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The possible role of macroelement content on bud abscission in pistachio (*Pistacia vera* L.)

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Abstract

Pistachio is the economically important nut tree in Turkey. Alternate bearing is one of the most important problems in pistachio, and it has a negative effect on producers, consumers and the country's economy. The cultivar 'Uzun' is one of the most important commercial pistachio cultivars in Turkey, and it has strong tendency to alternate bearing. There are no nuts completely in "Off" year while the trees are highly productive in the following year ("ON" year). The physiological mechanisms of the bud abscission process caused alternate bearing is unknown. In this study it was aimed to detect a relation between nutrient uptake and alternate phenomena in the pistachio 'Uzun' cultivar. For this purpose, nutrition concentrations were determined in various physiological periods from full flowering to harvest in one year old shoots of 'Uzun' pistachio cultivar under arid conditions. The shoots were compared based on their N, P, K, Ca and Mg content on shoots of "ON" and "OFF" year trees separately. According to the results, N, P, K, Ca and Mg contents of shoots were changed in "ON" and "OFF" year shoot samples and varied during the developmental stage and generally N, Mg and Ca elements were detected higher in shoots of "ON" year trees, while P and K, higher in "OFF" year trees.

Keywords: pistachio, alternate bearing, nutrient uptake, shoots

INTRODUCTION

Alternate bearing is one of the most important problems in pistachios. Alternate bearing in fruit trees is the result of poor flower initiation in most cases but in pistachio (*Pistacia vera* L.) it is unusual and arises as a result of inflorescence bud abscission during the year in which a heavy crop is produced (Crane and 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 abscission in pistachio was markedly affected by both leaf area and number of nuts per branch. Crane and Nelson (1971) reported that bud abscission was primarily responsible for the competition of nutrition and some endogene metabolites between developing ovaries and seeds and flower buds. Although there are many previously published papers on alternate bearing on pistachio, the physiological mechanisms of the bud abscission process are still unknown (Crane et al., 1973; Nzima et al., 1997; Marschner, 1995; Vemmos, 1999a; Seyedi et al., 2003; Fernández-Escobar et al., 1999). The objective of the present study was to detect seasonal change of macro element composition of "ON" and "OFF" year shoots of 'Uzun' pistachio cultivar.

MATERIALS AND METHODS

The experiment was conducted in 2015 growing period at the Research and Experimental area of Ministry of Agriculture Pistachio Research Institute of Gaziantep. 33

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years old *Pistachio vera* 'Uzun' trees (grafted on *Pistacia atlantica* Desf., planted at 10×10 m intervals) were used as plant material (Figure 1).



Figure 1. A view from the experimental area ("OFF" and "ON" year trees).

Shoots were sampled from "ON" and "OFF" year trees (Figure 2) every 10, 15 and 30 day intervals, from full flowering time (April) until the end of the harvesting time (October) (Table 1). Shoot samples were taken between 08:00-10:00 am and then immediately brought to the laboratory under cold chain conditions. Sample materials were rinsed several times with distilled water to remove dust and soil, and dried using lyophilize and ground and stored at +4°C until analysis.



Figure 2. Shoots from "ON" and "OFF" year trees.

Table 1. Sampling time schedule for nutrient analysis (in 2015).

Physiological periods	Date
NDAFF-36	15.06.2015
NDAFF-46	25.05.2015
NDAFF-56	04.06.2015
NDAFF-76	24.06.2015
NDAFF-86	05.07.2015
NDAFF-116	06.08.2015
NDAFF-146	03.09.2016

NDAFF: number of days after full flowering.

The content of macro nutrients such as N, P, K, Ca, Mg were determined in shoots at various physiological periods from the beginning of full flowering time until at the end of the harvesting season (Kaçar, 1972). The N content of shoots were identified using some modifications by Kjeldahl method (Kaçar, 1972) as for the other macronutrients such as P, K, Ca and Mg were done by ICP (Inductively Coupled Plasma Atomic Emission Spectrophotometer) (Kaçar and İnal, 2008).

Statistical analysis

Triplicate spectrometric analyses were performed and the results were analyzed in a completely randomized block design using analysis of variance (ANOVA). Means were separated by Duncan's multiple range test at $P \leq 0.05$.

