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PHOSPHORUS AND ZINC NUTRITION OF TRITICALE (*TRITICOSECALE WITTMACK*) AND WHEAT (*TRITICUM AESTIVUM* L.) ON AN ALKALINE CALCAREOUS SOIL

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A field experiment on an alkaline calcareous soil was conducted to investigate P and Zn nutrition of triticale and wheat. In general, the grain yield of wheat was higher ($P < .05$) than that of triticale and the opposite was true as far as straw yield was concerned. Phosphorus application increased ($P < .05$) the grain and straw yields of both crops and Zn application had little effect. Lower response of triticale to applied P was attributed to its extensive root system which explored more of the native P. Applied P decreased Zn concentration ($P < .05$) because of dilution effect and Zn application had little effect on the P concentration of the two crops. Total uptake of P and Zn by triticale was higher ($P < .05$) than that of wheat.

Key words: Phosphorus; Triticale; Wheat; Zinc.

INTRODUCTION

Field crops in general and wheat in particular respond to P application under calcareous soil conditions. It has become a general practice to apply P fertilizer along with N fertilizer to wheat crop. There are, however, some reports that P application induces Zn deficiency in crops [1, 2], while others [3] have shown P and Zn to be mutually antagonistic whenever either element exceeded some threshold value.

Kausar *et al.* [4] reported severe and extensive Zn deficiency in soils of Pakistan and suspected induced Zn deficiency due to applied macronutrient fertilizers, particularly on soils having marginal (< 1 ppm) amounts of available Zn. The present study on an alkaline calcareous soil was undertaken in the field to investigate the P and Zn nutrition of triticale and wheat.

MATERIALS AND METHODS

This experiment on triticale (T-183) and wheat (LU-26) was conducted at the NIAB farm. Some of the soil properties have been given in Table 1. Zinc at the rate of 0 and 10 kg ha^{-1} as $ZnSO_4$ and P at the rate of 0, 75 and 300 kg ha^{-1} P_2O_5 as superphosphate were applied apart from a basal dressing of N at the rate of 100 kg ha^{-1} as urea. Wheat and triticale were sown at the seed rate of 87 kg ha^{-1}. After two months of growth, 100 mature leaves were collected randomly from each plot (5 x 3m). They were washed thoroughly with deionized water and dried at 70^o. Grain and straw yields were recorded at maturity. Subsamples of grains and leaves were taken for P and Zn determination on a spectrophotometer and Atomic Absorption Spectrophotometer respectively after digestion with a diacid mixture of HNO_3 and $HClO_4$ in 4:1 ratio.

Root studies: Triticale and wheat were grown in glass cylinders of 5 cm diameter and 50 cm length containing 1500 g soil with basal doses of N and P at the rate of 50 and 25 ppm respectively. Moisture was maintained at 60% of the field capacity by the daily addition of deionized water. Moisture was maintained at 60% of the field capacity to avoid the saturation of the top soil for longer time which could adversely affect the plant growth in relatively narrow cylinders. The plants were harvested after 36 days of growth. After recording the dry weights of roots and shoots, they were analysed for P.

RESULTS AND DISCUSSION

Effect of phosphorus application on the yield and phosphorus uptake by wheat and Triticale: Applied P increased the grain and straw yields ($P < .05$) of triticale and wheat (Table 2). Data regarding the % response revealed that grain and straw yields of wheat due to P application were affected to a greater extent than those of triticale. Both levels of P in wheat and only higher level (P 300) in triticale increased the P concentration of leaves and grains of the two crops. Total contents as well as P concentration in leaves and grains of triticale were higher than that of wheat at all levels of P application (Tables 3 and 5). The lower response of triticale to applied P could be attributed to its root system which might have explored more of the native nutrients from the soil. This is clear from the data of P and Zn concentration in leaves and grains (Table 3) of the triticale at control ($P < .05$). In a complementary pot experiment, triticale showed to have extensive root system than that of wheat (Table 4). Its root weight was also higher. Phosphorus concentration in shoots and roots of triticale were found similar to those of wheat. But total P contents were higher which indicated the better efficiency of triticale.

Table 1. Some properties of the soil used in the experiment.

Property	Unit	Value
pH of the saturated paste	–	7.95
Electrical conductivity of the saturation extract	mmhos cm^{-1}	1.50
DTPA extractable Zn	ug g^{-1}	0.42
HCO_3 extractable P	ug g^{-1}	6.00
$CaCO_3$ equivalent	%	3.50

Applied P had little effect on the Zn concentration in leaves while it decreased ($P < .05$) Zn concentration in grains of both the crops. This decrease was attributed to the increased grain yields obtained by the applied P resulting in dilution of Zn in the grains. Other workers [5] have also reported similar results. In a case so reported, more than a

Table 2. Effect of P and Zn application on the grain and straw yield of wheat (LU-26) and triticale (NIAB T-183)

