The Seasonal Changes of Nutritional Elements of Chestnut *(Castanea sativa)* Plant and Determination of Leaf Sampling Times[a]

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Abstract

This study was carried out in 2006-2007 years and Kösk district of Aydın province to determinate of plant nutrient status and the most suitable time to take leaf samples of chestnut three trees from each orchard were selected. The samples were taken from the twenty five years old Karaası chestnut local variety from the beginning of vegetation to the harvest. At the same time, soil samples were taken from 0-30 cm soil depth at the beginning of vegetation period. According to the leaf analysis results, N, P and Mg concentrations increased up to August, then they decreased. K and Cu contents gradually increased from the beginning of vegetation to the end of harvest. Ca and Mn contents continuously increased during the vegetation period while Fe content decreased up to August and it increased then decreased at the end of harvest. Zn content was stable until September. Then it rose to the harvest. As a result, the most suitable time to take leaf samples of Karaası chestnut local variety was determined as 15 July – 15 August period.

Key Words : Chestnut *(Castanea sativa Mill.)*, nutrients, seasonal changes, leaf sampling time

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[a]Master Thesis are used as a reference.

Introduction

Chestnut belongs to the genus Castanea of the Fagaceae family. Usually spread 13 species known chestnuts to different parts of Northern Hemisphere. Areas of natural spread of these species in East Asia (China, Korea, Japan), Turkey, Southern Europe and North America (Ozkarakas et al, 1995).

Chestnuts and many temperate fruit tree species have been grown in Anatolia since ancient times. Chestnuts abundantly exist in the East Black Sea subsection, the Marmara region, and the Antalya coastal area via the West Anatolia subsection in Turkey (Soylu, 1984). The leading chestnut-growing countries in the world are China, Korea, Italy, and Turkey. Of the total chestnut production in the world (1.223.385 t), 75.6% (925.000 t) came from China, and Turkey was in third place with 63.000 t (5.14%) (FAO, 2008).

The Aegean, Black Sea, and Marmara are the leading chestnut-growing regions of Turkey. There were approximately 2.800.000 chestnut trees in the country, consisting of 2.232.000 bearing trees and 568.000 nonbearing trees. Aydin province provided 37% of the total chestnut production in Turkey (TUIK, 2008), followed by İzmir, Sinop, Kastamonu, Kütahya, Bartın, Balıkesir, Manisa, Zonguldak, and Bursa. Since chestnut growing in Anatolia dates back to ancient times, numerous chestnut genotypes with different tree characteristics and fruit quality have emerged (Soylu and Ufuk, 1994). This is evident from the chestnuts sold in local markets. These chestnuts vary in terms of taste, color, shape, and peeling. In Anatolia, there was a great diversity among the 3.000.000 chestnut trees. Within these rich genetic sources, we can find genotypes having high yields, attractive and bright color, and large fruit size, and those having fewer, smaller and low-quality fruits reported by Soylu (1984).

Soil and leaf analysis methods are often applied to determine plant nutritional status. Leaf analyses methods are often used to determine total amount of nutrients and used for evaluating soil fertility status. With these methods, determined nutrient concentrations are compared to sufficiency level and evaluated. Because nutrient requirement changes among plant species and genotypes, critic levels indicating healthy plant growth may differ.Therefore, some standard values are used to interpret plant nutritional status. However; for evaluating nutritional status of chestnut trees some different values were reported by authors Vossen (2000).

Materials and Methods

The study was carried out in the Köşk districts of the Aydin province with the Karaşı zonal cultivars in 2006-2007. In this study, 180 selected trees were marked from 30 orchards and 4500 leaves samples were taken during the vegetation period. Furthermore soil samples were taken in May. For this purpose, 30 orchards provided by commercial farm from 25 years old Karaaşı chestnut local variety. Trees (5 trees for each thousand square meters) from different points of the orchards were selected. Leaf samples were collected during the vegetation periods from terminals representing whole tree from four sides.

Soil characteristics of research areas

Some soil properties of the research areas were given in Table 1. When the soil properties were evaluated by Ülgen and Yurtsever (1995) and Viets and Lindsay (1973), it was seen that 40% of the soils was notr, 60% of was slightly asidic and lime content of about all of the soils was low (Kellog 1952). Soil textures research arreas were determinated as claymloam and claym 13% and 87% respectively (Black 1965). About 63%, 57% and 87% of the soils were insufficient in terms of organic matter, nitrogene and calcium contents, respectively (Schlincting and Blume 1960). Moreover iron and zinc contents were seen insufficient by order of 77% and %67 (Viets and Lndsay 1973). Phosphorus, magnesium copper and manganese contents of the soils were sufficient (Olsen and Dean 1965). (Table 1).

