International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

INVESTIGATION ON SEASONAL CHANGES OF MACRO ELEMENT CONCENTRATIONS OF CLUSTER AND NUTS OF 'UZUN' PISTACHIO VARIETY

Muhammet Ali GÜNDEŞLİ[1*], Nesibe Eru KAFKAS[2], Salih KAFKAS[2], Nevzat ASLAN[3]

[1]East Mediterranean Transitional Zone Agricultural Research of Institute, Kahramanmaras, TURKEY

[2]University of Cukurova, Faculty of Agriculture, Department of Horticulture, Adana, TURKEY

[3]Pistachio Research of Institute, Gaziantep, TURKEY

*Corresponding Author

ABSTRACT

Turkey is a country with rich in plant genetic resources and diversity because of having both suitable geographical and different climate characteristics. Pistachio is a traditionally very important crop grown extensively in the South East Anatolia region of Turkey. In this region the most important problem is alternate bearing that yied fluctuation occure which is a big problem for producer and consumer. The mineral nutrient content in the cluster and nuts of 'Uzun' pistachio variety trees were investigated in this paper. Sampling were done using various pysiological periods from full flowering to harvest time. According to the results, concentration of N, P, K and Ca decreased level during the fruit bud abcissionperiod that needed more during these periods and after this period the concentration of the elements increased up to the maximum values specially after nut development. P, K, Mg, were determined to be inversely correlated to fruit and cluster. N, P were higher in the fruit than the fruit cluster. It is thought generally that the N, P, K, Ca elements may have a key role in the annual fruit production and yield of pistachios. It was found that these elements are essential for fruit formation in pistachios and have an effect on fruit bud abscission. It has been proved that there is a relationship between nut set and flower bud abscission based on macroelemt contents during various developmental stages in pistachio.

Keywords: Pistachio, alternate bearing, fruit set, nutrient

I. INTRODUCTION

In Turkey, especially in the Middle East region, pistachios are known as 'Green Gold'. Pistachio is an important source of revenue for producers, which is an important product in the domestic

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

and international markets. In particular, the Southeastern Anatolia region is well suited for pistachio cultivation due to its suitable ecological conditions and holding 95% of total pistachio growing area with covers 91.5% of pistachio production of Turkey (Yavuz, 2011; Gündeşli, 2017). Moreover, Turkey is one of the main pistachio producers in the world after USA and Iran (Faostat, 2018).

'Uzun' pistachio (*Pistacia vera* L.) shows fully alternate bearing characteristics that its a traditionally important crop grown extensively in the Southeastern Anatolia region. Inspite of the having a big potential area in this region we have still problems on pistachio production and marketing in the worldwide. Alternate bearing is one of the most important problem in pistachios. Alternate bearing is a big problem in pistachio (*Pistacia vera*) and occurred a high yield "on" year followed by low yield "off" year (Monselise and Goldschmidt, 1982; Stevenson and Shackel, 1998). Pistachio fruits are occred on 1-year-old fruiting shoots, while leaves and buds are occured on current year (new) shoots. (Ayfer, 1964; Crane and Nelson, 1971; Porlingis,1974; Crane and Iwakiri, 1981; Tekin, 1992). The effects of alternate bearing on nutrient content, uptake and nutrient storage in pistachio trees and nutrient utilization (removal) in different organs. The physiological mechanisms of the bud abscission and fruit set process are unknown that effects nutritional (Nzima et al., 1997). The purpose of this study was to determine the seasonal changes nutrient (N, P, K, Ca, Mg, Fe, Mn, Cu, Zn and B) contents in the cluster and nuts of trees and the relationship between in bud abscission and nuts in various developmental stages.

II. MATERIALS AND METHODS

2.1. Material

This experiment was conducted at the Research and Experimental area of Ministry of Agriculture Pistachio Research Institute of Gaziantep. 33 years old *Pistachio vera* 'Uzun' trees (grafted on *Pistacia atlantica* Desf., planted at 10x10 m intervals) were used as plant material.

