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ADVANCED RESEARCH IN LIFE SCIENCES
1(1), 2017, 7-20

www.degruyter.com/view/j/arls

DOI: 10.1515/arls-2017-0002
Research Article

The Determine of Sugar Beet Nutrition Problems in Konya Plain's Soils

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Accepted June, 2017

Abstract
This study was aimed to determine the deficiency or excessivity of nutrients for sugar beet crop in Konya plain. The results showed that the pH value was found as 7.65 and soils were classified as sodic; the organic matter was 1.59% and 92.9% of the soil samples was poor in terms of the organic matter. The mean lime content ($CaCO_3$) was determined capacity was 26.07 and 97.1% of the soil samples was limy and the mean cation Exchange capacity was 26.07 me/100g, and it was varied between 10.72 me/100g and 44.7 me/100g. The mean available NH_4+NO_3 nitrogen content, phosphorus and potassium for crop were as 0.059%, 10.21 ppm and 1.39 me/100g, respectively. According to the these results, NH_4+NO_3 nitrogen and potassium amounts were sufficient while the phosphourus content was sufficient in 65.8% and insufficient in 34.2%. Cu and Mn content in soil samples were adequate. The sufficient amounts of Zn, B and Fe were 85.7%, 45.8% and 95.7% and their insufficient amounts were 14.53%, 54.2% and 4.3%, respectively. According to the result of leaf analyses, the content of nitrogen, phosphorus, potassium, calcium, magnesium and sodium were sufficient. The deficiencies of iron, zinc and bor were found in 4.3%, 14.3% and 38.6% of the total samples, respectively.

Key words: sugar beet, leaf and soil analyses, deficiency, nutrition elements

Introduction

Agriculture of sugar beet contributes significantly to national economy and farmer. All the studies performed up to this day, the yield of sugar beet obtained from decare is reached the level of developed countries that apply modern agricultural techniques, but the quality or sugar yield is very low. Besides, in most cases, the rate of sugar decreases in parallel with the increase in beet yield, which we have received from decare. Leaf analysis is a way of determining the nutritional status of plants. At the same time leaf analysis is an important means to reveal toxicity and serious nutrient imbalance. Additionally, it is superior to soil analysis due to reflect factors affecting intake of nutrients in the soil. In the study of Gezgin et al. [1], the increase of 86% of beet yield and 45% of sugar yield was obtained with applying nitrogen, phosphorus, potassium and additional zinc in sugar beet compared to control. The results of this investigation show that the deficiency or excess of other nutrients (Zn, Fe, Mn, Cu, B, etc.) apart from nitrogen, phosphorus and potassium are observed in the sugar beet growing soil in Konya plain. In addition, the excess or inadequacy of a single nutrient element is detrimental to the intended yield and quality when all other factors are kept the same. Therefore, it is desirable that the amount of plant nutrient element and, if necessary, the level of the relationship between the other factors should be balanced. In order to ensure that this amount and relationships are appropriate, it is necessary to first determine the current situation and then investigate the methods to be applied when the disruptions are eliminated. For this reason,

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determination the amounts of nutrients in soils and growing plants has great importance. Substantial solution to obtain the finest quality and highest yield of sugar beet per unit area is applied the adequate and balanced fertilization program with various agricultural measures. The aim of this study was to determine the nutritional status and problems of sugar beet, as well as the plant nutrients that control the yield and quality of sugar beet by soil and plant analysis.

Material and Methods

Research site and general features. The research was carried out in the Konya Plain, located on the south-western part of Central-Anatolia and 1000 m of altitude above sea level. The research area includes center of Konya and Cihanbeyli, Altınekin, Çumra, İsmil, Beyşehir, Seydişehir, Kulu and Şarkikaraağaç districts. Soils of the research area have high lime and pH and low organic substance. Generally, there are alkaline soils together with salinity problem in this area. In research area, the largest soil group was brown soil (18.2%), followed by red brown, alluvial, red yellow podzolic, red chestnut color, colluvial (6.2%) and other lands (total 26.3%). The research area has a continental climate with hot and dry summers and cold and rainy winters. The annual precipitation falls around 300-350 mm, with 36% of annual precipitation falling in winter, 20% in fall, 33% in spring and 11% in summer. Annual average relative humidity is 60%. Soil and plant samples, taken from 70 units (sugar beet field) in the province whose general characteristics are briefly described above, constitute this research material.

Taking soil samples and preparing the analyses. Great attention has been paid to the taking of soil samples in order to determine nutritional problems of sugar beet in cropped area of sugar beet growing. For this purpose, sampling sites from a unit in about 3000 decare were selected from the research field which had 400.000 decare of sugar beet cultivation area. Soil samples were taken from total 70 land according to the size of the cultivation area of beet regional. The proportional distribution of large soil groups in the sugar beet cultivation areas was taken into consideration in the selection of the specimens taken at the cropped area of the regional directorates. Additionally, the selected fields have been taken care to be large fields in the area. Soil samples were collected in July and August, when sugar beet plants received about 65-70% of their nutrient requirement. After selecting of sugar beet cultivated fields to be sampled, the size, slope, direction, soil color and other criteria of the fields are taken into consideration. A sample representing each field was taken by mixing the samples taken from different spots (0-20 cm of depth) by drawing a zigzag on the field. The soil samples brought to the laboratories were dried in the shade, the rough stones, pebbles and plant residues were cleaned and kneaded with a wooden hammer and then passed through a 2 mm sieve and made ready for analysis.

Taking leaf samples and preparing the analyses. Leaf samples were collected together with soil samples. Leaf samples were taken from several plants in a decare area with drawing zigzag on the field in order to represent the plants well as reported by Reuter and Robinson [2], sampling was also carried out between the outer most leaves of the sugar beet plant and the youngest leaves formed newly in the interior by hand-breaking. Leaf samples were brought to laboratories in paper bags. The samples brought to the laboratories were first washed with tap water, then 0.1 N HCl solution, followed by washing twice with pure water and then distilled water. After washing, the blade sections of the samples were separated manually or stainless steel knife and dried in a drying cabinet at 70°C. After drying, the blade samples ground in the chromium-nickel alloy mill and were stored in closed polyethylene bottles for analysis.

Physico-chemical analyses made in soil samples. Texture [3], soil reaction and electrical conductivity (EC × 10^6 μmhos/cm) [4], lime ($CaCO_3$ %) [5], organic matter (%) [5] NH_4 + NO_3 [6], available Ca, Mg, K and Na [5], available phosphorus [7], available Fe, Zn, Mn and Cu [8] and available boron [9] were determined in sugar beet soils.

