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SOME BIOCHEMICAL FEATURES OF BORON (B) CONTENT IN SOILS OF THE ZARAFSHAN VALLEY

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Annotation. This research investigated the factors influencing boron (B) availability in soils of the Zarafshan Valley. Soil samples were collected from the plow layer of 17 soil profiles along the Zarafshan River, encompassing a region from Jomboy to Olot districts. Soil properties analyzed included organic matter content, pH, and concentrations of various nutrients such as phosphorus, potassium, molybdenum, manganese, zinc, and cobalt.

Correlation and regression analyses revealed significant relationships between water-soluble B and several soil characteristics. Strong positive correlations were observed with soil texture (heavier soils), soil pH (alkaline conditions), and available molybdenum. Moderate positive correlations were found with available manganese, total B content, parent material, available zinc, and organic matter content. Conversely, a moderate negative correlation was observed between exchangeable potassium and water-soluble B.

The results indicate widespread boron deficiency in the arable layer of soils within the Samarkand oasis. Consequently, boron fertilization is recommended to optimize crop productivity. Various application methods, including seed treatment, soil application, and foliar feeding, can be considered. In contrast, alluvial soils of the Bukhara and Karakul oases exhibit elevated levels of water-soluble B, potentially exceeding optimal ranges for some crops. In these regions, boron fertilizer applications should be carefully evaluated and primarily considered for seed treatment and foliar feeding.

Key words: soil environment, humus, coefficient of correlation, mobile phosphorus, exchangeable potassium, coefficient of migration.

Аннотация. В данном исследовании изучались факторы, влияющие на доступность бора (B) в почвах долины Зарафшана. Образцы почвы были отобраны из пахотного и под пахотного слоя 17 почвенных разрезов вдоль реки Зарафшан, охватывающих регион от Джомбойского до Олотского района. Анализировались такие свойства почвы, как содержание органического вещества, pH и концентрация различных питательных веществ, таких как фосфор, калий, молибден, марганец, цинк и кобальт.

Корреляционный и регрессионный анализы выявили значимые связи между водорастворимым бором и несколькими характеристиками почвы. Сильные положительные корреляции наблюдались со структурой почвы (более тяжелые почвы), pH почвы (щелочные условия) и доступным молибденом. Умеренные положительные корреляции были обнаружены с доступным марганцем, общим содержанием бора, материнской породой, доступным цинком и содержанием органического вещества. Напротив, умеренная отрицательная корреляция наблюдалась между обменным калием и водорастворимым бором.

Результаты указывают на широко распространенный дефицит бора в пахотном слое почв Самаркандского оазиса. Следовательно, для оптимизации продуктивности сельскохозяйственных культур рекомендуется внесение борных удобрений. Можно рассмотреть различные способы внесения, включая обработку семян, внесение в почву и внекорневую подкормку. В отличие от этого, аллювиальные почвы Бухарского и Каракульского оазисов характеризуются повышенным содержанием водорастворимого бора, потенциально превышающим оптимальные значения для некоторых сельскохозяйственных культур. В этих регионах применение борных удобрений следует тщательно оценить и в первую очередь рассматривать для обработки семян и внекорневой подкормки.

Ключевые слова: почвенная среда, гумус, коэффициент корреляции, подвижной фосфор, обменный калий, коэффициент миграции.

Annotatsiya: Ushbu tadqiqot Zarafshon vodiysi tuproqlarida suvda eriydigan bor (B)ga ta'sir qiluvchi omillarni o'rgandi. Jomboydan Olot tumanigacha bo'lgan hududni qamrab olgan Zarafshon daryosi bo'yidagi 17 ta tuproq kesmasining ustki va ostki qatlamidan tuproq namunalari olindi. Gumus miqdori, pH va fosfor, kaliy, molibden, marganets, rux va kobalt kabi turli xil ozuqa moddalarining konsentratsiyasi kabi tuproq xususiyatlari tahlil qilindi. Korrelyatsiya va regressiya tahlillari suvda eriydigan bor va tuproqning bir qancha xususiyatlari o'rtasida sezilarli bog'liqlik mvjudligini aniqladi. Tuproq strukturasi (og'ir tuproq), tuproq pH (ishqoriy sharoit) va o'zlashtiriluvchan molibden bilan kuchli ijobiy bog'liqlik kuzatildi. O'zlashtiriluvchan marganets, yalpi bor, ona jins, o'zlashtiriluvchan rux va gumus miqdori bilan o'rtacha ijobiy korrelyatsiya aniqlandi. Aksincha, almashinuvchan kaliy va suvda eriydigan bor o'rtasida o'rtacha salbiy korrelyatsiya kuzatildi. Natijalar Samarqand vohasi tuproqlarining ustki qatlamida borning tanqisligini ko'rsatadi. Shuning uchun hosildorlikni oshirish uchun bor bilan o'g'itlash tavsiya etiladi. Turli qo'llash usullarini ko'rib chiqish mumkin, jumladan, urug'larni namlash, tuproqqa qo'llash va bargdan oziqlantirish. Bundan farqli ravishda, Buxoro va Qorako'l vohalarining allyuvial tuproqlari suvda eruvchan borning ko'pligi bilan ajralib turadi, bu esa ayrim ekinlar uchun optimal qiymatlardan yuqori. Ushbu hududlarda borli o'g'itlari diqqat bilan baholanish va birinchi navbatda urug'larni namlash va bargdan oziqlantirishda foydalanish uchun ko'rib chiqilishi kerak.

