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Estimation of Plant Available Boron Status in Some Agricultural Soil of Pasinler Plain With Chemical and Biological Method

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Abstract: The purpose of this investigation was to determine chemical extraction and biological method to be used in determining plant available bor in Pasinler Plain Soils. For this purpose 11 representative soil samples were sampled. A glasshouse experiment was conducted using randomised block design was used in three replicates. Corn (Zea mays L.Var.Akpınar) plants were harvested 8 weeks after germination and, rye plants (S.Cerale Tetraploid) were harvested 17 day after germination. Boron uptake of the tested plants were determined. In order to determine the available boron contents of soils, chemical methods (Azometin-H spectrofotometric and ICP spektrometric) were used: Boron content of tested plants (corn and rye) were taken as biological indexes.
As a result, the Azometin-H spectrofotometric method indicated that 7 of 11 soil samples (1,2,7 and 9 soil number) had not enough plant available B content. Where as the 11 soil samples had enough sufficiency for B content of corn plants. On the other hand , it was obtained that B content of rye plants was enough in 7 out of 11 soil samples based on the Neubauer seedling technique.
Conclusion in 11 soil samples representing Pasinler Plain ,Azometin-H spectrofotometric and ICP spektrometric method produced the highest correlation ($p<0.05$) with the biological indexes.
Keywords: soil tests, available boron, corn, rye, neubauer seedling technique

Introduction

The most direct way of determining nutritient availability in soils is to measure the growth response of plants by means of field plot fertilizer trials. This is a time consuming procedure, however, and the results are not easily extrapolated from one location to another.

In contrast, chemical soil analysis-soil testing is a comparatively rapid and inexpensive procedure for obtaining information on nutrient availability in soils as a basis for recommending fertilizer application.

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Soil testing makes use of a whole range of conventional extraction medhods involving different forms of dilute acids, salt or complexing agents. Quite often several methods are equally suitable for soil testing of the same mineral nutrient (Vetter et. all. 1978)

There is a long history of controversy as to whether soil or plant analysis provides a more suitable basis for making fertilizer recommendations. Both methods rely in a similar manner on calibration, i.e. the determination of the relationship between concentrations in soils or plants and the corresponding growth and yield response curves, usually obtained in pot or field experiments using different concentrations of fertilizers. Both methods have advantages and limitations, and they also give qualitatively different results (Schlichting, 1976). Chemical soil analysis indicates the potential availability of nutrients that roots may take up under conditions favourable for root growth and root activity. Plant analysis in the strict sense reflects only the actual nutritional status of plants. Therefore, a combination of both methods provides a better basis for recommending fertilizer applications than one alone. The relative importance of each method for making recommendations differs, however, depending on plant species, soil properties and the nutrient in question (Marschner, 2012).

Boron (B): Boron is a member of the metalloid group of elements. Boron uptakeis closely related to the external B concentration overa wide concentration range. Boron availability is strongly affected by soil water content and becomes limiting in dry conditions wheremass flow to roots is reduced . Boron deficiency is a widespread nutritional disorders. Under high rainfall conditions , boron is readily leached from soils as B(OH)3. Boron availability to plants decreases with increasing soil pH , particularly in calcareous soils and soils with a high clay content, presumably as a result of the formation of B(OH)4 - and subsequent anion adsorbtion. (Shorrocks, 1997) Boron is considered to be an important trace element in human nutrition and it is also necessary for metabolism. Boron is probably taken in the form of boric acid. The pH is particularly high at 6.5 and below. Boron is usually associated with potassium and calcium metabolism. Along with regulating carbohydrate metabolism, it also plays a role in RNA synthesis (Yıldız, 2008, Marschner, 2012))

Material and Methods

Representative composite surface soil samples (0-30 cm) were collected from 11 different soil sampling area or village soils (Pasinler, Altınbaşak, Alvar, Çakırtaş, Çöğender, Korucuk, Müceldi, Sunak, Tepecik, Taşkaynak and Yiğittaşı) , same chemical and physical properties of soil samples .

