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EFFECTS OF GA_3, CALCIUM AND BORON APPLICATIONS TO SEASONAL CHANGES OF LEAF, PEEL AND ARIL MINERAL NUTRITIONS ON HICAZNAR POMEGRANATE (*Punica granatum* L.)

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Abstract

In this study, the effects of GA3, Calcium and Boron sprays on seasonal changes of leaf, peel and aril mineral nutrition were studied during 2012 in Mugla which is the second pomegranate producing regions in Turkey. GA_3 (50ppm and 75 ppm), Calcium Nitrate (2 %, 4 %) and Boron (1.5 %, 3 %) were applied on two occasions (firstly, in full blossoming; secondly, one month post full blossoming). After applications of GA_3, Calcium and Boron, Macronutrients (N, P, K, Mg, Ca) and micronutrients (Fe, Zn, Cu, Mn, B) levels measured from May till October in leaf, from June till October in peel and aril. Calcium applications have increased mineral uptake. Mineral content in aril and peel decreased during vegetation period. The concentration of mineral nutrition in leaf samples was stable between August 15 and September 15.

Keywords: Pomegranate, foliar application, nutrients, seasonal changes, leaf and fruit analysis.

INTRODUCTION

Due to many reasons for health, pomegranate consumption and pomegranate production are increasing day by day. Pomegranate is produced and consumed for thousands of years in Turkey (Okatan et al, 2015). Turkey is the third largest pomegranate producer in the world. Pomegranates (*Punica granatum* L.) are one of most important commercial fruits in Turkey esppecially for in Subtropical region. In Turkey, pomegranate features highly both in terms of local consumption and, due to European exportation, as a main attraction for foreign currencies (Korkmaz and Askın, 2013). The Pomegranate production is steadily increasing in Turkey. It has risen from 60.000 tons in 2002 to 465.200 tons in 2016, (Anonymous, 2016) Esspecially, Pomegranate is an important commercial fruit crop grown in the subtropical regions of Turkey. Mugla region is located in south west Turkey and ıt is second producing area after Antalya in

Turkey. These area, climate is very hot and dry summer season and mild and rainy winters (Mediterranean Climate) (Korkmaz et al., 2017). For the healty growth of plants, it is necessary for them to supply needed water and nutrients. Leaf-nutrient analysis is the best method for diagnosing the nutritional status of trees, and represents an important tool for determining future fertilization requirements (Benton Jones, 1985, Bar-Akiva et al. (1968). Physical and chemical changes in pomegranate juice have been recently researched and researchers have shown the mineral composition of the pomegranate in tree maturation period. Potassium, nitrogen, calcium and sodium are found at the highest level in both fruit juice and aril, followed by magnesium, phosphorus, zinc, iron and copper (Al-Maiman and Ahmad, 2002). The optimal situaiton for the neutral feedingon the mentioned trees should be determined. Seasonal changes of nutritional elements should be known which is the biggest.

Eroğul et al. (2011) reported that the effect of GA_3 applications on the macro and micro nutrient elements of the fruit of Satsuma Mandarin was insignificant for the elements other than P. The auxins and gibberellins are used to control the fruit drop in citrus for improve the quality of fruit (Almeida et al., 2004).

First studies interested with calcium had began which it is effect to physiological diseases in fruits and vegetables (Delong, 1936). Calcium is the most important minerals in all mineral nutrients for the mechanical resistance and stability of the cell structure of fruit. In the calcium deficiency, middle lamellae enlarge, thin out and then crack(Asgharzade et al., 2012). Ferguson (1984) stated that Ca coverage is important in the regular maturation process. Eroğul et al. (2011) investigated the effect of Ca application on the nutrient content of mandarin. it was found important when combined with GA_3. It was stated that applications increased the amount of N, K, Ca, Mg in fruit aril before harvest in autumn .

Eroğul et al. (2011) investigated that the effect of Ca application on the intake of some micro and macro nutrients in Satsuma mandarin. The effect of Ca to intake macro and micro nutrient elements of fruit was found to be insignificant in the elements except P.

Boron is one of the basic nutrients. It is known that the excess of a little bit of boron element in the leaf causes toxic effect. However, lack of this element is caused by serious problems (Maurer, 1999*).* Sanchez (2005) studied boron application from soil and foliar, which examined the distribution effect of apple trees. As a result of the study, the researcher stated that the boron applied from the leaves were transported to flower buds and flowers higher than other organs.

The criteria for determining optimum nutrition requirements include: seasonal accumulation of nutrients in part of plants for the fruit quality and yield. Macro and micro elements cause undesirable changes in a wide range of deficits and surpluses.

In this study, the effects of plant nutrients and hormone application on fruit yield and quality were investigated in a different region and different pomegranate variety. Seasonal changes of plant nutrients in leaf, aril and peel were examined and stability periods were determined.

MATERIAL AND METHODS

The study was conducted in the 2012 year orchard located within the Ortaca region of Mugla province, Turkey. The average annual rainfall in this area 1074 mm for the year 2012. Soil character was alkaline. The experiment was laid out in randomized design in split plots, with tree replications.

Forty five pomegranate (Punica granatum L. var Hicaz Nar) trees were selected.The applied treatments were GA_3 at concentrations of 50 ppm (GA1) and 75 ppm (GA2), calcium as calcium nitrate at concentrations of 0 % (C), 2 % (CN1),4 % (CN2) and boron as boric acid at concentrations of 0 % (C), 1.5% (B1), 3% (B2). All treatments were applied at full bloom (16 May 2012) and one month after full bloom (16 June 2012). All solutions were applied in the afternoon (6-7 p.m) using a hand pressure sprayer with a capacity of 15 liters. Leaf samples were collected at montly approximately starting in the period May to October. Fruit samples were collected at montly approximately starting in the period June to October. Ripe fresh fruits picked on 20 October 2012. Leaf samples from each plot were combined as samples of 100 -120 leaves for the determination of nutrient concentration. Nine sound fruits per each replicate were selected to calculate mean fruit weight, fruit lengh and diameter.

The methods used by the laboratory for the determination of the leaf, aril and peel elements were: for nitrogen Kjeldahl procedure, for phosphorus spectrophotometry, for potassium flame photometry, for calcium, magnesium, iron, zinc and copper atomic absorption spectrophotometry,

Collected data were analysed with the TARIST analysis programme, to detect statistically significant differences with a 5% confidence level.

RESULTS AND DISCUSSION

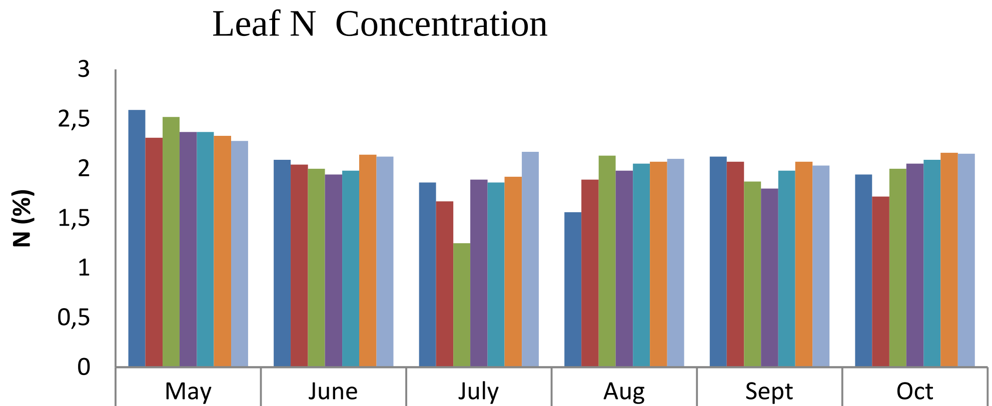
Leaf, Aril and Peel Nutrition Concentration And Seasonal Changes

When seasonal changes of some nutrient elements were investigated, Leaf N concentrations varied 1.25-2.59%, P 0.02-0.08 %, K 0.63-1.17 %, Ca 1.68-3.30 %, Mg 0.34-1.18%, Cu 4.30-11.30 ppm, Mn 8-18 ppm, Fe 66.9-256.93 ppm and Zn 6.29-19.78 ppm and B 17.733-46.667 ppm changed during the growth period in the leaves of all applications.

When seasonal changes of some nutrient elements were investigated, Aril N concentrations varied 0.9-3.49 %, P 0.03-0.113 %, K 0.74-1.75 %, Ca 0.241-1.768%, Mg 0.074-0.212%, Cu 6.10-13.80 ppm, Mn 5-18 ppm, Fe 21.30-94.7 ppm and Zn 11.57-47.56 ppm and B 30.467-82.500 ppm changed during the growth period in the arils of all applications.