Kalit so'zlar: tuproq muhiti, gumus, korrelyatsiya koeffitsienti, harakatchan fosfor, almashinuvchan kaliy, migratsiya koeffitsienti.

INTRODUCTION

The main indicator characterizing soil is its elemental composition, which in turn determines soil fertility [34; p. 352]. The elemental composition of soil is of theoretical and practical importance in studying its fertility and determining the direction of processes in it. Therefore, studying the elemental composition of soil, their distribution, and migration is a pressing problem.

The amount of mobile boron (B) and its availability depend on soil humus [12; p. 67-72., 13; p. 1988-1994., 15; p. 288., 17; p. 30-43., 30; p. 333-346], the composition of the parent rock from which the soil is formed and the granulometric composition of the soil [22; p. 2053-2069], the level of soil supply with micro-elements [31; p. 176], the oxidation-reduction conditions in the soil [32; p. 671-677], the environmental reaction [2; p. 10., 7; p. 882-892], in addition, the amount and rate of mineral and organic fertilizers applied [6; p. 839-849., 8; p. 250., 11; p. 9399-9405., 23; p. 233-242., 29; p. 132-133] has been confirmed in a number of scientific studies.

Boron is found in nature as acharite – $2MgO*B_2O_3*H_2O$, hydroboracite – $CaO*MgO*3B_2O_3*6H_2O$, in small quantities in ulexite – $Na_2O*2CaO*5B_2O_3*16H_2O$, inoite – $2CaO*3B_2O_3*13H_2O$, and other minerals [5; p. 111., 9; p. 272., 18; p. 252].

Boron is highly mobile depending on the soil environment (pH), and can migrate in both acidic and alkaline environments. The highest mobility of boron compounds is observed in acidic environments (pH=1-5) and strongly alkaline environments (pH=8-11) [2; p. 10., 7; p. 882-892].

Water-soluble boron is very low in soils, but accumulates in high

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concentrations in saline soils. The water-soluble form of boron in soil accounts for 3-10% of the total amount [28; p. 179].

In the experiments of O.I.Alikhanova [3; p. 22], it was found that the content of water-soluble boron in saline soils is significantly higher than in non-saline soils, with the highest content recorded in saline gypsum soils of the chloride-sulfate type, ranging from 3-30 mg/kg, and the lowest content in carbonate saline soils (1.5-2.7 mg/kg).

According to N.Khayriyeva, D.Eshmurodov [16; p. 101-102], the amount of water-soluble boron in soils varies between 0.9-4.3 mg/kg. This amount varies in direct proportion to the amount of easily water-soluble salts ($CaHCO_3$, NaCl, Na_2SO_4) in the soil. As the amount of water-soluble salts in the soil increases, the amount of boron in the form that plants can absorb also increases, and vice versa. However, even with a high salt content in the soil, the amount of mobile boron decreases as the soil's granulometric composition becomes lighter.

Long-term high rates of mineral fertilizers, including nitrogen fertilizers, lead to a significant decrease in the amount of water-soluble boron in soils [10; p. 38-42].

Currently, the area of boron (B) deficiency in Uzbekistan is 450 thousand hectares [27; p. 29].

MATERIALS AND METHODS

The Zarafshan Valley is characterized by a wide variety of natural and geographical conditions. The natural and geographical conditions and soil properties of the valley have been described in detail in a number of works [14; p. 9., 15; p. 288., 19; p. 120., 20; p. 351., 35; p. 237-238].

The Zarafshan Valley is mainly composed of Tertiary sedimentary rocks overlain by Quaternary alluvial rocks. Soil formation in the valley occurred in Quaternary rocks. Based on their genesis, the rocks are divided into loess, alluvial, proluvial, and alluvial-proluvial deposits [21; p. 45].

The Zarafshan Valley is divided into two sharply different landscape and geographical regions according to its natural conditions. The first is the eastern part - foothills, steppes and loess plains, the second is the western part - desert. They differ sharply according to their hydrogeological and land reclamation conditions. The soils of the Samarkand oasis belong to the first region, and the soils of the Bukhara and Karakul oases belong to the second region. In addition, the Zarafshan Valley is divided into four geomorphological regions, which differ significantly in the structure of the relief and the nature of the Quaternary deposits: 1) Samarkand Basin, 2) Bukhara subaerial delta, 3) Karakul subaerial delta, 4) Navoi-Kanimekh oasis [1; p. 5-11].

