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Effect of Different Levels of Zinc and Phosphorus on Growth and Chlorophyll Content of Wheat

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Abstract: Water culture experiment was conducted to observe the effects of different levels of zinc and phosphorus alone and in combination on wheat (cv. Sarsabz). The concentration for the study were Zn: 0.0, 5.0, 10.0 and 20.0 mg^{-1}, and P 0.0, 20.0, 40.0, 60.0 mg^{-1}. it was observed that the growth of fresh and dry weights of wheat shoot and its length were increased in more or less all the treatments as compared to control. Contrary to this reverse trend was found with root growth irrespective of treatments. The chlorophyll contents were generally increased at the lower level of Zn and P, while at the higher Zn and P levels the chlorophyll contents were decreased as compared to control.

Key words: Zn, P, chlorophyll, wheat

Introduction

Continuous use of phosphoric fertilizers and intensive cultivation of high yield crop varieties have resulted in widespread deficiency of Zn and decrease in the growth of many field crops on almost all soil types, which are generally calcareous in nature. This may be due interaction between Zn and P and also due to the variability of other growth factors, i.e., pH, moisture, zinc and phosphorus sources, organic matter, temperature, soil salinity, etc. (Brown *et al.*, 1970; Maji *et al.*, 1993; Orabi and Abuleenane, 1980; Phillips, 1998; Rodriguez *et al.*, 1999; Saleque *et al.*, 1998; Sharma *et al.*, 1968; Shuman, 1998; Van den Driessche, 2000).

There is an interaction between P and Zn availability, which is usually attributed to plant effect, but has also been reported to be a soil process. Zinc has been shown to interact with soil P in strawberry plants (May and Pritts, 1993), being significant, along with soil pH, in multiple regression expressions to predict Zn uptake (Peaslee, 1980; Shang and Bates, 1987). For soybeans on a Southeastern Ultisol, Zn deficiency was induced by high P rates and high pH, and the magnitude of the yield decrease corresponded well with the intensity of deficiency symptoms (Adams *et al.*, 1982). Corn yields increased in response to Zn application on soils of Zimbabwe, which were either limed or had received 240 kg P_2O_5 ha^{-1} (Tagwira *et al.*, 1993). The increase in soil CEC caused by P application correlated with the decrease in plant tissue Zn concentration.

In saline alluvial Haplaquepts, available P_2O_5 was correlated negatively with available Zn (Maji *et al.*, 1993). Mawardi *et al.* (1975) applied P at a high rate to corn plants grown in a calcareous soil, their results showed that both dry matter and Zn content were doubled. Similar findings have been reported by Orabi and Abuleenane (1980). Widespread of P induced Zn deficiencies on many agricultural crops have been reported around the globe. When micro nutrient sources are incorporated in macro nutrient carriers, the chemical interactions that may occur during formulation, in storage or during initial dissolution stage in soil caused a wide variety of reaction mechanisms (Alpaslan *et al.*, 2001; Barman *et al.*, 1998; Erenoglu *et al.*, 1999; Hossain *et al.*, 1997).

Considering the importance of Zn and P in the nutrition of plants, an experiment was conducted with variable levels of Zn and P under water culture using wheat as a test crop.

Materials and Methods

Water culture experiment was conducted at Nuclear Institute of Agriculture, Tandojam in 1997, to study the effects of different levels of Zinc and Phosphorus alone and in combination using wheat (cv. Sarsabz) as a test crop. Different concentrations of Zinc as 0.0, 5.0, 10.0 and 20.0 mg^{-1} in the form of $ZnSO_4$, $7H_2O$ and P as 0.0, 20.0, 40.0 and 60.0 mg^{-1} in the form of KH_2PO_4 were added to 250 ml capacity plastic glasses containing Hoagland nutrient solution. Five days old wheat seedlings of uniform height, which previously raised in plastic bread box, were transplanted to plastic glasses at the rate of three seedlings per pot. These glasses were kept overnight in the laboratory to acclimatize the temperature, then transferred to the wire-netted pot house in the open sunlight and randomized with three replicates of each treatment. The nutrition solution was stirred occasionally with a glass rod and changed thrice during the experimental period.

