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DETERMINATION OF SPATIAL VARIABILITY IN OLIVE PRODUCTION. PART II - LEAF

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Abstract

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This research was carried out in an olive orchard with 84 trees in Turkey to determine spatial variability of plant nutrition in leaves. Leaf analyses were realized by using samples which were taken from grids. The soil of the olive orchard was suitable for olive growing due to physical and chemical analysis except organic matter, Mn, and Zn. The leaf analysis showed that the levels of K, Ca, Mg, and P were sufficient. These results were parallel to the results obtained from soil. When micro element levels were investigated; the levels of Fe and Mn were adequate, and level of Cu was excessive. Due to the analysis results; N, P, Mn and Zn will be required for the next year olive production. The fertilization strategies must include these applications.

Key words: olive, spatial variability, nutrition, leaf analysis

Introduction

Olive is a plant of Mediterranean climatic conditions (Saracoglu, 2001). Olive are produced over 8.5 Million Ha. and 15 Million Tonnes in the World. Total number of olive trees which 97% of these trees are growing in Mediterranean Countries is 810 Million (Anonymous, 2004). Olive is usually produced in poor soil which is not suitable for field crops in Turkey. Big percentage (75 %) of olive orchard is located in sloppy hills. Olive orchard are usually established by grafting of wild olive trees Mean density of olive trees is 100-110 trees per hectare in Turkey (Goksu, 2003).

Lack of microelements such as Fe, Mn, Zn, Cu, B, Mo and Cl in soils and plants affect agricultural production in stead of few amount of these elements. If there is a lack of micro elements, fertilization does not improve the yield (Sendemirci and Korkmaz, 2008).

Important growing factors are absorption rate of nutrient, distribution and mobility of the nutrient in plants (Aydemir and Koleli, 1994).

Olive is known as rich plants of poor soils and it is not given any importance to its nutrition. Olive takes the great amount of its water and nutrition element needs from the soil with its wide and deep root sys-

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tem. Both the amount and the quality of the olive grown without fertilizer are low. In order to have bountiful harvest with high quality, nutrition elements in proper ratio and amounts should be given to the soil as fertilizer. According to 2004 data, 37230 tons of total fertilizer ($N:P_2O_5:K_2O$) has been used in fertilization of olive. This amount is 1.8 % of the fertilizer used in Turkey overall. The ratio of nutrition elements ($N:P_2O_5:K_2O$) used in olive fertilization is (5.2:1.9:1.0). The chemical fertilizers for olive are suggested considering: a) Climate factors (rainfall, temperature, light), b) Soil factors (physical and chemical properties of soil, humidity, soil temperature and c) Plant factors (type and species of olive, age of the tree, growth condition of the tree, root structure and growth). The probability of the fertilizer suggestions offered considering these factors being suitable, balanced and economical is high (Kacar and Katkat, 2007).

Olive preserves its property of being an important and strategical product nowadays because of medicinal importance in human diet and health. Approximately 10% of the production of olive accepted as an important product in the world agriculture economy is in Turkey.

This research is carried out in order to determine the local variation of plant nutrition elements in leaves in the olive orchards and to set fertilization program considering this local variation. This research is carried out in an olive orchard placed in Sarkoy borough in Tekirdag province. Plant nutrition elements in leaf samples are determined in the research. Local variation maps are charted from the data obtained by the help of coordinate information and fertilizers are applied for every tree in the ratio of its need.

Materials and Methods

Materials

Trimble AgGps132 and Ag170 Field Computer were used in this research for determining coordinates.

Ammonium Nitrate (33%) and Triple Super Phosphate fertilizers (42%) are used. The amount of the fertilizers was applied according to results of the soil and leaves analyses used to determine requirement of olive trees.

A fertilization program was set up according to N and P content of all trees and the soils around them with a calculation of 1 kg of pure N to the tree with minimum N and 0.5 kg of P_2O_5 to the tree with minimum P and fertilization has been applied according to controlled calculations.

N and P fertilization was applied from the soil and Mn and Zn fertilization was applied from the leaf according to leaf analyses. Ammonium nitrate (33%) for N, triple super phosphate (42% P_2O_5) for P and leaf fertilizers including Mn and Zn are used for the fertilization of this olive orchard.

Methods

Only 20 leaf samples are taken from an olive orchard with 84 olive trees in Sarkoy village. All the olive trees in the orchard are “Gemlik” species for oil.

Leaf samples are taken in October which the trees are in stationary period. The samples (4-8 leaf pairs north, south, east and west sides of all trees) are taken from the mature leaf pairs in the center of buds developed in that year of the trees with 1.5-2 m height. Totally 200-400 leaves taken from each 20 trees were put into cloth bag, labeled, sent to the laboratory in ice boxes for analysis with necessary information and analyzed (Kacar and Katkat, 2007).