In the research, to study the effect of the humus content, pH, nutrient content, and granulometric composition of the Zarafshan Valley soils on the quantitative and qualitative changes in microelements, 3-7 replicate samples were taken from the plow layer of the main soil types and subtypes distributed along the Zarafshan River (from Jomboy district to Olot district, a total of 17 soil pit (profile) and analyzed. Fieldwork was carried out on an expedition route along the base plots characterizing the irrigated soil type. Soil samples were taken by tillage, subsoil, and parent rock. Humus, pH, mobile phosphorus, exchangeable potassium, and boron (B) were determined for agrochemical characterization of the soils.

In the studies, total boron was determined according to E.K.Kruglova [26; p. 40]. The total boron (B) content in the topsoil of the studied soils was compared with the content of the standard sample SP-1 (53 mg/kg) in Kursk black soils, which was taken as a standard. Water-soluble boron was determined using a Shimadzu AA-7000 atomic absorption spectrophotometer.

In the experiment, agrochemical and agrophysical analyses were performed using the following methodological manuals: “Methods of agrochemical,

agrophysical and microbiological studies in cotton fields [26; p. 40]", "Methods of agrochemical studies [24; p. 33]", "Methods for determining macro and microelements in plants, soil and water [25; p. 91]" and "Guide to chemical analysis of soil [4; p. 490". In the experiment, the granulometric composition of the soil was determined according to N.A.Kachinsky [26; p. 40].

Agrochemical analyses included humus (%) according to I.V.Tyurin; total nitrogen, phosphorus, and potassium (%) according to I.M.Malsyev, L.P.Gritsenko; mobile phosphorus (mg/kg) according to B.P.Machygin, exchangeable potassium (mg/kg) according to P.V.Protasov, and soil pH determined using an Anion-7010 ionomer.

Statistical analysis of the experimental results was carried out according to B.A.Ushkarenko et al. [33; p. 336].

RESULTS AND DISCUSSION

Based on the expedition route, the total boron content in all soils of the Samarkand oasis studied was on average higher than the reference value and fluctuated within a wide range.

While in automorphic soils the accumulation of total boron was quite clearly manifested in the humus layer, in hydromorphic soils, especially in meadow-gray (soil pit (profile) 1/31) and old irrigated meadow-gray (soil pit (profile) 5/31) soils, this phenomenon was observed in soil-forming rocks.

Among the studied soils of the Samarkand oasis, the old irrigated swamp-meadow soils (Payariq district, soil pit (profile) 6/34) were characterized by the lowest retention of total boron in the tillage layer. This is probably due to the mineralogical composition of the parent rock and the water-salt regime of these hydromorphic soils.

The total boron content in the plow layer of the automorphic old irrigated typical gray soils of the 3rd terrace of the right and left banks of the Zarafshan River (Payariq district, soil pit (profile) 7/16; and Pastdarg'om district, soil pit (profile) 8/16) was found to be on average 90.0 and 91.9 mg/kg, respectively, which is higher than that in the standard black soils. Its content decreases towards the lower layers, and the lowest content was recorded in the soil-forming parent rocks.

The total boron content along the profile of the weakly saline, old-irrigated light gray soils of the left bank of the Zarafshan River (Narpay district, soil pit (profile) 10/38) varied from 66.8 mg/kg to 112.8 mg/kg. In the arable layer, its content was found to be 87.8 mg/kg, which is higher than the reference value (Fig. 1). This is probably due to the granulometric composition and soil solution environment, and accordingly, the coefficient of variation is small.

