Pak. j. life soc. sci. (2003), 1(1): 75-77

Pakistan Journal of
Life and Social Sciences

Phosphorus Use Efficiency in Wheat Genotypes: Plant Growth

Muhammad Yaseen, M. Sohail, and Saif-ur-Rehman Kashif
Institute of Soil and Environment Science, Unversity of Agricultue, Faisalabad

Abstract

Substantial differences in shoot and root biomass accumulation and root:shoot ratio among twenty four wheat genotypes were obvious at stress and adequate P levels. Shoot dry matter (SDM) ranged from 1.09 (D-91733) to 0.52 g. 2 plants-1 (Pasban) at stress P level and 2.03 (D-90640) to 1.35 g. 2 plants-1 (D-90627) at adequate P level. Differences in SDM indicate that more than 50% of genotypes produced SDM less than the mean average shoot dry matter at both the P levels. It is obvious that genotypes producing higher SDM produced lower root dry matter (RDM) and vice versa. High root:shoot ratio is evident of wheat genotype response to phosphorus deficiency stress in the growth medium. Overall, phosphorus deficiency stress reduced shoot biomass yield to 52%. Three genotypes (D-89626, D-90627 and D-91733) showed a phosphorus stress factor (PSF) $\leq$ 30%. Existence of such differences among wheat genotypes may provide useful basis of their selection when grown in the field.

Key words: Phosphorus, wheat genotypes, growth

Introduction

The present yield of the wheat crop is far below the average yield in many other wheat growing countries of the world. Even yield gap between potential yield and obtained yield is more than 35 % in our country (Ahmad, 1998). The production of wheat can be increased either by bringing more area under cultivation or by increasing yield per unit area. However, to increase the area under wheat is not possible at this stage because of water shortage in the country. Only alternative left is to increase the yield vertically.

Of several constraints to increase yield per unit area, inadequate and unbalance use of fertilizer is considered the most important one. Phosphorus (P) is the nutrient that requires large application as a fertilizer to maintain high productivity of plants. However, its uptake and utilization of applied P by plants is low on alkaline calcareous soils of Pakistan (Zia *et al.*, 1991). Low availability of P can be tackled by genetic variability as plants within species widely differ in their ability of absorption and utilization of mineral elements from a nutrient stress environment (Clark and Duncan, 1991).

The differential growth responses of genotypes in a nutrient stress environment are the outcome of a number of plant factors such as morphological features of root, root modification of rhizosphere, nutrient movement across root to xylem, nutrient distribution/and remobilization in shoot and ability of genotypes for normal metabolism at low tissue concentration of a nutrient etc. (Gerloff, 1987).

Using these differences, identification of these genotypes which can tolerate P stress in the growth medium more efficiently and give relatively higher yield can reduce P fertilizer requirements and can reduce cost of production of crop. Keeping this in view, the experiment was conducted to evaluate twenty four wheat genotypes for growth at adequate and deficient levels of P in solution culture.

Materials and Methods

Seeds of twenty four wheat genotypes (Table 1) were collected from Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad and Wheat Research Institute, AARI, Faisalabad. The seeds were germinated in plastic trays containing washed gravel. Distilled water was used for irrigation. Twelve days old seedlings were transplanted in foam plugged holes of thermopol sheet floating on a continuously aerated modified Johnson nutrient solution (Johnson *et al.*, 1957) contained in two polyethylene lined iron tubs of 200 L capacity. Two phosphorus levels were established by using Ammonium phosphate; adequate (250μM) and deficient (25μM) P levels. The pH of the solution was maintained at 5 $\pm$ 0.5 with HCl or NaOH. There were 168 holes in each thermopole sheet and each hole being one repeat contained two seedlings. The experiment was laid out in Completely Randomized Factorial Design with seven replications. The plants from each replication were harvested after 36 days of transplanting and thoroughly washed with distilled water and separated into roots and shoots. Data on total plant shoot and root dry matter yields, P stress factor and root:shoot ratio were recorded. Plant samples were dried at 65 ± 5^{o}C in a forced air-driven oven to a constant weight were fine grind to 40-mesh seive.