According to meteorological data of Tekirdag region covering long years (57 years) average included year 2006, average annual temperature is 13.9^0C, average annual total rainfall is 578.6 kgm^{-2}, average annual vapor pressure is 12.7 hPa, average annual atmosphere pressure is 998.3 mb, average annual rainy days is 99.3 days and average annual relative moisture ratio is 76.0 % (Anonymous, 2007).

Total nitrogen in the leaf samples burned dry and wet are determined with vapor distillation (Kjeldahl) method (Saglam, 2008), available phosphorus with yellow color method in spectrophotometer and other exchangeable cations (Ca^{++}, Mg^{++}, K^+) and available Fe, Mn, Zn, Cu contents with ICP-OES instrument (Kacar and Inal, 2008).

Each olive tree was harvested by hand and harvested olive was weighted with a weighbridge.

Field divided grids that its dimensions were 7m x 7m. Field markers were used to determine grids position in the field. Each tree was harvested by hand and olives put in sacks and were weighed with weighbridge.

Measured results were used to produce maps (plant nutrition elements maps etc.). The maps are produced by using a methodology that developed and published by Denmark Royal Veterinary and Agricultural University, Centre for Precision Farming (Blackmore and Marshall, 1996; Blackmore, 1998; Akdemir and Blackmore, 2004). Positioning of data points on the maps were determined due to field size. Coordinates of the onion field is given in table.

Data will also be used to determine next year fertilizing strategy for different agricultural applications such as chemical applications, seeding rate, etc.

Results and Discussions

Different from the previous years, the fertilization with nitrogen and phosphorus fertilizers is carried out in control in order to be effective on amount and quality of the product of the next year considering the inadequacy of Zn in research soils.

The results concerning the macro and micro element contents of leaf samples are given in Table 1 and

Table 1

The amounts of available macro and micronutrition elements of leaf samples, %

Sample No	Tree No	Macro elements, %					Micro elements, ppm			
		N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
1	2	0.920	0.168	1 261	2 967	0.296	159 168	52 820	22 449	158 955
2	5	0.974	0.207	1 373	2 603	0.263	629 568	64 620	20 059	128 455
3	10	0.971	0.171	1 378	2 552	0.290	595 868	56 200	16 529	174 155
4	13	0.960	0.189	1 489	2 253	0.262	209 368	59 810	19 939	111 055
5	18	0.901	0.165	1 385	2 850	0.268	176 068	57 740	16 229	73 115
6	22	0.960	0.176	1 639	2 581	0.230	195 968	78 760	14 379	232 955
7	28	0.934	0.159	1 478	2 792	0.274	478 168	74 440	19 639	115 555
8	31	0.903	0.163	1 333	2 921	0.274	259 768	68 200	18 389	180 655
9	35	0.917	0.194	1 526	2 202	0.251	339 868	43 570	21 899	148 055
10	41	0.890	0.186	1 519	2 552	0.264	240 868	58 420	18 999	144 755
11	47	0.901	0.173	1 396	2 832	0.363	589 268	75 260	19 469	158 755
12	50	0.933	0.148	1 343	2 715	0.306	182 468	51 680	19 009	46 225
13	53	0.896	0.191	1 377	2 826	0.276	255 468	62 870	21 569	164 155
14	56	0.885	0.160	1 339	3 031	0.307	87 838	69 310	16 999	44 975
15	61	0.862	0.143	1 206	3 283	0.323	160 268	80 360	14 609	52 885
16	65	0.894	0.128	1 088	2 692	0.242	446 468	101 200	12 399	86 555
17	69	0.902	0.170	1 528	2 579	0.279	171 668	67 400	17 089	103 255
18	74	0.905	0.165	1 325	2 676	0.295	299 068	66 360	16 029	60 375
19	79	0.893	0.190	1 397	2 796	0.253	266 198	51 440	20 729	143 855
20	83	0.901	0.171	1 234	3 163	0.335	232 868	73 230	17 709	141 155
MIN		**0.862**	**0.128**	**1 088**	**2 202**	**0.230**	**87 838**	**43 570**	**12 399**	**44 975**
MAX		**0.974**	**0.207**	**1 639**	**3 283**	**0.363**	**629 568**	**101 200**	**22 449**	**232 955**
AVG		**0.915**	**0.171**	**1 380**	**2 743**	**0.282**	**298 813**	**65 685**	**18 206**	**123 495**

