences between different cultivars. Mean of fresh yield rate per tree were higher in 'Fandoghi-riz' (12,870 g), 'Badami-Ravar' (10,950 g), 'Harati' (9284 g) and 'Ahmad-Aghaii' (8380 g) cultivars, respectively, and it were lower in 'Safid pesteh-Nough' (776.3 g), 'Amiri' (2115 g), 'Momtaz' (2165 g) and 'Shahpasand' (3376 g), respectively (Table 1).

The rate of dried yield was higher in 'Fandoghi-riz' (4054 g), 'Ahmad-Aghaii' (3066 g) and 'Mosa-abadi (3037 g) and it was lower in 'Safid pesteh-Nough' (241.5 g), 'Momtaz' (558.8 g) and 'Saifadini' (603 g), respectively. Fresh yield/dry yield ratios in these cultivars were 31.5, 36.6, 36.3, 31.1, 25.8 and 14.6, respectively (Table 1). These differences related to hull thickness, primary moisture rate, cluster weight, blank percent and nut size (ounce). These ratios in commercial cultivars such as: 'Ahmad-Aghaii', 'Kalleh-Ghochi', 'Ohadi' and 'Akbary' were 36.6, 27.4, 30.4 and 33.2, respectively.

The number of nuts per ounce (28.3 g) varied in different cultivars from 19.8 to 35.9 nuts per ounce.

Bigger nuts were found, for example, in cultivars 'Fandoghi-48' (19.8 nuts per ounce), 'Hassanzadeh' (20.4 nuts per ounce), 'Harati' (21.3 nuts per ounce) and 'Akbary' (21.9 nuts per ounce). Smaller belonged to 'Badami zarand' (35.9 nuts per ounce), 'Ghazvini' (35.7 nuts per ounce) and 'Saifadini' (32.1 nuts per ounce).

The percentage of blank nuts was found significantly different in different cultivars. 'Fandoghi-48' (4.9%), 'Ebrahimi' (6.4%), 'Khanjari-damghan' (6.5%), 'Jandaghi' (7.2%) and 'Ahmad-Aghaii' (7.7%)

cultivars had the lowest blanking, and 'Saifadini' (39.1%), 'Kalleh-ghochi' (34.5%) and 'Sirizi' (33.3%) had the highest blank percentage.

Table1. Fresh and dry mean yield, fresh/dry ratio, alternate bearing intensity and blank percentage of Iranian pistachio cultivars

Cultivar	Mean of fresh yield (g)	Mean of dry yield (g)	Fresh/dry yield ratio	Alternate bearing intensity	Blanking (%)
'Italiaii'	8187 abc	2594 abcd	31.7	0.1 lm	9.2 bcd
'Ebrahimi'	8330 abc	2815 abc	33.8	0.2 klm	6.4 cd
'Fandoghi-Ghafori'	6167 abcd	2159 abcd	35	0.6 ae	22.5 abcd
'Badami zarand'	7958 abc	2050 abcd	25.8	0.5 af	31.9 abcd
'Hassan zadeh'	6314 abcd	1676 bcd	26.5	0.6 abc	20.3 abcd
'Gholam rezaii'	5111 bcd	1607 bcd	31.4	0.3 fk	23.4 abcd
'Ebrahim abadi'	6953 abcd	1501 bcd	21.6	0.2 klm	32.9 abc
'Momtaz'	2164 cd	558.8 cd	25.8	0.4 ch	12.3 abcd
'Harati'	9284 abc	2551 abcd	27.5	0.3 gl	18.1 abcd
'Fandoghi-48'	6629 abcd	2093 abcd	31.6	0.2 im	4.9 d
'Jandaghi'	4875 bcd	1346 bcd	27.6	0.1 m	7.2 bcd
'Ghazvini'	5742 bcd	1704 bcd	29.7	0.3 kl	18.9 abcd
'Badami-Ravar'	10,950 ab	2557 abcd	23.3	0.5 bh	23.1 abcd
'Fandoghi riz'	12,870 a	4054 a	31.5	0.4 di	9.6 bcd
'Amiri'	2150 cd	635.8 cd	29.6	0.3 klm	13.1 abcd
'Shahpasand'	3376 cd	1169 bcd	34.6	0.1 m	14.6 abcd
'Khanjari-Damghan'	5064 bcd	1887 abcd	37.3	0.5 bh	6.5 cd
'Sirizi'	4354 bcd	1117 bcd	25.6	0.4 ej	33.3 abc
'Mosa-Abadi'	8369 abc	3037 ab	36.3	0.4 ej	10.4 bcd
'Akbary'	4069 bcd	1311 bcd	32.2	0.5 bg	11.3 bcd
'Kalleh-ghochi'	8103 abc	2222 abcd	27.4	0.4 di	34.5 ab
'Rezaii zodras'	5241 bcd	1303 bcd	24.9	0.6 ae	23.6 abcd
'Ohadi'	5738 bcd	1745 abcd	30.4	0.5 ch	21.5 abcd
'Badami Nish kalaghi'	3638 cd	1192 bcd	32.8	0.2 jm	12.8 abcd
'Fandoghi zodras'	5384 bcd	1665 bcd	30.9	0.7 ab	20.0 abcd
'Ahmad-Aghaii'	8380 abc	3066 ab	36.6	0.7 a	7.7 bcd
'Safid pesteh-Nough'	776.3 d	241.5 d	31.1	0.7 a	15.0 abcd
'Saifadini'	4137 bcd	603 cd	14.6	0.6 abcd	39.1 a

