INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2006/08–3–360–362
http://www. fspublishers.org

Abscission of Inflorescence Buds as Affected by Genetic Characteristics in Some Iranian Commercial Pistachio Cultivars

ALI ESMAEILPOUR[1] AND MASOOD KHEZRI†
Pistachio Research Institute; P.O. Box 77175.435, Rafsanjan, Iran
†*Department of Horticulture, College of Agriculture, University of Tehran, Karaj, Iran*
[1]Corresponding author's e-mail: aesmailpour@yahoo.com

ABSTRACT

Four commercial cultivars of Iranian pistachio nuts including Ohadi, Kale-Ghoochi, Ahmad-Aghai and Akbari were studied for abscising of inflorescence buds. Although it is generally accepted that decreasing of leaf area and increasing of load level induce abscission, results showed that genetic characteristics of different cultivars can affect abscission. There was only a logical relationship between leaf area and load level on abscising of inflorescence buds in Ohadi, not in other cultivars. Abscission of inflorescence buds might be in relation to vegetative growth of current branches, which was different among cultivars. Genetic characteristics might be responsible for the possible involvement of plant growth substance (s) or other metabolites originating in the leaves of different cultivars.

Key Words: *Pistacia vera* L.; Abscission; Genetic characteristics; Vegetative growth; Bearing level

INTRODUCTION

Alternate bearing in fruit trees is the result of poor flower initiation in most cases but in pistachio (*Pistacia vera* L.) it is un-usual and arises as a result of inflorescence bud abscission during the year in which a heavy crop is produced (Crane & Nelson, 1971). Monselise and Goldschmidt (1982) described the possible external and internal factors, which might cause alternate bearing in fruit trees. It is accepted that bud drop in pistachio was markedly affected by both leaf area and number of nuts per branch. In general, as leaf area progressively decreased, there was a progressive increase in percentage of buds that abscised (Crane *et al*., 1973). Other studies by Crane and Nelson (1972) showed that de-fruiting, girdling and auxin application substantiated the notion that dominance of developing ovaries and seeds over the inflorescence buds in competition for metabolites was primarily responsible for bud abscission. Subsequent works by Crane and Iwakiri (1987), showed that sugar and starch levels in the bark and wood of bearing branches were not significantly different in identical parts of non-bearing branches but Takeda and Crane (1980) found that inflorescence buds on de-fruited trees accumulated twice as much ^{14}C-photosynthetic as those on fruiting trees, indicating that carbohydrate deficiency may be responsible for the bud drop. Other studies by Nzima *et al.* (1997) and Vemmos (1999) indicated that accumulation of starch in inflorescent buds of "Off" trees was higher than "On" trees. Seyedi *et al*. (2003) showed that soluble carbohydrate declined from June to August in "On" and July to August in "Off" trees and caused flower bud abscission. These studies suggested the possible role of carbohydrates in bud drop. Additionally, un-balanced nutrition was not the primary cause of bud abscission (Crane & Al-shalan, 1977). Also in relation to plant growth substances, neither abscisic acid levels in developing kernels nor in the developing inflorescence buds themselves were found to be related to abscission of inflorescence buds (Takeda & Crane, 1980) and the levels of gibberellin like substances in developing fruits and inflorescence buds have no relation to abscission (Lin *et al*., 1984). Application of auxins like 2, 4 -D and PCPA (Para-chloro phenoxy acetic acid) decreased the abscission percentage when was done on whole trees (Ferguson & Maranto, 1989). Esmaeilpour (2002) evaluated the alternate bearing intensity in Iranian pistachio cultivars and mentioned that consideration to genetic characteristics of different cultivars is an important criterion for physiological responses. Abscission of inflorescence buds in pistachio is still un-known. Most of researches in this field are restricted only to one cultivar. The objective of this study is to determine if different cultivars with various genetic characteristics can affect abscission.