Leaf analysis. The blade samples prepared for for analysis were subjected to wet decomposition with H_2SO_4 + H_2O_2 and filtrates were obtained for their analysis, as declared by Bayraklı [7]. In these filtrates, nitrogen with Kjeldahl method; phosphorus using Barton method; K and Na with Jenway PF 7 flame photometer; Ca, Mg, Fe, Zn, Mn and Cu using GBC 902 A.A.S. were determined according to Bayraklı [7]. The total amount of boron in plant samples was determined by Azomethine-H method [7].

Sugar beet analysis. Beet root yield (Kg / da) and root samples were taken from the units of soil and leaf samples in harvest period in order to determine the relationship between soil properties and nutrient contents of leaf blade with yield and some quality characteristics of sugar beet. Sugar content (%) and dry matter (%) of root, and amino-N content were determined in the Konya Sugar Factory laboratory for the purpose of determining the quality levels of sugar beet roots, according to ICUMSA [10,11] and Kubadinow and Wieninger [12], respectively.

Results and Discussions

Evaluation of Results of Soil Analysis. Physical and chemical properties of soil samples are given Table 1. The mean of the pH values of soils was 7.65, and pH values ranged from 7.0 to 8.1. 78.6% of soils were mild alkali, 14.3% were moderate alkali and 7.1% have neutral reaction. Electrical conductivity of soil samples varied from 143 to 1306 μmhos/cm and the mean was 281.1 μmhos/cm (Table 1). The conductivity value was lower than 200 μmHos/cm measured in 1:5 soil-water suspension for salt-sensitive plants. This value could be the highest 600 μmhos/cm for salt-tolerant crops such as sugarbeet and it could be said that 7.2% of the soil needed to reclamation and 5.7% of the soil should be used cautiously. Besides, 7.2% of the soil contained salt-resistant plants (sugarbeet, tomato, etc.) and 68.6% contained salt at a level that could cause harmful effects on other cultivated plants. The lime ($CaCO_3$) content of soils varied between 0.4 and 60.2% and the mean value was 19.1% (Table 1). According to the limit values reported by Ülgen and Yurtsever [13], 32.8% of soils were in very high limy class (+25%), 12.9% of soils were in high limy class (15-25%), 42.8% of soils were in medium limy class (5-15%), 8.6% of soils were in limy class (1-5%) and 2.9% of soils were in low limy class (0-1%). According to mechanical analysis rate of soils in other words sand, lime and silt rates, 47% was in lime, 22.8% was in limy loam, 18.5% was in sandy limy loam, 3% was in sandy loam, 2.9% was in silty loam, 1.5% was in loam, 2.8% was in loamy sand and 1.5% was in sandy lime texture class. Accordingly, 48.5% was fine textured soil, 2.8% was sandy soil and 48.7% was loamy soil. 5.8% of the loamy soils were roughly textured, 8.9% are medium textured and 85.3% are very fine textured (Table 1). The contents of organic substance ranged from 0.4% to 7.4% and the mean value was 1.59%. 18.6% of the soils were found to be very few (0-1%), 45.7% was contained few (1-2%), 28.6% was contained moderate (2-3%), 4.3% was contained good (3-4%) and 2.8% was contained high (4%) levels of organic matter (Table 1). These results showed that 92.9% of the cropped area of Konya Sugar Plant was poor in terms of organic matter. It was necessary to increase the organic matter content of the soils in order to obtain high yield and high quality crop from the unit area of these soils.

The cation exchange capacities of soils varied between 10.72 and 44.79 me/100g and the mean value was 26.07 me/100g (Table 1). The cation exchange capacity prevented the loss of plant nutrients in the soil and at the same time affeced positively the uptake by plants. Studies should be carried out to increase the cation exchange capacity of 74.3% (CEC <30 me/100 g) of soils. This may be due to the addition of organic matter to the soil. The changeable sodium percentages of soils ranged from 1.1 to 47.05% and the mean value was 4.5% (Table 1). The percentage of changeable sodium was lower than 15% in other soils except for the numbers of 20 and 68 unit, and there was no level of alkalinity in the soil to deteriorate the structure and affect the plant growth. However, there was a degree of alkalinity that affects plant growth negatively in units 20 and 68. In these units, breeding studies should be carried out to remove excess sodium from the soil.

Amounts of NH_4 + NO_3 nitrogen that could be taken into plants in the soil ranged from 0.02% to 0.775% and the mean value was 0.059% (Table 1). Considering that 92.9% of soils were poor in organic matter, the amounts of NH_4 + NO_3 nitrogen were very high. It can be said that this situation is mainly due to the fact that farmers have a large amount of nitrogen fertilizer applied to the soil. The amount of phosphorus varied from 3.07 and 27.21 ppm and the mean value was 10.21 ppm (Table 1). According to the limit values reported by Ülgen and Yurtsever [13], the available phosphorus amounts of the soil were very low (0-5.24 ppm P) in 14.3%, low (5.24 – 10.48 ppm P) in 51.5%, moderate (10.24 ppm) in 21.4% (10.48 – 15.72 ppm P), high in 7.1% (15.72 – 20.96 ppm P) and very high in 5.7% (20.96 + ppm). Cultivation area of Sugar beet had low phosphorus content showed that a large part of the phosphorus fertilizer was fixed in the soil due to the phosphorous fertilizer is not used or the wrong use of the phosphorous fertilizer. The amounts of potassium that could be taken into plants in the soil ranged from 0.01 me/100 g to 3.47 me/100 g, and the mean value was 1.39 me/100gr (Table 1). According to the limit values reported by Ülgen and Yurtsever [13], 9 numbered (Çumra-Büyükaşlama, Recep Crop) was very poor in potassium (0-0.01 me/100g) and all other soils contained high potassium (K> 0.255 me/100 g) (Table 1). The amounts of calcium and magnesium that could be taken into plants in the soil ranged from 6.0 to 34.1 me/100 g and from 0.5 to 17.0 me/100 g, respectively and the mean values were 18.23 me/100 g and 5.4 me/100 g, respectively (Table 1). There was sufficient and generally high levels of potassium, calcium and magnesium in the soil of the research area, with the exception of unit 9 in terms of potassium, when a balanced fertilization was carried out according to soil and plant analysis. The amounts of boron that could be taken into plants in the soil ranged from 0.129 to 3.227 ppm and the mean value was 0.589 ppm (Table 1). According to the limit values reported by some researchers [14,15] for boron tolerant plants such as sugar beet and others, 54.2% of the cultivated land of Konya Sugar Plant was inadequate (<0.5 ppm B) and 45.8% of them contained sufficient (0.5 - 5 ppm B) boron. Boron had positive effects on mainly sugar content and yield, resistance to diseases, and storage stability. Therefore, boron fertilizers must be considered. The amounts of iron that could be taken into plants in the soil ranged from 1.21 to 28.30 ppm and the mean value was 6.39 ppm (Table 1). According to the limit values reported by [16], 4.3% of soils were insufficient (<2.5 ppm Fe), 95.7% were sufficient (2.5 - 4.5 ppm) and high (> 4.5 ppm) level of iron content for non-sensitive plants such as sugar beet, wheat and barley. The contents of zinc that could be taken into plants in the soil ranged from 0.36 to 1.46 ppm and the mean value was 0.74 ppm (Table 1). According to the limit values reported by [16], 14.3% of the soil was unsatisfactory (<0.5 ppm), 72,9% was medium (0.5 - 1 ppm) and 12.8% was sufficient level of zinc. Based on the results of soil and plant analysis, these data indicated that 87.2% of the soil in all regions needed of zinc fertilizer, depending on plant variety and fertilization status. The contents of mangan that could be taken into plants in the soil ranged from 3.90 to 68.32 ppm and the mean value was 10.74 ppm (Table 1). According to the limit values (>1,0 ppm) reported by [16], all of the soil provided sufficient or high level of manganese to the plants. The contents of copper that could be taken into plants in the soil ranged from 0.48 to 2.84 ppm and the mean value was 1.50 ppm (Table 1). According to the limit values (>1,0 ppm) reported by [16], the suitable copper amounts of the soil were adequate or generally high.

