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Differential Response of Wheat Cultivars to Phosphorus Supply under Saline Conditions.

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Abstract

Three wheat cultivars (Pak-81, Punjab-85 and Inqlab) were grown in solution supplied with low (10 μm) and high (100 μm) levels of P at 0 and 100 mM NaCl salinity. Root medium salinity depressed the growth of all the three cultivars. Phosphorus supply in the root medium altered the growth depressing effects in the three cultivars to variable extent. Root behaviour of the three cultivars also differed with P application and salinity. In all the three cultivars, the relative rates of Na uptake were significantly decreased with increasing P supply to roots.

Introduction

Salinity causes growth depression invariably in all non-halophytes. Besides osmotic and specific ion effects of salts, the water conducting properties of plants are impaired due to the presence of excess salts in the root medium (O' leary, 1969, 1974; Salim, 1991). Similarly, due to nutritional stress, plant growth inhibition is a common observation. This growth inhibition in plants is also attributed to the depressed hydraulic conductivity in plant roots (Radin and Eidenbock, 1984; Syvertsen and Graham, 1985; Salim, 1991). Similarly, many plant species and their cultivars differ in their responses to salt and nutritional stress (Goodman, 1979; Salim, 1988).

Most soils in Pakistan are deficient in P, therefore, P fertilizer application is inevitable for successful crop production (Ahmed, 1992) whereas, shift in deleterious effects of salinity on plant growth by P application is most likely. Wheat is the major cereal crop of Pakistan and is grown in a variety of soils ranging from normal to moderate saline. For improved wheat growth under saline soil conditions, special emphasizes needed on the proper nutrient management of wheat crop. The present study was conducted to highlight the variable response of three commercial wheat cultivars to graded salinity and to investigate the possible role of phosphorus nutrition in improving wheat growth under saline root medium. The results of this controlled conditions study could potentially he applicable in the field for enhanced wheat production under salt stress.

Materials and Methods

Seeds of three cultivars of wheat viz: Pak-81, Pb-85 and Inqlab-91 were germinated on a polystyrene screen suspended over saturated $CaCO_3$ solution for proper root development of the seedlings. Seven day old four uniform seedlings of wheat were transplanted in 4 liter plastic containers having continuously aerated solution in greenhouse. The nutrient solution contained 16 mM N (KNO_3), 6 mM K, (KNO_3/KCl^{-1}), 4 mM Ca, ($Ca(NO_3)_2.4H_2O$), 1 mM Mg, ($MgSO_4.7H_2O$), 25 μM B (H_3BO_3), 2 μM Mn ($MnSO_4.H_2O$), 2 μM Zn ($ZnSO_4.7H_2O$), 20 μM Fe, (Fe-EDTA), 0.5 μM Mo (H_2MoO_4) and 1000 μM S, ($MnSO_4.H_2O/MgSO_4.7H_2O/ZnSO_4.7H_2O/CuSO_4.5H_2O$). The experiment comprised two levels of (P 10 and 100 μM P (KH_2PO_4)) and two levels of salinity (0 and 100 mM NaCl). The solution pH was maintained at 5.7±0.2. The experiment was laid out according to completely randomized design (CRD) with three replications. The nutrient solution was changed weekly to maintain nutrient supply uniform throughout growth period. Fifteen days after transplanting in treatment solution, two seedlings of each cultivar were harvested and the harvested plants were separated into roots and shoots. They were subsequently dried at 70°C for 48 hours and weighed. Remaining two seedlings were harvested after 21 days. Drained shoot and root samples were digested in nitric: perchloric acid mixture (2:1). Phosphorus in the digest was measured by vanedomoly bedate yellow color method (Winkleman *et al.*, 1986) and sodium was measured on flame photometer. Relative uptake rate of P was calculated according to Salim and Rahmatullah (1986).

$$\text{elative Rate of Uptake (mg g}^{-1}\text{ dry wt day}^{-1}) = \frac{Q_2 - Q}{\ln w}$$

where, T = time interval.
ln w = log mean plant weight.
$Q_2 - Q_1$ = nutrient content of plants at harvest time 1 and 2.