MATERIALS AND METHODS

Four commercial cultivars including Ohadi, Kale-Ghoochi, Ahmad-Aghai and Akbari were studied in Pistachio Research Institute, Rafsanjan, Iran. Three levels of bearing e.g., high bearing level (≥ 4 clusters), medium bearing level [1 - 4 cluster (s)], and none-bearing level were examined with three replications on 20-years-old pistachio trees. The selected pistachio branches were similar in number of leaves. Different bearing levels were tagged with different colors. Number of clusters, abscised buds, number of nuts in cluster and leaf area, length and diameter growth

was all recorded throughout the examination. The number of inflorescence buds on each branch was first recorded in June 21. There-after buds were counted at various time intervals until September 23. Sixteen leaves were picked at random for each level of bearing for determination using a leaf area digital planimeter. However, diameter and length growth of selected branches were measured from early season to late September. Data were analyzed based on randomized complete block design, and Duncan's Multiple Range Test was used for means comparison (Yazdisamadi & Rezaie, 1998).

RESULTS AND DISCUSSION

Results showed that Ohadi and Ahmad-Aghai cultivars had the maximum percentage of abscised buds in comparison to Akbari and Kale-Ghoochi. No significant differences were found between Ohadi and Ahmad-Aghai (Table I). Although abscission percentage in Akbari cultivar was more than Kale-Ghoochi, it was not statistically significant ($p > 0.05$). Also, we observed that abscission percentage in high bearing shoots was more than the others (Table II). Interaction effects between cultivar and load level showed that maximum abscission was related to Ohadi cultivar with high load level shoots (97.4%), and minimum abscission was found in Kale-Ghoochi cultivar with non-load level (21.7%) (Table III).

Leaf area was significantly different between cultivars ($p < 0.05$). Maximum leaf area was found in Ahmad-Aghai and minimum level was obtained in Ohadi. It was interesting that leaf area was significantly higher in non-bearing selected shoots and as soon as the minimum bud abscission was found in non-bearing shoots, this can support the hypothesis of inflorescence buds abscission as affected by decreasing the leaf area. It is obvious that leaves are the main source of hormones, metabolites and carbohydrates synthesis and these products are necessary for preventing bud drop. Interaction effects between cultivar and bearing level showed that maximum leaf area was for Ahmad-Aghai shoots with non-load level (103 cm^2) and minimum for Ohadi with high load level (58.2 cm^2) shoots (Table III). Bud abscission in the pistachio has been correlated with available leaf area (Crane *et al*., 1973; Porlingis, 1974) and with nut load (Crane & Nelson, 1971; Crane & Nelson, 1972; Porlingis, 1974; Crane & Iwakiri, 1981). In a particular cultivar, as leaf area progressively increases, the abscission of buds decreases (Crane *et al*., 1973) but in comparison of different cultivars this rule is abolished. Ahmad-Aghai cultivar with maximum leaf area had high abscission percentage of inflorescence buds (Table I). In fact various genetic characteristics of different cultivars are responsible. Maximum inflorescence buds drop were observed in Ohadi cultivar with maximum number of nuts in clusters. Although it is accepted that abscission is also caused by number of nuts (Crane *et al*., 1973) but in this experiment only Ohadi cultivar logically followed the rule of abscission of buds as affected by number of nuts in clusters (Table III).

In general, vegetative growth in trees is depressed during periods of reproductive growth (Wardlaw, 1990) and vegetative growth of pistachio to be depressed during "on" years. Several studies (Weinbaum *et al*., 1994; Brown *et al*., 1995; Rosecrane *et al*., 1996; Picchioni *et al*., 1997) had found that the whole tree level that "on" year trees have depressed vegetative growth of new shoots compared to "off" year trees. Crane and Nelson (1972) and Crane and Alshalan (1977) reported that more growth occurred during the "on" year than during the "off" year at the individual branch level. Nzima *et al*. (1997) suggested that extension growth of new shoots is depressed during the light crop year instead of the heavy crop year. Also average length of "on"

Table I. Effect of different cultivars on abscission percentage, leaf area, number of nuts, length and diameter

Cultivar	Factor				
	Abscission %	Leaf area (cm^2)	No of nuts in clusters	Length (cm)	Diameter (mm)
Ohadi	75.1 a	63.3 c	31.5 a	7.6 a	5.6 c
Ahmad-Aghai	70.2 a	89.9 a	23.1 b	3.8 b	5.9 bc
Kale-Ghoochi	53.4 b	77.9 b	19.6 b	4.4 b	6.7 a
Akbari	60.1 b	80.7 b	18.8 b	4.1 b	6.1 b

Table II. Effect of load levels on abscission percentage, leaf area, number of nuts, length and diameter