Relations between some physical and chemical properties of soils and elements of nutrients are given in Table 2. As can be seen from the examination of Table 2, there were significant negative correlations between the amounts of Fe, Zn, Mn and Cu and the amounts of pH, lime and sand. In this situation, the pH, lime and sand amounts of these soils were increased, while the amounts of Fe, Zn, Mn and Cu were decreased. There were significant positive correlations between the amount of available boron for plants and the amounts of salt (EC), sodium, clay and organic matter; there were negative relations between sand, Fe, Zn, Mn and Cu. According to this, the amount of available boron in the soil will increase in parallel with the increase in the amounts of salt, sodium, clay and organic matter, but will decrease with the increase in the amounts of sand, Fe, Zn, Mn and Cu. Significant negative correlations between available phosphorus amounts of soil and pH and calcium amounts were observed and significant positive correlations were found between the amount of organic matter. These relationships indicate that the amount of available phosphorus in the soil will decrease with increasing pH and Ca, and will increase in parallel with the increase in the amount of organic matter. There were positive relations between the amounts of Ca, Mg and K of the soils and clay, pH, salt contents; There were negative relations between sand quantities. According to these relations, the amounts of Ca, Mg and K in the soil decreased with increasing amount of sand; increased with increasing amount of clay, pH and salt. Significant negative correlations were statistically found between magnesium content of soils and sugar content and dry matter content of sugar beet (Table 2).

Evaluation of Results of Leaf Analysis. The leaf analysis results of leaf samples taken from sugar beet with soil samples from the units are given in Table 2. The nitrogen contents of leaf blade varied from 2.55 to 5.12% and the mean value was 4.99% (Table 2). According to the the limit values reported by Finck [17] (2-4%) and Draycott and Durrant [18] (1.9-2.3%), nitrogen contents of all leaf blades taken from the units were sufficient or high. According to Draycott and Durrant [18], all of the leaf blades contained high level of nitrogen; with regard to Finck [17] 38.5% (> 4%) of the leaf blades contained high nitrogen amount. On the other hand, the nitrogen contents of leaf blade in total five units (2.8%) were low; in the other units (97.2%) were at sufficient level according to the limit value (3.08%) given by Boawn et al. [19] (Table 2). The phosphorus amounts of sugar beet leaf blade ranged from 0.22 to 0.72% and the mean value was 0.65% (Table 2). According to the the limit values of leaf blade reported by Hills and Ulrich [20] (0.1-0.8%), in all of the units, the phosphorus ranges of the leaf blade and stems were adequate and even high on some of them. The potassium contents of leaf blade varied from 1.78 to 5.93% and the mean value was 4.2% (Table 2). According to the the limit values of leaf blade reported by Hills and Ulrich [20] (1.0-6.0%), the potassium amounts of leaf blade were sufficient for all of the units.

Table 1

Some physico-chemical properties of soil samples and nutrients usable by sugar beet

