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SUSCEPTIBILITY OF WHEAT VARIETIES TO ZINC

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Several wheat varieties were grown under Zn stress and Zn supplimented conditions in green house pot trial to study the differential behaviour in dry matter production and Zn accumulation in plant tops. The varieties showed considerable differences in growth, Zn absorption, total Zn uptake, P/Zn and Fe/Zn ratios in the plants under Zn stress condition. The depression in yield due to Zn deficiency, however, was significantly negatively related to Zn concentration only and not to P/Zn or Fe/Zn ratios in the plant. Lyallpur-73 appeared more while Chenab-70 less susceptible to Zn stress condition in the soil.

INTRODUCTION

Although wheat (*Triticum aestivum* L.) is regarded as low responsive crop to Zn application [1], differences among varieties in their susceptibility to Zn deficiency in soil has been reported [2–4]. The soils of Pakistan are reported to be widely deficient in micronutrients [5, 6] particularly in Zn. Thorough screening of the existing varieties of wheat against Zn deficiency is, therefore, necessary in order to meet the ever increasing demand of improved food quality and enhanced yield per unit of input. A soil-pot-culture experiment was conducted to test several wheat varieties to Zn stress under glasshouse conditions.

MATERIALS AND METHODS

A pot culture experiment was conducted in the glasshouse with several wheat varieties (Table 1) on an alkaline (pH 8.1), sandy loam soil from Chimranwali (Jhang) containing 0.74 ppm DTPA extractable Zn. Polythene lined plastic pots containing 4.5 kg soil were fertilized with 75 ppm N from urea and 50 ppm P_2O_5 and 27 ppm K from KH_2PO_4. Zinc treatments in triplicate were applied at the rate of 0, 5 and 15 ppm Zn as $ZnSO_4$, $7H_2O$ in solution form. Five plants of each variety were grown for 49 days. Dry matter yield of the harvested plant material was recorded after drying at 70°. The percent depression in yield was calculated as under:

$$\% YD = \frac{\text{DMY at 5 ppm Zn-DMY at 0 ppm Zn}}{\text{DMY at 5 ppm Zn}} \times 100$$

Sub-portions of the ground plant material was digested in HNO_3 : $HOC1_4$ (5 : 1 ratio) acid mixture. Zinc and iron were determined by atomic absorption spectrophotometer and P by vanadate yellow color method.

RESULTS AND DISCUSSION

Visual symptoms of Zn deficiency were not evident in any variety except that a few plants in control pots of Lyallpur-73, Mexi-Pak and Yecora developed irregular small white spots on the older leaves spreading towards the base which later on disappeared. There was no death of lower leaves in any variety. The varieties showed variation in the expression of the effect of Zn stress condition on their shoot growth (Table 1). Dry matter production was not increased significantly by Zn rates greater than 5 ppm. The percent depression in shoot dry matter yield as compared to 5 ppm and 15 ppm Zn ranged from 1.33 (Chenab-70) to 27.74 (Blue Silver) and 5.73 (Mexi-Pak) to 27.06 (Lyallpur-73) respectively. On an over all basis Lyallpur-73 and Blue Silver appeared to be more susceptible and Chenab-70 and Mutant-17 to be relatively resistant to Zn deficiency in soil.

Varietal differences in shoot Zn concentrations were also highly significant (Table 2). On an average Mutant-17 contained highest Zn concentration and Pari-73 the least. In the control plants the concentration ranged from 13.00 ppm (Lyallpur-73) to 17.33 ppm (Chenab-70). Zinc concentration increased significantly with the application of Zn. The increased ranged from 139.1 (Blue Silver) to 186.6 % (Mutant-17) at 5 ppm and 228.3 (Pari-73) to 442.2 % (Mutant-17) at 15 ppm Zn rate. Tissue Zn concentration of all varieties were not much above the critical

Table 1. Dry matter yield (g/pot) of wheat varieties as affected by Zn application.

Varieties	Zn rate, ppm			Variety mean*	Percent depression in yield compared to 5 ppm Zn
	0	5	15		
1. Mexi-Pak	4.28	4.79	4.54	4.54	10.65
2. Barani-70	3.99	4.75	4.36	4.37	16.00
3. Blue Silver	4.35	6.02	5.94	5.44	27.74
4. Lyallpur-73	3.45	4.77	4.73	4.32	27.67
5. Mutant-17	3.91	4.14	4.18	4.08	5.56
6. Pari-73	4.03	4.40	4.80	4.41	8.41
7. Chenab-70	4.45	4.51	5.11	4.69	1.33
8. Yecora	4.00	4.33	4.59	4.31	7.62
Zn rate mean*	4.06	4.72	4.78		

*LSD (P=0.05) for difference among means of variety and Zn rate was 0.46 and 0.28 respectively. Variety x Zn rate interaction was non-significant.

Table 2. Zinc concentration and uptake by wheat varieties as affected by Zn application.