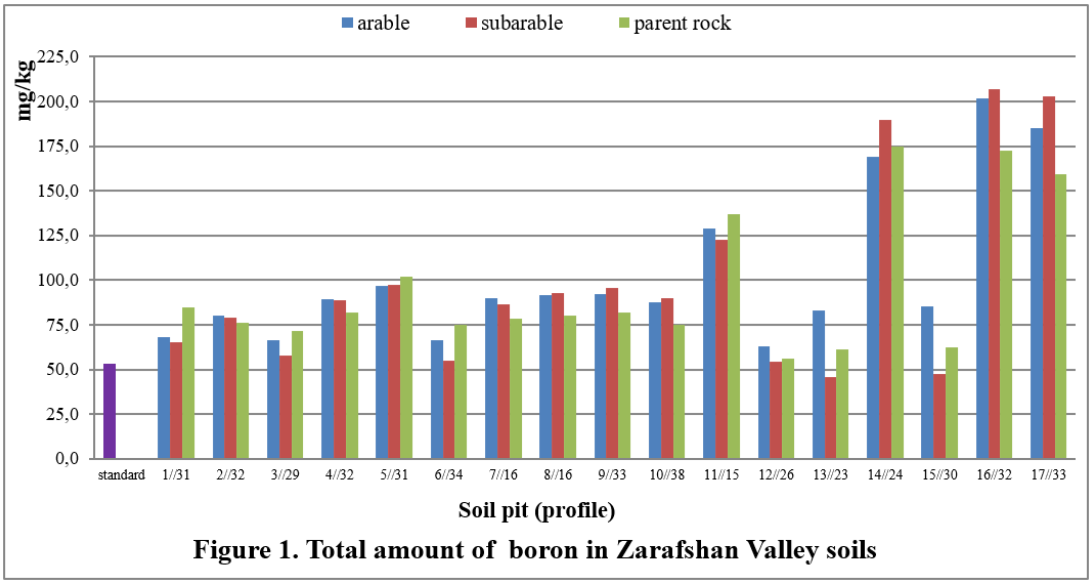


Figure 1. Total amount of boron in Zarafshan Valley soils

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According to the results of the analysis, among the studied soils of the Samarkand oasis, hydromorphic soils, in particular, meadow-gray soils with a peat layer (Jomboy district, soil pit (profile) 1/31), have a high content of water-soluble boron in the plow layer (average 0.70±0.10 mg/kg), but belong to the group of undernourished soils in terms of this indicator (Table 1).

Table 1

Distribution of the microelement boron in the soils of the Zarafshan Valley

Soil pit (profile)	Repetition	Profile	Boron, mg/kg									Km	
			total				water soluble					total	water soluble
			lim	x̄	$tS_{\bar{x}}$	$V,\%$	lim	x̄	$tS_{\bar{x}}$	$V,\%$	% of total		
1/31	4	*	55,8-78,3	68,1	9,27	13,61	0,56-0,79	0,70	0,10	14,29	1,03	0,80	1,27
		**	36,3-82,2	65,1	20,25	31,11	0,55-0,81	0,71	0,12	16,90	1,09		
		*/	34,3-86,1	57,3	21,82	38,08	0,24-0,78	0,39	0,26	66,67	0,68		
		***	61,3-98,7	85,0	16,35	19,24	0,27-1,12	0,55	0,39	70,91	0,65		
2/32	3	*	75,2-88,3	79,9	7,29	9,12	0,25-0,52	0,41	0,14	34,15	0,51	1,05	1,95
		**	74,3-87,1	79,0	7,04	8,91	0,21-0,33	0,26	0,06	23,08	0,33		
		***	70,8-82,7	75,9	6,13	8,08	0,17-0,26	0,21	0,05	23,81	0,28		
3/29	3	*	53,2-78,9	66,1	12,85	19,44	0,43-0,73	0,59	0,15	25,42	0,89	0,92	1,34
		**	31,4-86,5	58,0	27,60	47,59	0,32-0,69	0,52	0,19	36,54	0,90		
		*/	23,5-78,2	50,9	27,35	53,73	0,18-0,27	0,23	0,05	21,74	0,45		
		***	48,3-89,8	71,6	21,21	29,62	0,28-0,71	0,44	0,23	52,27	0,61		
4/32	7	*	75,4-110,3	89,6	14,26	15,92	0,25-0,54	0,41	0,10	24,39	0,46	1,09	1,64
		**	74,3-110,1	88,7	13,00	14,66	0,21-0,44	0,33	0,09	27,27	0,37		
		***	70,8-99,7	81,9	9,82	11,99	0,06-0,48	0,25	0,16	64,00	0,31		
5/31	3	*	95,2-98,9	96,8	1,91	1,97	0,30-0,35	0,32	0,03	9,38	0,33	0,95	1,78
		**	93,4-102,3	97,3	4,55	4,68	0,22-0,29	0,26	0,04	15,38	0,28		
		***	83,5-120,8	102,0	18,65	18,28	0,14-0,23	0,18	0,05	27,78	0,18		
6/34	4	*	54,7-78,1	66,4	9,91	14,92	0,55-0,73	0,64	0,09	14,06	0,96	0,89	1,36
		**	33,9-81,6	55,2	20,00	36,23	0,49-0,80	0,59	0,14	23,73	1,07		
		***	59,2-96,4	75,0	15,79	21,05	0,22-1,00	0,47	0,36	76,60	0,63		
7/16	5	*	82,3-98,5	90,0	7,73	8,59	0,47-0,73	0,62	0,16	25,81	0,69	1,15	0,87
		**	75,7-98,2	86,3	8,00	9,27	0,32-0,90	0,62	0,16	25,81	0,72		
		***	66,3-91,4	78,2	11,52	14,73	0,27-1,00	0,71	0,18	25,35	0,91		
8/16	3	*	76,4-102,8	91,9	13,77	14,98	0,45-0,73	0,63	0,15	23,81	0,69	1,15	1,00
		**	85,3-97,6	93,0	6,73	7,24	0,35-0,68	0,53	0,17	32,08	0,57		
		***	65,4-93,1	80,1	13,92	17,38	0,31-0,86	0,63	0,29	46,03	0,79		
9/33	3	*	78,1-101,7	92,4	12,57	13,60	0,70-0,80	0,76	0,05	6,58	0,82	1,13	1,73
		**	84,3-104,2	95,5	10,17	10,65	0,62-0,66	0,64	0,02	3,13	0,67		
		***	66,2-98,4	82,1	16,11	19,62	0,41-0,46	0,44	0,03	6,82	0,54		
10/38	5	*	81,7-96,6	87,8	6,66	7,59	0,24-0,69	0,47	0,12	25,53	0,54	1,17	0,71
		**	83,5-112,8	90,0	12,77	14,19	0,42-0,66	0,53	0,13	24,53	0,59		
		***	66,8-96,4	75,1	12,36	16,46	0,41-0,93	0,66	0,16	24,24	0,88		
11/15	3	*	104,2-156,4	128,7	26,25	20,40	0,98-1,23	1,12	0,13	11,61	0,87	0,94	1,38
		**	102,3-144,2	122,6	20,98	17,11	0,68-0,75	0,71	0,04	5,63	0,58		
		***	117,6-158,6	137,2	20,55	14,98	0,78-0,83	0,81	0,03	3,70	0,59		