Biological extraction method (Greenhouse experiment) ; Corn (Zea mays.L.var Akpınar) and rye (S.Cerale Tetraploid) were grown in pots under greenhouse conditions as a test plants using randomised block design and each replicate twice (Alparslan et al, 1998; Kacar 1995; Özbek ,1969 ; Neubauer and Schneider, 1923) Plants were harvested 8 week (for corn) and 17 day (for rye) after germination and dry matter yield for determining Boron status (plant boron uptake) of soil samples.

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In determining chemical extraction method for plant available boron contents of soil samples, 0.01 M $CaCl_2$ hot water (Azometin-H) and ,ionic boron with ICP method was used.

The correlations between by Boron extraction methods with Neubauer seedling method (biological indexes) were calculated.

Results and Discussion

Dry matter yield of corn and rye plants, nutrient content (Ca, Mg,K,Na, Fe, Cu,Zn ,Mn and Boron) , on the other hand some soil chemical end physical analyses (pH, organic matter, texture , CEC, $CaCO_3$,total N, exchangable Ca, Mg,K,Na, plant available P, Fe, Cu,Zn ,Mn and Boron (Tablo;1,2,3) The results of this study Show that plant available Boron element obtained with Azometin-H spectrophotometric and ICP ionic analysis after hot water exraction method were interelated with biological indexes (neubauer seedling method, boron uptake both of corn and rye plant) in some Pasinler palin agricultural land soils.

Results also showed that the Azometin-H spectrophotometric and ICP ionic analysis after hot water exraction method might be used for plant available soil boron nutrient at least in that soils because of positive correlation between both of corn and rye leaf Boron concentration with soil available boron were found. ($p<0.05$) (Tablo; 4-10).

According to the soil analysis and between correlation of soil tests and plant boron uptake it was seen that most of the soils (63.6 %) plant available boron are sufficient.

As a result, the Azometin-H spectrofotometric method indicated that 7 of 11 soil samples (1,2,7 and 9 soil number) had not enough plant available B content. Where as the 11 soil samples had enough sufficiency for B content of corn plants. On the other hand , it was obtained that B content of rye plants was enough in 7 out of 11 soil samples based on the Neubauer seedling technique.

Conclusion in 11 soil samples representing Pasinler Plain ,Azometin-H spectrofotometric and ICP spektrometric method produced the highest correlation ($p<0.05$) with the biological indexes.

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Table.1. Some physical and chemical properties of Pasinler Plain Soil samples

Soil samples		1	2	3	4	5	6	7	8	9	10	11
pH		8.05	7.95	8.11	6.93	8.05	7.83	7.73	8.05	8.24	7.7	8.25
$CaCO_3$		2.27	0.97	4.87	0.16	1.3	0.32	0.19	12.35	14.23	12.61	7.93
CEC ($cmol.kg^{-1}$)		21.59	30.08	26.58	16.08	28.25	22.13	21.87	33.24	24.69	35.73	22.99
Exchangeable cations ($cmol.kg^{-1}$)	Na	trace	trace	trace	trace	trace	trace	trace	trace	trace	trace	trace
	Ca	Ara.19	Nis.96	16.Kas	Nis.44	15.98	Mar.98	Ağu.54	19.22	35.08	41.88	34.82
	Mg	7.1	12.27	9.9	3.25	8.03	7.43	7.96	11.07	9.53	5.87	10.81
	K	9.65	8.61	13.01	3.84	12	5.71	8.25	15.14	22.30	23.87	22.82
Micro nutrients ($mg.kg^{-1}$)	Fe	1.41	1.17	1.37	3.3	1.14	1.57	1.42	1.19	1.43	1.22	1.3
	Cu	3.15	3.41	4.05	2.54	2.37	2.59	2.23	2.94	2.26	2.35	2.31
	Zn	2.02	0.25	trace	2.05	trace	0.2	0.2	0.26	trace	trace	trace
	Mn	2	2.75	1.74	6.45	2.56	5.85	3.77	1.91	1.49	2.18	3.01
B $mg\ kg^{-1}$	Azometin-H	0.34	0.63	0.35	0.3	0.44	0.52	0.89	0.45	0.53	0.28	0.37
	B (ICP)	1.36	1.44	0.81	0.83	0.81	0.84	1.93	0.97	1.36	0.86	0.86
Nitrogen %		0.06	0.25	0.37	0.02	0.06	0.05	0.18	0.06	0.05	0.07	0.23
Org.matter %		2.56	2.04	1.9	2.18	1.83	2.1	1.73	2.56	2.12	2.85	2.11
P($mg.kg^{-1}$)		43.3	40	4	3	6.66	56.6	10	10	16.66	20	10
Texture class		Sandy-clay-loam-	clay	Clay-loam	Sandy-loam	clay	Sandy-clay-loam	loam	clay	Clay-loam	clay	Sandy-clay-loam

