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Study of the role of soluble carbohydrates on floral bud abscission of pistachio trees

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SUMMARY – An experiment on pistachio cv. 'Ohadi' was conducted at Kerman Pistachio Research Center. Its objective was to determine the role of soluble carbohydrate concentration on flower bud abscission. The results showed that interaction of time and alternate bearing trees on soluble carbohydrate concentration of inflorescence buds was significant, but effect of alternate bearing on soluble carbohydrate concentration was not significant. The effects of interaction of time and alternate bearing trees on soluble carbohydrate concentration of leaves of pistachio trees were not significant. Soluble carbohydrates of on-year trees declined from June to July and caused flower bud abscission. But it increased during this time in off-year trees.

Key words: Pistachio, floral bud, abscission, carbohydrate.

RESUME – *"Etude du rôle des hydrates de carbone solubles sur l'abscission des bourgeons floraux des pistachiers". Une expérience a été menée au Centre de Recherches sur le Pistachier de Kerman sur le cultivar 'Ohadi'. L'objectif de ces recherches était de déterminer le rôle de la concentration en hydrates de carbone solubles sur l'abscission des bourgeons floraux. Les résultats ont montré que l'interaction du temps et des arbres en production alternante sur les hydrates de carbone des bourgeons d'inflorescences était significative mais que l'effet de l'alternance sur la concentration en hydrates de carbone solubles n'était pas significative. L'effet de l'interaction du temps et des arbres en production alternante sur la concentration en hydrates de carbone solubles des feuilles de pistachier n'était pas significatif. Les hydrates de carbone solubles des arbres en année de production ont baissé de juin à juillet et ont causé l'abscission des bourgeons floraux. Mais ils ont augmenté pendant cette période sur les arbres non productifs cette année-là.*

Mots-clés : *Pistachier, bourgeon floral, abscission, hydrate de carbone.*

Introduction

Pistachio tree is native from western Asia and Asia Minor. Iran is the largest producer of pistachio nuts in the world. Biennial, or irregular bearing occurs in many fruit trees. In most deciduous fruit species, few floral buds are produced in the year of heavy crops. This habit usually causes a great economical and technical lost for pistachio growers. It is shown that pistachio flower buds abscission is correlated with the amount of leaf area and nut production which are different sink for carbohydrate absorption, so that this phenomena in pistachio results from the excessive abscission of floral buds during summer of heavy crops, causing a small crop in the following year (Crane and Iwakiri, 1981). Most pistachio floral buds abscission coincide with rapid seed growth (Crane and Nelson, 1972; Crane *et al*., 1973), suggesting competition between floral buds and developing nuts for carbohydrates and other resources (Crane and Al-Shalan, 1977; Porlingis,1974; Takeda *et al*.,1980). There is no report about the role of carbohydrate on inflorescence bud abscission of cultivars of Iran and biennial bearing has an impact on the economic survival of the pistachio producer. This experiment was designed to determine the role of soluble carbohydrate on floral bud abscission on pistachio trees.

Materials and methods

Experiments were conducted on pistachio trees of 'Ohadi' cultivar growing at Kerman Pistachio Research Center in 2000-2002 years. Twelve 20 years old *Pistacia vera* cv. 'Ohadi' trees with uniform

size of canopy were selected. Six trees were "on" and six of them in their natural "off" cycle. Standard commercial practices for weed control, fertilization, and irrigation of the trees were followed during the experiment. We arranged the split-plot in time as a completely randomized block experiment design, it consisted of two "on" and "off" trees with 3 replications. Ten shoots were sampled on first of June, July and August and placed in an oven at 50°C until dry weight stabilized and grind. Soluble carbohydrates were measured by sulfuric acid – phenol methods. Data were analysed by SAS 8.2 program.