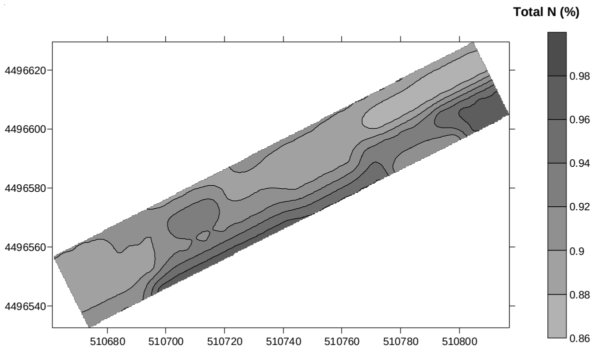

Fig. 1. Spatial variability of total N

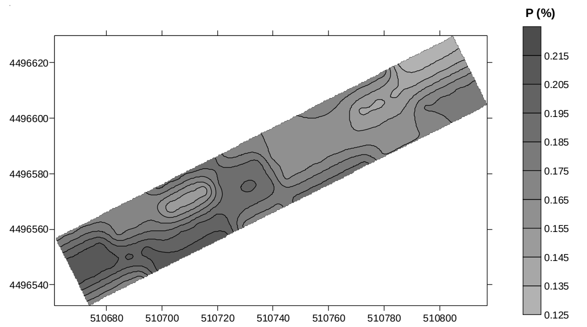

Fig. 2. Spatial variability of P

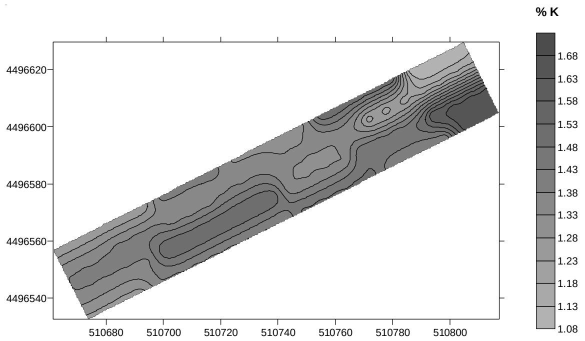

Fig. 3. Spatial variability of K

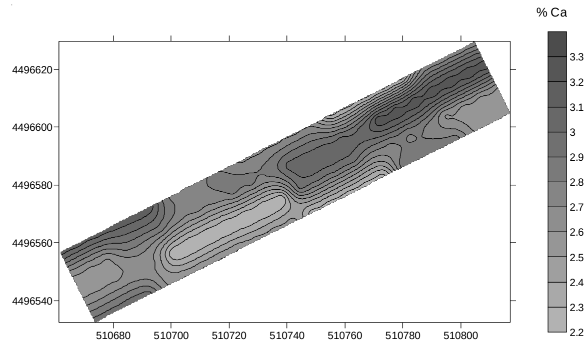

Fig. 4. Spatial variability of Ca

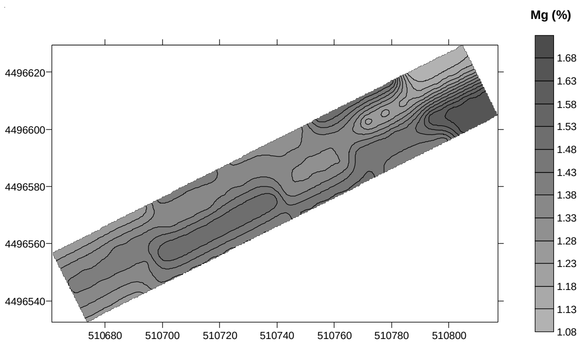

Fig. 5. Spatial variability of Mg

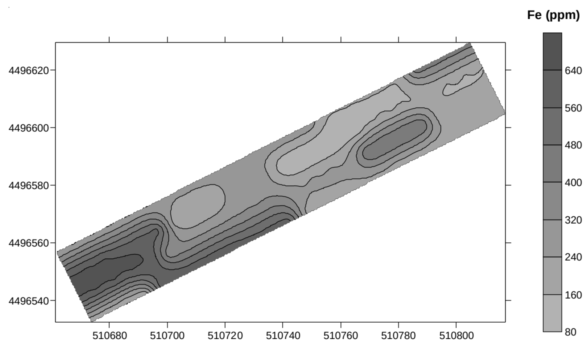

Fig. 6. Spatial variability of Fe

Figure 1 to Figure 9.

The average available N, K, Ca, Mg and P % amounts in olive leaves is found to be 0.915, 1.380, 2.743, 0.282 and 0.171 % respectively. Olive leaves are in “inadequate” class in terms of total nitrogen content since it includes less than 1.50 % nitrogen. One leaf sample (sample no:16) is in “adequate” class since it is between 1.088 % and 0.90-1.20 % in terms of K content, the other 19 leaf samples are in “excess” class since they have more than 1.20 % K content. All of the leaf samples are in “adequate” class in terms of Ca content since they have more than 1 % Ca content. Leaf samples are in “adequate” class in terms of beneficial Mg content as like in calcium, since they have more than 0.20 % Mg content. Leaf samples are in “adequate” class in terms of beneficial P content, since they have 0.1-0.30 % phosphorus content (Kacar and Inal, 2008).