Table 1. Some characteristics of the soils taken from the research areas (2006-2007).

				%				ppm							
Orchard No	Depth (cm)	Texture	pH	Salt	Lime	O.M.	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn
1	0-30	L	6.2	-	2.3	1.6	0.12	15.08	457	794	97.60	5.02	0.78	2.29	0.91
2	0-30	L	6.8	-	2.1	1.7	0.12	17.06	364	298	66.30	4.83	0.48	2.04	0.81
3	0-30	L	6.7	-	2.1	1.8	0.11	17.86	327	198	67.70	5.32	0.52	2.18	0.93
4	0-30	L	6.1	-	2.2	1.9	0.12	16.27	289	99	81.20	5.61	0.67	2.31	0.78
5	0-30	L	6.9	-	2.2	1.2	0.12	7.80	524	496	156.68	4.31	0.81	2.65	1.04
6	0-30	L	6.3	-	2.1	1.9	0.13	8.33	352	595	152.32	4.82	0.83	2.18	0.67
7	0-30	L	6.5	-	2.0	1.6	0.12	18.25	491	595	149.62	4.11	0.73	2.61	1.02
8	0-30	L	6.9	-	2.0	1.8	0.11	7.28	524	496	137.83	5.23	0.54	1.94	0.82
9	0-30	L	6.1	-	1.9	1.9	0.12	7.28	423	397	175.62	5.72	0.89	2.39	0.86
10	0-30	L	6.5	-	1.6	1.6	0.12	8.73	339	397	154.34	4.54	0.57	2.54	1.08
11	0-30	L	6.3	-	1.9	2.5	0.11	23.41	645	893	127.12	4.89	0.69	2.85	0.88
12	0-30	CL	6.2	-	1.9	3.5	0.10	6.48	237	695	158.24	4.12	0.91	1.81	1.39
13	0-30	L	6.7	-	2.0	2.2	0.12	15.34	376	794	145.52	4.05	1.03	2.02	1.43
14	0-30	L	6.4	-	1.9	2.6	0.11	9.52	327	595	155.23	4.17	1.24	1.81	1.08
15	0-30	L	6.4	-	2.1	2.0	0.12	4.76	251	595	175.42	4.12	1.44	2.12	1.42
16	0-30	CL	6.3	-	2.0	3.1	0.20	4.23	224	695	177.59	4.04	1.52	1.49	1.37
17	0-30	L	6.5	-	2.0	1.3	0.11	11.38	491	397	145.61	4.72	0.77	1.92	1.13
18	0-30	L	6.4	-	2.1	1.8	0.13	15.74	555	298	137.83	4.62	0.67	1.85	1.14
19	0-30	L	6.7	-	2.0	4.2	0.19	23.68	929	695	125.94	4.32	0.74	1.97	1.06
20	0-30	L	6.6	-	1.8	1.7	0.02	14.02	352	794	132.84	4.34	0.79	1.94	1.03
21	0-30	L	6.1	-	2.5	0.6	0.04	20.50	457	397	175.42	4.89	0.82	2.23	1.24
22	0-30	L	6.3	-	2.1	0.5	0.04	5.82	211	893	136.86	5.02	0.91	2.37	1.02
23	0-30	L	6.3	-	2.4	2.1	0.03	28.44	457	496	151.24	5.12	1.18	1.82	1.13
24	0-30	L	6.4	-	2.1	2.1	0.01	17.59	264	695	143.86	4.54	0.81	2.28	1.18
25	0-30	CL	6.8	-	2.1	4.0	0.19	13.89	171	992	101.02	3.91	1.62	1.84	0.73
26	0-30	CL	6.8	-	2.0	3.2	0.17	11.64	276	695	112.02	4.81	0.91	1.88	0.81
27	0-30	L	6.4	-	2.1	1.3	0.11	28.97	376	397	84.23	4.13	1.23	1.69	1.07
28	0-30	L	6.6	-	1.9	1.8	0.12	20.24	314	496	82.73	4.58	1.51	1.73	1.03
29	0-30	L	6.6	-	2.0	1.6	0.11	12.54	267	751	91.17	4.61	1.32	1.63	0.71
30	0-30	L	6.4	-	2.1	1.7	0.13	21.63	328	487	102.40	3.74	1.44	1.68	0.84
	Maximum		6.9	-	2.5	4.2	0.20	28.97	929	992	177.59	5.72	1.62	2.85	1.43
	Minimum		6.1	-	1.6	0.5	0.01	4.23	171	99	66.30	3.74	0.48	1.49	0.67
	Average		6.5 ± 0.2	-	2.1 ± 0.2	2.0 ± 0.8	0.08 ± 0.07	14.59 ± 6.80	397 ± 153	569 ± 215	129.54 ± 33.51	4.62 ± 0.50	0.95 ± 0.33	2.08 ± 0.33	1.02 ± 0.21

