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ZINC AVAILABILITY AS INFLUENCED BY PERMANENT FERTILIZATION AND AGRICULTURAL ROTATION

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Abstract

Pot experiments were carried out using disturbed soil surface samples, collected from the different plots of Bahtim Experimental Station , and mixed with 20 U ci of carrier free ^{65}Zn. Barely plants were grown and harvested after 42 days . The results showed that the dry matter yield , Zn-content and total Zn-uptake values were not affected by different crop rotations, while initial Zn value was increased in soil under 3-year rotation.

Zinc content and total zinc uptake were significnatly affected by different inorganic fertilizer treatments , but dry matter yield of barely plants was not significantly affected. On the other hand, native Zn value was increased by farmyard manure addition while it was decreased by inorganic fertilizer treatments.

INTRODUCTION

The interaction between some macro and micro nutrients are widely reported to exist ,they may take plance in the soil or within the plant itself . Swarup and Ghosh (1981) and Subba and Ghosh (1981) studied the effect of crop rotation and fertilizer use on the crop removal of Zn and its availability in a slightly alkaline alluvial soil. They indicated that N, NP and NPK promoted the uptake of Zn by 64.4 , 23.4 and 14% over the control. They added that an increase in Zn uptake occurred with farmyard manure and $ZnSo_4$. They also found that the available Zn in soil decreased when no Zn was added. The addition of 10kg $ZnSO_4$/ha improved its availability. El -Badry *et al.* (1982) found that the effect of FYM was evident in increasing orgainc matter contents as well as total and available Zn in soil through the continuous addition of organic matter for long periods.

The aim of this study is to clarify the effect of permanent inorganic or farmyard manure fertilization and crop rotation on the availability of native zinc in soil, dry matter yield , Zn-content and total Zn-uptake zince in soil , dry matter yield, Zn-content and total Zn-uptake by barely plants.

MATERIALS AND METHODS

Disturbed soil samples were collected from the surface layer of different fertilization treatments (O,N,NP,NPK and FYM) under different crop rotations (1, 2 and 3-days rotation) of the permanent experiment at Bahtim. Some soil physical and chemical properties were determined according to Black (1965) and shown in Table 1.

Hundred g of soil samples + 50g sand + 5ml aliquots carrier free ^{65}Zn (give 20U ci of Zn) were thoroughly mixed in plastic pots. 10 barely seedling (*Hordeum vulgare* L.) were planted and irrigated. After 42 days, plants were harvested, oven dried, weighted, ground and kept for analyses.

The activity of ^{65}Zn in soil extraction was measured using Scalar Ratemeter, while Zn in plants was determined by atomic apsorption spectorphotometer. Experimental data were statistically anaylsed according to Duncan's multiple range test (1955).

RESULTS AND DISCUSSION

The data given in Table 2 indicate the effect of both rotation and fertilization treatments on the dry meatter yield, Zn-content and total Zn-uptake by barely plants as well as native zinc in soil . No significant differences between the main effect of different agricultural rotations on the dry matter yield, Zn-content and total Zn-uptake by barely plants. However, the main effect of agricultural rotations on Zn availability (native Zn) was significant. The highest value was realized for soils under 3-year rotation, while the lowest one was for those soils under 1-year rotation.

Table 1. Physical and chemical properties of the studied soil samples.