Soil No	pH	ECx10[6]	Lime	Texture classification	Organic matter	NH_4 + NO_3 Nitrogen	Changeable Na	Cation exchange capacity	Na	K	Ca	Mg	P	B	Fe	Zn	Mn	Cu
	Soil:Water	Soil:Water	($CaCO_3$)															
	(1:2)	(1:5) μmhos/cm	%		%			me/100g					ppm					
1	7.8	296	21.5	Clay	2.5	0.04	2.68	33.18	0.89	1.8	18.5	12	4.06	0.83	8.7	0.7	18.5	2.44
2	8	252	12.8	Clay	1.6	0.04	2.26	44.74	1.01	1.7	16.8	13.2	2.97	3.22	5.71	0.8	4.9	0.72
3	7.9	211	7.1	Loam	1.4	0.1	1.64	31.11	0.51	1.7	33.6	8.4	7.62	0.6	5.04	0.7	22.3	2
4	7.8	286	11.2	Clay	1.5	0.06	2.8	38.64	1.08	1.8	27.6	1.2	9.8	0.19	10.6	0.9	19.8	1.03
5	7.9	194	25.5	Clay loam	2.2	0.05	2.12	32.64	0.69	1.6	29.4	6.6	5.84	0.45	4.83	0.5	7.97	1.56
6	7.8	297	24.8	Clay loam	1.8	0.04	3.88	34.83	1.35	1.8	24	6	7.82	0.42	3.08	0.7	8.86	1.58
7	7.9	421	34.1	Loam	2.3	0.04	6.87	31.28	2.15	1.1	24	8.4	14.45	0.49	4.25	0.4	9.3	1.2
8	7.9	248	24.4	Sandy clay loam	1	0.04	3.53	24.37	0.86	1.5	25.8	1.8	3.96	0.42	4.2	0.4	4.52	1.34
9	7.8	372	34.3	Clay	2.1	0.04	4.7	41.72	1.96	0	18	5.5	6.63	0.29	3.18	0.6	7.17	1.1
10	7.8	493	24.3	Clay loam	2	0.05	4.89	33.34	1.63	1.4	24.6	13.8	4.75	0.37	4.63	0.7	5.58	1.38
11	7.8	289	35.3	Clay	2.4	0.04	1.82	42.38	0.77	1.7	21.6	8.4	8.81	0.4	4.58	0.4	16.3	1.45
12	7.7	362	35.4	Clay	2.2	0.04	1.24	40.32	0.5	1.4	26.4	13.8	10.09	0.67	6.86	0.6	5.49	1.96
13	7.6	1306	32.8	Clay	1.8	0.03	8.43	32.62	2.75	1.4	28.2	10.2	7.92	1.04	4.88	0.5	4.78	1.54
14	7.8	237	33.6	Clay	1.8	0.05	5.39	29.11	1.57	1.8	21.4	6.7	11.78	2.3	4.1	0.5	3.9	1.67
15	7.8	774	35.1	Clay	2.5	0.04	7.74	28.28	2.19	1.4	18.5	7.6	6.83	0.98	7.43	0.6	4.16	2.24
16	8	199	14.3	Clay	1.2	0.09	1.68	29.09	0.49	1.5	12.2	12.4	6.93	0.93	7.02	0.6	4.34	2.35
17	7.5	396	12.1	Clay loam	1.1	0.06	2.17	26.25	0.57	1.2	21.9	5.5	7.22	0.61	3.54	0.6	9.21	1.38
18	7.6	292	29	Clay loam	1.3	0.11	1.87	23.56	0.44	1.4	18.1	6.2	6.14	0.55	3.11	0.6	10.7	1.34
19	7.5	431	23	Clay	3	0.05	4.3	28.59	1.23	1	15.9	6.2	8.21	0.74	3.99	0.5	12.6	1.05
20	7.8	273	28.2	Clay	1.9	0.05	47.05	39.53	18.6	2.8	19.7	4.9	16.03	0.95	3.84	1.1	16.7	1.85
21	7.8	243	53.6	Clay	2.5	0.06	3.53	19.84	0.7	1.8	14.8	4.3	6.04	0.95	3.62	0.7	16.4	1.27
22	7.8	143	73	Loam sandy	1.1	0.04	1.89	13.75	0.26	1	14.2	3.9	18.21	0.78	3.05	0.8	10.4	0.9

Table 1

(continued)

Soil No	pH	ECx106	Lime	Texture classification	Organic matter	NH4 + NO3 Nitrogen	Changeable Na	Cation exchange capacity	Na	K	Ca	Mg	P	B	Fe	Zn	Mn	Cu
	Soil:Water	Soil:Water	($CaCO_3$)															
	(1:2)	(1:5) µmhos/cm	%		%			me/100g					ppm					
23	7.7	186	49.4	Sandy clay loam	1.8	0.06	2.76	18.85	0.52	0.7	11.9	0.9	5.74	0.41	2.31	0.5	5.05	0.55
24	7.8	195	48.1	Sandy clay loam	1.4	0.1	2.68	23.53	0.63	1.3	15.4	1.6	7.92	0.26	3.12	0.5	6.82	1.01
25	7.6	274	60.2	Sandy clay loam	2.2	0.04	2.5	16.83	0.42	1.7	14.4	6.8	7.62	0.38	8.24	0.5	6.91	0.72
26	7.7	198	32.8	Sandy clay loam	0.9	0.05	2.17	22.62	0.49	0.5	14.7	1.2	11.97	0.49	3.15	0.5	7.26	0.48
27	7.8	237	10.9	Clay loam	2.5	0.05	5.74	23.18	1.33	1.6	18.3	2.2	9.2	0.34	5.59	0.7	8.41	1.52
28	7.8	181	17.6	Clay loam	2.4	0.05	4.29	23.06	0.99	1.4	16.7	3.8	13.95	1.21	3.9	0.8	12.8	0.57
29	7.7	248	33.7	Sandy clay loam	2.3	0.04	4.33	20.09	0.87	2	17.1	3	11.68	0.53	3.98	0.6	7.35	0.61
30	7.7	657	10.5	Sandy clay	2.1	0.05	14.1	27.58	3.89	1.3	14.4	3.5	10.79	0.82	2.7	0.6	8.5	1.01
31	7.6	176	8.2	Clay	1.7	0.06	4.53	28.91	1.31	1.6	16.3	5.8	7.82	3.23	3.77	0.7	7	1.19
32	7.5	519	36.4	Sandy clay loam	1.8	0.04	5.53	20.81	1.15	1.5	20.9	5.2	5.24	0.64	4.65	0.8	12.1	1.34
33	7.5	259	13.2	Clay	2.9	0.04	3.41	28.75	0.98	1.7	15.3	2.7	9.3	0.85	3.6	0.5	10	0.99
34	7.7	298	38.8	Clay loam	4.1	0.04	3.91	20.71	0.81	2.2	22.2	3.4	9.9	0.72	4.36	1.5	11.8	1.08
35	7.6	210	5.1	Sandy clay loam	2.5	0.04	2.66	25.21	0.67	1.5	14.2	4.2	13.95	1.68	3.87	0.8	15.3	0.9
36	7.5	233	13.7	Sandy clay loam	2.6	0.04	4.06	22.4	0.91	0.9	22.4	1.2	7.42	0.21	3.09	0.7	10.8	1.5
37	7.4	290	8.3	Sandy clay loam	1.6	0.04	2.1	27.57	0.58	1	19.2	1.3	7.42	0.19	2.6	0.6	7.7	0.9
38	7.4	318	55.6	Clay loam	7.4	0.05	1.92	22.86	0.44	1.1	24.8	1.1	8.21	0.19	2.69	0.5	5.67	1.12
39	7.4	170	0.54	Clay loam	2	0.04	2.51	14.73	0.37	0.5	20.3	1.6	11.28	0.84	17.8	0.9	3.9	0.84
40	7.4	245	23.7	Clayl	3.9	0.05	1.27	40.26	0.51	0.5	11.6	2.3	6.04	0.21	7.23	0.8	19.6	1.67
41	7.4	197	47.3	Clay	2.4	0.04	1.41	20.53	0.29	1.3	34.1	4.4	12.96	0.25	14.1	0.7	13.7	3.52