Values followed by the same letters are not statistically different as measured by Duncan's multiple range test, $P<0.05$.

Evaluation of alternate bearing intensity showed that different cultivars had different alternate bearing intensity and it was significant (Table 1). 'Ahmad-Aghaii' (0.74), 'Safid pesteh-Nough' (0.73), 'Fandoghi-zodras' (0.68) cultivars showed the higher rate and 'Jandaghi' (0.06), 'Shahpasand' (0.1) and 'Italiaii' (0.14) cultivars showed the lower alternate bearing intensity (Fig. 1). Alternate bearing intensity in 'Akbary', 'Kalleh-ghochi' and 'Ohadi' commercial cultivars were 0.25, 0.44 and 0.48, respectively, which were significant in comparison to 'Ahmad-Aghaii' (0.74), another commercial cultivar.

Discussion

Wood (1989) reported that alternate bearing intensity index (I) ranged from 0 to 1.0. If I = 0, there is no alternate bearing and if I = 1.0, there is total alternate bearing. Therefore, if the alternate bearing intensity would be close to 1, differences in crop production between 2 years are very high. Results of this study showed that Iranian pistachio commercial cultivars such as 'Ahmad-Aghaii' have the highest, while 'Kalleh-ghochi', 'Ohadi' and 'Akbary', have middle, and 'Shahpasand' the lowest

alternate bearing. Severe hand-pruning could be used annually to prevent or minimize alternate bearing of pistachios (Ferguson *et al*., 1995). Thinning out of pistachio trees in winter prior to an *on year* controlled and regulated alternate bearing of pistachio trees (Esmailpour, 1996). Alternate bearing intensity varied in different ages, thus the alternate bearing intensity of Iranian pistachio cultivars in different stages of life of productive trees needs to be investigated. Finally, alternate bearing in commercial pistachio cultivars that showed severe alternate bearing, should be regulated and improved.

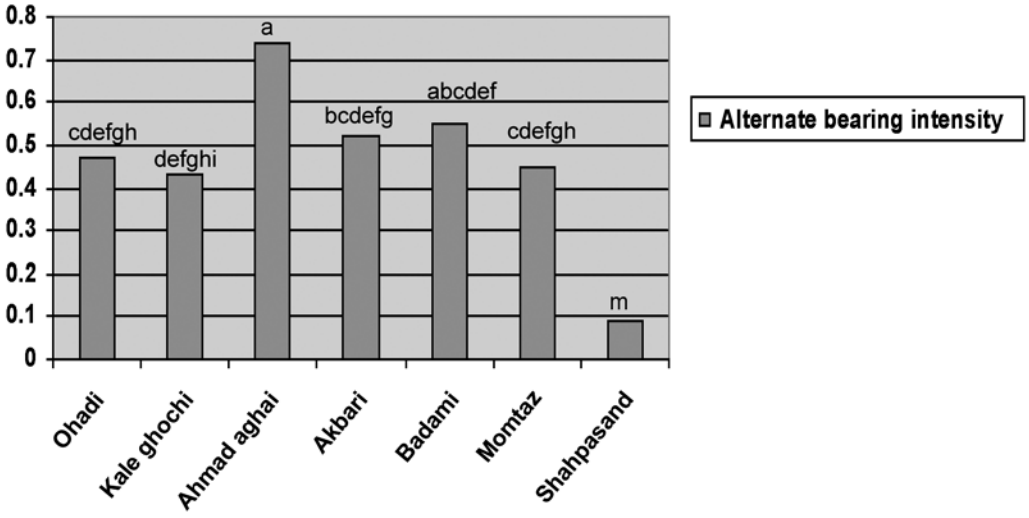

Fig. 1. Alternate bearing intensity in different pistachio cultivars. Values followed by the same letters are not statistically different by Duncan's multiple range test, P<0.05.

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