The visual observations were taken from time to time. Leaf tips burning were noted in some of the treatments such as in no Zn and P treatment (control) and Zn 5 ml L^{-1} with P 40 and P 60 mg^{-1}. After two weeds of growth the leaf samples were taken for chlorophyll determination. At that time the wheat plants were harvested and their shoot and root lengths, and the fresh as well as their dry weights were recorded and statistically analyzed for their treatment effects by SE.

Results and Discussion

Leaf tips burning were noted in some of the treatments such as in no Zn and P treatment (control) and Zn 5 with P 40 mg^{-1} and P 60 mg/L. Similarly, yellowish green symptoms on leaves were noted in Zn 10 and P 20 and P 40 mg^{-1} and Zn 20 mg/L with P 60 mg/L. It was observed that fresh dry weight of shoot and root were generally increased in all the treatments of Zn and P compared to control. The present increase in growth parameters of shoot (fresh and dry weight) was comparatively higher than the root growth in majority of the Zn and P treatments. Similarly, the shoot length of wheat seedlings was increased considerably, irrespective of treatments. Contrary to the shoot length, the reverse trend was found with root length, where the root length in all the treatments of Zn and P was found to be substantially decreased (Table 1).

The chlorophyll contents were increased in zero Zinc (Zn 0) and with 20, 40 and 60 mg pl^{-1} treatments. Whereas, it was decreased in all the treatments, where Zinc was applied as Zn 5 along with P 20, Zn 10 with P 20 and 60 and Zn 20 with P 20 mg^{-1}. The decrease in the chlorophyll contents in these treatments was possibly caused by the interactions of Zinc and phosphorus with iron in the growth medium. It is well known fact that iron-containing enzyme is needed in chlorophyll formation in plants. This may also cause the appearance of yellowish green symptoms (chlorosis) in most of the Zn and P treated plant leaves. Zinc deficiency may also be prevalent, where the growth medium is high in available P, and interaction involving Zn, P and Fe lead to poor utilization of Zn by plants (Viets, 1966; Mortvedt and Giordano, 1968) attributed the decreased agronomic effectiveness of Zn and N reaction due to formation of complex compound of Zn and N in the growth medium. It has also been reported that Zn and P form complexes reducing the solubility of Zn and P in the growth medium (Young, 1969). Such reactions after the chemical

Table 1: Effect of different levels of zinc (Zn) and phosphorus (P) on the seedling growth, growth parameters and chlorophyll contents of wheat