Rotation	Treatments	pH 1:2.5	Soluble cations meq/ 100 g soil				Soluble cations meq/ 100 g soil			E.C. mmhos/cm2	O.M	C.E.C meq/ 100g.	$CaCO_3$	Total N	Avail. N	Avail. P Olsen	Avail. Zn DTPA
			Na^+	K^+	Ca^+	Mg^{++}	HCO_3^-	Cl^-	$SO^=$		%		%	%	ppm	ppm	ppm
1 - Year	O	7.95	2.17	0.32	2.63	1.37	2.75	2.60	1.14	0.83	0.82	44.65	3.82	0.075	40.0	10.90	4.40
	N	8.25	1.56	0.30	2.35	1.75	1.95	1.77	2.24	0.66	0.85	45.20	4.32	0.089	50.0	13.95	3.80
	NP	8.20	2.15	0.32	2.30	1.72	1.85	1.90	2.74	0.77	0.99	45.95	3.90	0.090	58.0	14.40	3.20
	NPK	8.15	2.22	0.41	2.15	0.85	2.25	1.78	1.60	0.70	0.61	42.20	4.40	0.092	55.0	15.30	3.60
	FYM	8.10	1.45	0.69	3.02	1.51	2.30	1.98	2.39	1.01	1.84	47.50	3.91	0.110	70.0	18.80	4.00
	Mean	8.13	1.91	0.41	2.49	1.44	2.22	2.01	2.02	0.79	1.02	45.70	4.08	0.091	54.4	14.55	3.80
2 - Year	O	8.10	1.75	0.28	2.49	1.52	2.75	1.79	1.32	0.85	1.30	43.70	3.93	0.079	45.0	11.00	4.70
	N	8.10	1.35	0.29	2.18	1.40	2.80	1.15	1.47	0.68	1.33	44.60	4.12	0.092	56.0	14.60	3.60
	NP	8.10	1.92	0.27	2.18	2.05	2.65	1.62	2.15	0.88	1.28	44.30	4.01	0.095	60.0	15.65	3.60
	NPK	8.10	1.93	0.35	2.00	1.30	2.70	1.43	1.45	0.90	1.58	44.35	3.75	0.099	62.0	16.45	5.99
	FYM	8.10	1.92	0.58	3.02	1.87	3.15	2.50	1.44	1.05	2.48	45.70	3.79	0.150	80.0	20.45	6.40
	Mean	8.10	1.71	0.35	2.37	1.36	2.18	1.75	1.57	0.87	1.59	44.49	3.92	0.100	60.6	15.63	4.84
3 - Year	O	8.00	1.68	0.33	2.45	1.71	2.70	1.45	1.25	0.89	1.32	44.25	4.00	0.080	45.0	11.05	4.80
	N	8.10	1.17	0.20	2.06	1.15	2.95	0.95	1.68	0.72	1.35	45.95	3.93	0.099	59.0	14.95	2.90
	NP	8.10	1.75	035	2.00	2.04	2.90	1.44	1.80	0.94	1.26	45.15	4.05	0.100	65.0	15.99	3.20
	NPK	8.10	1.78	0.44	2.63	1.53	2.90	1.35	2.13	1.06	1.61	44.50	3.62	0.150	90.0	17.20	3.70
	FYM	8.10	1.95	0.61	3.32	2.04	3.35	2.72	1.85	1.34	2.51	48.00	3.89	0.190	95.0	21.35	4.60
	Mean	8.06	1.67	0.39	2.49	1.69	2.96	1.58	1.47	0.98	1.61	45.57	3.90	0.120	71.4	16.11	3.84

Mechanical analysis:

Coarse sand %	Fine sand %	Silt %	Clay %	Texture
3.55	18.20	28.25	50.00	clay soil

This may be due to that soils under 1-year rotation, where cotton plants were grown every year in more than 75 years whcih resulted in exhausting different nutrients.

Data in Table 2 indicate that the dry matter yield was not significantly affected by different fertilization treatmens , while Zn-content and total Zn-uptake were significantly affected. The highest mean values of Zn-content and Zn-uptake by barely plants were obtained for those soils treated by NPK, FYM or control, while the lowest ones were found in soils treated by nitrogen. These results may be atributed to that permanent fertilization of NPK and /or FYM as well as the unfertilized treatments did not induce the nutrient imbalance within the plant or the soil while the opposite trend was clearly obtained by application of nitrogen fertilizer only. Similar results wer obtained by Ruskaya *et al.* (1981) who concluded that addition of NPK and FYM to soil under long-term application of these fertilizers increased Zn-content in leaves and promoted total Zn-uptake by different plants.

Table 2. Effect of fertilization and agricultural rotation on the dry matter yield, Zn-content total Zn-uptak by barely plants as well as native Zn in the studied soil samples.

Treatment	Dry matter g/pot	Content ppm	Zn in plant total uptake Ug/pot	Native Zn g/ kg soil "L-value"
Agric. rot.				
1-year rot.	0.45 a	25.46 a	11.46 a	24.28 b
2-year rot	0.44 a	25.72 a	11.32 a	25.10 ab
3-year rot.	0.45 a	25.47 a	11.46 a	25.83 a
Fert. Treat.				
Control	0.45 a	27.26 a	12.28 a	27.92 b
N	0.44 a	22.86 c	10.06 a	22.51 c
NP	0.45 a	24.13 b	10.86 b	19.96 d
NPK	0.45 a	26.65 a	11.99 a	22.28 c
FYM	0.46 a	26.84 a	12.35 a	32.24 a

Regarding available Zn in soil (L-value), data in Table 2 show that the highest value was found for farmyard manure application, while inorganic fertilizer treatments tended to decrease availability of zinc in comparison with control treatment . This favourable effect of farmyard manure may be attributed to the formation of metalloorganic complex with organic ligands, which decreased its susceptility to adsorption, fixation or precipitation reaction in soil (Mann *et al.*, 1978).

