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# Residual effect of phosphorus fertilization and farmyard manure on productivity of succeeding wheat (*Triticum aestivum*) after soybean (*Glycine max*)

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## ABSTRACT

A field experiment was carried out during winter (*rabi*) seasons of 1997–98 and 1999–99 to investigate the residual effect of levels of P (30, 60 and 90 kg/ha) and sources of P [single superphosphate (SSP), Udaipur rockphosphate (URP), partially acidulate rockphosphate (PARP) and PARP + phosphate-solubilizing bacteria (PSB)] with and without farmyard manure (FYM) @ 10 tonnes/ha on yield attributes and yield of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) after soybean [*Glycine max* (L.) Merr.]. A significant improvement in effective tillers/m row length, 1,000-grain weight and grain yield of wheat was found owing to residual effect of increased levels of P fertilization at 90 kg $P_2O_5$/ha. Residual effect of PARP and PARP+PSB recorded significantly higher grain yield than SSP and URP. Application of FYM (10 tonnes/ha) also had significant residual effect in improving yield attributes and yield of succeeding wheat after soybean.

***Key words :*** Residual P, FYM, Wheat, Soybean

Soybean is a highly nutrient exhaustive legume and requires higher amount of nutrients pariticularly P for its optimum production. Even then, P applied to soybean showed residual effects on succeeding crops. Rao *et al.*(1995) inferred that P applied to soybean was more efficiently utilized by the succeeding wheat comparable to that applied to wheat in sequence. However, Dhama and Sinha (1983) did not find significant improvement in wheat grain yield due to residual effect of fertilizer P in legumes, viz. soybean, greengram, cowpea and pigeonpea–wheat sequence. The contradictory results may be ascribed to variation in build up of residual P and rate of change of soil-available P owing to different P sources. Application of SSP resulted in significantly higher level of residual available P compared to other phosphatic sources (Sharma and Sinha, 1989). However, residual effectiveness of partially acidulate rock phosphate (PARP) was

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found significantly higher than superphosphate (Marwah, 1983). Utilization of P by crops with various P sources is considerably affected by organic manures. A substantial increase in plant available P was observed when rockphosphate was applied with FYM (Sharma *et al.*, 1995). The present investigation was, therefore, carried out to work out residual effect of P fertilization and FYM on productivity of succeeding wheat crop.

## MATERIALS AND METHODS

The field experiment was conducted during the winter *(rabi)* seasons of 1997–98 and 1998–99 at Agronomy Farm, Rajasthan College of Agricultural, Udaipur. The experimental soil was clay loam in texture, having available N 270 kg/ha (alkaline $KMnO_4$ method – Subbiah and Asija, 1956), P 17.3 kg/ha (Olsen's method – Olsen *et al.*, 1954) and K 390 kg/ha (flame photometer method – Richards, 1968). It was slightly alkaline in reaction (pH 7.9). Treatments consisted 3 levels of P (30, 60 and 90 kg/ha) and 4 sources of P (SSP, URP, and PARP+PSB) with and without FYM (10 tonnes/ha) along with absolute control and sole FYM application @ 10 tonnes/ha, replicated 4 times in factorial randomized block design. The Udaipur rock phosphate (URP) and partially acidulate rock phosphate (PARP) contained 17.8 and 33.8% $P_2O_5$, respectively. *Bacillus megatherium* was used for soybean seed inoculation @ 5g/kg seed. A uniform dose of 30 kg N/ha, well-rotten FYM and all the P sources as per treatment were applied at sowing of soybean. After harvesting of soybean, each experimental plot was prepared manually without disturbing original plant layout. Wheat variety 'Raj 3077' was used for study. Only N application through urea was made to the extent of 75% of recommended (90 kg N/ha) into 2 equal splits, at sowing and first irrigation. No P application was made to wheat crop. The observations were recorded on yield determinants and yield of wheat.

## RESULTS AND DISCUSSION

Dry-matter accumulation/m row length at 60 days after sowing, effective tillers/m row length, grains/ear and 1,000-grain weight of wheat significantly increased owing to residual effect of all soybean applied treatments compared with absolute control during both the years. This resulted in increase of yield the dry matter significantly. Residual effect of P fertilization also significantly increased the effective tillers and grain yield of wheat over sole FYM application (Table 1).