Results and discussion

The analysed data indicated that the interaction of alternate bearing trees and time on soluble carbohydrate concentration of inflorescence buds was significant (P≤0.05) (Table 1). The effect of time on soluble carbohydrate concentration of floral buds also was significant (P≤0.05) (Table 2). The effect of alternate bearing trees on soluble carbohydrate concentration of flower buds was not significant (Table 3). The effect of alternate bearing trees, time and interaction of time and alternate bearing trees on soluble carbohydrate concentration of leaves of alternate bearing pistachio trees was not significant. Inflorescence buds of "on" trees had a concentration of soluble sugars that was 14.16% and 36.3% greater than those of "off" trees on first of June 2000 and 2002, respectively (Table 1). After this time soluble carbohydrates declined in inflorescence buds of "on" trees (Table 1). Concentration of soluble carbohydrate increased on first of August among inflorescence buds of "off" trees. By the last sampling dates, inflorescence buds of "off" trees had 48% and 28.5% greater soluble carbohydrate concentration than those of "on" trees on first of August 2000 and 2002, respectively. Soluble carbohydrates of leaves of "on" trees on first of June was greater than "off" trees and after this time soluble carbohydrate of leaves of "off" trees increased compared to "on" trees.

Table 1. Effect of alternate bearing trees and time interaction on soluble carbohydrate of inflorescence buds and leaves of pistachio trees[†]

Year	Time	Soluble carbohydrate concentration of leaves (mg/g)		Soluble carbohydrate concentration of inflorescence buds (mg/g)	
		On	Off	On	Off
2000	June	10.78 a	9.28 a	7.20 a	6.18 ab
	July	7.70 a	11.19 a	5.14 abc	4.62 bc
	August	8.73 a	10.41 a	3.74 c	6.15 ab
	C.V.%	23.36		14.07	
2002	June	15.70 a	10.78 a	6.80 a	4.30 bc
	July	9.30 a	12.30 a	3.80 bc	3.50 bc
	August	9.70 a	11.30 a	3.80 c	4.80 abc
	C.V.%	25.83		18.60	

[†]Mean separation within columns by Duncan's multiple range test(P≤0.05).

There is evidence that initial growth and development of reproductive and vegetative organs of deciduous tree species derive considerable proportion of the carbohydrate requirement from stored reserves (Dickson, 1989; Ferree and Palmer, 1982; Kozlowski, 1992; Loescher *et al.,* 1990) because anthesis and fruit set precede the development of a competent photosynthetic system. The use of stored reserves by alternate bearing pistachio is unique because this involves vegetative growth during the "off" year and also includes the growth of fruit, nuts and the initiation and development of inflorescence buds in the "on" year. Kernel development and flower buds abscission have been associated with competition for resources among fruitlets and between reproductive and vegetative organs (Farrington and Pate, 1981; Lloyd, 1980; Newell, 1987; Stephenson, 1983). Carbohydrate levels in heavily bearing trees or branches were implicated as a cause for bud loss (Crane and Al-Shalan, 1977; Crane *et al*., 1976). At sampling date of first June each year "on" trees had higher concentration of soluble carbohydrate than "off" trees in inflorescence buds. Carbohydrate

concentration in inflorescence buds of "on" trees decreased until nut maturity because the buds were either weak sinks (Takeda *et al*., 1980) or inefficient in using imported photosynthates. Our results for soluble carbohydrate concentration of floral buds in the "on" trees are similar to what was reported by Nzima *et al*. (1997). A study of the effect of developing nuts on translocation and distribution of photosynthates from leaves revealed that most of the C14-photosynthate transported from leaves accumulated in developing nuts. Inflorescence buds competed poorly against the developing nuts for photosynthate, as those on bearing branches had about half as much as those on non bearing branches and led to the suggestion that developing fruits induce a change in photosynthate partitioning, depleting bud carbohydrates and resulting in bud abscission (Takeda *et al*., 1980). Irregular bearing in pecan was proposed to be related to carbohydrates whether a tree is "on" or "off" depends on the levels of carbohydrates that accumulate during the previous season (Sparks, 1974). Thus carbohydrate deficiency in the buds may be responsible for the inflorescence bud abscission phenomenon and subsequent alternate bearing.

Table 2. Effect of time on concentration of soluble carbohydrate of inflorescence buds and leaves of pistachio trees†

Year	Time	Soluble carbohydrate of leaves (mg/g)	Soluble carbohydrate of inflorescence buds (mg/g)
2000	June	9.28 a	6.69 a
	July	11.19 a	4.88 ab
	August	10.41 a	4.94 b
	C.V.%	23.36	14.07
2002	June	10.3 a	5.77 a
	July	11.86 a	4.23 ab
	August	10.5 a	4.89 ab
	CV%	25.83	18.60

†Mean separation within columns by Duncan's multiple range test (P≤0.05).