Plant analysis

Leaf samples were washed thoroughly with fountain water, dilute acid (0.2 N HCl) and re-distilled water to remove surface residues then dried at 65 C^0 and grounded for nutrient analysis. Nitrogen concentration in samples was determined according to modified Kjeldahl method. In order to determine P, K, Ca, Mg, Zn and Mn concentrations, 1 g of leaf sample was dry ashed at 500 ± 50 ^{0}C for 8 h, and the ash was dissolved in 4 ml of 3N HCl and filled up with re-distilled water. Phosphorus concentrations of leaf samples were measured by vanadate-molybdate colorimetric method. The other nutrients were determined by an atomic absorption spectrophotometer (Kacar 1972).

Evaluation of analysis results

Plant nutrient concentrations were evaluated with adequate ranges for chestnut trees. Adequate ranges of leaf mineral nutrient contents in chestnut trees were indicated as 1.94-2.81 %, 0.14-0.19 %, 1.88-2.92 %, 0.14-0.33 %, 0.43-0.48 %, 197-271 ppm, 337- 728 ppm, 34-60 ppm, 16-24 ppm for N, P, K, Ca, Mg, Fe, Mn, Zn and Cu respectively by Jones et al. (1991).

Results

Nitrogen concentrations of trees grown in the research areas were given in Table 2. Leaf N concentrations ranged between 1.94-2.81 %. Average N concentration of trees in Köşk district was found to be 2.43 %. Average P concentrations of leaf samples ranged from 0.14 to 0.19 %. General mean P contents samples were determined 0.17%. Mean K concentrations in districts ranged between 1.88-2.92% (Table 2). Because leaf K concentrations were higher than 2.19%, there was not a nutritional problem in Köşk orchards had also sufficient K levels at rate of 100% from soil samples of chestnut orchards.

Table 2. Leaf macro plant nutrients concentration of chestnut trees

Months	%				
	N	P	K	Ca	Mg
May	2.42	0.14	2.92*	0.14	0.43
June	2.43	0.16	2.20**	0.22*	0.45
July	2.81*	0.18	2.18	0.30	0.48**
August	2.72**	0.19**	2.05	0.31	0.46
September	2.26	0.18*	1.88	0.32**	0.44*
October	1.94	0.14	1.93	0.33	0.45
Maximum	2.81	0.19	2.92	0.33	0.48
Minimum	1.94	0.14	1.88	0.14	0.43
Average	2.43 ± 0.32	0.17 ± 0.02	2.19 ± 0.38	0.27 ± 0.07	0.45 ± 0.02

P< 0.05 p<0.01***

Seasonal Ca concentrations were changed dramaticalls in leaves taken from the orchards. Average Ca concentrations were 0.14-0.33 and insufficient whole for Köşk districts. This findings indicates that there are some factors preventing Ca uptake by plant. In the literature, it is mentioned that there are several factors affecting Ca uptake. For instance, in-balanced watering, low transpireation rates and low soil pH negatively affect plants Ca uptake (Kacar and Katkat 1998).

According to results, all soil samples taken from Köşk contained low level Ca. By the way higher rate of P and sometimes N in the external solution might be another factor for decreasing plant Ca uptake. Because P and N easily carried in plant tissues, higher amount of these nutrients prevents plants from uptaking sufficient Ca. The other important factor leading to Ca deficiency in plants might be higher concentration of Fe, Zn and Mn in soil solition by Kacar (1995).

It was observed that leaf Mg concentrations were ranged from 0.43-0.48 and as well as determinated all of orchards soils to Mg sufficient. Average Zn concentration of trees in Köşk district represented all of orchards were found to be 40.67 ppm. On the other hand in Köşk district, most of the orchards had insufficient Zn concentration (Table 2).

Manganese concentration as general mean for the region was found to be 534.17 ppm . (Table 2). According to the results obtained, whole orchards in Köşk were sufficient in Mn. Similarly, most of the of orchards soils samples in chestnut orchards were found to be Mn sufficient. When the region was examined generally, it was seen that 60% of the samples were Mn-sufficient and 40% was Mn-deficient (Table 3).