Treatments (mg L^{-1})	Fresh wt. shoot (g)	Dry wt. shoot (g)	Fresh wt. root (g)	Dry wt. root (g)	Shoot length (cm)	Root length (cm)	Chlorophyll (mg gm^{-1}) fresh wt.
Zn_0 P_0	0.403	0.0624	0.79	0.040	19.03	45.58	0.2173
Control	0.098	0.026	4.308	0.022	1.72	20.49	0.201
Zn_0 P_{20}	1.724	0.250	1.237	0.1512	29.65	35.93	0.3911
	0.821	0.115	0.706	0.067	3.37	7.40	0.0719
	(+327.79)	(+300.64)	(+56.58)	(+268.00)	(+55.80)	(-21.17)	(+79.98)
Zn_0 P_{20}	2.404	0.287	2.069	0.157	34.19	37.58	0.4213
	0.719	0.124	0.295	0.027	4.73	6.14	0.0407
	(+496.52)	(+359.93)	(+161.89)	(+292.5)	(+79.66)	(-17.55)	(+116.88)
Zn_0 P_{20}	1.837	0.229	2.108	0.186	29.61	36.5	0.4866
	0.575	0.095	0.738	0.061	2.02	2.98	0.1063
	(+355.83)	(+266.98)	(+166.83)	(+365.0)	(+55.59)	(-19.92)	(+123.93)
Zn_0 P_{20}	0.500	0.666	0.809	0.0862	20.59	46.51	0.2672
	0.186	0.020	0.524	0.038	3.63	5.25	0.1503
	(+24.06)	(+967.30)	(+2.40)	(+115.5)	(+8.19)	(+2.04)	(+22.96)
Zn_0 P_{20}	1.417	0.1638	1.715	0.127	24.15	30.62	0.1417
	1.220	0.155	1.236	0.092	6.80	3.35	0.0798
	(+251.61)	(+162.50)	(+117.08)	(+217.5)	(+26.90)	(-32.79)	(-34.79)
Zn_0 P_{20}	0.108	0.106	1.169	0.103	20.95	22.21	0.1021
	1.400	0.156	1.156	0.088	8.36	11.03	0.0318
	(-73.20)	(+69.87)	(+47.97)	(+157.5)	(+10.08)	(-51.27)	(-53.01)
Zn_0 P_{20}	0.898	0.181	0.867	0.114	24.30	75.46	0.3312
	0.807	0.116	0.988	0.072	4.20	2.42	0.2341
	(+122.82)	(+190.06)	(+9.74)	(+185.0)	(+27.69)	(-44.14)	(+52.41)
Zn_0 P_{20}	1.507	0.1160	1.299	0.096	22.56	36.96	0.2364
	0.900	0.024	0.297	0.031	1.96	13.91	0.0627
	(+273.94)	(+85.89)	(+64.43)	(+140)	(+18.54)	(-18.91)	(+8.78)
Zn_0 P_{20}	1.227	0.223	2.330	0.164	26.39	32.73	0.2135
	0.566	0.109	3.225	0.056	6.77	3.69	0.0415
	(+204.46)	(+257.37)	(+194.93)	(+310)	(+38.67)	(-28.19)	(-1.74)
Zn_0 P_{20}	1.293	0.140	1.297	0.1007	24.23	24.60	0.5669
	0.928	0.096	1.099	0.086	3.73	7.01	0.4019
	(+220.84)	(+124.35)	(+64.17)	(+151.75)	(+27.32)	(-46.02)	(+160.88)
Zn_0 P_{20}	1.263	0.221	2.164	0.1760	28.87	28.20	0.2009
	0.655	0.015	0.180	0.052	2.46	3.37	0.1501
	(+213.39)	(+254.16)	(+173.92)	(+340.00)	(+51.39)	(-38.13)	(-7.54)
Zn_0 P_{20}	0.621	0.0964	1.199	0.1120	20.79	34.72	0.3405
	0.202	0.036	0.445	0.050	4.81	8.59	0.0176
	(+54.09)	(+54.48)	(+51.77)	(+180.00)	(+9.24)	(-23.18)	(+56.69)
Zn_0 P_{20}	0.995	0.1293	1.098	0.120	22.82	27.15	0.1467
		0.053	0.757	0.035	1.32	4.62	0.2134
	(+146.89)	(+107.21)	(+38.18)	(+200.00)	(+19.91)	(-39.93)	(-32.48)
Zn_0 P_{20}	0.9200	0.133	1.368	0.118	24.27	28.76	0.4487
	0.246	0.020	0.4800	0.033	2.75	7.87	0.0212
	(+128.28)	(+113.14)	(+73.16)	(+195.00)	(+27.53)	(-36.36)	(+106.48)
Zn_0 P_{20}	0.857	0.130	1.244	0.1013	24.58	28.71	0.2452
	0.268	0.039	0.358	0.022	0.92	6.61	0.0968
	(+122.65)	(+108.33)	(+57.46)	(+153.25)	(+29.16)	(-36.48)	(+12.89)
LSD at 5 %	5.429	NS	NS	NS	7.457	14.383	0.2416

Figures in the parenthesis indicate percent increase (+) and decrease (-) over control. NS, non significant

and physical form of the plant nutrition present in the medium. Phosphorus and zinc have great relationships in the growth and development of plants. In the present experiment, the fresh and dry weights and their shoot and root were considerably increased in the Zn and P treatments compared to control. Root showed a negative trend. At lower levels of Zn and P, the chlorophyll contents were increased, Therefore, a lower level of Zn and P is suitable for normal growth of wheat.

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