RESULTS AND DISCUSSION

A result of shoot samples of nitrogen content of "ON" and "OFF" years of 'Uzun' cultivar was shown in Figure 3. Nitrogen concentration of shoots in "ON" year trees ranged from 0.85-2.42%, while 0.79-1.35% in "OFF" year trees. The nitrogen concentration was very high in the early days of vegetation (April to May) of both "ON" and "OFF" year trees and detected higher in "ON" year while lower in "OFF" year trees. It was determined that nitrogen content decreased during bud abscission intensively started. Similar to our results several authors previously published in pistachios (Porlingis, 1974; Weinbaum and Muraoka, 1989; Baninasab et al., 2007; Yueng-feng et al., 2009; Tekin et al., 1990; Amiri, 2009; Vemmos, 1999a, b) and similar changes have been reported for olive (Amnon et al., 2013) and almond (Roohi and Mohammadi, 2002), also.

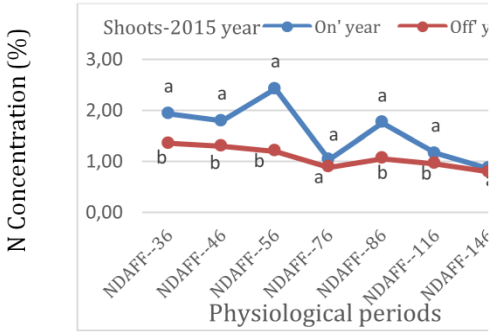


Figure 3. Nitrogen concentrations of "ON" and "OFF" years of shoots at various physiological stages (%). NDAFF: Number of days after full flowering, (NDAFF-36: 15.06.2015, NDAFF-46: 25.05.2015, NDAFF-56: 04.06.2015, NDAFF-76: 24.06.2015, NDAFF-86: 05.07.2015, NDAFF-116: 06.08.2015, NDAFF-146: 03.09.2015).

Nitrogen (N) is essential to the construction of primary metabolites such as amino acids, proteins, and nucleotides as well as numerous secondary metabolites. Nitrogen is important for the establishment of equilibrium between growth and fertility in fruit trees. So, its requirement increases when the developing nuts begins to grow the day after full flowering in pistachios. Tekin et al. (1986), reported optimum N concentration in pistachio leaves is ranging between 1.8 and 2.20% of dry matter.

The results of P content of shoot samples obtained from different physiological periods in "ON" and "OFF" years of 'Uzun' cultivar were shown in Figure 4. P concentration of shoots "ON" trees in 2015 year is ranged from 0.11 and 0.24% while "OFF" year ranged between 0.15 and 0.25%. The P concentrations were very high in the early days of vegetation (April to May) for both "ON" and "OFF" year trees and decreased until harvesting time. Due to the fruiting P was detected in low concentration in "ON" year trees while high in "OFF" year trees. Similar results with our study were previously reported by several authors (Tekin et al., 1990; Rosecrance et al., 1998; Moghaddam et al., 2006; Baninasab et al., 2007; Yueng-feng et al., 2009).

The results of K content of shoot samples obtained from different physiological periods on "ON" and "OFF" years of 'Uzun' cultivar were shown in Figure 5. K concentration of shoots "ON" trees ranged from 0.94-1.25% while "OFF" year ranged 0.91-1.51%. It has been reported that K are mostly taken from plants during vegetative growth stage. In a previous report, Amnon et al. (2013) reported that K decreased during the vegetation period and high values obtained in "OFF" year trees comparing to the "ON" year trees.

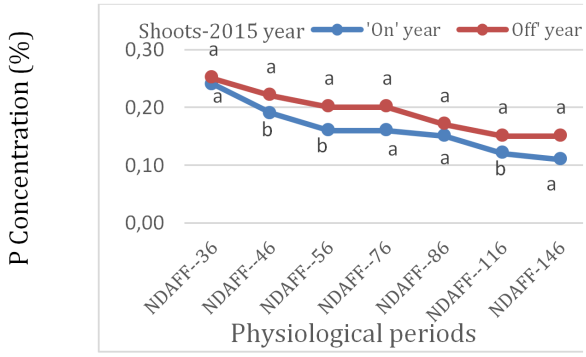


Figure 4. Phosphorus concentrations of "ON" and "OFF" years of shoots at various physiological stages (%). NDAFF: Number of days after full flowering, (NDAFF-36: 15.06.2015, NDAFF-46: 25.05.2015, NDAFF-56: 04.06.2015, NDAFF-76: 24.06.2015, NDAFF-86: 05.07.2015, NDAFF-116: 06.08.2015, NDAFF-146: 03.09.2015).