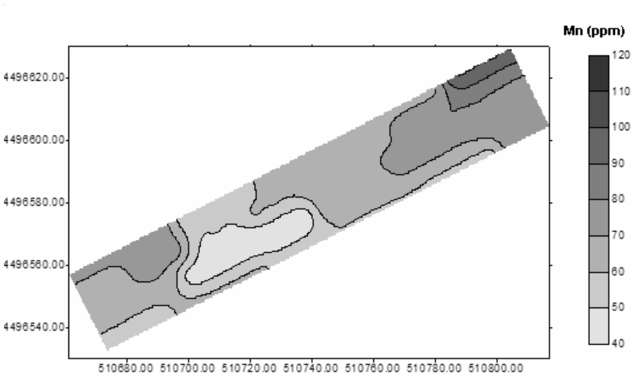

Fig. 7. Spatial variability of Mn

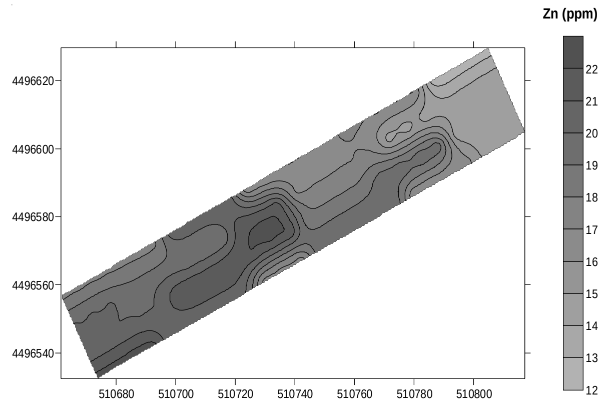

Fig. 8. Spatial Variability of Zn

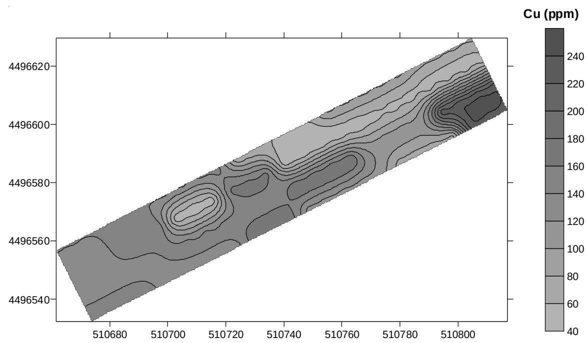

Fig. 9. Spatial variability of Cu

It is determined that the average beneficial Fe, Mn, Zn and Cu amounts are 298.813 ppm, 65.685 ppm, 18.206 ppm and 123.495 ppm respectively. Seven of the leaf samples are in "adequate" class since it is 70-200 ppm in terms of Fe content; thirteen of them are in "excess" class since they have more than 200 ppm Fe content. All of the leaf samples are in "adequate" class in terms of Mn content since they have more than 25 ppm Mn content. All of the leaf samples are in "inadequate" class in terms of Zn content since they have less than 25 ppm Zn content. All of the leaf samples are in "excess" class in terms of Cu content since they have more than 18 ppm Cu content (Kacar an Inal, 2008).

15-20 ppm may be accepted as a limit for the shortage level of zinc in the leaves. Mostly the seed and grain efficiency is affected from zinc shortage. Plant species may be affected from Zn shortage in different ways (Gunes et al., 2007).

Conclusions

According to the research results, there is also requirement of leaf nutrition which includes Mn and Zn. In addition, leaf nutrition was applied according to the required amount of Mn and Zn.

Agriculture of olive in Turkey has not developed as expected although Turkey is in the second rank in olive production after European Union countries and is in the major olive regions of the world. The reason of this is the lack in reflecting the developments in agricultural technologies to agriculture of oil. The fundaments of olive production should be considered in newly established olive orchards. A necessary importance should be given to the care operations like irrigation and nutrition of olive as like of other fruits (Nikpeyma, 2008).

In order to get bountiful harvest in good quality, it is necessary to determine the nutrient (fertilizer) need of the tree and related to this, a balanced fertilization is necessary. In order to provide the correct and balanced fertilization in Turkey, it is necessary to enlarge and increase the quality of leaf analysis. The contribution of the increment of conscious fertilizer consumption and especially precise farming applications to the economy will be high.

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