Table 1

(continued)

Soil No	pH	ECx106	Lime	Texture classification	Organic matter	NH4 + NO3 Nitrogen	Changeable Na	Cation exchange capacity	Na	K	Ca	Mg	P	B	Fe	Zn	Mn	Cu
	Soil:Water	Soil:Water	($CaCO_3$)															
	(1:2)	(1:5) µmhos/cm	%			%				me/100g					ppm			
42	7.5	207	13.4	Clay	1.1	0.04	1.1	24.49	0.27	1.5	16.4	2.3	18.01	0.17	10.3	0.8	14.4	1.71
43	7.6	200	3.27	Clay	1.2	0.04	1.63	17.19	0.28	0.9	18.7	4.6	11.08	0.6	10.1	0.8	8.77	1.58
44	7.4	178	3.3	Clay loam	1.3	0.04	1.4	21.43	0.3	0.5	9.2	7.2	13.56	0.28	13.1	0.6	7.1	1.3
45	7.4	181	7	Clay	1.4	0.04	2.3	29.98	0.69	0.7	18.2	2.2	10.6	0.35	11.5	0.7	11.3	1.89
46	7.6	280	6.3	Sandy clay loam	1.4	0.04	6.71	18.64	1.25	0.9	23.3	5.1	6.04	0.5	28.3	1.2	9.39	2.64
47	7.4	214	2.2	Loam sandy	0.9	0.04	2.98	11.09	0.33	1.5	13.8	2.1	15.93	0.31	9.95	1	1.06	0.79
48	7.3	285	8.2	Clay	1	0.04	2.34	25.19	0.59	1.2	7.9	1.7	14.45	0.25	5.7	1	8.77	0.79
49	7.3	385	0.4	Sandy loam	1.2	0.05	5.4	13.9	0.75	1.4	20.2	3	3.07	0.29	3.78	0.6	14.2	1.32
50	7.3	315	4	Clay	3.1	0.04	1.46	27.37	0.4	1.6	6	5.6	25.33	0.21	10.6	1.4	25.8	1.38
51	7	179	1.4	Clay loam	0.7	0.11	3.71	13.46	0.5	3.5	20.2	3.3	22.17	0.32	2.67	1.2	5.4	1.8
52	7.2	179	10.1	Clay	0.5	0.04	1.28	24.24	0.31	0.6	9.1	3.3	27.21	0.81	15.6	0.8	62.3	2.48
53	7.6	230	9.5	Clay	0.9	0.04	10.4	29.9	3.11	1.4	17.5	5	3.96	0.38	7.31	0.8	12.5	2.51
54	7.6	164	10.8	Silt loam	0.4	0.05	2.24	10.72	0.24	1.3	19.7	6.8	3.36	0.64	4.82	0.8	5.05	2.04
55	7.5	638	18.8	Clay	1.6	0.04	4.31	33.91	1.46	0.9	9.1	0.5	5.05	0.24	2.85	0.5	6.38	1.49
56	7.9	251	12.4	Clay	1.1	0.03	2.64	25.03	0.66	1.2	14.3	17	9.5	0.84	15	0.8	8.32	2.84
57	7.7	179	14.9	Clay loam	0.6	0.78	1.95	17.46	0.34	1.4	13.9	9.1	5.84	0.66	4.71	0.4	4.43	2.26
58	7.7	254	8.2	Clay	0.9	0.03	2.88	30.6	0.88	0.8	12.3	4	6.04	0.31	5.1	0.6	5.7	1.3
59	7.8	147	5.4	Sandy loam	0.5	0.05	1.74	16.71	0.29	2.2	22.2	5.3	16.13	0.64	1.21	1.2	6.73	1.45
60	7.8	146	2.1	Clay	1.1	0.04	1.64	31.05	0.51	2.1	21.7	6.7	4.95	0.37	3	0.9	12.3	2.18
61	7.7	179	5.6	clay	1.4	0.04	1.6	25.7	0.41	1.8	17.8	5.7	7.92	0.24	2.22	0.7	6.11	1.21
62	8	230	13	Clay loam	0.6	0.06	6.2	24.5	1.52	1.1	14.8	7.1	6.73	0.86	6.55	0.4	8.94	2.09
63	7.6	203	25	Clay loam	1.1	0.05	1.37	21.89	0.3	2	18.7	0.9	7.92	0.38	5.67	0.9	16.8	1.45
64	7.7	190	9.8	Clay	0.7	0.02	1.96	21.39	0.42	0.9	11.4	8.7	12.77	0.17	4.18	0.6	5.78	0.99
65	7.7	147	10	Clay loam	0.4	0.04	2.62	24.47	0.64	1.6	19.3	2.9	5.84	0.3	3.72	0.5	4.25	1.03
66	7.7	232	30.3.	Clay	2.3	0.05	1.73	24.31	0.42	1.4	13.8	8.7	15.54	0.3	6.73	1.3	5.76	1.47

Table 1

(continued)

Soil No	pH	ECx106	Lime	Texture classification	Organic matter	NH4 + NO3 Nitrogen	Changeable Na	Cation exchange capacity	Na	K	Ca	Mg	P	B	Fe	Zn	Mn	Cu
	Soil:Water	Soil:Water	($CaCO_3$)															
	(1:2)	(1:5) µmhos/cm	%		%			me/100g					ppm					
67	7.6	771	6.9	Sandy clay loam	0.4	0.05	1.38	20.98	0.29	1.6	13.7	5.4	7.92	0.28	2.73	0.7	14.6	1.3
68	7.7	177	6.8	Sandy clay loam	1.15	0.03	24.05	26.45	6.36	2.1	11.6	6.4	23.85	0.23	3.79	1.4	13.9	1.03
69	8.1	291	13	Clay	1.19	0.04	9.31	29.11	2.71	1.5	21.2	3.7	6.83	0.53	8.94	0.6	9.65	1.1
70	7.9	248	21.4	Silt loam	1.37	0.04	3.62	33.66	1.22	1.3	18.7	12.4	4.85	0.49	11.3	1	8.06	1.1
Mean	7.7	285	19.1		1.59	0.06	4.5	26.07	1.27	1.39	18.23	5.4	10.21	0.59	6.39	0.74	10.74	1.50
Min.	7.0	143	0.4		0.4	0.02	1.1	10.72	6.24	0.01	6.0	0.5	3.07	0.13	1.21	0.36	3.9	0.48
Max.	8.1	1306	60.2		7.4	0.78	47.05	44.74	6.36	3.47	34.1	17	27.21	3.23	28.3	1.46	68.32	2.84