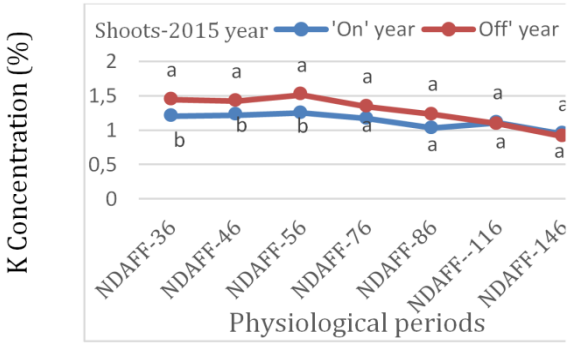


Figure 5. Potassium concentrations of "ON" and "OFF" years of shoots at various physiological stages (%). NDAFF: Number of days after full flowering, (NDAFF-36: 15.06.2015, NDAFF-46: 25.05.2015, NDAFF-56: 04.06.2015, NDAFF-76: 24.06.2015, NDAFF-86: 05.07.2015, NDAFF-116: 06.08.2015, NDAFF-146: 03.09.2015).

The results of Ca content of shoot samples obtained from different physiological periods on "ON" and "OFF" years of 'Uzun' cultivar were shown in Figure 6. Ca concentration of different organs "ON" trees ranged from 0.52-1.99% while "OFF" year ranged from 0.89-1.50%. The Ca concentration was detected higher in "OFF" year until 76 days after full flowering while lower in "ON" year trees. 76 days after full flowering time Ca concentration increased in "ON" year trees. Vemmos (1999b) also reported similar results to our study in 'Aegenes' pistachio trees.

The results of Mg content of shoot samples taken in different physiological periods on "ON" and "OFF" years of 'Uzun' cultivar were shown in Figure 7. Mg concentration of shoots of "ON" year trees ranged from 0.38-0.47% while "OFF" year from 0.36-0.44%. The Mg concentration changed similarly during the vegetation period both "ON" and "OFF" year trees, but detected somewhat higher in "ON" year trees. Güzel et al. (2002) reported that for optimum plant growth Mg should be ranged from 0.10-0.40%. Baninasab et al. (2007), Yueng-feng et al. (2009), İdem (1994), and Picchioni et al. (1997), reported that Mg was detected higher in amounts in "ON" year trees compared to the "OFF" year trees.

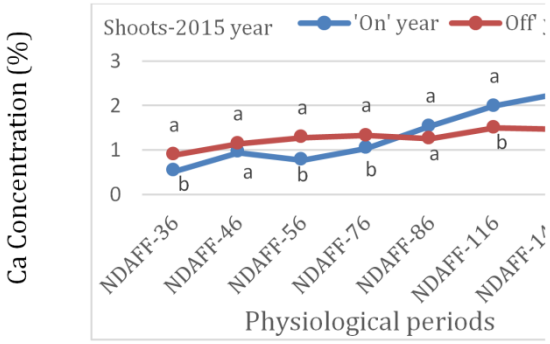


Figure 6. Calcium concentrations of "ON" and "OFF" years of shoots at various physiological stages (%). NDAFF: Number of days after full flowering, (NDAFF-36: 15.06.2015, NDAFF-46: 25.05.2015, NDAFF-56: 04.06.2015, NDAFF-76: 24.06.2015, NDAFF-86: 05.07.2015, NDAFF-116: 06.08.2015, NDAFF-146: 03.09.2015).

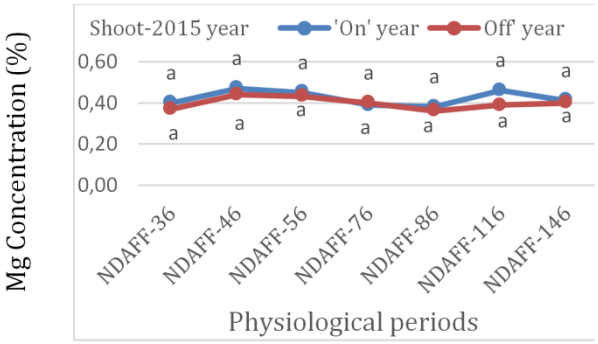


Figure 7. Magnesium concentrations of "ON" and "OFF" years of shoots at various physiological stages (%). NDAFF: Number of days after full flowering, (NDAFF-36: 15.06.2015, NDAFF-46: 25.05.2015, NDAFF-56: 04.06.2015, NDAFF-76: 24.06.2015, NDAFF-86: 05.07.2015, NDAFF-116: 06.08.2015, NDAFF-146: 03.09.2015).

As a conclusion, N, P, K, Ca and Mg uptake may play an important role for regular yield every year in 'Uzun' pistachio cultivar. Nutrient application with those elements are important especially on "ON" year trees of 'Uzun' pistachio cultivar and this application helps to decrease bud abscission caused alternate bearing phenomena.

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