2.1.2. Plant tissue sampling

Cluster and nuts were sampled from "On" year trees every 10, 15 and 30 days, from full flowering time (April) until ending of harvesting time (October). Samples were washed with water and kept in liquid nitrogen and then dried by freeze drying and stored at + 4 ° C until analysis by the following methods. As described below, are made in 3 replications and the methods to be used in the analyzes are briefly summarized below.

2.2.1. Methods

2.2.1. Determination of Plant Nutrient Elements

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

In order to determine the contents of N, some modifications were made to the Kjeldahl following the precedures method used by Kaçar (1972). In the determination of nutrients of P, K, Ca, Mg, Cu, Fe, Mn, Zn and B, an age-burning method was applied and the reading was done by ICP (Inductively Coupled Plasma Atomic Emission Spectrophometer) device (Kacar et al.2008) (Fig.3).

2.3. Statistical Analysis

The experiments were designed as a randomized complete block with three replications and three trees per replication. Statistical analysis was performed using the JMP software for Windows (SAS Institute Inc., Cary, NC, USA). Differences among the mean values were detected by the least significant differences (LSD) test at a 5% level.

III. RESULTS AND DISCUSSION

3.1. Seasonal changes in the macro element composition of Pistachio trees

3.1.1. Nitrogen

Nitrogen concentrations of cluster and nuts were found to be significantly differences among the sampling dates ($P< 0.05$) (Table 3.1). According to the results of the research, nitrogen content of the cluster was ranged between 0.97% to 2.40% (2015); 1.64% to 2.23% (2016). The highest nitrogen content was obtained after 146 days after full flowering with 3.45% (2015) and 3.41% with NDAFF-14 (2016). The lowest nitrogen content was determined as 1.50 % NDAFF-35 (2015) and 1.53 % NDAFF-64 period (2016). (Table 3.1). In fact, Weinbaum et al. (1995) and Ak et al. (2015), reported similar results in pistachios.

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

Table 3.1: Variations of N Content (%DW) in Cluster and Nuts of "On" year 'Uzun' Pistachio Trees (%)

Physiological periods	2015		Physiological periods	2016	
	Cluster	Nuts		Cluster	Nuts
NDAFF-35	1.95^{c}	1.50^{e}	**NDAFF-36**	1.87^{bc}	1.71^{cd}
NDAFF-45	2.10^{bc}	1.88^{d}	**NDAFF-50**	2.23^{a}	2.02^{c}
NDAFF-55	1.56^{d}	1.26^{f}	**NDAFF-64**	1.73^{cd}	1.53^{d}
NDAFF-75	0.97^{e}	2.24^{c}	**NDAFF-78**	1.64^{d}	1.85^{cd}
NDAFF-85	1.96^{c}	2.55^{b}	**NDAFF-92**	2.03^{b}	1.99^{c}
NDAFF-118	2.24^{ab}	3.44^{a}	**NDAFF-127**	2.23^{a}	2.50^{b}
NDAFF-146	2.40^{a}	3.45^{a}	**NDAFF-147**	1.81^{c}	3.41^{a}
'On' Average	**1.88**	**2.33**	**'On' Average**	**1.93**	**2.14**
D %5$_{\text{Period x 'On' year}}$	**0.19****	**0.19****	**D %5$_{\text{Period x 'On' year}}$**	**0.15****	**0.30****

*NDAFF: Number of days after full flowering

$^{*, **}$: Significant at $P < 0.05$, $P < 0.01$, respectively, by LSD test.

3.1.2. Phosphorous

Concentration of phosphorous in cluster and nuts were significantly different amog different periods of "On-year" trees ($P < 0.05$) (Table 3.2). Phosphorous contents of the clusters were ranged between 0.06% to 0.37% in 2015 and 0.05%-0.22% in 2016. The content of phosphorus in the nuts were ranged between 0.15% to 0.30% in 2015 and 0.11% to 0.35% in 2016. The phosphorus concentrations of nuts were almost low during the first several sampling dates, and then they gradually increased till harvest period.