	Yield Kg ha^{-1}									
	Grain				Straw				Straw/grain ratio	
Treatment	Wheat	Response %	Triticale	Response %	Wheat	Response %	Triticale	Response %	Wheat	Triticale
Control	3634	–	3747	–	4177	–	8627	–	1.15	2.30
Zn 10	3449	– 5.1	3820	+ 1.9	4383	+ 4.9	7887	– 8.6	1.27	2.06
P 75	4563	+ 25.6	3993	+ 6.6	7100	+ 70.0	9980	+ 15.6	1.56	2.50
P 300	4865	+ 33.9	4200	+ 12.1	7106	+ 70.1	10713	+ 24.2	1.46	2.55
P 75 Zn 10	4691	+ 29.1	3760	+ 1.3	6767	+ 62.0	9693	+ 12.4	1.44	2.58
P 300 Zn 10	4929	+ 35.6	4207	+ 12.3	7237	+ 73.3	10127	+ 12.4	1.47	2.41
Zn			N.S.				N.S.			
LSD P			234.92				587.28			
(0.05) V			123.73				380.72			

Table 3. Effect of P and Zn application on P and Zn concentration in wheat (LU-26) and triticale (NIAB T-183).

	P%				Zn ppm			
	Grain		Leaf		Grain		Leaf	
Treatment	Wheat	Triticale	Wheat	Triticale	Wheat	Triticale	Wheat	Triticale
Control	.25	.40	.21	.27	21.8	24.7	16.1	19.2
Zn 10	.25	.34	.20	.23	22.9	33.3	16.3	20.0
P 75	.30	.40	.23	.27	17.9	23.3	16.1	19.0
P 300	.30	.43	.25	.30	17.9	18.7	15.7	17.5
P 75 Zn 10	.27	.41	.24	.29	21.2	29.4	15.2	20.9
P 300 Zn 10	.30	.42	.25	.32	19.8	29.1	14.5	21.7
Zn	N.S.		N.S.		1.7421		N.S.	
L.S.D. P	.0139		.0207		1.6828		N.S.	
(.05) V	.0172		.0116		1.4951		1.0125	

twofold increase in corn yield due to applied P had no significant effect on total Zn uptake [6].

Table 4. Shoots and roots weight and P composition of triticale and wheat grown in the cylinders

	Dry weight g pot^{-1}		P conc. %		Total contents $\mu g\ pot^{-1}$	
	Tops	Roots	Tops	Roots	Tops	Roots
Wheat	0.59	0.59	0.26	0.22	1510	1301
Triticale	0.85	0.76	0.21	0.19	1837	1493

In general, the grain yield of triticale was lower while it produced an appreciably higher straw yields than that of wheat. Straw/grain ratio in triticale was approximately double (2.4) that of wheat (1.4) which was attributed to very high vegetative growth and shrivelled grains to some extent. On the whole, Zn contents of triticale grains and leaves were higher ($P < .05$) than that of wheat. This could be attributed to its extensive root system.

CONCLUSIONS

Greater uptake of native P and Zn from the soil by triticale suggests that it could be a successful and profitable crop in low fertility areas. While the grain yield of triticale is lower than that of wheat, its grain is higher in P and Zn, while its straw yield is considerably higher making it suitable both for human and animal consumption.

Table 5. Total contents of P and Zn in wheat and triticale grains as affected by P and Zn application.

Treatment		P contents: Wheat ($kg\ ha^{-1}$)	P contents: Triticale ($kg\ ha^{-1}$)	Zn contents: Wheat ($g\ ha^{-1}$)	Zn contents: Triticale ($g\ ha^{-1}$)
Control		9.32 (–)	14.40 (–)	79 (–)	89 (–)
Zn 10		8.74 (– 6.4)	13.12 (– 8.9)	79 (–)	126 (+ 41.6)
P 75		13.79 (+ 47.8)	15.78 (+ 9.6)	82 (+ 3.8)	91 (+ 2.2)
P 300		14.59 (+ 56.5)	17.99 (+ 24.9)	87 (+ 10.2)	78 (– 8.1)
P 75 Zn 10		12.51 (+ 34.1)	15.39 (+ 6.9)	100 (+ 26.6)	109 (+ 22.5)
P 300 Zn 10		15.06 (+ 61.4)	17.87 (+ 24.1)	98 (+ 24.0)	122 (+ 27.0)
	Zn	N.S.		3.79	
L S D					
(.05)	P	.9248		N.S.	
	V	.8288		6.24	

Figures given in the brackets indicate % decrease or increase over control.

Effect of Zinc application on the yield and Zinc uptake of triticale and wheat: Applied Zn had little effect on the grain and straw yields of the two crops (Table 2). Lack of response to applied Zn was attributed to higher plant and soil Zn being higher than the critical levels (15 and 0.34 ppm respectively) [7, 8]. In addition, wheat among the cereals is less sensitive to Zn deficiency [9]. Triticale appears to be even a better explorer of native Zn.

Zinc application increased ($P < .05$) concentration and total uptake of Zn in grains of wheat and triticale (Tables 3 and 5) while in leaves it remained unaffected. Higher Zn concentration in leaves of triticale than that of wheat was accounted for higher Zn concentration in its grain. Applied Zn had no effect on the concentration and total uptake of P in grains and leaves (Table 3 and 5) of both the crops. Olsen *et al.* [9] have comprehensively reviewed various interactions in the plant nutrition.

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