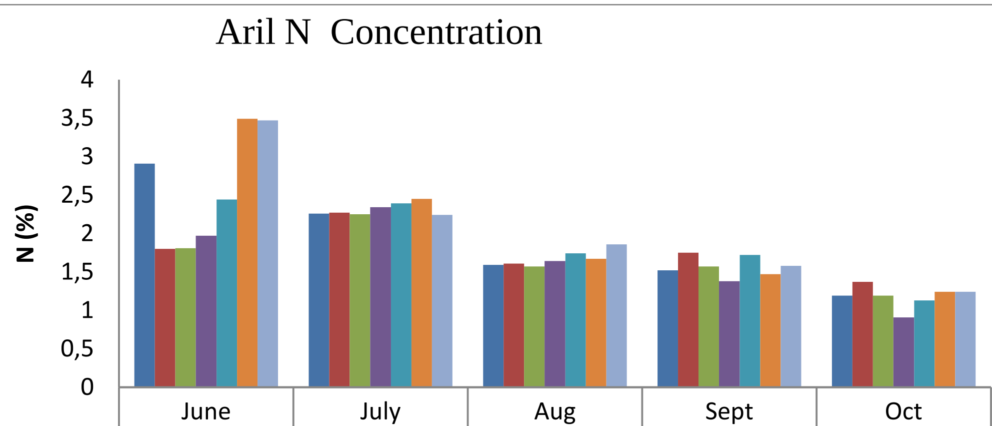
When seasonal changes of some nutrient elements were investigated, Peel N concentrations varied 0.08-1.43%, P 0.23 -0.60 %, K 0.69-1.57%, Ca 0.333-1.851%, Mg 0.053-0.093%, Cu 2.43-8.13 ppm, Mn 2-7 ppm, Fe 11.93-41.2 ppm and Zn 3.73-11.03 ppm and B 21.567-77.467 ppm changed during the growth period in the peels of all applications.

1. **Aplications and Seasonal Changes of Leaf, Aril and Peel Nitrogen Concentration**



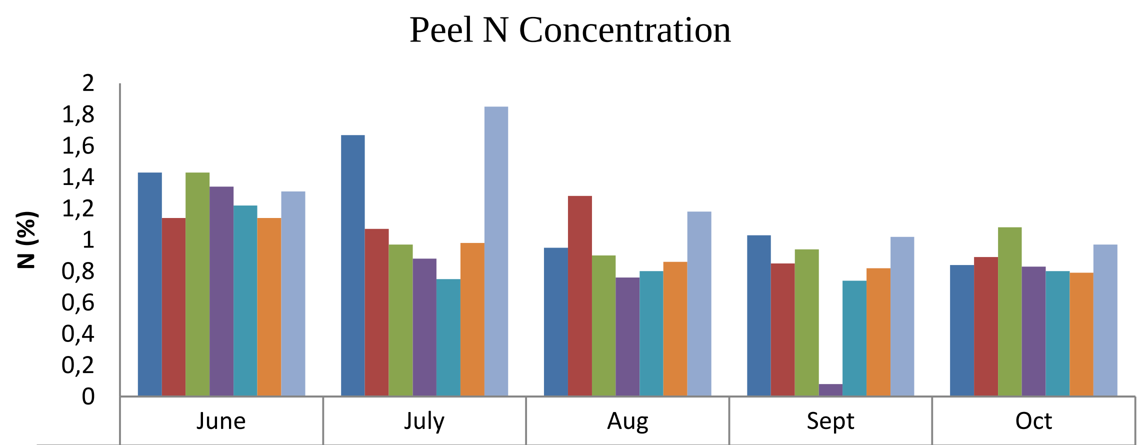
	May	June	July	Aug	Sept	Oct
C	2,59	2,09	1,86	1,56	2,12	1,94
CN1	2,31	2,04	1,67	1,89	2,07	1,72
CN2	2,52	2	1,25	2,13	1,87	2
B1	2,37	1,94	1,89	1,98	1,8	2,05
B2	2,37	1,98	1,86	2,05	1,98	2,09

Figure 1. Seasonal Changes of Leaf N Concentration in Applications



	June	July	Aug	Sept	Oct
C	2,91	2,26	1,59	1,52	1,19
CN1	1,8	2,27	1,61	1,75	1,37
CN2	1,81	2,25	1,57	1,57	1,19
B1	1,97	2,34	1,64	1,38	0,91
B2	2,44	2,39	1,74	1,72	1,13

Figure 2. Seasonal Changes of Aril N Concentration in Applications



	June	July	Aug	Sept	Oct
C	1,43	1,67	0,95	1,03	0,84
CN1	1,14	1,07	1,28	0,85	0,89
CN2	1,43	0,97	0,9	0,94	1,08
B1	1,34	0,88	0,76	0,08	0,83
B2	1,22	0,75	0,8	0,74	0,8
GA1	1,14	0,98	0,86	0,82	0,79
GA2	1,31	1,85	1,18	1,02	0,97

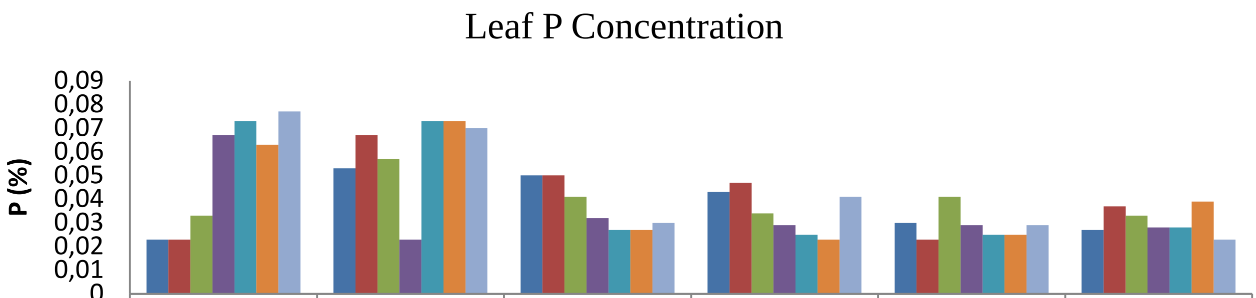
Figure 3. Seasonal Changes of Peel N Concentration in applications

Leaf N concentration was variable until July, and stabilized from July. These results were in line with Nachtigall and Decken (2006) which is in apple. The highest N concentrations of the leaf was observed in C (2.59 %) application in May and $GA_3$1 (2.16%) application in October(Fig.1).

It was determined that GA1 application had the highest N value (3.49%) in June and CN1 application had the highest N value (1.37%) in October for the aril samples. Aril N concentration showed a decreasing trend toward the end of vegetation. This results are in accordance with Parashar (2010) which studied determining seasonal N accumulation in “Banati” pomegranate fruits.

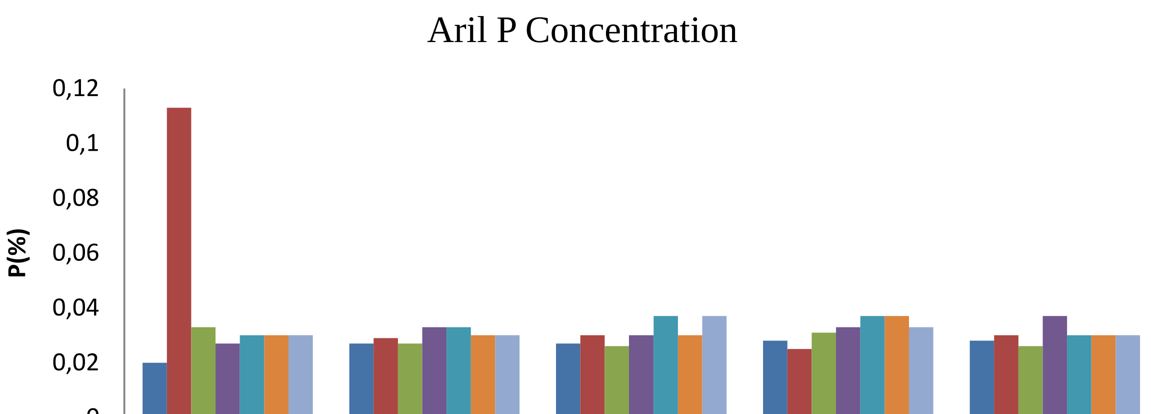
Application of CN2 led to an increase in the peel N concentration. Rogers and Batjer (1954) has been reported to have decreased macro element levels towards the end of vegetation Bellamy navel orange, similar to other fruits such as apples. Overall, in our study, decreasing was observed throughout vegetation in all applications except CN2 and GA2 applications.