Load level	Factor				
	Abscission %	Leaf area (cm^2)	No of clusters in shoot	Length (cm)	Diameter (mm)
High	95.7 a	70.24 b	4.4 a	5.4 a	5.8 b
Medium	54.2 b	76.6 b	1.6 b	4.9 a	5.9 b
Non	28.03 c	87.03 a	0 c	4.5 a	6.5 a

Table III. Interaction effects between cultivars and load levels on different factors

Treatment	High load				Medium Load				Non Load			
	Ohadi	Ahmad aghai	Kale-Ghoochi	Akbari	Ohadi	Ahmad aghai	Kale-Ghoochi	Akbari	Ohadi	Ahmad aghai	Kale-Ghoochi	Akbari
%Abscission	97.4 a	96.1 a	83.4 b	93.7 ab	81.1 b	78.4 bc	50.1 c	66.3 bc	46.2 c	36.1 cd	21.7 d	26.3 d
Leaf area (cm^2)	58.2 d	81.1 bc	72.1 bcd	69.5 cd	61 d	85.6 bc	75.2 bcd	84.8 bc	70.6 bcd	103 a	86.6 abc	88 ab
No. nut in cluster	72.1 a	55.9 b	43.1 b	43.4 b	22.5 c	13.3 cd	15.8 c	12.9 cd	0 d	0 d	0 d	0 d
No. clusters in shoot	4.8 a	4.6 ab	3.9 b	4.3 ab	1.4 c	1.6 c	1.5 c	1.7 c	0 d	0 d	0 d	0 d
Length (cm)	8.1 a	3.9 b	5.4 ab	4.2 b	8.1 a	3.6 b	4.6 ab	3.4 b	6.7 ab	3.8 b	3.1 b	4.5 ab
Diameter (mm)	5.2 e	5.6 de	6.2 bcd	6.2 bcd	5.3 e	5.8 cde	6.6 ab	6.0 bcd	6.5 bc	6.3 bc	7.2 a	6.1 bcd

a,b,c,d,e means differ significantly at ($p<0.05$)

and "off" year new shoots was not significantly different (Stevenson *et al*., 2000). Our results indicated that only Ohadi cultivar had significant difference in length growth of current shoots in comparison to others, then the different percentage of abscission in the other cultivars is not dependent to length growth of new shoots. Although shoots with high bearing level had more length growth instead of non-bearing shoots, it was not statistically significant. Maximum length growth in Ohadi cultivar with high load level and minimum in Kale-Ghoochi cultivar with non-load shoots was found 8.1 cm and 3.1 cm, respectively (Table III). This result led to give this hypothesis that high apical dominance of the current shoots may cause the severe bud abscission. Results also showed that diameter growth of current shoots is also an important criterion and should be considered. There was a significant difference among various cultivars in diameter growth of current shoots, which is in relationship to genetic characteristic of cultivars. Maximum was found in current shoots of Kale-Ghoochi cultivar (6.7 mm), whereas Ohadi had the minimum diameter (5.6 mm) growth, ($p < 0.05$). There is a correlation between length and diameter growth in Ohadi. When the length growth progressively increased, diameter growth decreased (Table I). The present results showed that maximum diameter growth was found in non-bearing selected shoots. Fruit presence on the branches may be the cause of low diameter growth because of carbohydrates, minerals and metabolites absorption. Selected shoots of Kale-Ghoochi with non-load level and Ohadi with high load level had maximum and minimum diameter growth, respectively (Table III). Rosecrance *et al*. (1996) stated that different treatments like some plant growth substances and proper concentration of nitrogen, phosphorous and potassium up-take by roots can control alternate-bearing in pistachio to some extend. Although a successful control of alternate bearing in pistachio should be based on regulation of inflorescence bud abscission and retention in "on" and "off" years, respectively application of some treatments may have no economic or practical sound for orchardists. Now-a-days, several countries have started both the establishment and replacement of new pistachio orchards and also advanced breeding programs. Consideration to genetic characteristics and logical selection of cultivars with low alternate bearing and high qualitative and quantitative production habits is necessary for achieving these aims.