Soil pit (profile)	Repetition	Profile	Boron, mg/kg									Km	
			total				water soluble					total	water soluble
			lim	$\bar{x}$	$tS_{\bar{x}}$	$V,\%$	lim	$\bar{x}$	$tS_{\bar{x}}$	$V,\%$	% of total		
12/26	4	*	61,7-63,6	62,7	0,78	1,24	0,37-0,42	0,39	0,02	5,13	0,62	1,10	0,46
		**	52,8-56,4	54,4	1,83	3,36	0,63-0,75	0,69	0,05	7,25	1,27		
		***	53,8-59,7	56,3	2,73	4,85	0,82-0,85	0,84	0,01	1,19	1,49		
13/23	4	*	80,9-85,7	83,2	2,02	2,43	0,98-1,09	1,03	0,05	4,85	1,24	1,36	0,63
		**	42,7-49,2	45,9	2,84	6,19	0,95-1,05	1,00	0,05	5,00	2,18		
		***	58,7-62,8	61,0	2,02	3,31	1,58-1,71	1,64	0,05	3,05	2,69		
14/24	4	*	127,8-219,4	169,2	39,34	23,25	2,51-3,21	2,83	0,31	10,95	1,67	0,97	2,50
		**	157,3-232,1	189,6	31,36	16,54	0,91-2,30	1,60	0,73	45,63	0,84		
		***	132,8-204,5	174,5	30,70	17,59	0,62-1,70	1,13	0,46	40,71	0,65		
15/30	5	*	81,2-92,6	85,3	4,41	5,17	0,98-1,33	1,07	0,15	14,02	1,25	1,36	0,63
		**	43,4-51,1	47,2	3,20	6,78	0,94-1,12	1,02	0,07	6,86	2,16		
		***	59,3-67,6	62,3	3,19	5,12	1,62-1,84	1,69	0,09	5,33	2,71		
16/32	3	*	187,9-219,0	201,8	15,80	7,83	1,45-3,87	2,66	1,21	45,49	1,32	1,17	2,02
		**	188,5-221,8	206,9	16,92	8,18	1,24-3,43	2,31	1,10	47,62	1,12		
		***	155,4-186,2	172,7	15,75	9,12	0,97-1,54	1,32	0,31	23,48	0,76		
17/33	3	*	179,2-190,7	185,3	5,78	3,12	1,50-3,70	2,68	1,11	41,42	1,45	1,16	2,20
		**	185,7-218,4	202,9	16,42	8,09	1,20-3,30	2,16	1,06	49,07	1,06		
		***	154,2-162,6	159,1	4,37	2,75	0,83-1,44	1,22	0,34	27,87	0,77		