2. Aplications and Seasonal Changes of Leaf, Aril and Peel Phosphorus Concentration



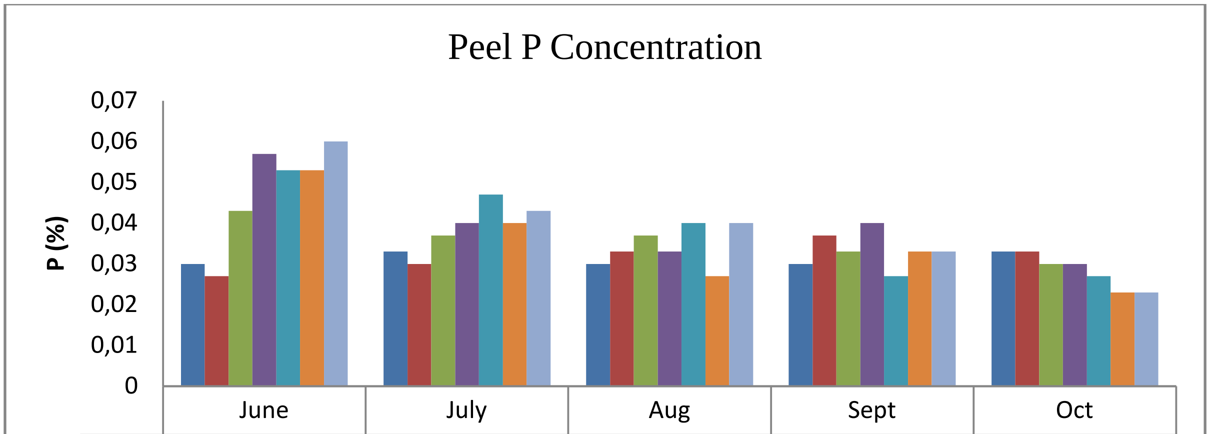
	May	June	July	Agu	Sept	Oct
C	0,023	0,053	0,05	0,043	0,03	0,027
CN1	0,023	0,067	0,05	0,047	0,023	0,037
CN2	0,033	0,057	0,041	0,034	0,041	0,033
B1	0,067	0,023	0,032	0,029	0,029	0,028
B2	0,073	0,073	0,027	0,025	0,025	0,028
GA1	0,063	0,073	0,027	0,023	0,025	0,039
GA2	0,077	0,07	0,03	0,041	0,029	0,023

Figure 4. Seasonal Changes of Leaf P Concentration in applications



	June	July	Agu	Sept	Oct
C	0,02	0,027	0,027	0,028	0,028
CN1	0,113	0,029	0,03	0,025	0,03
CN2	0,033	0,027	0,026	0,031	0,026
B1	0,027	0,033	0,03	0,033	0,037
B2	0,03	0,033	0,037	0,037	0,03
GA1	0,03	0,03	0,03	0,037	0,03
GA2	0,03	0,03	0,037	0,033	0,03

Figure 5. Seasonal Changes of Aril P Concentration in applications



	June	July	Aug	Sept	Oct
C	0,03	0,033	0,03	0,03	0,033
CN1	0,027	0,03	0,033	0,037	0,033
CN2	0,043	0,037	0,037	0,033	0,03
B1	0,057	0,04	0,033	0,04	0,03
B2	0,053	0,047	0,04	0,027	0,027
GA1	0,053	0,04	0,027	0,033	0,023
GA2	0,06	0,043	0,04	0,033	0,023

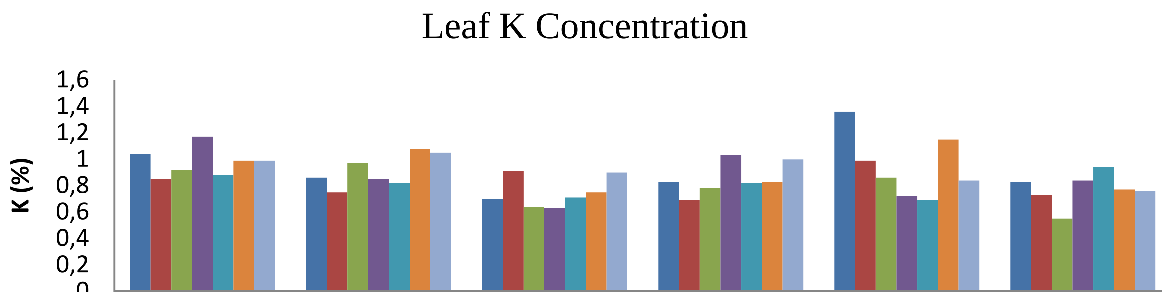
Figure 6. Seasonal Changes of Peel P Concentration in applications

When the seasonal variation of Leaf P concentration is examined, the change shows a decreasing course toward the end of vegetation (Fig.4). This result is in line with Ryugo (1988) in not evergreen trees, in citrus trees by Embleton et al. (1973) in citrus and Navel orange by Xiao et al (2007) in Navel orange.

It was determined that the highest concentration of P was CN1 in June and B1 application was the highest concentration in October for the aril (Fig.5). The P concentrations in GA2 and CN1 applications were showed a decreasing trend from the beginning of vegetation. This result was similar to the work done by Mirdehghan and Rahemi (2006), in the pomegranate Researcher was investigated that P concentration had decreased throughout the vegetation.

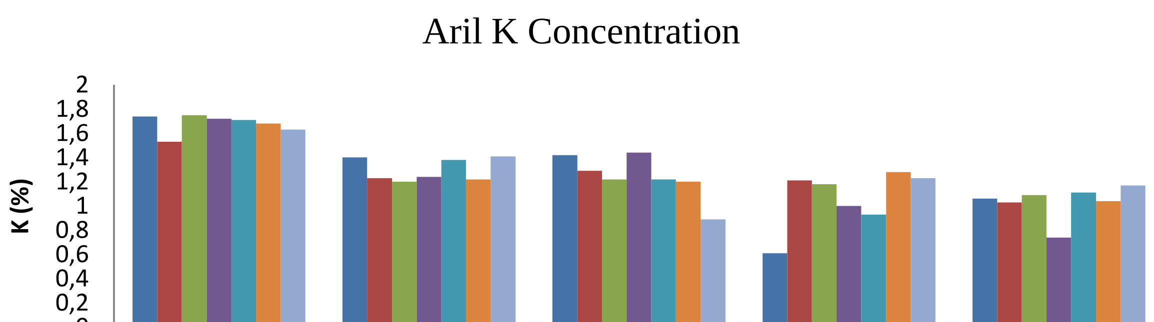
When we look P concentrations of the peel samples of June were examined, it was determined that phosphorus was highest in GA2 application and highest in C and CN1 application in October (Fig.6). A decreasing trend was observed in all applications throughout the vegetation. These results were consistent with the work done by Storey and Treeby (1999) on Navel oranges.

3. Aplications and Seasonal Changes of Leaf, Aril and Peel Potassium Concentration



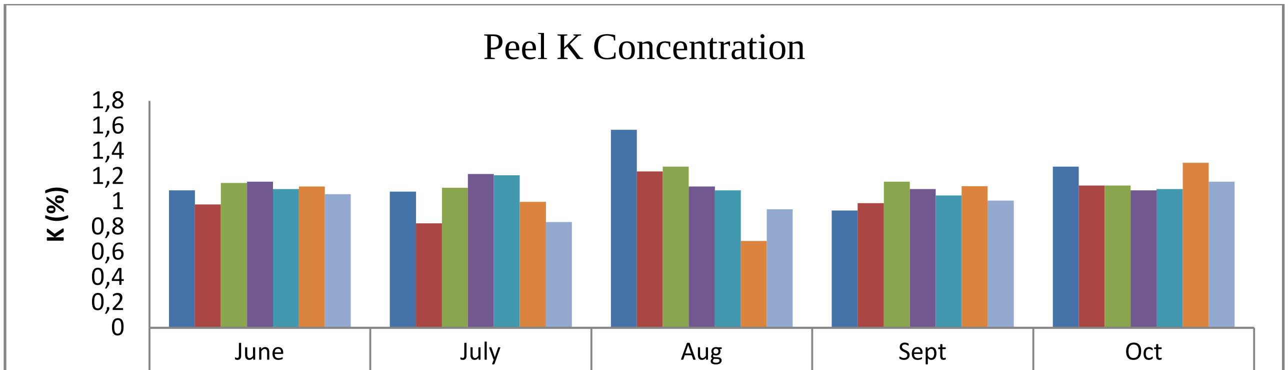
	May	June	July	Aug	Sept	Oct
C	1,04	0,86	0,7	0,83	1,36	0,83
CN1	0,85	0,75	0,91	0,69	0,99	0,73
CN2	0,92	0,97	0,64	0,78	0,86	0,55
B1	1,17	0,85	0,63	1,03	0,72	0,84
B2	0,88	0,82	0,71	0,82	0,69	0,94
GA1	0,99	1,08	0,75	0,83	1,15	0,77
GA2	0,99	1,05	0,9	1	0,84	0,76

Figure 7. Seasonal Changes of Leaf K Concentration in application



	June	July	Aug	Sept	Oct
C	1,74	1,4	1,42	0,61	1,06
CN1	1,53	1,23	1,29	1,21	1,03
CN2	1,75	1,2	1,22	1,18	1,09
B1	1,72	1,24	1,44	1	0,74
B2	1,71	1,38	1,22	0,93	1,11
GA1	1,68	1,22	1,2	1,28	1,04
GA2	1,63	1,41	0,89	1,23	1,17

Figure 8. Seasonal Changes of Aril K Concentration in application



	June	July	Aug	Sept	Oct
C	1,09	1,08	1,57	0,93	1,28
CN1	0,98	0,83	1,24	0,99	1,13
CN2	1,15	1,11	1,28	1,16	1,13
B1	1,16	1,22	1,12	1,1	1,09
B2	1,1	1,21	1,09	1,05	1,1
GA1	1,12	1	0,69	1,124	1,31
GA2	1,06	0,84	0,94	1,01	1,16

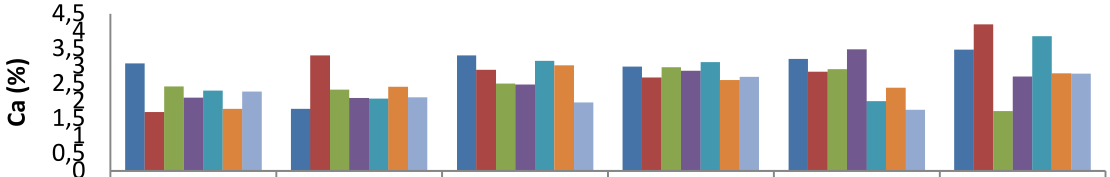
Figure 9. Seasonal Changes of Leaf K Concentration in application

It was determined that the highest concentration of K was B1 (1.17%) in May and B2 (0.94%) application was the highest concentration in October for the leaf (Fig.7). Leaf K concentration was decreased throughout vegetation.