Table 3. Effect of alternate bearing trees on concentration of soluble carbohydrate of inflorescence buds and leaves of pistachio trees†

Year	Alternate bearing trees	Soluble carbohydrate of leaves (mg/g)	Soluble carbohydrate of inflorescence buds (mg/g)
2000	On	9.07 a	5.36 a
	Off	10.29 a	5.65 a
	CV%	23.36	14.07
2002	On	11.61 a	5.60 a
	Off	11.41 a	4.20 a
	CV%	25.83	18.60

†Mean separation within columns by Duncan's multiple range test (P≤0.05).

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References

Crane, J.C. and Al-Shalan, I.M. (1977). Carbohydrate and nitrogen level in pistachio branches as related to shoot extension and yield. *J. Amer. Soc. Hort. Sci*., 102: 396-399.

Crane, J.C., Al-Shalan, I. and Carlson, R.M. (1973). Abscission of pistachio inflorescence buds as affected by leaf area and number of nuts. *J. Amer. Soc. Hort .Sci.,* 98: 591-592.
Crane, J.C., Catlin, P.B. and Al-Shalan, I. (1976).Carbohydrate levels in pistachio as related to alternate bearing. *J. Amer. Soc. Hort. Sci.*, 101(4): 371-374.
Crane, J.C. and Iwakiri, B. (1981). Morphology and reproduction in pistachio. *Hort. Rev.*, 3: 376-393.
Crane, J.C. and Nelson, M.M. (1972). Effect of crop load and girdling and auxin application on alternate bearing of pistachio. *J. Amer. Soc. Hort. Soc.,* 97: 337-339.
Dickson, R.E. (1989). Carbon and nitrogen allocation in trees. *Ann. Sci. Forest.*, 46: 631-647.
Farrington, P. and Pate, J.S. (1981). Fruit set in *Lupinus angustifolius* cv. 'Unicrop'. I. Phenology and growth during flowering and early fruiting. *Austral. J. Plant Physiol.*, 8: 293-305.
Ferree, D.C. and Palmer, J.W. (1982). Effect of spur defoliation and ringing during bloom on fruiting, fruit mineral level and photosynthesis of Golden Delicious apple. *J. Amer. Soc. Hort. Sci.*, 107: 1182-1185.
Kozlowski, T.T. (1992). Carbohydrate sources and sinks in woody plants. *Bot. Rev.*, 58: 208-222.
Lloyd, D.G. (1980). Sexual strategies in plants. I. A hypothesis of serial adjustment of maternal investment during one reproductive session. *New Phytol.*, 86: 69-79.
Loescher, W.H., McCamant, T. and Keller, J.D. (1990). Carbohydrate reserves, translocation and storage in woody plant roots. *HortScience.*, 25: 274-281.
Newell, E.A. (1987). The cost of reproduction in *Aesculus californiaca* the California Buckeye tree. Ph. D diss., Stanford University, Stanford, USA.
Nzima, M.D.S., Martin, G.C. and Nishijima, C. (1997). Seasonal changes in total nonstructural carbohydrates within branches and roots of naturally "on" and "off" Kerman pistachio trees. *J. Amer. Soc. Hort. Sci.,* 122(6): 856-862.
Porlingis, I.C. (1974). Flower bud abscission in pistachio as related to fruit development and other factors. *J. Amer. Soc. Hort. Sci.*, 99: 121-125.
Sparks, D. (1974). The alternate bearing problem in pecan. *Annual Report North. Nut Growers Assoc.*, 65: 160.
Stephenson, A.G. (1983). Cost of over initiating fruit. *Amer. Midland Natur.*, 112: 379-386.
Takeda, F., Ryugo, K. and Crane, J.C. (1980). Translocation and distribution of C14-photosynthates in bearing and non bearing pistachio branches. *J. Amer. Soc. Hort. Sci.*, 105: 642-644.