Table 3. Leaf micro plant nutrients concentration of chestnut trees

Months	ppm			
	Fe	Zn	Cu	Mn
May	223	39**	24**	337
June	203	34	18*	423
July	197	39	18	560*
August	271*	34	17	563
September	240**	38	16	594
October	225	60*	16	728**
Maximum	271	60	24	728
Minimum	197	34	16	337
Average	226 ± 26.8	41 ± 0.7	18 ± 2.9	534 ± 137

P< 0.05 p<0.01***

Finaly, leaf Cu concentration ranged between 1.49-2.85 ppm. According to soil samples not observed Cu deficiency and was measured higher than 0.2 ppm all the orchards.

Discussion

According to the leaf analysis results, K, Cu and, Na contents gradually increased from the beginning of vegetation to the end of harvest. Ca and Mn contents continuously increased during the vegetation period while Fe content decreased up to August and it increased then decreased at the end of harvest.

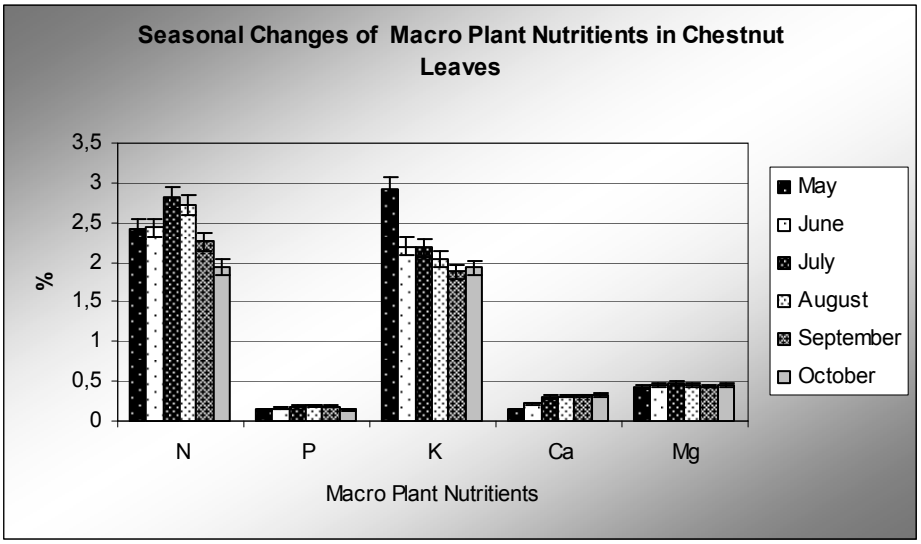

Figure 1. Seasonal Changes of Macro Plant Nutritients in Chestnut Leaves.

Zn content was stable until September. N, P, Mg, and B concentrations increased up to August, then they decreased. Then it rose to the harvest. This results showed the most suitable priod to take leaf samples for Karaası chestnut local variety was determined as 15 July – 15 August period (Figure1-2).

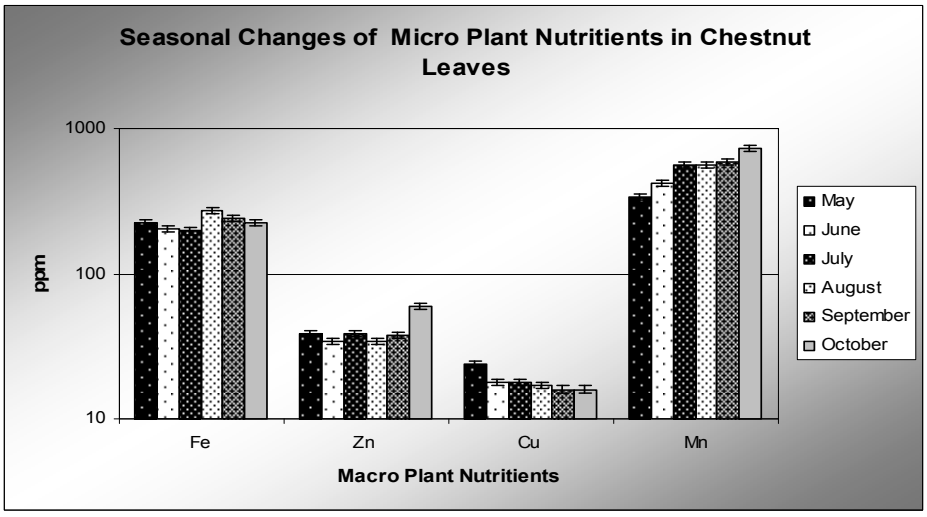

Figure 2. Seasonal Changes of Micro Plant Nutritients in Chestnut Leaves.

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