It is well known that phosphorus in plant is an essential element for embryo formation and reproductive organs (Kaçar et al., 2002). Similar results were obtained by Ak and Fidan (2015) and Çetinkaya (2004). Güzel et al. (2002) reported that the phosphorus element should be between 0.1-0.5% concentrations in different organs of the plant. These results are consistent with earlier studies reported by Güzel et al., (2002)

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

Table 3.2: Variations of P Content (%DW) in Cluster and Nuts of "On" year 'Uzun' Pistachio Trees (%)

Physiological periods	2015		Physiological periods	2016	
	Cluster	Nuts		Cluster	Nuts
NDAFF-35	0.37[a]	0.15[c]	**NDAFF-36**	0.22[a]	0.11[d]
NDAFF-45	0.29[b]	0.18[bc]	**NDAFF-50**	0.18[b]	0.13[d]
NDAFF-55	0.25[b]	0.17[bc]	**NDAFF-64**	0.13[c]	0.21[c]
NDAFF-75	0.18[c]	0.20[bc]	**NDAFF-78**	0.09[d]	0.22[c]
NDAFF-85	0.13[d]	0.22[b]	**NDAFF-92**	0.09[d]	0.22[c]
NDAFF-118	0.07[e]	0.29[a]	**NDAFF-127**	0.05[e]	0.35[a]
NDAFF-146	0.06[e]	0.30[a]	**NDAFF-147**	0.05[e]	0.30[b]
'On' Average	**0.19**	**0.22**	**'On' Average**	**0.12**	**0.22**
D %5$_{\text{Period x 'On' year}}$	**0.04**[**]	**0.08**[**]	**D %5$_{\text{Period x 'On' year}}$**	**0.02**[**]	**0.05**[**]

*Details are similar to Table 3.1.

3.1.3. Potassium

Potassium concentrations of cluster and nuts were found to be significantly different ($P < 0.05$) (Table 3.3) in various sampling dates and the highest potassium content was obtained after 75 days after full flowering with 1.80% in 2015, and 1.80% NDAFF-36 with period in 2016, the lowest nitrogen content in 2015 'On' year was 1.20% in NDAFF-35 and 1.34% with NDAFF-92 period in 2016 (Table 3.3). The highest potassium content was obtained from 75 days after full flowering as 1.65% and as 2.23% NDAFF-92 period in 2016, the lowest potassium content in 2015 'On' year was 0.63% in NDAFF-146 and 0.86% in DAFF-47 period in 2016 (Table 3.3). The amount of potassium in the cluster is higher than the nuts. Potassium has a wide range of functions including carbohydrate translocation, protein synthesis, enzyme activation, cell expansion and stoma regulation. (Pallardy, 2008). According to our results K requirement and intake are more common especially when it begins to kernel development (Çizelge 3.3).

These results are consistent with the results reported by Rosecrance et al., (1998) and Vemmos (1999b). Güzel et al. (2002) reported that for the optimum plant growth potassium element should be between 0.5-6.0% in different organs of the plant.

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

Table 3.3: 'Variations of K Content (%DW) in Cluster and Nuts of "On" 'Uzun' Pistachio Trees (%)

Physiological periods	2015		Physiological periods	2016	
	Cluster	Nuts		Cluster	Nuts
NDAFF-35	1.20^{b}	1.42^{ab}	**NDAFF-36**	1.80^{a}	1.13^{d}
NDAFF-45	1.76^{a}	1.21^{bc}	**NDAFF-50**	1.37^{d}	1.01^{e}
NDAFF-55	1.56^{a}	1.07^{cd}	**NDAFF-64**	1.45^{cd}	1.37^{c}
NDAFF-75	1.80^{b}	1.65^{a}	**NDAFF-78**	1.53^{bc}	1.38^{c}
NDAFF-85	1.33^{b}	1.60^{a}	**NDAFF-92**	1.34^{d}	2.23^{a}
NDAFF-118	1.62^{a}	0.86^{de}	**NDAFF-127**	1.60^{b}	1.65^{b}
NDAFF-146	1.27^{b}	0.63^{e}	**NDAFF-147**	1.35^{d}	0,86^{f}
'On' Average	**1.41**	**1.21**	**'On' Average**	**1.49**	**1,37**
D %5$_{\text{Period x 'On' year}}$	**0.21****	**0,30****	**D %5$_{\text{Period x 'On' year}}$**	**0.13****	**0.11****

*Details are similar to Table 3.1.