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Table 2. Mineral contents of corn plant according to Neubauer seedling method

Plant samles		1	2	3	4	5	6	7	8	9	10	11
Macro nutrients	N %	0.58	1.23	1.15	1.16	1.11	1.55	1.48	1.29	0.97	1.18	1.12
	P %	0.35	0.33	0.28	0.43	0.22	0.43	0.29	0.14	0.19	0.14	0.13
	Ca (mg kg^{-1})	2612.67	2819.67	3375	3574	2481	3777.33	2863	3598.67	3951.33	3868	4938.33
	K (mg kg^{-1})	871.2	940.41	1125.48	1191.86	827.44	1259.77	954.92	1200.03	1317.5	1289.77	1646.53
	Mg (mg kg^{-1})	1242	1996.33	2005.67	1752.33	1609.67	3227.67	2439	2577.67	2765.33	1976.67	3363.67
	Na (mg kg-1)	2584.33	2185.33	1444.33	1623.67	3995.67	2424.33	1474	2115.33	2220.33	1839.67	1810.33
Micro nutrients (mg.kg^{-1})	Fe	76.09	45.67	44.22	46.53	33.8	123.67	51.53	72.37	211.63	57.69	78.51
	Zn	1300.81	1409.11	1164.74	1140.84	1879.71	1925.22	1321.51	1588.46	1732.43	1291.34	1750.84
	Mn	1320.41	1213.37	884.43	937.01	1969.72	1491.07	949.01	1258.72	1388.13	1062.9	1213.23
	Cu	120.32	4.66	10.94	58.35	33.15	6.38	159.37	159.13	174.07	255.53	114.1
	B	8.31	5.45	9.23	13.2	6.46	9.1	13.34	5.99	10.15	15.5	17.82

Table 3. Mineral contents of Rye plant according to Neubauer seedling method

Soils samples		1	2	3	4	5	6	7	8	9	10	11
Dry weight (gr/pod)		2.08	1.97	0.85	1.83	1.22	1.92	0.94	1.33	1.31	1.23	1.82
cations	%N	1.64	1.17	2.04	1.29	2.18	1.34	1.87	1.99	1.66	2.06	1.55
	%P	0.35	0.39	0.23	0.18	0.3	0.34	0.38	Yüksek	Yüksek	0.28	0.28
	Ca	14955	13285	13366	19865	13885	17385	6835	7403	8694	15720	11085

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	K	23956.67	22413.33	22800	20550	21503.33	20843.33	24540	22805	27960	24230	23660
	Mg	2902	4407.33	3619	4736.33	3288	6526	3250.33	3320.67	4124.33	5120	4601.33
	Na	4086	5901.33	8905.33	4739	4547.33	4349.33	5475	2973.33	4278	3808	3597.33
Micro nutrients	Fe	1841	9473.33	1436	4496	1680.5	5706.33	1115.33	1358	1706.33	3114.33	2530.33
($mg.kg^{-1}$)	Zn	110.63	183.3	87.77	21.46	80.04	86.29	52.4	114.57	83.57	78.07	265.13
	Mn	101.79	106.4	117.6	143.65	76.64	172.22	114.73	79.54	150.83	155.1	118.85
	Cu	56.8	19.4	45.01	17.72	16.05	21.34	39.8	34.12	21.68	36.4	22.68
	B	5.86	5.75	10.6	4.33	5.58	3.98	13.96	trace	trace	trace	trace