Table 2

Mineral contents of sugar beet leaves and quality properties of sugar beet

Soil No	Leave blade (dry weight)											Quality properties		
	N	P	K	Ca	Mg	Na	Fe	Zn	Mn	Cu	B	Dry-matter	Amino -N	Sugar rate
	%						ppm					%		
1	3.53	0.37	5.05	0.97	0.2	1.25	215.6	13.75	67.83	16.2	124.36	21.23	0.126	13.65
2	3.43	0.4	2.85	1.57	3.18	1.29	392	33.75	150.33	16.2	85.93	23.02	0.028	16.2
3	3.58	0.47	5.3	1.02	2.14	1.05	294	32.92	125.58	10.8	97.7	23.97	0.121	16.1
4	3.66	0.42	5.37	1.4	3.06	0.99	235.2	26.25	129.25	12.6	60.37	23.44	0.069	15.65
5	3.4	0.51	3.8	1.17	2.16	1.16	274.4	34.58	179.66	19.8	73.18	23.27	0.056	16.05
6	4.15	0.47	4.65	1.21	2.56	1.04	215.6	35.83	97.17	18	82.74	26.13	0.075	17.8
7	4.14	0.41	3.79	1.12	2.63	1.23	78.4	29.58	68.75	19.8	81.2	23.63	0.105	15
8	3.72	0.33	3.14	1.57	2.72	1.11	254.8	18.75	98.08	18	75.62	22.69	0.074	14.5
9	3.41	0.52	3.21	1.34	3.38	1.3	176.4	33.33	126.5	19.8	85.93	22.42	0.068	13.7
10	4.04	0.43	3.73	1.04	1.74	1.15	137.2	45.83	111.83	18	73.6	23.2	0.042	15.65
11	3.36	0.43	5.49	1.09	1.96	1.15	235.2	32.92	85.25	18	83.75	23.22	0.07	16.15
12	3.09	0.31	5.93	0.76	1.35	1.29	235.2	33.5	57.75	17.1	48.67	24.42	0.066	16
13	3	0.42	3.72	0.98	2.27	1.29	196	23.75	118.25	12.6	153.5	23.61	0.054	15.6
14	3.8	0.35	2.97	1.39	3.11	1.36	137.2	18.33	113.67	29.4	132.6	24.34	0.086	17.2
15	3.76	0.71	4.02	1.2	3.29	1.22	254.8	37.08	97.17	21.6	59.02	24.49	0.042	17.25
16	4.28	0.46	3.03	0.94	1.84	0.96	313.6	29.58	153.08	9	94.46	23.01	0.073	15.45
17	4.34	0.7	3.67	1.07	1.97	0.97	333.2	32.08	110.92	19.8	64.48	24.32	0.059	16.2
18	4.07	0.37	4.18	1.49	2.62	0.79	274.4	30.83	127.42	21.6	188.49	24.73	0.143	16.2
19	3.36	0.47	4.09	0.96	1.77	1.01	352.8	28.33	69.67	12.6	49.18	24.06	0.097	15.6
20	3.74	0.52	5	1.44	3.35	1.14	372.4	34.58	142.08	19.8	60.91	24.68	0.078	17.35
21	3.28	0.42	4.15	1.36	2.2	1.04	156.8	33.75	55.92	14.4	146.56	25.89	0.046	17
22	4.24	0.43	4.41	1.35	2.42	0.74	254.8	32.08	47.66	16.2	125.63	21.73	0.007	17.45
23	3.72	0.39	3.14	1.98	2.61	0.92	235.2	33.33	124.66	18	146.56	23.08	0.111	16.85
24	3.77	0.47	4.4	1.22	1.93	1.01	39.2	26.25	95.33	19.8	92.7	23.91	0.076	17.1
25	4.49	0.35	1.94	1.7	3.35	1.04	39.2	24.58	76.08	7.2	104.05	23.6	0.053	16.65
26	3.54	0.37	4.71	1.43	2.4	0.69	235.2	28.75	124.66	10.8	71.06	25.26	0.056	18.35

Table 2

(continued)

Soil No	Leave blade (dry weight)											Quality properties		
	N	P	K	Ca	Mg	Na	Fe	Zn	Mn	Cu	B	Dry-matter	Amino -N	Sugar rate
	%						ppm					%		
27	3.84	0.53	3.58	1.7	2.05	1.22	254.8	28.54	97.17	14.4	82.94	23.7	0.081	16.2
28	3.72	0.38	2.48	1.63	3.06	1.91	117.8	48.44	121.57	12.04	76.23	20.06	0.081	13.9
29	3.26	0.39	3.51	1.42	2.34	1.24	254.8	36.67	99	14.4	49.73	25.29	0.095	17.6
30	4.06	0.52	3.86	0.91	2.35	1.16	313.6	14.58	108.17	12.6	99.61	28.53	0.086	18.4
31	3.8	0.72	2.77	0.42	0.85	0.92	235.2	31.67	74.25	19.8	108.07	24.12	0.1	14.85
32	4.17	0.51	3.65	1.24	2.44	1.02	176.4	46.67	108.17	16.2	72.28	24.47	0.081	16.8
33	3.2	0.42	4.8	1.31	2.48	1.24	235.2	25	140.25	14.4	97.71	22.09	0.082	14.85
34	3.28	0.34	4.77	0.68	3.17	1.02	176.4	24.17	106.33	11.7	83.75	26.79	0.046	19.55
35	3.99	0.37	3.09	1.24	2.33	1.3	235.2	20.5	149.42	13.6	76.84	26.83	0.047	19.6
36	4.12	0.43	3.64	1.25	2.25	1.05	254.8	26.67	123.75	18	132.61	25.39	0.088	16.85
37	4.05	0.42	4.84	1.72	2.86	0.93	352.8	73.75	188.83	14.4	70.74	24.4	0.051	16.95
38	4.02	0.48	3.06	1.15	1.88	0.74	196	43.33	124.67	18	127.64	24.93	0.058	17.1
39	4.17	0.38	2.27	1.84	3.35	0.92	176.4	45	46.75	14.4	174.48	25.18	0.049	17.55
40	3.37	0.47	3.6	1.19	2.29	0.81	176.4	18.75	186.08	16.2	119.53	26.61	0.079	19.25
41	3.24	0.37	3.2	1.12	2.02	1.25	196	20.42	43.08	18	67.25	25.48	0.042	18.15
42	4.06	0.4	3.93	1.29	1.55	0.74	313.6	37.5	141.16	23.4	125.63	25.78	0.078	18.8
43	4.21	0.38	3.97	0.92	1.64	0.89	225.4	30.5	198.92	16.2	103.42	24.6	0.074	17.4
44	3.46	0.56	4.13	1.03	3.68	1.02	215.6	23.33	140.25	27	61.19	27.07	0.032	19.6
45	4.04	0.27	2.36	1.56	3.63	0.95	196	16.25	52.25	16.2	33.3	26.7	0.052	18.4
46	3.78	0.43	3.16	0.92	1.97	1.31	254.8	32.5	83.42	14.4	80.44	23.94	0.051	16.9
47	3.99	0.46	4.4	1.11	2.43	1.15	313.6	47.5	52.25	14.4	78.06	25.3	0.087	17.45
48	4.13	0.47	4.24	1.3	2.36	1.02	235.2	38.75	124.67	16.2	85.02	24.3	0.057	16.85
49	4.02	0.43	4.49	1.11	1.93	0.76	196	21.67	113.67	19.8	82.88	25.9	0.077	18.05
50	3.9	0.55	3.55	1.1	2.11	0.87	196	45.42	106.33	16.2	61.54	23.54	0.06	15.85
51	4.26	0.56	4.98	0.87	1.55	0.91	137.2	29.17	67.83	21.6	73.6	24.9	0.059	16.9
52	5.12	0.72	3.91	0.86	1.23	0.85	313.6	69.17	61.42	23.4	90.73	24.54	0.043	17.65