Aril K concentrations are highest in CN2 application for June (1.75%) and GA_3 (1.17%) for October samples (Fig.8). This result is similar to the results studied by Mirdehghan and Rahemi (2006) about seasonal changes of nutrition in pomegranate fruits. Researcher was investigated that K concentration had decreased throughout the vegetation. The stabilization period is between August and September. The highest K concentrations of the peel was observed in B1 (1.16%) application in June and GA1 (1.31%) application in October (Fig.9).

4. Aplications and Seasonal Changes of Leaf, Aril and Peel Calcium Concentration

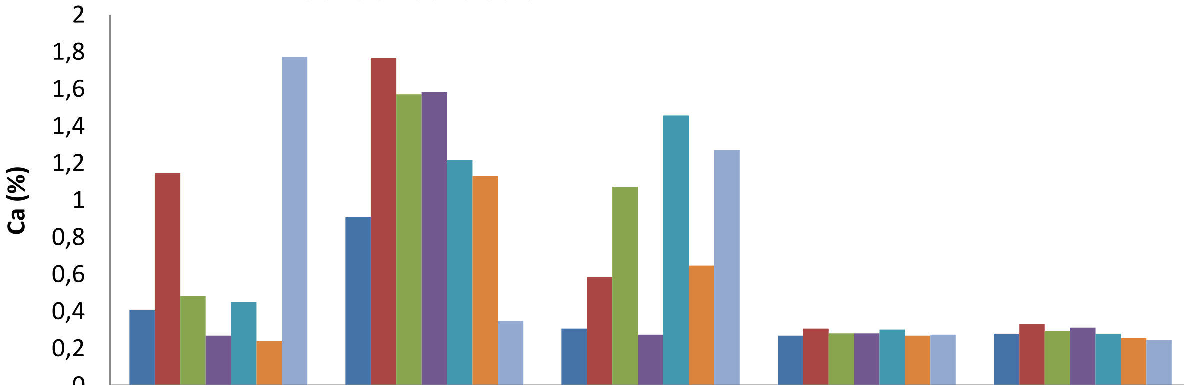
Leaf Ca Concentration



	May	June	July	Aug	Sept	Oct
C	3,081	1,781	3,304	2,985	3,204	3,474
CN1	1,684	3,31	2,895	2,673	2,837	4,195
CN2	2,424	2,326	2,5	2,97	2,914	1,716
B1	2,097	2,088	2,47	2,867	3,486	2,708
B2	2,298	2,067	3,153	3,119	1,997	3,861
GA1	1,779	2,408	3,02	2,6	2,387	2,795
GA2	2,273	2,111	1,964	2,695	1,754	2,784

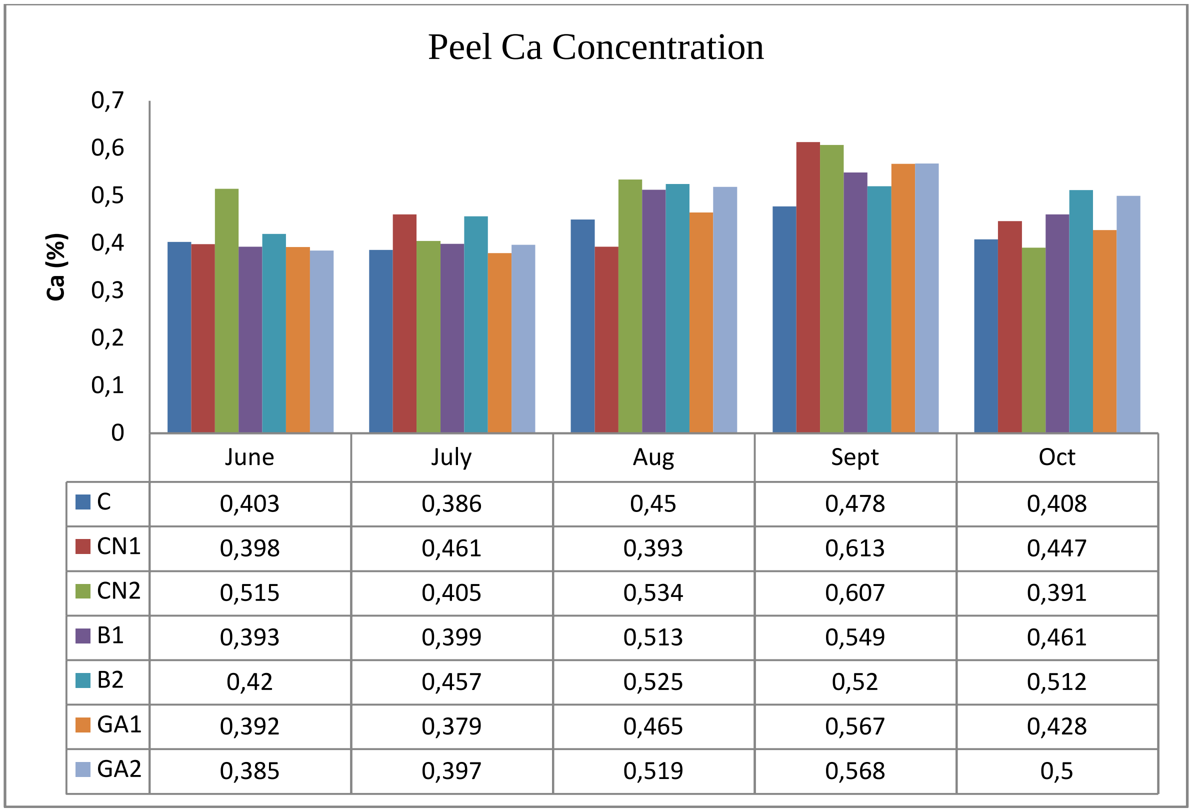
Figure 10. Seasonal Changes of Leaf Ca Concentration in Applications

Aril Ca Concentration



	June	July	Aug	Sept	Oct
C	0,41	0,909	0,307	0,27	0,28
CN1	1,147	1,768	0,585	0,307	0,334
CN2	0,483	1,571	1,072	0,282	0,293
B1	0,27	1,583	0,275	0,281	0,312
B2	0,45	1,216	1,458	0,303	0,28
GA1	0,241	1,131	0,648	0,269	0,256
GA2	1,774	0,349	1,272	0,275	0,245

Figure 11. Seasonal Changes of Aril Ca Concentration in Applications

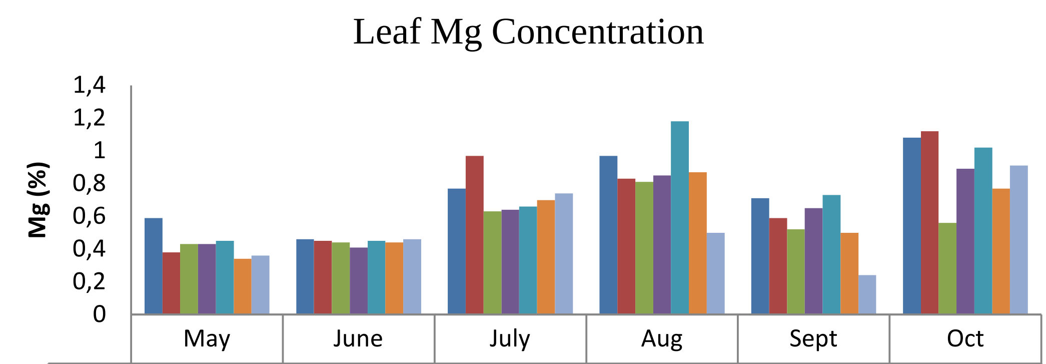


	June	July	Aug	Sept	Oct
C	0,403	0,386	0,45	0,478	0,408
CN1	0,398	0,461	0,393	0,613	0,447
CN2	0,515	0,405	0,534	0,607	0,391
B1	0,393	0,399	0,513	0,549	0,461
B2	0,42	0,457	0,525	0,52	0,512
GA1	0,392	0,379	0,465	0,567	0,428
GA2	0,385	0,397	0,519	0,568	0,5