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Table.4 Available boron concentrations of soil samples (mg.kg-1)

Soil samples		1	2	3	4	5	6	7	8	9	10	11
		MERKEZ	ALTINBAŞAK	ALVAR	ÇAKIRTAŞ	ÇÖĞENDER	KORUCUK	MÜCELDİ	SUNAK	TEPECİK	TAŞKAYNAK	YİĞİTTAŞI
		Lahana	Ayçiçeği	Ayçiçeği	Ayçiçeği	Buğday	Buğday	Buğday	Buğday	Buğday	Arpa	Arpa
B(mg.kg-1)	ICP	0,34	0,63	0,35	0,30	0,44	0,52	0,89	0,45	0,53	0,28	0,37
	A-H	1,36	1,44	0,81	0,83	0,81	0,84	1,93	0,97	1,36	0,86	0,86

Table.5 Boron content of corn plant (mg.kg-1)

Soil samples	1	2	3	4	5	6	7	8	9	10	11
	MERKEZ	ALTINBAŞAK	ALVAR	ÇAKIRTAŞ	ÇÖĞENDER	KORUCUK	MÜCELDİ	SUNAK	TEPECİK	TAŞKAYNAK	YİĞİTTAŞI
B(mg.kg-1)	8,31	5,45	9,23	13,20	6,46	9,10	13,34	5,99	10,15	15,50	17,82

Table.6 Boron content of rye plants (mg.kg-1)

Soil samples	1	2	3	4	5	6	7	8	9	10	11	kontrol plant
	MERKEZ	ALTINBAŞAK	ALVAR	ÇAKIRTAŞ	ÇÖĞENDER	KORUCUK	MÜCELDİ	SUNAK	TEPECİK	TAŞKAYNAK	YİĞİTTAŞI	
B (mg.kg-1	5,86	5,75	10,60	4,33	5,58	3,98	13,96	trace	trace	trace	trace	11,04

*; plant dry matter weight was 0.3 gr.

Table.7 Critical range for Soil available boron acording to Azometin-H method (Wolf, 1971)

Boron analaysis metod	Çok Az	Az	Yeterli	Fazla	Çok Fazla
Bor (CH_3COONH_4) ppm	< 0.4	0.4-0.9	1.0-2.4	2.5-4.9	> 5.0

Table.8. The linear correlation cofficients between Biological methods and boron chemical extraction methods for Pasinler plain soil samples (SPSS ,1997)

Soil	ICP	Azometin-H	Rye	Corn
ICP	1	0.788**	0.440*	-0.183
Azometin-H		1	0.384*	-0.59

Table.9. Available boron content of soil samples according to Neubauer seedling method

Soil sample No;	B ppm Çavdar	H_3BO_3 *mg.100gr^{-1}	H_3BO_3 **kg/ha
1	5.86	3.34	20.04 adequate
2	5.75	3.28	19.68 adequate
3	10.60	6.05	36.30 adequate
4	4.33	**2.47**	14.82 adequate
5	**5.58**	3.18	19.08 adequate
6	**3.98**	**2.27**	13.62 adequate
7	**13.96**	7.97	47.82 adequate
8	trace	Trace deficient	3.0 deficient
9	trace	Trace deficient	3.0 deficient
10	trace	Trace deficient	3.0 deficient
11	trace	Trace deficient	3.0 deficient

Table.10 Critical range for Soil available boron acording to Azometin-H method (Wolf. 1971)

Bor (metot)	Very low	low	sufficient	high	Very high
Bor (CH_3COONH_4) ppm	< 0.4	0.4-0.9	1.0-2.4	2.5-4.9	> 5.0

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