3.4. Calcium

Calcium (Ca) concentrations of cluster and nut were significantly different between in different period "On' year trees ($P < 0.05$). In cluster; the highest Ca content of 2015 years was obtained after 36 days after full flowering with 0.43%, while it was 128 days after full flowering with 0.33% in 2016, the lowest Ca content in 2015 'On' year was 0.24% in NDAFF-76 and 0.21% with NDAFF-84 period in 2016 years (Table 3.4). The Ca content in the cluster decreased gradually during growing season with a slight minimum levels during heavy bud abscission period (June) (Table 3.4).

AS fort he nuts; the highest Ca content of 2015 years was obtained after 75 days after full flowering with 0.24%, while it was 64 days after full flowering with 0.26% in 2016, the lowest Ca content in 2015 'On' year was 0.10% in NDAFF-35 and 0.13% with NDAFF-36 period in 2016 years (Table 3.4). It was determined that the calcium contents started to fill the inside of the fruit after the full flowering (embryo formation) until the period and after the formation of the inside of the fruit decreased (Table 3.4). These results are consistent with earlier studies reported by Vemmos ve ark., (1999b); Piccihioni et al., (1997); Ak and Fidan, (2015).

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

Table 3.4: 'Variations of Ca Content (%DW) in Cluster and Fruits of "On" year 'Uzun' Pistachio Trees (%)

Physiological periods	2015		Physiological periods	2016	
	Cluster	Nuts		Cluster	Nuts
NDAFF-35	0.43^{a}	0.10^{d}	**NDAFF-36**	0.32^{a}	0.13^{d}
NDAFF-45	0.34^{abc}	0.10^{d}	**NDAFF-50**	0.26^{ab}	0.14^{cd}
NDAFF-55	0.38^{ab}	0.17^{bc}	**NDAFF-64**	0.27^{ab}	0.26^{a}
NDAFF-75	0.24^{c}	0.24^{a}	**NDAFF-78**	0.21^{b}	0.24^{a}
NDAFF-85	0.25^{c}	0.22^{ab}	**NDAFF-92**	0.28^{ab}	0.22^{ab}
NDAFF-118	0.28^{bc}	0.12^{cd}	**NDAFF-127**	0.33^{a}	0.19^{bc}
NDAFF-146	0.30^{bc}	0.15^{cd}	**NDAFF-147**	0.25^{ab}	0.21^{ab}
'On' Average	**0.31**	**0.15**	**'On' Average**	**0.27**	**0.20**
D %5$_{\text{Period x 'On' year}}$	**0.11***	**0.06***	**D %5$_{\text{Period x 'On' year}}$**	**0.09***	**0.06***

*Details are similar to Table 3.1.

3.5. Magnesium

Magnesium (Mg) concentrations of cluster and nuts were not significantly different between in different period in "On'' year trees ($P < 0.05$). According to the results, the highest magnesium content of 2015 years was obtained after 45 days after full flowering with 0.14%, and 0.12% with NDAFF-50 period in 2016; the lowest Mg content in 2015 'On' year was 0.02% in NDAFF-146 and 0.02% with NDAFF-147 period in 2016 years (Table 3.5). It has been found that the amount of Mg in the fruit bunch skeleton of 'On' trees declines gradually from the time of full flowering to harvest (Table 3.5).