Variety	Zn rate, ppm			Variety mean*	Zn rate, ppm			Variety Means*
	0	5	15		0	5	15	
	Zn conc., ppm				Zn uptake, ug/pot			
1. Mexi-Pak	13.67	35.67	63.33	37.56	58.4	168.6	289.3	172.14
2. Barani-70	13.33	37.00	63.33	37.89	52.8	175.8	277.0	168.56
3. Blue Silver	14.50	34.67	59.00	39.56	63.1	208.7	350.6	207.48
4. Lyallpur-73	13.00	35.67	70.00	39.56	45.0	170.2	331.0	182.11
5. Mutant-17	15.00	43.00	81.33	46.33	58.6	177.5	337.8	191.37
6. Pari-73	15.33	37.33	50.33	34.33	61.7	164.3	241.4	155.87
7. Chenab-70	17.33	41.67	60.33	39.78	76.9	187.9	306.0	190.31
8. Yecora	17.00	47.33	74.83	46.39	68.2	205.8	341.8	205.30
Zn rate mean*	14.90	39.04	65.31		60.6	182.4	309.4	

*LSD (P=0.05) for differences among means of variety, Zn rate and variety x Zn rate interaction for Zn concentration was 3.67, 2.25 and 9.00 and for Zn-uptake was 23.29, 14.26 and 57.06 respectively.

Table 3. P/Zn and Fe/Zn ratio in wheat varieties as affected by Zn application.

Variety	Zan rate, ppm 0	5	15	Variety mean*	Zn rate, ppm 0	5	15	Variety mean*
	P/Zn ratio in shoots				Fe/Zn ratio in shoots			
1. Mexi-Pak	223.9	97.1	50.3	123.78	14.6	3.9	2.6	7.08
2. Barani-70	280.2	98.6	51.9	143.57	14.9	4.6	2.4	7.33
3. Blue Silver	232.6	86.6	54.0	124.42	10.9	4.6	2.4	5.99
4. Lyallpur-73	284.2	84.2	47.6	138.68	12.7	3.6	2.0	6.10
5. Mutant-17	203.2	82.2	40.6	108.92	9.3	3.3	1.6	4.78
6. Pari-73	232.4	92.1	70.6	131.72	10.2	3.2	2.7	5.40
7. Chenab-70	217.3	83.2	66.1	122.24	8.6	2.0	1.6	4.39
8. Yecora	235.1	78.0	49.0	120.72	8.0	2.1	1.6	3.91
Zn rate mean*	238.65	87.85	53.77		11.16	3.57	2.14	

*LSD (P=0.05) for differences among means of variety, Zn rate and variety x Zn rate interaction for P/Zn ratio was 14.69, 8.99 and 35.99 and for Fe/Zn ratio was 0.93, 0.57 and 2.28 respectively.

level (14.5 ppm Zn) suggested for alkaline calcareous soils of Pakistan [7].

Similar to Zn concentration the varieties also differed in their power to extract soil Zn under Zn stress condition. On an average Pari-73 extracted low while Blue Silver high amount of Zn from the soil. The increase in Zn uptake by Zn fertilization ranged from 144.3 (Chenab-70) to 277.8 % (Lyallpur-73) at 5 ppm Zn rate and 291.2 (Pari-73) to 613.3 % (Lyallpur-73) at 15 ppm Zn rate over that of control.

From the above results it appeared that there was considerable variation in response to Zn deficiency. The reason for the differential response are not adequately known. Agarwala *et al.* [8] indicated a possibility of genetic control as being responsible for differential susceptibility of some wheat variety to Zn stress. Shukla and Raj [4] while trying to explain the variability based on tissue Zn, P and Fe concentration could not establish any relationship between the genes responsible for dwarfing and the differential Zn response in wheat. They however, reported that the depression in yield was negatively related to P/Zn and Fe/Zn ratios. In the present study the depression in yield was significantly negatively related to Zn concentration only (r=–0.70*) and not to P/Zn (r= 0.64) or Fe/Zn (r= 0.47) ratios given in Table 3. The depression in yield was further not influenced by P (r= 0.02) or Fe (r= 0.28). Shukla and Raj [4] argued that the magnitude of susceptibility to Zn deficiency in different wheat varieties was primarily dependent on their capacity to utilize soil Zn and the apparent positive relationship of P/Zn or Fe/Zn ratio with percent depression in yield was actually an attribute of shoot Zn concentration. Shoot Zn concentration was less in variety showing more depression in yield without supplimental Zn. Thus the tissue Zn concentration was less in more susceptible variety (Lyallpur-73 and Blue Silver) and more in the less susceptible variety (Chenab-70 and Mutant-17). Other workers have also reported [9,10] that under Fe stress condition, a non-susceptible cultivar of soybean translocated a large portion of Fe from the roots to the shoot than a susceptible cultivar. However, the explanation was not consistant with the data compared in this study.

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