REFERENCES

Brown, P.H., S.A. Weinbaum and G.A. Picchioni, 1995. Alternate bearing influences annual nutrient consumption and the total nutrient content of mature pistachio trees. *Trees*, 9: 158–64

Crane, J.C. and I. Al-shalan, 1977. Carbohydrate and nitrogen levels in pistachio as related to shoot extension and yield. *J. American Soc. Hort. Sci.*, 102: 396–9

Crane, J.C., I. Al-shalan and R.M. Carlson, 1973. Abscission of inflorescence buds as affected by leaf area and number of nuts. *J. American Soc. Hort. Sci.*, 98: 591–2

Crane, J.C. and B. Iwakiri, 1981. Morphology and reproduction in pistachio. *Hort. Rev.*, 3: 376–93

Crane, J.C. and B. Iwakiri, 1987. Reconsideration of the cause of inflorescence bud abscission in pistachio. *Hort. Sci.*, 22: 1315–6

Crane, J.C. and M.M. Nelson, 1971. The un-usual mechanism of alternate bearing in pistachio. *Hort. Sci.*, 6: 489–90

Crane, J.C. and M.M. Nelson, 1972. Effect of crop load, girdling and ouxin application on alternative bearing of the pistachio. *J. American Soc. Hort. Sci.*, 97: 337–9

Esmaeilpour, A., 2002. *Evaluation of Alternate Bearing Intensity in Iranian Pistachio Cultivars*. Opt Med, Series A. No. 63

Ferguson, L. and J. Maranto, 1989. *Effect of Growth Regulators on Pistachio Inflorescence Bud Retention*. Pp: 78–80. Annual Report, Crop year

Lin, T.S., J.C. Crane and K. Ryugo, 1984. Gibberellin-like substances in pistachio as related to inflorescence bud abscission. *Hort. Sci.*, 19: 267–8

Monselise, S.P. and E.E. Goldschmidt, 1982. Alternate bearing in fruit trees. *Hort. Rev.,* 4: 128–73

Nzima, M., G. Martin and C. Nishijima, 1997. Leaf development, dry matter accumulation and distribution within branches of alternate bearing Kerman pistachio trees. *J. American Soc. Hort. Sci.*, 122: 31–7

Nzima, M., G. Martin and C. Nishijima, 1997. Seasonal changes in total non-structural carbohydrates within branches and roots of naturally "off" and "on" 'Kerman' pistachio cultivar. *J. American Soc. Hort. Sci.*, 122: 856–62

Picchioni, G.A., P.H. Brown, S.A. Weinbaum and T.T. Muraoka, 1997. Macronutrient allocation leaves and fruit of mature, alternative-bearing pistachio trees: Magnitude and seasonal patterns at the whole-canopy level. *J. American Soc. Hort. Sci.,* 122: 267–74

Porlingis, I.C., 1974. Flower bud abscission in pistachio (*Pistacia vera* L.) as related to fruit development and other factors. *J. American Soc. Hort. Sci.*, 99: 121–5

Rosecrance, R.C., S.A. Weinbaum and P.H. Brown, 1996. Assessment of nitrogen, Phosphorous and potassium up-take capacity and root growth in mature alternate bearing pistachio (*pistacia vera* L.) trees. *Tree Physiol.*, 16: 949–56

Seyedi, M., A. Talaie and H. Lessani, 2003. Studies on soluble carbohydrates role on floral bud abscission in pistachio trees. *Int. J. Agric. Biol.*, 3: 284–6

Stevenson, M.T., K.A. Shackel and L. Ferguson, 2000. Shoot length distribution and its relation to yield of alternate-bearing pistachio trees. *J. American Hort. Sci.*, 125: 165–8

Takeda, F. and J.C. Crane, 1980. Abscisic acid in pistachio as related to inflorescence bud abscission. *J. American Soc. Hort. Sci.*, 105: 573–6

Vemmos, S.N., 1999. Carbohydrate content of inflorescent buds of de-fruited and fruiting pistachio (*Pistacia vera* L.) branches in relation to biennial bearing. *J. Hort. Sci. Bio.*, 74: 94–100

Wardlaw, I.F., 1990. The control of carbon partitioning in plants. *New Phytal.*, 116: 341–81

Weinbaum, S., G. Picchioni, T. Muraoka, P. Brown and L. Ferguson, 1994. Fertilizer nitrogen and boron up-take, storage and allocation very during the alternate bearing cycle in pistachio trees. *J. American Soc. Hort. Sci.*, 119: 24–31

Yazdisamadi, B. and A. Rezaie, 1998. *Experimental Designs in Agriculture*. Tehran University Publisher. Tehran- Iran

(Received 17 January 2006; Accepted 20 March 2006)