Results and Discussion

Dry matter yield increased with higher rate of P application in Inqlab wheat variety. It was observed that application of 100 mM NaCl salinity reduced dry matter yield at both the P levels. In 15 days old plants, 37 per cent yield reduction was noted in Pak-81 at both the P levels. During second harvest yield reduction was 14 per cent at 100 mM NaCl in low P level. At high P level, 39 per cent yield reduction was observed. In Pb-85, yield reduction of 19 per cent and 33 per cent was recorded at 10 and 100 μM P levels, respectively in 15 days old wheat plants. However, in second harvest, yield reduction was in the order of 17 per cent and 31 per cent at 10 and 100 μM P levels, respectively. Biomass accumulation in 15 days old plants of Inqlab cultivar was not affected by NaCl salinity with 100 μM P. However, a yield reduction of 40 per cent and 45 per cent was recorded in lower and high P levels applied, respectively for 21 days old plants (Table1).

The data indicated that application of higher P level decreased root/shoot ratio in all the three cultivars.

Table 1: Growth response of wheat cultivars to phosphorus and NaCl salinity.

Treatment			Dry Shoot Yield (mg/plant)		Root/Shoot	
			H_1	H_2	H_1	H_2
Pak-81	P_1	S_1	91.5±8	199±9	0.591	0.291
	P_1	S_2	57.5±5	103±8	0.491	0.312
	P_2	S_1	75.5±6	103±9	0.502	0.193
	P_2	S_2	47.0±3	63±5	0.877	0.309
Pb-85	P_1	S_1	68.0±6	109±8	0.744	0.340
	P_1	S_2	55.5±4	90±7	0.689	0.350
	P_2	S_1	00.8±7	154±11	0.460	0.220
	P_2	S_2	55.5±5	105±9	0.818	0.320
Inqlab-91	P_1	S_1	57.5±4	169±12	0.788	0.316
	P_1	S_2	64.5±5	100±8	0.736	0.244
	P_2	S_1	7505±5	169±13	0.416	0.224
	P_2	S_2	75.5±5	94±8	0.552	0.240

Table 2: Relative growth rates (RGR) and phosphorus uptake of three wheat cultivars as affected by silinity and P nutrition.

		Pak-81	Pb-85	Inqlab
		RGR (mg $g^{-1}d^{-1}$)		
S_1	P_1	0.0125	0.0225	0.0513
	P_2	0.0147	0.0294	0.0384
S_2	P_1	0.278	0.230	0.209
	P_2	0.0140	0.0304	0.104
		Total P uptake mg / plant		
S_1	P_1	0.297	0.253	0.386
	P_2	0.240	0.357	0.425
S_2	P_1	0.239	0.210	0.233
	P_2	0.146	0.245	0.218
		Relative rate of P uptake		
S_1	P_1	0.21	0.21	0.19
	P_2	0.23	0.29	0.30
S_2	P_1	0.28	0.22	0.13
	P_2	0.22	0.39	0.23
		Total shoot P uptake		
S_1	P_1	0.489	0.412	0.558
	P_2	0.416	0.55	0.601
S_2	P_1	0.374	0.338	0.365
	P_2	0.255	0.390	0.373

P_1 and P_2 = Phosphorus level of 10 μM and 100 μM in root medium respectively; S_1 and S_2 = NaCl salinity level of O and 100 mM in root medium respectively; H_1 and H_2 = Harvests at two times on 15 days and 21 days of growth respectively.

Application of 100 mM NaCl salinity increased root/shoot ratio in low as well as in high P level. The root/shoot ratios was lower in high P treated pots than in the low P pots. Significantly higher uptake rate of Na was recorded in 100 mM NaCl treatment than in 0 NaCl all of the wheat cultivars. Uptake rates of Na were higher at low P than at high P level. It indicated that higher level of P resulted in lower uptake rate of Na (Table2).

High P uptake rate with both P application was observed in Inqlab and Pb-85, while no significant response in Pak-81 was observed. In Inqlab, of 100 mM NaCl salinity depressed P uptake rate at both P levels. No significant effects of levels and NaCl salinity were observed on P uptake rate Pak-81. Result of this study indicated that the root mediu salinity depressed the growth of the three wheat cultiva to variable degree whereas the two P concentrations altere the growth depressing effects to different extent a reported by Salim (1991) for other plant species. One of th deleterious effects of salinity and sub-optimal P nutrition o most plants is the impaired water relations of plants. The negative effects ultimately are translated into depresse vegetative and reproductive growth. Comparatively le growth inhibition in the cultivar Inqlab-91 was achieve through effective control on nutrient acquisition a translocation. Similar observations have also been report by some other workers for a variety of crop plan (Syvertsen and Graham, 1985; Salim, 1988; Gill *et a* 1991). The results of this study indicate anple avenues improve growth under saline conditions by exploiti genetic potential coupled with optimum nutrition.

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