Corresponding Author:
Institute of Soil and Environment Science
University of Agriculture, Faisalabad-Pakistan.
E. mail:

Relative reduction in yield of shoot was calculated by the formula

$$\text{PSF} = \frac{Y_{250} - Y_{25}}{Y_{250}} \times 100$$

Where PSF = Phosphorus stress factor
Y_{25} = Shoot dry matter at stress P level
Y_{250} = Shoot dry matter at adequate P level

Results and Discussion

Results on the effect of stress and adequate P levels, dry matter yield of shoot (SDM) and root (RDM) of twenty four wheat genotypes are presented in the Table 1. Both the P levels and wheat genotypes had a significant ($P < 0.01$) individual and interactive effect on shoot and root dry matter yields and total dry matter production (Table). Shoot dry matter ranged from 1.09 g 2pants^{-1} (D-91773) to 0.52 g 2pants^{-1} (Pasban) at stress P levels. Atleast 50 % of the genotypes produced statistically similar SDM. Genotype 91773 produced significantly the highest SDM at this P levels. At adequate P levels, genotype (D-90640) had significantly maxium SDM (2.03 g 2 pants^{-1}). Average across all genotypes SDM increased 122 % with increasing P supply from stress to adequate in the growth medium. Genotypes D-90640 produced the highest SDM among all the genotypes at both P levels. Genetic differences for SDM under differential P levels were also reported in earlier studies by Gill *et al.*, (1994) and Yasin *et al.* (1998). Average across the genotypes means root dry matter (RDM) decreased about 50 % with the increase in P level. This decrease in RDM was possibly due to stimulation of root growth under P stress. High root biomass production at stress P has been reported by many workers (Haynes *et al.*, 1991; Gill *et al.*, 1994; Yasin *et al.* (1998). They suggested that plant increases its root biomass at the response of shoot biomass which probably can help them to absorb P under limited supply in the growth mean. This conclusion is further supported by root: shoot ratio. Root shoot ratio was significantly ($P<0.01$) higher (fold) in genotypes grown at stress P levels compared to adequate P level.

Genotypes differtent significantly for relative reduction in shoot biomass production when grown in stress P level. The maximum reduction in shoot biomass was observed in genotypes 89251, Pasban, Blue silver, 91173, 91169 and FSD-83 while genotypes 89626, 90627 and 91733 showed less reduction in shoot biomass production and hence could be grown safely under limited P supply conditions. Genotypes differed in SDM, RDM, TDM and root: shoot ratio at both P levels. These results agree with the earlier reports (Yasin *et al.*, Gill *et al.*, 2002; Kosar *et al.*, 2002).

Table 1: Total plant, shoot and root dry matter yield, root:shoot ratio and phosphorus stress factor of twenty four wheat genotypes at stress and adequate P levels.