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

Table 3.5: Variations of Mg Content (%DW) of Cluster and Nuts of "On" year 'Uzun' Pistachio Trees (%)

Physiological periods	2015		Physiological periods	2016	
	Cluster	Nuts		Cluster	Nuts
NDAFF-35	0.12[a]	0.08	**NDAFF-36**	0.08[b]	0,10
NDAFF-45	0.14[a]	0.05	**NDAFF-50**	0.12[a]	0,06
NDAFF-55	0.08[b]	0.12	**NDAFF-64**	0.06[bc]	0,11
NDAFF-75	0.04[c]	0.08	**NDAFF-78**	0.053[bc]	0.08
NDAFF-85	0.03[c]	0.06	**NDAFF-92**	0.05[c]	0,07
NDAFF-118	0.02[c]	0.09	**NDAFF-127**	0.02[d]	0.05
NDAFF-146	0.02[c]	0.09	**NDAFF-147**	0.02[d]	0.09
'On' year Average	**0.06**	**0.08**	**'On' year Average**	**0.05**	**0.08**
D %5Period x 'On' year	**0.02**[**]	**0.36**	**D %5Period x 'On' year**	**0.02**[**]	**0.03**

*Details are similar to Table 3.1.

The highest Mg content of 2015 years was obtained after 55 days after full flowering 0.12% and 0.11% with NDAFF-64 period in 2016, the lowest Mg content in 2015 'On' year was 0.05% in NDAFF-45 and 0.05% with NDAFF-127 period in 2016 years. The amount of manganese in the cluster is higher than the nuts (Table 3.5). Baninasab et al. (2007), and Picchioni et al. (1997) found similar results to our results. Güzel et al. (2002) reported that the Mg element for plant growth should be between 0.1-0.4% for plant growth in different organs of the plant. When the results of Çetinkaya (2004) were found in pistachio fruits (Mg: 1.58%), it was observed that Magnesium contents in fruits were insufficient in pistachio varieties.

IV. CONCLUSION

This study shows that nutritional elements necessary for fruit development are provided from the cluster in pistachio trees and especially in the periods of in nut development (July) stages. It is observed that plant nutrient requirement and its intake is more when it starts to kernel of fruit. Among the macronutrients, the amounts of Nitrogen, potassium and phosphorous were affected by the presence of fruits on the trees. It is thought generally that the N, P, K and Ca elements

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

may have a key role in the annual nut production and yield of pistachios. It was found that these elements are essential for nut development in pistachios and have an effect on fruit bud abscission. This indicates that pistachios are strong sinks for P and K. It is possible that these two elements are involved in flower bud formation. Thus, a good management in the application of these two essential elements in pistachio orchards is very important, especially for "On" years.

V. ACKNOWLEDGEMENTS

This work was supported by grant no TAGEM/BBAD/14/A10/P01 from the 'General Directorate of Agricultural Research and Policies (TURKEY).

REFERENCES

Ak, B.E., and Fidan, M., 2015**.** Verim ve Periyodisite Yılında 'Ohadi'Antepfıstığı Çeşidinin Değişik Organlarında Bazı Makro ve Mikro Element Kapsamlarının Belirlenmesi.VII. Ulusal Bahçe Bitkileri Kongresi Bildirileri.Cilt-1.Meyvecilik. Çanakkale. s.314-319.

Ayfer, M.,1964. Pistachio Nut Culture and Its Problems with Special Reference to Turkey. Univ. Of Ankara, Fac. Of Agriculture Yearbook, 189-217.

Baninasab, B., M. Rahemi, and H. Shariatmadari. 2007. Seasonal changes in mineral content of different organs in the alternate bearing of pistachio trees. Commun. Soil Sci. Plant Anal. 38:241–258.

Crane, J.C., and Nelson, M.M., 1971**.** The Unusual Mechanism of Alternate Bearing in Pistachio. HortScience 6:489-490.

Crane, J.C., and B.T. Iwakiri. 1981. Morphology and reproduction of pistachio. Hort. Rev. 3: 376-393.

Çetinkaya, H., 2004**.** Mutlak ve Oransal Periyodisite Gösteren Bazı Antepfıstığı Çeşitlerinde Periyodisite ile İçsel Hormonlar, Karbonhidrat ve Bitki Besin Maddeleri Düzeyleri Arasındaki İlişkiler. Doktora tezi. Ç.Ü. Fen Bilimleri Enstitüsü, Bahçe Bitkileri ABD. 194s.

Faostat, 2018. Food and Agriculture Organization of The United Nations **(**FAO), Web Page. http://www.apps.fao.org , Erişim Tarihi: 10.06.2018.