Figure 12. Seasonal Changes of Peel Ca Concentration in Applications

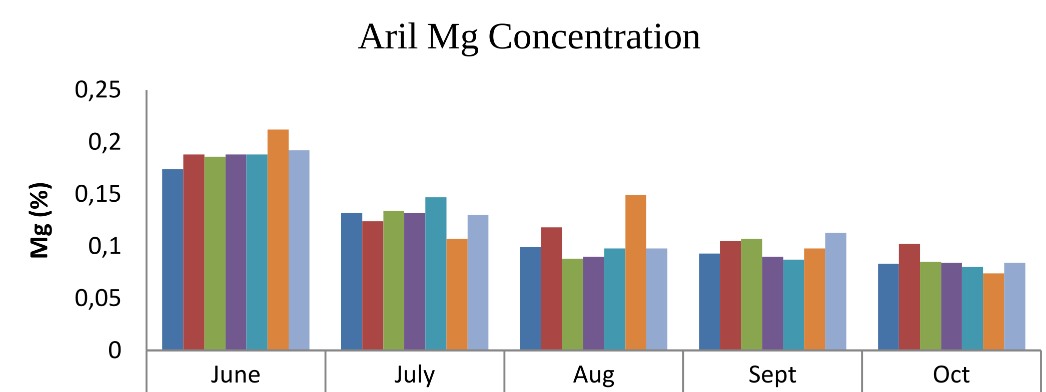
It was determined that the highest concentration of Ca was C (3.081%) in May and CN1 (4.195%) application was the highest concentration in October for the leaf (Fig.10).
The highest Ca concentrations of the aril was observed in GA2 (1.774%) application in June and CN1 (0.334%) application in October (Fig.11).Aril Ca concentration had showed a decreacing throughout vegetation period. This result is similar to the results studied by Mirdehghan and Rahemi (2006) about seasonal changes of nutrition in pomegranate fruits. Researcher was investigated that Ca concentration had decreased throughout the vegetation
It was determined that the highest concentration of Ca was CN2 (0.515%) in June and B2 (0.512 %) application was the highest concentration in October for the peel (Fig.12). Peel Ca concentration was decreaced throughout vegetation period. Hernandez-Munoz et al., (2006) observed that the foliar Ca applications had increased fruit Ca concentration.These results were in line with our study.

5.Aplications and Seasonal Changes of Leaf, Aril and Peel Mg Concentration



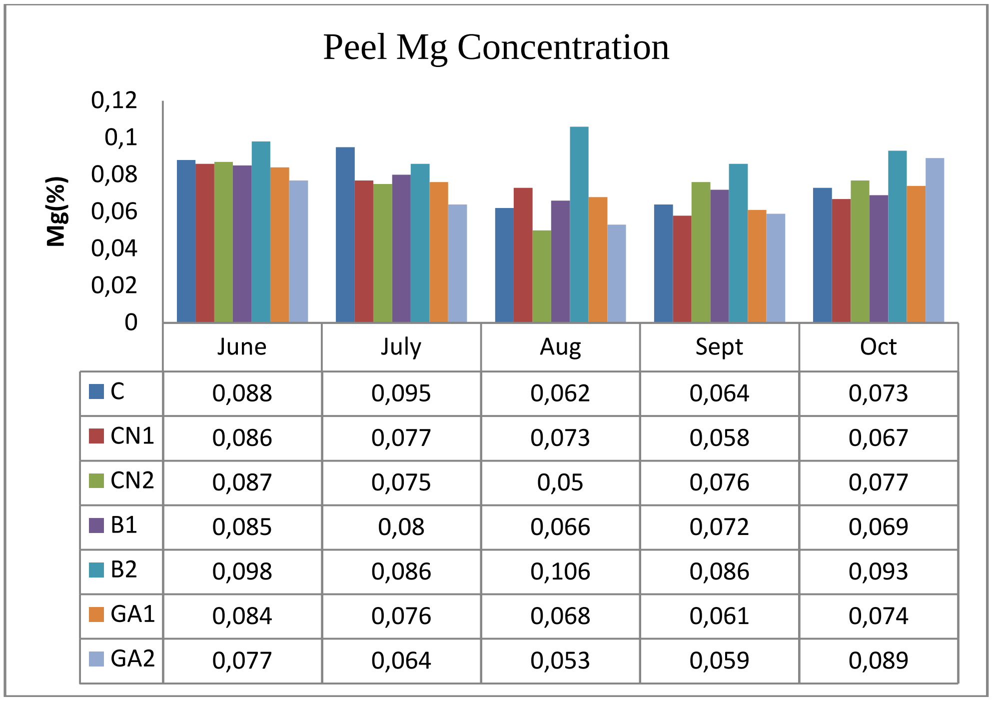
	May	June	July	Aug	Sept	Oct
C	0,59	0,46	0,77	0,97	0,71	1,08
CN1	0,38	0,45	0,97	0,83	0,59	1,12
CN2	0,43	0,44	0,63	0,81	0,52	0,56
B1	0,43	0,41	0,64	0,85	0,65	0,89
B2	0,45	0,45	0,66	1,18	0,73	1,02
GA1	0,34	0,44	0,7	0,87	0,5	0,77
GA2	0,36	0,46	0,74	0,5	0,24	0,91

Figure 13. Seasonal Changes of Leaf Mg Concentration in Applications



	June	July	Aug	Sept	Oct
C	0,174	0,132	0,099	0,093	0,083
CN1	0,188	0,124	0,118	0,105	0,102
CN2	0,186	0,134	0,088	0,107	0,085
B1	0,188	0,132	0,09	0,09	0,084
B2	0,188	0,147	0,098	0,087	0,08
GA1	0,212	0,107	0,149	0,098	0,074
GA2	0,192	0,13	0,098	0,113	0,084

Figure 14. Seasonal Changes of Aril Mg Concentration in Applications



	June	July	Aug	Sept	Oct
C	0,088	0,095	0,062	0,064	0,073
CN1	0,086	0,077	0,073	0,058	0,067
CN2	0,087	0,075	0,05	0,076	0,077
B1	0,085	0,08	0,066	0,072	0,069
B2	0,098	0,086	0,106	0,086	0,093
GA1	0,084	0,076	0,068	0,061	0,074
GA2	0,077	0,064	0,053	0,059	0,089

Figure 15. Seasonal Changes of Peel Mg Concentration in Applications

It was determined that the highest concentration of Mg was C (0.590 %) in May and CN1 (1.123%) application was the highest concentration in October for the leaf (Fig.13).

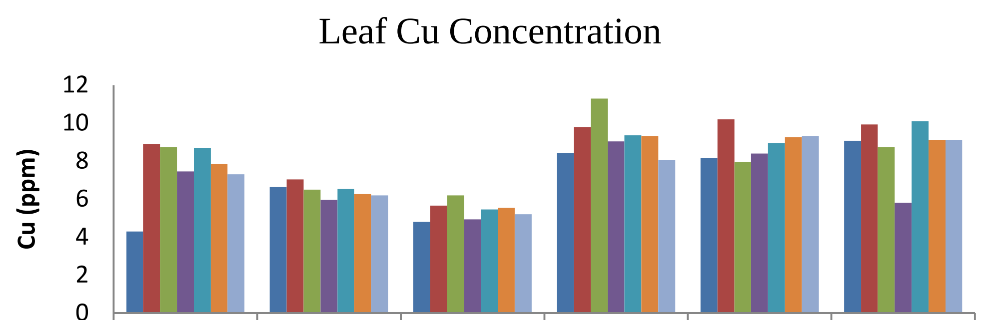
While Leaf Mg concentration was lowest concentration May, ıt was highest value in October. These results were in line with Özkan vd(2005) in pomegranate, by Soyergin vd. (2010) in “Bursa Siyahı “ fig.

It was determined that the highest concentration of Mg was GA1 (0.212 %) in June and CN1 (0.102%) application was the highest concentration in October for the aril (Fig.14).

Mirdehghan and Rahemi (2006) determined that Pomegranate fruit Mg concentration of pomegranate fruit was decreased the and of the vegetation. The stabil period observed between August-September.

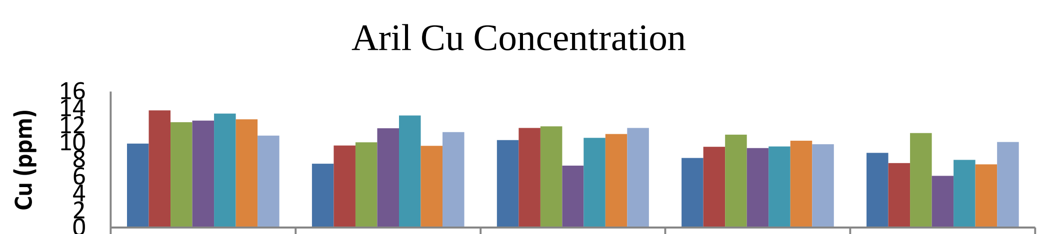
It was determined that the highest concentration of Mg was B2 (0.098 %) in June and B2 (0.093%) application was the highest concentration in October for the peel (Fig.15).