*Note: *- arable; **- subarable; ***-parent rock; */ - stratum corneum*
The soil pit (profile) is the same in tables and diagrams: 1/31- Jomboy district, meadow-serozem soil with stratum corneum; 2/32- Jomboy district, right bank of the Zarafshan River, 2 terrace, irrigated meadow alluvial; 3/29- Oqdarya district, meadow-serozem soil with matrix horizons; 4/32-Ishtikhan district, right bank of the Zarafshan River, 2 terrace, irrigated meadow alluvial; 5/31-Ishtikhan area irrigated meadow; 6/34-Payariksky area, meadow marsh, irrigated; 7/16-Payariksky district, right bank of the river Zarafshan, 3 terrace, irrigated typical serozem soil; 8/16-Pastdargom district, left bank of the river Zarafshan, 3 terrace, irrigated typical serozem soil; 9/33-Kattakurgan District, 2 terrace, irrigated meadow alluvial; 10/38-Narpay district, left bank of the river Zarafshan, 3 terrace, light serozem soil; 11/15-Navoiy district, irrigated meadow alluvial; 12/26-Kiziltepa district, newly irrigated brown-grassland; 13/23-Vobkent district, Bukhara upper delta, irrigated meadow takir; 14/24-Romitan district in the central part of the Bukhara delta, alluvial meadow; 15/30-Dzhandar area, the lower reaches of the Bukhara delta, alluvial meadow; 16/32-Karakul district, the upper part of the region Karakul delta, alluvial meadow; 17/33-Alat district, in the central part of the region, the meadow-alluvial soils

It was found that the amount of water-soluble boron in the plow layer of typical gray soils on the 3rd terrace of the right and left banks of the Zarafshan River (Payariq district, soil pit (profile) 7/16; and Pastdarg'om district, soil pit (profile) 8/16) is on average less than the permissible amount (0.62±0.16 and 0.63±0.15 mg/kg, respectively), but higher than in other studied soil types and subtypes

ISSN 2181-0826 3/2025 y.

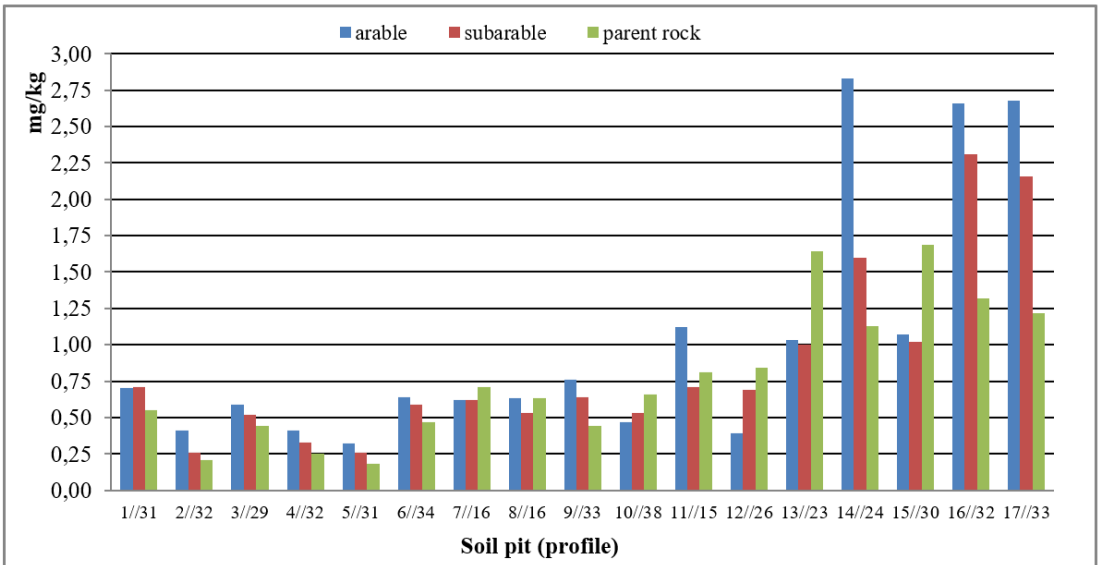


Figure 2. Amount of water-soluble boron in Zarafshan Valley soils

The highest content of water-soluble boron in the oasis was recorded in the old irrigated meadow alluvial (Payshanba town, soil pit (profile) 9/33) soils (average 0.76±0.05 mg/kg), but it should be noted that this content is less than the permissible content. It should also be noted that the coefficient of variation for the content of water-soluble boron in the old irrigated meadow alluvial soils (Payshanba town, soil pit (profile) 9/33) was the smallest among the studied soil types and types in the Samarkand oasis (V=6.58%), which indicates that its content is almost evenly distributed in the arable layer. It was determined that these soils belong to the group of poorly supplied with water-soluble boron according to the gradation of water-soluble boron supply.

In the plow layer of the old irrigated light gray soils of the 3rd terrace of the left bank of the Zarafshan River (Narpay district, soil pit (profile) 10/38), the amount of water-soluble boron was recorded as lower than the permissible amount (average 0.47±0.12 mg/kg). It is noteworthy that the light gray soils differ somewhat from other studied soil types and subtypes in terms of the distribution of water-soluble boron along the profile, and its amount increases towards the parent rock, accordingly, the migration coefficient of water-soluble boron in these soils was recorded as Km=0.71.

As a result of correlation-regression analysis of the collected data, it was determined that there are certain relationships between soil properties and water-soluble boron (Table 2).