Dealing with the effect of interaction between different agricultural rotations and permanent application of mineral or organic fertilizer on the dry matter yield, Zn-content and total Zn-uptake by barely plants as well as native zinc in soil are shown in Table 3. Data indicate that the highest amount of available Zn in soil, dry matter, Zn-content as well as total Zn-uptake in barely plants were generally obtained by the interaction between different agricultural rotations and organic manure if compared with the effect of the other studied interactions. These results were

Table 3. Effect of interaction between fertilization and agricultural rotation on dry matter yield, Zn-content and total zn-uptake by barely plants as well as native Zn in studied soil samples.

Agric rot.	Fert. treat.	Dry matter g/pot	Content ppm	Zn in plant total uptake Ug/pot	Native Zn g/kg soil "L-value"
1-year rot.	Control	0.40	25.60	11.78	27.583
	N	0.42	25.94	10.89	22.677
	NP	0.46	22.99	10.58	12.107
	NPK	0.46	23.37	10.75	17.863
	FYM	0.48	29.39	14.10	29.287
2-year rot	Control	0.42	27.65	11.60	27.973
	N	0.44	22.19	9.76	24.563
	NP	0.42	23.33	9.80	18.573
	NPK	0.37	28.81	10.66	23.623
	FYM	0.50	26.41	13.21	30.783
3-year rot.	Control	0.41	24.73	10.14	28.2000
	N	0.46	20.25	9.32	20.300
	NP	0.47	26.08	12.26	24.203
	NPK	0.41	27.73	11.37	27.150
	FYM	0.51	28.52	14.55	36.643
L.S.D.	at 1%	0.03	1.58	0.71	1.398

in harmony with those obtained by Ruskaya et al. (1981) and El-Badry et al. (1982).

For agricultural rotation or fertilization treatments and within each column values followed by the same letter are not significantly at 1% level, according to Duncan's multiple range test.

$$\text{* Specific activity} = \frac{\text{Total c.p.m. in the above ground part of the plant}}{\text{(Ug Zn in plant) - (Ug Zn in reagents)}}$$

$$\text{Labile Zn in the pot} = \frac{\text{c.p.m. of carrier-free } ^{65}\text{Zn applied to each pot}}{\text{Specific activity}}$$

$$\text{L- value} = \frac{\text{Labile } ^{65}\text{Zn in the pot}}{\text{Kg soil in pot (oven dry at 105 } ^{o}\text{C)}}$$

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تأثير التسميد المستديم والدورة الزراعية على تيسر الزنك

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أقيمت تجربة أصص باستخدام عينات سطحية مأخوذة من التجربة المستديمة ببهتيم لدراسة تأثير الدورة الزراعية والتسميد المعدني والعضوي المستديم علي تيسير الزنك حيث تم خلط عينات التربة تحت الدراسة بالزنك المشع وزراعة الشعير لمدة ٤٢ يوما. سجل الوزن الجاف للنباتات وقدر تركيز كمية الزنك الميسر بالأرض.

وكانت النتائج المتحصل عليها مايلي:-

١ - لم يتأثر الوزن الجاف للنباتات وكذلك تركيز كمية الزنك الممتص باختلاف الدور ة الزراعية في حين لوحظ زيادة الزنك الميسر بالتربه تحت تأثير الدورة الثلاثية .

٢- كان تأثير التسميد المستديم واضحاً علي تركيز وكمية الزنك الممتص بالنبات بينما لم يتأثر الوزن الجاف ، كما لوحظ أن كمية الرنك الميسر بالتربة زادت بإضافة التسميد العضوي وتناقصت بإضافة التسميد المعدني .

٣- كان تأثير التفاعل بين الدورة الزراعية المتبعة والتسميد المستديم معنوياً علي الوزن الجاف للنباتات وتركيز كمية الزنك الممتص كذلك كان هذا التأثير معنوياً علي الزنك الميسر بالتربة خاصة تحت نظام الدورة الثلاثية .