6. Aplications and Seasonal Changes of Leaf, Aril and Peel Cupper Concentration



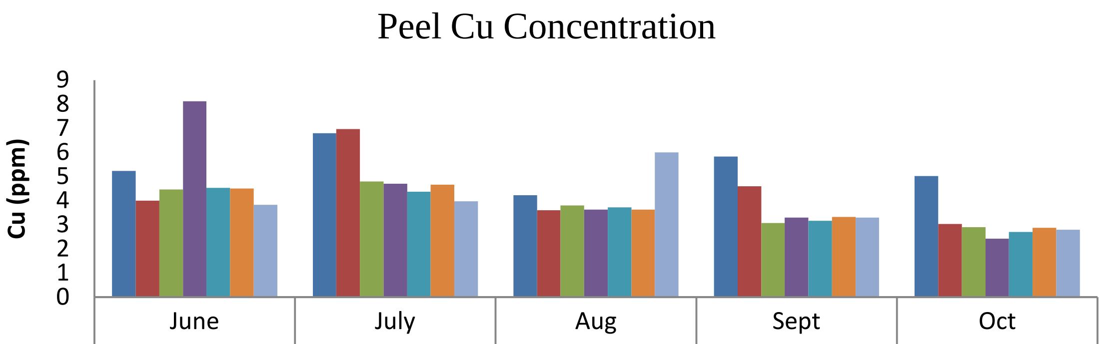
	May	June	July	Aug	Sept	Oct
C	4,3	6,63	4,8	8,43	8,16	9,07
CN1	8,9	7,03	5,66	9,8	10,2	9,93
CN2	8,73	6,5	6,2	11,3	7,96	8,73
B1	7,46	5,96	4,93	9,03	8,4	5,8
B2	8,7	6,53	5,46	9,36	8,95	10,1
GA1	7,86	6,26	5,53	9,33	9,26	9,13
GA2	7,3	6,2	5,2	8,06	9,33	9,13

Figure 16. Seasonal Changes of Leaf Cu Concentration in Applications



	June	July	Aug	Sept	Oct
C	9,87	7,5	10,3	8,2	8,8
CN1	13,8	9,67	11,73	9,5	7,6
CN2	12,4	10,03	11,9	10,93	11,1
B1	12,6	11,67	7,3	9,37	6,1
B2	13,4	13,2	10,57	9,53	7,97
GA1	12,73	9,6	11	10,2	7,43
GA2	10,8	11,23	11,73	9,8	10,07

Figure 17. Seasonal Changes of Aril Cu Concentration in Applications



	June	July	Aug	Sept	Oct
C	5,23	6,8	4,23	5,83	5,03
CN1	4	6,97	3,6	4,6	3,03
CN2	4,47	4,8	3,8	3,07	2,9
B1	8,13	4,7	3,63	3,3	2,43
B2	4,53	4,37	3,73	3,17	2,7
GA1	4,5	4,67	3,63	3,33	2,87
GA2	3,83	3,97	6	3,3	2,8

Figure 18. Seasonal Changes of Peel Cu Concentration in Applications

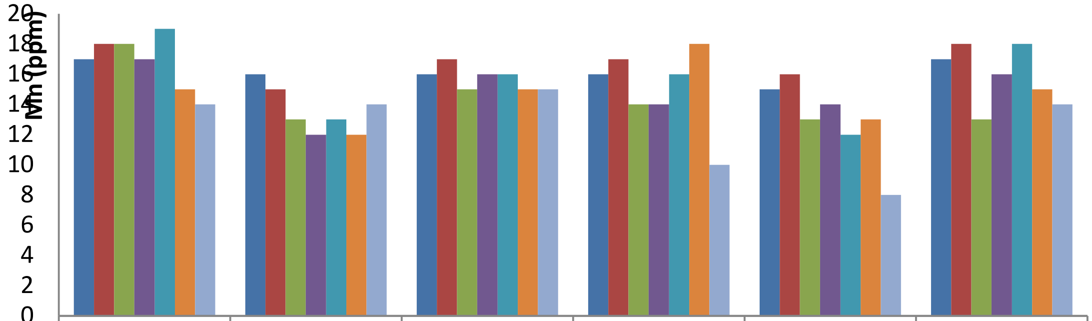
It was observed that the highest concentration of Cu was CN1 (8.90 ppm) in May and B2 (10.10 ppm) application was the highest concentration in October for the leaf (Fig.16). Leaf Cu concentration increased throughout vegetation except B1. Toprak and Seferoğlu (2013) observed that Leaf Cu concentration had increased throughout the vegetation in the chestnut (*Castanea sativa*).

It was observed that the highest concentration of Cu was CN1 (13.8 ppm) in June and CN2 (11.1 ppm) application was the highest concentration in October for the aril (Fig.17). Mirdehghan and Rahemi (2006) observed that the fruit Cu concentaration had decreased the end of the vegetation The stabil period for the applications between September and October.

The highest concentration of Cu was B1 (8.13 ppm) in June and C (5.03 ppm) application was the highest concentration in October for the peel (Fig.18). Peel Cu concentrations were decreased from June till October. Nachtigall and Dencen (2006) observed that rit and leaf Cu concentration decreased throughout the vegetation in apple.

7. Aplications and Seasonal Changes of Leaf, Aril and Peel Manganes Concentration

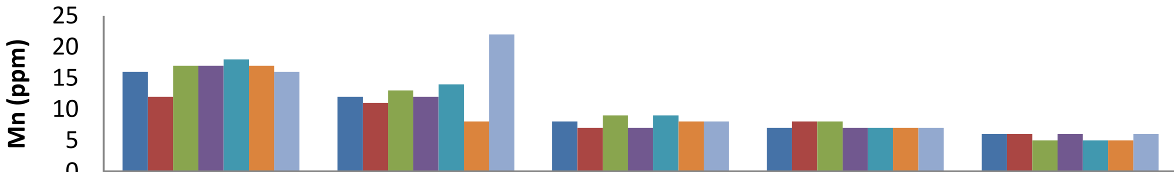
Leaf Mn Concentration



	May	June	July	Aug	Sept	Oct
C	17	16	16	16	15	17
CN1	18	15	17	17	16	18
CN2	18	13	15	14	13	13
B1	17	12	16	14	14	16
B2	19	13	16	16	12	18
GA1	15	12	15	18	13	15
GA2	14	14	15	10	8	14

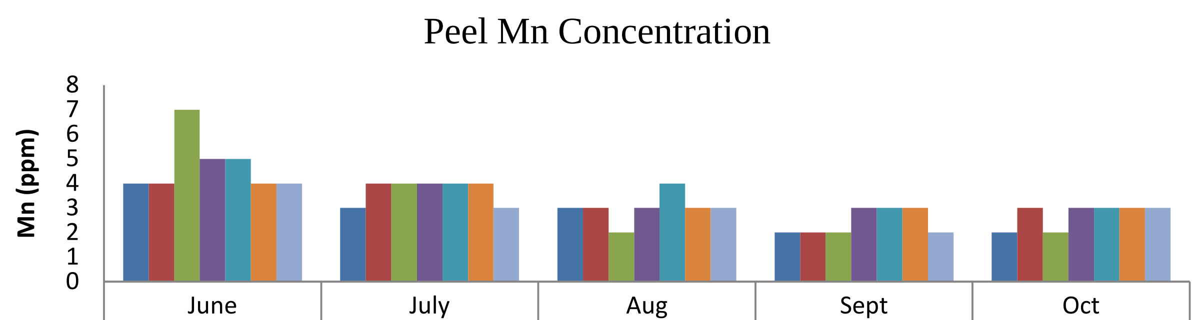
Figure 19. Seasonal Changes of Leaf Mn Concentration in Applications

Aril Mn Concentration



	June	July	Aug	Sept	Oct
C	16	12	8	7	6
CN1	12	11	7	8	6
CN2	17	13	9	8	5
B1	17	12	7	7	6
B2	18	14	9	7	5
GA1	17	8	8	7	5
GA2	16	22	8	7	6