Table 2

Response of water-soluble boron to soil properties

№	Indicators	Regression equation	Correlation coefficient	Impact
1	Granulometric composition	y = 0,24 + 0,14x	r = 0,84	strong, positive
2	pH	y = 0,23 + 0,14x	r = 0,83	
3	Mo, mg/kg	y = 0,09 + 0,12x	r = 0,73	
4	Mn, mg/kg	y = 0,02 + 0,12x	r = 0,69	average, positive
5	Total, mg/kg	y = 0,001 + 0,113x	r = 0,67	
6	In the parent rock, mg/kg	y = 0,08 + 0,104x	r = 0,62	
7	Zn, mg/kg	y = 0,14 + 0,1x	r = 0,58	
8	Humus,%	y = 0,51 + 0,06x	r = 0,34	
9	Co, mg/kg	y = 0,7 + 0,04x	r = 0,21	weak, positive
10	K_2O, mg/kg	y = 1,86 - 0,093x	r=-0,56	o‘rtacha, salbiy
11	P_2O_5, mg/kg	No connection		
12	Cu, mg/kg	No connection		

The relationship is linear (y=a+bx) according to the analytical expression for all indicators, but inverse (y=a-bx) according to the change in direction only in the interaction with exchangeable potassium, i.e., it was found that the high content of exchangeable potassium in the soil composition has a moderate negative effect on the accumulation of water-soluble boron. It has been statistically proven that the amount of boron soluble in water is strongly correlated with granulometric composition, pH and available molybdenum, moderately correlated with available manganese, total content, parent rock, available zinc and humus, and weakly correlated with mobile cobalt, i.e. the heavier the granulometric composition and the more alkaline the environment, the greater the increase in water-soluble boron.

CONCLUSION

The heavier the soil particle size and the more alkaline the reaction, the greater the amount of boron soluble in water. All studied soil types and types of the Samarkand oasis have a deficiency of water-soluble boron in the arable layer, and the use of boron fertilizers is considered effective, while it is advisable to apply them in various ways (for seed germination, soil application, foliar feeding). In the conditions of alluvial meadow soils of the Bukhara and Karakul oases, the amount of water-soluble boron in the arable layer is very high, almost 2-2.5 times higher than the permissible amount, and in these oases there is no need to apply boron fertilizers to the soil, but they can be used for seed germination and foliar feeding.

REFERENCES

1. Akhmedov, A.U., Karimov, H.N., Artikova, H.T., Parpiyev, G.T., Turdaliyev, J.M., Myrzambetov, A.B. (2018). Soil and meliorative conditions of the Zarafshan River basin. Scientific review, 3, 5-11.

2. Alessandra Aparecida de Sá, Paulo Roberto Ernani. (2016). Boron Leaching Decreases with Increases on Soil pH. Rev Bras Cienc Solo 2016; v40:e0150008. DOI: 10.1590/18069657rbcs20150008.

3. Alikhanova, O.I. (1971). Boron in the soils of Tajikistan. Abstract of diss. for a PhD in agricultural sciences. Dushanbe, 22.

4. Arinushkina, E.V. (1970). Guide to chemical analysis of soils. M.:, Moscow State University, 490.

5. Berlin, L.E. (1950). Production of boric acid, borax and boron compounds. M.L.: "Goskhimizdat", 111.

6. Boaretto, R.M., Quaggio, J.A., Mattos, Jr.,D., Muraoka, T., Boaretto, A.E. (2011). Boron uptake and distribution in field grown citrus trees. Journal of Plant Nutrition, 34(6), 839-849.

7. Communar, G., Keren, R. (2006). Rate-limited boron transport in soils: the effect of soil texture and solution pH. Soil Sci Soc Am J. 2006; 70: 882-892. doi:10.2136/sssaj2005.0259.

8. Du, W., Pan, Z.Y., Hussain, S.B., Han, Z.X., Peng, S.A., Liu, Y.Z. (2020). Foliar supplied boron can be transported to roots as a boron-sucrose complex via phloem in citrus trees. Frontiers in Plant Science, 11, 250. https://doi.org/10.3389/fpls.2020.00250.

9. Fedyushkin, B.F. (1989). Mineral fertilizers with microelements: technology and applications. L.: "Chemistry", 272.

10. Gaysin, I.A., Safiollin, F.N., Minnulin, G.S. (2002). Efficiency of using complex microfertilizers on spring rape crops. Journal of Agrochemistry, 4, 38-42.

11. Halil Erdem (2023). Boron resistance of tobacco varieties:can tobacco plants successfully grow underboron toxicity?. Fresenius Environmental Bulletin. Volume 30– No. 07A/2021 pages 9399-9405.

12. Kaptan, M.A., Aydın, M., Küçük, S. (2015). Effects of Boron And Humic Substance Treatments on the Available Boron Distribution inthe Soil Profile. Scientific Papers-Series A,Agronomy. 58, 67-72.