Gundesli, 2017. Antepfıstığında Meyve Gözü Dökümleri ile İlgili Mekanizmanın Belirlenmesi Doktora tezi. Ç.Ü. Fen Bilimleri Enstitüsü, Bahçe Bitkileri ABD. 353s.

Guzel, N., Gulut, Y.K., Büyük, G., 2002. Toprak Verimliliği ve Gübreler, Bitki Besşn Elementleri Yönetimine Giriş, Çukurova Üniversitesi Ziraat Fak. Genel Yayınları No: 246 Ders Kitapları Yayın No: A – 80, Adana.

Kacar, B., 1972**.** Bitki ve Toprağın Kimyasal Analizleri, II. Bitki Analizleri, A:Ü: Zir. Fak. Yayınları, 453. Katkat, A. V. , Aşık, B. B., Turan, M. A. ve Çelik, H., 2006. Farklı Kireç Dozları ve Tuz Konsantrasyonlarında Artan Miktarlarda Topraktan ve Yapraktan Uygulanan Humik Maddelerin Mısır ve Buğday Bitkilerinin Gelişimi ve Kimi Besin Elementleri İçeriği Üzerine Etkisi. Tübitak Proje No: TOVAG- 105 0 345.

Kacar, B., Katkat, V., Öztürk, Ş. **2002.** Bitki fizyolojisi. Uludağ Üniversitesi güçlendirme vakfı yayını, yayın no: 74, 563 s, Bursa.

Kacar, B., and İnal A., 2008**.** Bitki Analizlari Nobel yayın No: 1241. ISBN 978-605- 395-036-3 : s.164.

Nzima MDS, Martin GC, Nishijima C (1997) Seasonal changes in total nonstructural carbohydrates within branches and roots of naturally ‘of ’ and ‘on’ Kerman Pistachio trees. J Amer Soc Hort Sci 122: 856-862.

Pallardy, S.G. 2008. Mineral nutrition. In: S.G. Pallardy (ed.). Physiology of woody plants. Elsevier, Amsterdam, Netherlands.

Picchioni, G.A., Brown, P.H., Weinbaum, S.A., and Muraoka, T.T., 1997**.** Macronutrient allocation to leaves and fruit of mature, alternatebearing pistachio trees: Magnitude and seasonal patterns at the wholecanopy level. J. Amer. Soc. Hort. Sci. 122:267–274

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.

Rosecrance, R., Weinbaum, S.A., and Brown, H., 1998. Alternate bearing affects nitrogen, phosphorus, potassium and starch storage pools in mature pistachio trees. Annal Bot 82: 463-470.

Tekin, 1992**.** Gaziantep Yöresinde Topraktan ve Yapraktan Yapılan Farklı Gübre Uygulamalarının Antepfıstığının Yaprak Bileşimi, Gelişme, Verim ve Ürün Kalitesine Etkilerinin Araştırılması. Doktora Tezi. Ç. Ü. Zir. Fak. Fen Bilimleri Ens. Bahçe Bitkileri Adana.

Vemmos, S.N., 1999a. Carbohydrate content of inflorescent buds of defruited and fruiting pistachio (Pistacia vera L) branches in relation to biennial bearing. J. Horti. Sci. Biotechnol., 74(1): 94-100

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

Vemmos, S.N., 1999b**.** Mineral composition of leaves and inflorescent buds in fruiting and non-fruiting pistachio trees. In: J. Plant Nutr., 22, p. 1291-1301.

Weinbaum, S.A., Brown, P.H., and G.A Picchoni, G.A., 1994**.** Diagnosing and Correcting Nutrient Deficiencies. In: Ferguson L, ed. *Pistachio* production. Davis, CA: Center for Fruit and Nut Crop Research and Information, University of California, 95±100.

Yavuz, G.G., 2011**.** Sert Kabuklu Meyveler/ Antep Fıstığı. TEPGE BAKIŞ, Tarımsal Ekonomi ve Politika Geliştirme Enstitüsü, Aralık 2011 / ISSN: 1303–8346 / Nüsha: 5, Ankara