Figure 20. Seasonal Changes of Aril Mn Concentration in Applications

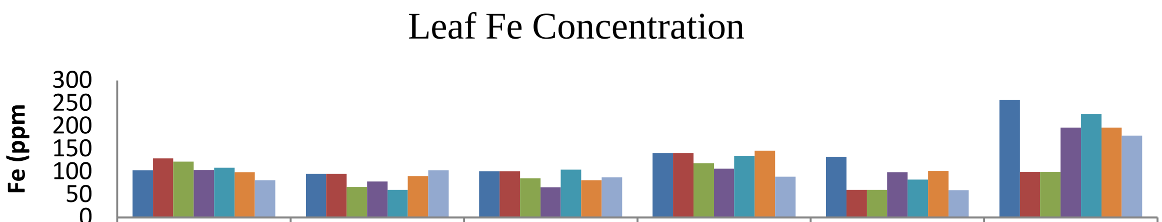


	June	July	Aug	Sept	Oct
C	4	3	3	2	2
CN1	4	4	3	2	3
CN2	7	4	2	2	2
B1	5	4	3	3	3
B2	5	4	4	3	3
GA1	4	4	3	3	3
GA2	4	3	3	2	3

Figure 21. Seasonal Changes of Peel Mn Concentration in Applications

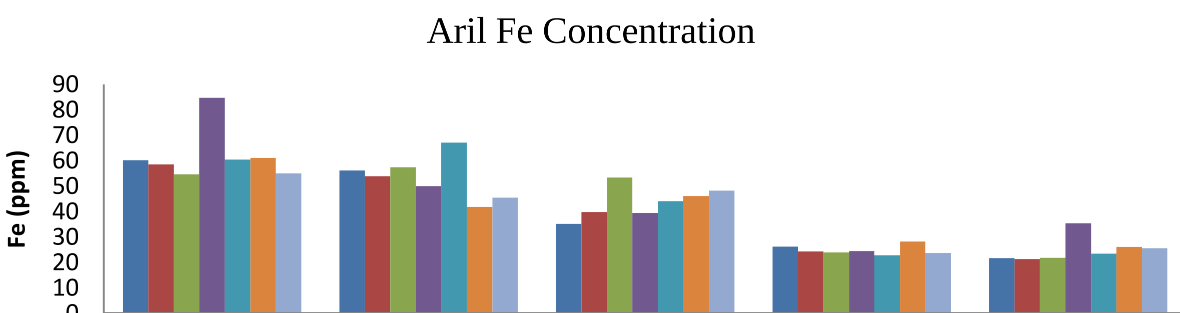
The highest concentration of Mn was observed B2 (19 ppm) in May and CN1 (18 ppm) application was the highest concentration in October for the leaf (Fig.19). It was observed that the highest concentration of Mn was B2 (18 ppm) in June and in all applications except C and CN2 (3 ppm) CN2 (11.1 ppm) application was the highest concentration in October for the aril (Fig.20). Mirdehghan and Rahemi (2006) had observed similar results seasonal changes of Mn for pomegranate. The highest concentration of Mn was observed CN2 (7 ppm) in May, C and CN1 (3 ppm) application was the highest concentration in October for the peel (Fig.21).

8- Aplications and Seasonal Changes of Leaf, Aril and Peel Iron Concentration



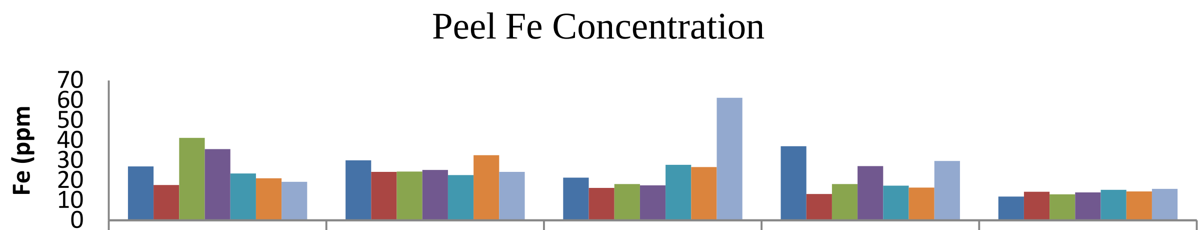
	May	June	July	Aug	Sept	Oct
C	103	95,9	101	141	133	257
CN1	129	95,9	101	141	60,1	99,9
CN2	122	66,9	85,5	119	60,1	99,9
B1	104	78,4	65,9	107	99,2	197
B2	109	60,3	105	135	83,1	227
GA1	98,8	90,5	81,3	146	102	197
GA2	81,7	103	88	88,9	60	179

Figure 22. Seasonal Changes of Leaf Fe Concentration in Applications



	June	July	Aug	Sept	Oct
C	60,13	56,17	35,1	26,2	21,63
CN1	58,53	53,93	39,83	24,27	21,3
CN2	54,6	57,43	53,33	23,97	21,83
B1	84,7	49,97	39,37	24,37	35,43
B2	60,4	67,13	44	22,77	23,43
GA1	61	41,77	46,13	28,17	26,07
GA2	55,03	45,43	48,23	23,67	25,57

Figure 23. Seasonal Changes of Aril Fe Concentration in Applications



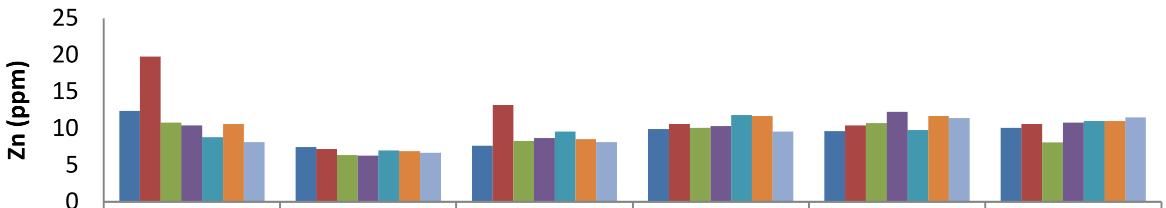
	June	July	Aug	Sept	Oct
C	26,93	30,03	21,37	37,07	11,93
CN1	17,73	24,17	16,2	13,13	14,27
CN2	41,2	24,47	18,1	18,13	13,07
B1	35,7	25,23	17,47	27,17	13,97
B2	23,4	22,63	27,83	17,3	15,33
GA1	21,1	32,53	26,63	16,3	14,5
GA2	19,2	24,27	61,33	29,7	15,8

Figure 24. Seasonal Changes of Peel Fe Concentration in Applications

The highest concentration of Fe was observed CN1 (129.07 ppm) in May and CN1 (256.93 ppm) application was the highest concentration in October for the leaf (Fig.22). The highest concentration of Fe was observed B1 (84.7 ppm) in June, B1 (35.43 ppm) application was the highest concentration in October for the peel (Fig.23). It was observed that Aril Fe concentration was decreased till September and stabilized after September. These results were in line with Mirdehghan and Rahemi (2006). The highest concentration of Fe was observed CN2 (41.2 ppm) in June, GA2 (15.8 ppm) application was the highest concentration in October for the peel (Fig.24).

9-Aplications and Seasonal Changes of Leaf, Aril and Peel Zinc Concentration

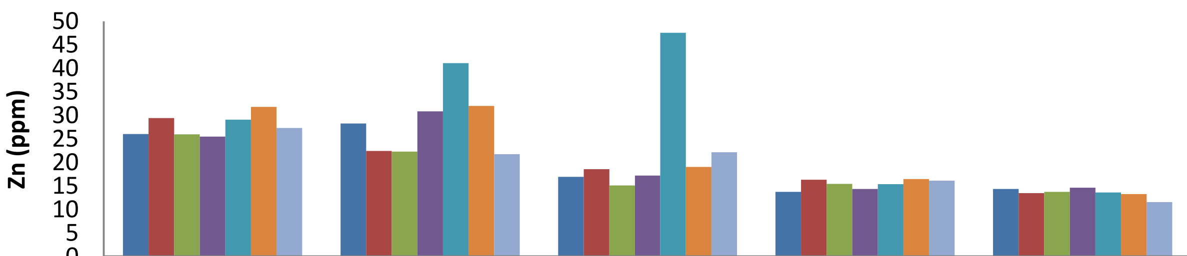
Leaf Zn Concentration



	May	June	July	Aug	Sept	Oct
C	12,4	7,48	7,66	9,94	9,63	10,1
CN1	19,8	7,23	13,2	10,6	10,4	10,6
CN2	10,8	6,4	8,32	10,1	10,7	8,08
B1	10,4	6,29	8,7	10,3	12,3	10,8
B2	8,78	6,98	9,59	11,8	9,79	11
GA1	10,6	6,92	8,53	11,7	11,7	11
GA2	8,14	6,69	8,13	9,56	11,4	11,5

Figure 25. Seasonal Changes of Leaf Zn Concentration in Applications

Aril Zn Concentration



	June	July	Aug	Sept	Oct
C	26,03	28,27	16,92	13,71	14,36
CN1	29,41	22,45	18,57	16,31	13,43
CN2	25,93	22,3	15,09	15,44	13,75
B1	25,47	30,83	17,19	14,33	14,58
B2	29,1	41,1	47,56	15,38	13,6
GA1	31,78	31,97	19	16,41	13,23
GA2	27,34	21,71	22,13	16,07	11,57