Genotypes	Total DM g . 2 plants^{-1}		SDM g . 2 plants^{-1}		RDM g . 2 plants^{-1}		R : S		PSF
	25µM	250µM	25µ M	250µM	25µM	250µM	25µM	250µM	%
Blue Silver	0.91	2.01	0.63	1.78	0.26	0.23	0.43	0.13	65.04
Faisalabad– 83	1.09	2.16	0.72	1.84	0.37	0.32	0.53	0.18	60.89
Inqulab –91	1.26	1.78	0.76	1.48	0.39	0.30	0.52	0.20	48.57
Punjab-85	1.01	1.61	0.59	1.41	0.35	0.20	0.60	0.14	49.89
LU 26-S	1.40	1.68	0.85	1.48	0.55	0.19	0.64	0.13	41.02
LU -31	1.29	1.87	0.83	1.58	0.46	0.29	0.56	0.18	46.72
NF-7, 6039-4	1.11	1.68	0.63	1.47	0.48	0.21	0.70	0.14	57.06
NF-7, 6529-11	1.14	2.00	0.75	1.73	0.40	0.26	0.51	0.15	56.08
NF-7, 6544-6	1.19	1.19	0.71	1.64	0.43	0.26	0.51	0.16	49.95
4070	1.14	1.93	0.61	1.69	0.40	0.24	0.60	0.14	59.78
4770	0.97	1.81	0.60	1.57	0.37	0.23	0.62	0.15	59.90
Pasban	0.96	1.79	0.52	1.52	0.33	0.27	0.63	0.18	65.44
V-89251	0.89	2.06	0.55	1.85	0.35	0.21	0.64	0.11	70.08
V-89313	1.08	1.70	0.66	1.50	0.37	0.19	0.52	0.12	55.87
V-91109	1.24	1.77	0.73	1.59	0.42	0.18	0.61	0.16	52.27
V-91116	1.13	1.66	0.67	1.46	0.37	0.21	0.57	0.14	53.85
V-91141	1.25	1.75	0.82	1.52	0.44	0.23	0.54	0.15	45.67
V-91169	0.96	1.71	0.56	1.51	0.33	0.20	0.61	0.13	62.39
V-91173	1.19	2.02	0.73	1.76	0.40	0.25	0.54	0.14	62.81
D-88678	1.00	1.78	0.61	1.50	0.33	0.28	0.54	0.18	51.36
D-89626	1.51	1.81	1.04	1.58	0.47	0.23	0.45	0.14	28.78
D90627	1.25	1.56	0.78	1.35	0.44	0.21	0.56	0.15	32.35
D90640	1.25	2.25	0.89	2.03	0.34	0.22	0.53	0.11	56.15
D-91773	1.49	1.80	1.09	1.52	0.42	0.28	0.39	0.18	28.70
Mean	1.16	1.84	0.72	1.60	0.40	0.24	0.56	0.15	52.53

References

Ahmad, N. Plant nutrition management for sustainable agricultural growth in Pakistan. Proc. Symp. Plant Nutrition Management for sustainable Agricultural Growth, December, 1998, Islamabad, Pakistan, pp: 11-21.

Clark, R. B. and R.R. Duncun. 1991. Improvement of plant mineral nutrition through breeding. Field crop Res. 27:219-246

Gerloff, G. C. 1987. Intact, plant screening for tolerance of nutrient deficiency stress. Plant Soil, 99: 3-16.

Gill, M.A. Rahmatullah and Saleem, M. Growth responses of twelve wheat cultivars and their P utilization from Rock phosphate. 1994. J. Agron. Crop. Sci., 173(3-4): 204-209.

Gill, M.A., Mansoor, S., Aziz, T., Rahmatulla and Akhtar, M.S. Differential growth response and phosphorus utilization efficiency of rice genotypes. Pakistan J. Agric. Sci., 2002. 39(2): 83-87.

Haynes, B.R., Koide, T. and Elliott, G. Phosphorus uptake and utilization in wild and cultivated oats (Avena spp.). J. Plant Nutr., 1991, 14: 105-118.

Johnson, C. M., P. R. Stout, T. C. Broyer and A. B. Carlton. 1957. Comparative chlorine requirements of different plant species. Plant Soil. 8: 327 – 353

Kosar, H.S., Gill, M.A., Rahmatulla, Aziz, T., Akhtar, M.S. and Imran, M. Solubilization of tri-calcium phosphate by different wheat genotypes. Pakistan J. Agric. Sci., 2002, 39(4): 273-277.

Yaseen, M., Gill, M.A., Siddique, M., Ahmad, Z., Mahood, T. and Rehman, H.U. Phosphorus deficiency stress tolerance and phosphorus utilization efficiency in wheat genotypes. Procd. Symp. Plant Nutrition Management for Sustainable Agricultural Growth, NFDC. Islamabd. 1998. pp: 211-215.

Zia, M.S., M. A. Gill, M. Aslam and M. F. Hussain. 1991. Fertilizer use efficiency in Pakistan. Progressive Farming, 11: 35-38.