13. Keren, R., & Communar, G. (2009). Boron transport in soils as affected by dissolved organic matter in treated sewage effluent. Soil Science Society of America Journa. 73, 1988-1994.

ISSN 2181-0826 3/2025 y.

14. Khashimov, F.Kh., Ortikov, T.K., Toshkenboev, O. (1997) Agrochemical characterization of soils of the middle part of the Zarafshan valley. Factors of increasing the efficiency of agricultural production during the transition to a market economy. Contents of reports of the 55th scientific reporting conference of professors, teachers and postgraduates. –Samarkand, 9.

15. Khashimov, F.Kh., & Sanakulov, A.L. (2017). Microelement composition of Zarafshan valley soils and increasing the efficiency of microfertilizers in cotton cultivation (monograph). – Tashkent: “Turon-iqbol”, 288.

16. Khayriyeva, N.S., & Eshmurodov, D.E. (2002). The content of boron (B), copper (Cu) and manganese (Mn) elements in tricolor gray soils. Collection of articles dedicated to the 75th anniversary of Samarkand State University, Samarkand, 2002, 4, 101-102.

17. Kot, F.S., Farran, R., Kochva, M., Shaviv, A. (2012). Boron in humus and inorganic components of Hamra and Grumosol soils irrigated with reclaimed wastewater. Soil Research 50(1) 30-43 https://doi.org/10.1071/SR11232.

18. Kruglova, E.K., Aliyeva, M.M., Kobzeva, G.I., Popova, T.P. (1984). Microelements in irrigated soils of the Uzbek SSR and the use of microfertilizers. T.: “Science”, 252.

19. Kuziyev, R.K., & Bobomurodov, Sh.M. (2004). Irrigated soils of Zarafshan and ways to increase their productivity. T.: “Science”, 120.

20. Kuziyev R.K., & Sektimenko, V.E. (2009). Soils of Uzbekistan. Tashkent: Extremum Press, 351.

21. Kuziyev, R.K., Sektimenko, V.E., Ismonov A.J. (2010). Atlas of soil covers of the Republic of Uzbekistan. T.: State Committee “Ergeodezcadastre”, 45.

22. Lehto, T., Ruuhola, T., Dell, B. (2010). Boron in forest trees and forest ecosystems. Forest Ecology and Management. 260, 2053-2069.

23. Marschner, H. (2012). Mineral nutrition ofhigher plants. Boron, 3nd edition. AcademicPress is an imprint of Elsevier, USA. 233-242.

24. Methodology of agrochemical research. Edited by F.A. Yudin. M.: “Spike”, 1980, 336.

25. Methods for determination of macro and microelements in plants, soil and water. Taraz, 2002, 91.

26. Methods of agrochemical, agrophysical and microbiological research in irrigated cotton regions. T.: UzSRIC, 1963, 440.

27. Mirzajonov, Q.M., Nurmatov Sh.N. and others. Recommendations on the use of mineral and local fertilizers in crop nutrition. T.: UzSRIC, 2009, 29.

28. Nazarov, M., Mirzajonov, K., Ibragimov, O., Isayev, S. (2014). Use of micronutrient fertilizers in cotton farming. Cost-effective technologies of farming. T.: 179.

29. Pokrovskaya, M.N. (2006). The influence of microelements on salt tolerance and productivity of wheat in the conditions of Uzbekistan. Problems of breeding, seed production and cultivation technology of agricultural crops on irrigated lands. Republican scientific conference. July 19-20, 2006. Samarkand, 132-133.

30. Reid, R.J. (2013) Crop improvement under ad-verse conditions. Boron toxicity and tolerance incrop plants, Springer, New York, 333-346.

31. Senichkina, M.G., & Abasheyeva, N.E. (1986). Microelements in soils of Siberia. Novosibirsk, “Science”, 176.

32. Tanaka, M., & Fujiwara, T. (2008). Physiological role and transport mechanisms of boron: Perspectives from plants. Pflügers Archiv–European Journal of Physiology. 456, 671-677.

33. Ushkarenko, V.A., Lazarev, N.N., Goloborodko, S.P., Kokovikhin, S.V. (2011). Dispersion and correlation analysis in plant growing and grassland farming. RGAU – Moscow Agricultural Academy named after K.A.Timiryazev, 336.

34. Yuldashev G‘.Yu., & Isag‘aliyev M.T. (2014). Soil biogeochemistry. Tashkent, 352.

35. Yunusov, R., Makhmudov, M., Usmonov, T. (2013). Ways to improve the melioration condition of the soils of the Bukhara oasis. Problems and prospects of cultivation, storage and primary processing of agricultural products in southern Uzbekistan. Collection of articles of the Republican scientific and technical conference. Karshi, 237-238.