Figure 26. Seasonal Changes of Aril Zn Concentration in Applications

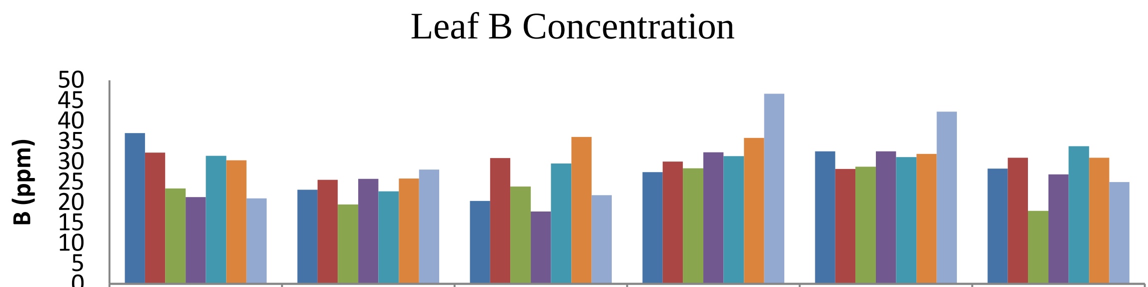
	June	July	Aug	Sept	Oct
C	7,81	12,99	5,93	6,84	6,36
CN1	7,3	12,8	6,83	5,62	6,9
CN2	8,2	11,24	6,91	5,7	7,02
B1	8,51	13,72	6,92	5,98	10,43
B2	9,61	14,97	14,29	6,07	7,23
GA1	9,08	16,42	6,81	7,4	3,73
GA2	8,17	9,35	12,36	7,83	6,74

Figure 27. Seasonal Changes of Peel Zn Concentration in Applications

The highest concentration of Zn was observed CN1 (19.78 ppm) in May, GA2 (11.54 ppm) application was the highest concentration in October for the leaf (Fig.25). Leaf Zn concentration had decreased at the beginning of vegetation and stabilized till the and of vegetation. Uçgun vd. (2009) had confirmed similar results for seasonal Zn in cherry “0900 Ziraat”. The highest concentration of Zn was observed GA1 (31.78 ppm) in June, B1 (14.58 ppm) application was the highest concentration in October for the aril (Fig.26). Aril Zn concentration was decreased throughout the vegetation. Nachtigall and Dencen (2006) had confirmed similar results for seasonal Zn concentarion changes in apple fruits.

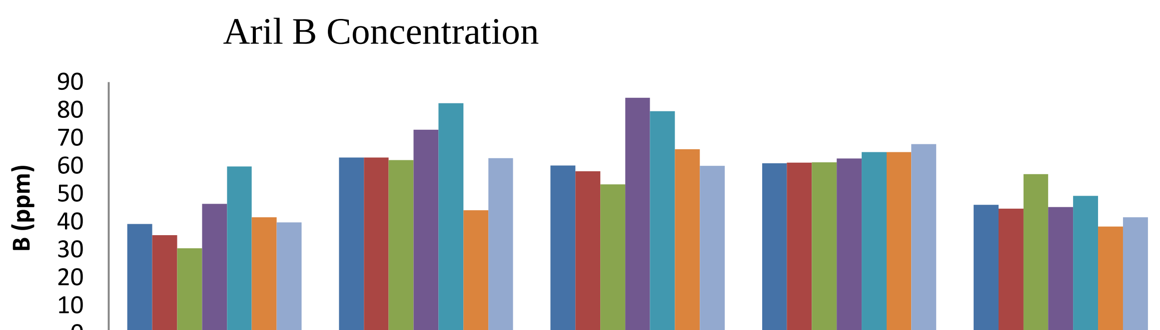
It was determined that the highest concentration of Mg was B2 (9.61 ppm) in June and B1 (10.43 ppm) application was the highest concentration in October for the peel (Fig.27). Peel Zn concentration was decreased the end of the vegetation.

10-Aplications and Seasonal Changes of Leaf, Aril and Peel Boron Concentration



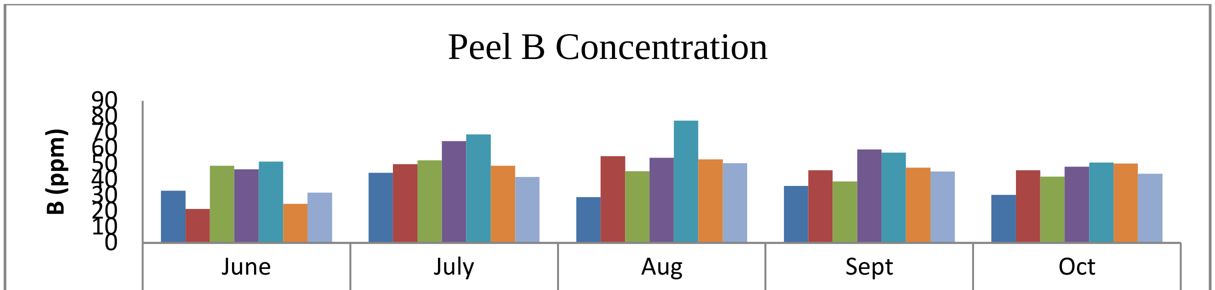
	May	June	July	Aug	Sept	Oct
C	37,067	23,133	20,4	27,4	32,533	28,267
CN1	32,233	25,567	30,933	30,067	28,233	30,967
CN2	23,433	19,533	23,933	28,367	28,8	17,9
B1	21,333	25,8	17,733	32,333	32,567	26,867
B2	31,433	22,733	29,567	31,333	31,133	33,8
GA1	30,333	25,9	36,067	35,833	31,9	31
GA2	21	28,067	21,8	46,667	42,267	24,967

Figure 28. Seasonal Changes of Leaf B Concentration in Applications



	June	July	Aug	Sept	Oct
C	39,167	62,967	60,067	60,933	46,067
CN1	35,2	62,967	58,033	61,2	44,6
CN2	30,467	62,067	53,333	61,233	57,067
B1	46,333	72,933	84,433	62,667	45,267
B2	59,733	82,5	79,6	64,9	49,233
GA1	41,567	44,1	65,9	64,933	38,267
GA2	39,7	62,733	59,967	67,833	41,567

Figure 29. Seasonal Changes of Leaf B Concentration in Applications



	June	July	Aug	Sept	Oct
C	32,967	44,367	29,067	36	30,5
CN1	21,567	49,833	55,033	46,067	45,967
CN2	48,9	52,267	45,467	38,967	41,933
B1	46,633	64,367	53,9	59,2	48,2
B2	51,567	68,733	77,467	57,167	50,833
GA1	24,7	48,833	52,833	47,733	50,267
GA2	31,9	41,7	50,567	45,133	43,833

Figure 30. Seasonal Changes of Leaf B Concentration in Applications

It was determined that the highest concentration of B was C (37.067 ppm) in May and B2 (33.80 ppm) application was the highest concentration in October for the leaf Fig.28). It was observed that Leaf B concentration decreased the beginning of vegetation and increased the end of vegetation. It is possible to see two different results interested with seasonal changes of leaf B elements. Whereas Buwalda and Meekings (1990) observed that leaf B concentration had decreased in (*Pyrus pyrifolia*), Takliavini et al. (2006) observed that Leaf B concentration had increased throughout the vegetation. It was determined that the highest concentration of B was B2 (59.733 ppm) in June and B2 (49.233 ppm) application was the highest concentration in October for the aril (Fig.29). Aril B concentration was decreased trend after August. These results were in line with Mirdehghan and Rahemi (2006). It was determined that the highest concentration of B was B2 (51.567 ppm) in June and B2 (50.833 ppm) application was the highest concentration in October for the peel(Fig.30). Peel B concentration was maximum in July and then ıt was observed a decreasing trend. Nachtigall and Dencen (2006) determined in apple that B was showed decreacing trend throughout vegetation period. These results were in line with our study.

CONCLUSIONS

N,P,K contents decreased during one vegetation period of leaf. Ca, Mg, Cu, Mn, Fe, B contents increased during the vegetation period. Zn showed an decreasing the beginning of vegetation after it showed an increasing towards the end of vegetation. In general, the accumulation of mineral nutrition in arils showed decreasing trend in all applications. This can be explained by the fact that the rate of growth of the fruit is higher than the rate of mineral matter accumulation in the fruit. Similarly, The accumulation of mineral nutrition in peel showed decreasing trend in all applications. Foliar sprays of GA_3 (50ppm) increased leaf N,P concentration, Aril N,K,Mg concentration and Peel K concentration. Foliar sprays of GA23 (75 ppm) increased leaf P concentration, Peel P and Fe concentration. Foliar sprays of CN1 (2%) increased leaf, Ca, Cu, Mn, Fe, Mg, Aril Ca, Cu concentration. Foliar sprays of CN2 (4%)

increased aril L, Cu and Peel N, Ca, Mn concentration. Foliar sprays of B1 (1.5 %) increased leaf K concentration, Aril P,Fe concentration and Peel B concentration. Foliar sprays of B2 (3%) increased leaf leaf K, Cu, Mn concentrations, Aril K, Mn concentarions and Peel Ca and Mg concentrations.

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