Table 2

(continued)

Soil No	Leave blade (dry weight)											Quality properties		
	N	P	K	Ca	Mg	Na	Fe	Zn	Mn	Cu	B	Dry-matter	Amino -N	Sugar rate
	%						ppm					%		
53	3.56	0.37	3.03	1.31	2.63	1.26	117.6	20	175.08	16.2	74.87	23.34	0.057	16.1
54	4	0.49	3.03	1.1	2.28	1.37	137.2	36.25	96.75	18	58.54	22.23	0.049	15.35
55	3.79	0.42	5.45	1.4	2.32	0.84	254.8	17.92	90.75	18	70.74	24.1	0.046	16.5
56	3.63	0.42	3.28	0.93	2.16	1.35	274.4	21.67	104.5	10.8	66.62	20.34	0.031	14.4
57	4.5	0.22	1.78	1.01	1.29	0.97	156.8	18.07	57.75	14.4	72.33	24.65	0.05	17.65
58	3.69	0.39	3.28	1.37	2.95	1.28	294	12.08	99.92	12.6	54.57	25.15	0.057	18.1
59	3.82	0.5	3.51	1.06	2.22	1.23	176.4	47.5	132.92	16.2	118.65	23.91	0.039	17.3
60	4.09	0.57	2.87	0.99	1.53	1.17	274.4	33.75	158.46	21.6	85.99	24.62	0.045	17.75
61	2.55	0.51	5.23	1.14	1.93	1.08	294	27.08	184.25	18	80.44	22.45	0.05	15.3
62	3.54	0.39	2.68	1.13	2.46	1.57	274.4	30	166.83	23.4	67.25	24.5	0.035	17.8
63	4.21	0.52	3.54	0.99	1.74	0.97	254.8	32.07	136.58	18	75.6	24.72	0.052	17.05
64	3.61	0.41	3.58	1.62	3.69	1.07	215.6	27.5	155.83	16.2	106.6	23.95	0.053	17
65	3.47	0.42	4.51	1.2	1.62	0.91	235.2	40	139.33	19.8	79.94	24.86	0.059	17.25
66	3.87	0.37	4.66	1.32	2.15	1	20	17.92	128.33	18	75.6	23.78	0.044	17.15
67	4.11	0.37	5.1	1.26	1.76	0.78	98	22.5	125.58	18	71.96	27.1	0.031	19.7
68	3.51	0.37	3.48	1.75	3.67	1.1	215.6	26.25	224.58	19.8	112.94	24.86	0.047	17.7
69	4.69	0.43	2.95	0.87	1.54	1.53	274.4	35	116.42	19.8	132.61	25.65	0.037	18.45
70	3.93	0.47	3.31	0.89	1.97	1.1	254.8	32.5	94.42	23.4	82.88	25.8	0.03	18.3
Mean	4.99	0.65	4.2	1.79	2.94	1.42	273.5	38.52	122.71	24.93	112.36	24.34	0.063	16.97
Min.	2.55	0.22	1.78	0.42	0.2	0.69	20	12.08	43.08	7.2	49.18	20.06	0.007	13.65
Max.	5.12	0.72	5.93	1.98	3.69	1.57	392	73.75	224.58	29.4	88.49	28.53	0.143	19.7

The calcium contents of leaf blade ranged from 0.42 to 1.98% and the mean value was 1.79% (Table 2). According to the the limit values of leaf blade reported by Hills and Ulrich [20] (0.4-1.5%), the calcium amounts of leaf blade taken from the units were sufficient and even at 15% of the units were high. The magnesium contents of leaf blade ranged from 0.20 to 3.69% and the mean value was 2.94% (Table 2). According to the the limit values of leaf blade reported by Hills and Ulrich [20] (0.1-2.5%), the magnesium contents of leaf blade in all units was adequate and even at 31.4% was in high level. The sodium contents of leaf blade ranged from 0.69 to 1.57% and the mean value was 1.42% (Table 2). According to the the limit values of leaf blade reported by Hills and Ulrich [20] (0.02-3.7%), the sodium amounts of the leaf blade of the units were found to be sufficient. The iron contents of leaf blade varied from 20.0 to 392 ppm and the mean value was 273.50 ppm. According to the the limit values of leaf blade reported by Hills and Ulrich [20] (60-140 ppm), the iron contents of leaf blade were deficient (insufficient) in 4.3% (units 24.25 and 66) and other units were sufficient or high (Table 2). The zinc contents of leaf blade varied from 12.08 to 73.75 ppm and the mean value was 38.52 ppm. According to the the limit values of leaf blade reported by Hills and Ulrich [20] (10-80 ppm), the zinc contents of leaf blade were deficient or insufficient in 2.3% and other units were sufficient (Table 2). However, according to the the limit values of leaf blade informed by Finck [17] and Bergmann [21], the zinc amounts of leaf blade were deficient (insufficient) level in 14.3% of all units.

The mangan contents of leaf blade ranged from 43.08 to 224.58 ppm and the mean value was 122.71 ppm (Table 2). According to the the limit values of leaf blade reported by Hills and Ulrich [20] (25-360 ppm), manganese amounts of leaf blade was sufficient in all units. According to the the limit values of leaf blade given by Sauchelli [22]; Haddock and Stuart [23] (7-20 ppm), copper contents of leaf blade in all units were enough and even 14.29% of leaf blade was high (> 20 ppm) level. The boron contents of leaf blade ranged from 49.18 to 188.49 ppm and the mean value was 112.36 ppm (Table 2). According to the the limit values of leaf blade reported by Hills and Ulrich [20] (35-200 ppm), the boron amounts of leaf blade was insufficient in one unit (units no: 45), and sufficient in all other units. However, according to the the limit value of leaf blade informed by Bergman [21] (75.6 ppm), the boron amounts of leaf blade, 38.6% of all units, were deficient or insufficient (<75.6 ppm). Sorauer et al. [24] informed that the critical boron content of leaf blade is 75.6 ppm for normal development of sugar beet. Kluge and Podlesak [25] reported that copper content of leaf blade at 20–30 ppm may be toxic. Chapmann et al. [26] reported that the plant of sugar beet did not show tolerance to the excess manganese content. Generally, plants contain from 0.004% to 2% sodium and between 0.65% and 6.20% potassium. The critical sodium values in soil and plants depend on environmental factors, varieties of plant and age of tissue and leaf of plant [21]. According to Finck [69], it was found that 4% and higher level of sodium in sugar beet leaf has a toxic effect, although the toxic effect amount of sodium in wheat leaves, young leaves of beans and barley leaves are 0.15%, 0.40% and 0.80%, respectively. The rate of nutrient elements in leaf blade for the normal feeding of sugar beet is as below [21]. Turhan [27] analysed the soil and leaf samples taken from 67 unit in cropped area of beet in sugar factory of Konya, Ilgın and Ereğli. It was found that sugar beet was inadequately fed with respect to Zn in 43% of the area; Cu and Mn in 1.5% of the field. Gezgin et al. [1] investigated the effects of phosphorus and zinc fertilizing on yield and quality of sugar beet. The highest root yield was obtained using 7 kg/da of P_2O_5 + 3.6 kg/da of Zn, while the highest sugar yield was observed using 7 kg/da of P_2O_5 + 2.4 kg/da of Zn. Additionally, the increase in root yield (86%) and in sugar yield (45%) was determined in comparison to control.

Relationship between the properties of soil and the content of nutrition element of leaf blade samples. There were significant positive correlations between the lime amounts of soils and the Ca and boron scales of leaf blade and there were negative correlations between the lime amounts of soils and the Fe and Mn contents of the leaf blade. There were negative correlations between the available (viable) Ca and Mg contents of the soils and the N, P, K, Fe, Zn, Mn, Cu and B contents of the leaf blades. In addition, there were negative correlations between the amount of available NH_4 + NO_3 nitrogen of soil and the P, K, Ca, Mg, N, Fe, Zn, Mn, Cu and B amounts of leaf blade.Negative relations between the available amounts of Ca, Mg and N (NH_4 + NO_3) to plants in the soil and the nutrient content of leaves showed that the negative effects on intake of P, K, Ca, Mg, Fe, Zn, Mn, Cu and B could be avoided in the case of excess nitrogen plants which could be added to the soil by controlling nitrogenous fertilization, since it was not possible to change the Ca and Mg contents of the region soils that were generally limy. There were generally negative relations between the clay contents of the soil and other nutrients (N, P, K, Ca, Mg, Fe, Zn, Mn, B) amounts of leaf blade except for Na. These relationships showed that as the amount of clay in the soil increased, the intake of other nutrients, except Na, generally decreased, which should be taken into consideration in fertilization. The relationships between nitrogen and other nutrients of leaf blade and also phosphorus and other nutrients were generally found to be negative. In addition, there was a negative relationship between nitrogen and phosphorus contents of leaf blade and sugar rate and dry matter content of sugar beet. The intake of other nutrients and the quality of the plants were destroyed when the amounts of nitrogen and phosphorus given to the sugar beet plant increased.

Conclusions

The results obtained in this research conducted to determine nutritional problems of sugar beet plant by soil and plant analysis are listed below:

1. 92.9% of sugar beet cropped area has alkali and 7.1% has neutral reaction. Neutral reacted soils are located in Beyşehir, Seydişehir and Şarkikaraağaç regions.
2. 97.1% of region soils are limy.
3. Approximately 97% of the surveyed lands is thin textured (high clay content) soil.
4. 93% of the surveyed lands is poor in terms of organic matter.
5. In about 2.9% of region soils, the percentage of changeable sodium is over 15% and these are alkaline soils.
6. When we examine the amounts of organic matter and NH_4 + NO_3 nitrogen in the soil, it is found that nitrogenous fertilizer is applied excessively to the plants in the region.
7. 65.8% of the surveyed land contain very little and little suitable phosphorus and 7.1% of them contain very high level of suitable phosphorus.
8. The quantities of potassium, calcium and magnesium that can be taken into the plants of the research field are usually sufficient and high.
9. 54.2% of the sugar beet cultivated soils contain boron in insufficient level for the sugar beet plant and it may require boron fertilizer depending on other factors.
10. The amount of available zinc in the soil is deficient in 14.3% and moderate in 72.9% and 87.2% of soils may require zinc fertilizer depending on the soil characteristics and amount of applied nitrogen and phosphorus.
11. According to the results of leaf analysis, the nitrogen, phosphorus, potassium, calcium, magnesium, sodium contents of the plants are sufficient or high.
12. According to the analysis results of sugar beet leaf blade, there are iron in 4.3%, zinc in 14.3% and boron deficiency in 38.6% of the units. There are zinc and boron deficiency in about 80% and 67% of the region soils, respectively, depending on the nitrogen and phosphorus fertilizing and soil properties.

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