### *Phosphorus level*

A significant increase in yield attributes, viz. dry matter/m row at 60 days during 1998–99, effective tillers/m row length and 1,000-grain, was registered with increase levels of residual P. Enhancement in the yield attributes resulted in significant increase in grain yield with residual P level 90 kg/ha over 30 kg/ha during both the years, however, 60 kg/ha residual P level could not increase grain yield significantly over 30 kg/ha (Table 1). A significant and positive association between residual P levels and effective tillers/m row (r=0.928), test weight (r=0.978*) also affirms the

**Table 1.** Residual effect of levels and source of phosphorus with and without farmyard manure on yield-attributing parameters and yield of wheat after soybean

| Treatment | Dry matter/m (g) at 60 DAS | | Effective tillers/m | | Grains/ ear | | 1,000-grain weight (g) | | Grain yield (q/ha) | | Straw yield (q/ha) | | Harvest index (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 | 1997–98 | 1998–99 |
| Absolute control | 32.30 | 35.59 | 78.5 | 90.2 | 31.6 | 33.2 | 38.41 | 38.89 | 33.00 | 36.53 | 52.25 | 55.70 | 39.06 | 39.65 |
| Rest treatments | 46.41 | 48.05 | 94.3 | 98.2 | 36.2 | 37.2 | 40.91 | 42.09 | 39.65 | 42.17 | 55.98 | 57.82 | 41.46 | 42.19 |
| 'F' test | * | * | * | * | NS | NS | * | NS | * | * | NS | NS | NS | NS |
| FYM (sole) | 35.79 | 37.09 | 82.5 | 91.5 | 36.3 | 36.3 | 39.14 | 40.56 | 35.06 | 38.70 | 54.29 | 56.43 | 39.33 | 40.67 |
| P treatments | 46.86 | 48.51 | 94.8 | 98.4 | 37.2 | 37.2 | 40.49 | 42.16 | 39.84 | 42.31 | 56.05 | 57.88 | 41.55 | 42.25 |
| 'F' test | * | * | * | * | NS | NS | * | NS | * | * | NS | NS | NS | NS |
| *P level (kg $P_2O_5$/ha)* | | | | | | | | | | | | | | |
| 30 | 45.78 | 46.82 | 92.5 | 96.7 | 35.4 | 36.4 | 40.32 | 41.44 | 38.48 | 41.17 | 55.37 | 57.10 | 41.00 | 41.97 |
| 60 | 46.77 | 48.74 | 94.8 | 98.2 | 36.2 | 37.4 | 41.09 | 42.10 | 39.84 | 42.48 | 56.05 | 57.77 | 41.57 | 42.44 |
| 90 | 48.01 | 49.97 | 97.1 | 100.4 | 37.0 | 37.9 | 41.56 | 42.89 | 41.18 | 43.28 | 56.73 | 58.77 | 42.09 | 42.42 |
| CD (P=0.05) | NS | 2.31 | 3.67 | 2.62 | NS | NS | 0.656 | 0.846 | 1.532 | 1.556 | NS | NS | NS | NS |
| *P source* | | | | | | | | | | | | | | |
| SSP | 41.33 | 42.91 | 93.2 | 96.4 | 35.7 | 37.3 | 40.23 | 41.46 | 38.66 | 41.24 | 55.54 | 57.05 | 41.05 | 41.95 |
| URP | 42.10 | 43.69 | 92.2 | 95.6 | 36.0 | 36.3 | 40.34 | 41.55 | 38.82 | 41.38 | 55.77 | 57.25 | 41.04 | 41.96 |
| PARP | 51.02 | 53.02 | 96.3 | 100.4 | 36.4 | 37.5 | 41.60 | 42.82 | 40.70 | 43.23 | 56.22 | 58.25 | 42.04 | 42.64 |
| PARP+PSB | 52.97 | 54.43 | 97.5 | 103.3 | 36.3 | 37.7 | 41.79 | 42.81 | 41.17 | 43.39 | 56.67 | 58.98 | 42.07 | 42.47 |
| CD (P=0.05) | 2.882 | 2.669 | 4.24 | 3.03 | NS | NS | 0.758 | 0.977 | 1.768 | 1.797 | NS | NS | NS | NS |
| *FYM (tonnes/ha)* | | | | | | | | | | | | | | |
| 0 | 45.05 | 46.72 | 92.5 | 97.3 | 34.9 | 36.1 | 40.44 | 41.55 | 37.37 | 39.77 | 53.94 | 55.19 | 40.96 | 41.92 |
| 10 | 48.67 | 50.30 | 97.1 | 99.5 | 37.5 | 38.3 | 41.53 | 42.77 | 42.30 | 44.85 | 58.16 | 60.57 | 42.14 | 42.59 |
| CD (P=0.05) | 2.038 | 2.504 | 3.00 | 2.14 | 1.05 | 1.03 | 0.536 | 0.691 | 1.251 | 1.271 | 2.320 | 2.136 | NS | NS |

*Significant at 5% level; NS, non-significant; PSB, phosphate-solubilizing bacteria
DAS, Days after sowing

**Table 2.** Response of yield parameters and wheat yield to residual P levels and relationship between grain yield and yield attributes of wheat

| Dependent character | Independent character | 'r' | Regression equation |
|---|---|---|---|
| Effective tillers/m | Residual P levels | 0.928 | Y=87.71 + 0.14 X |
| 1,000-grain weight (g) | Residual P levels | 0.978* | Y=39.72 + 0.03X |
| Grain yield (q/ha) | Residual P levels | 0.947* | Y=36.68 + 0.07X |
| Grain yield (q/ha) | Effective tillers/m | 0.851** | Y=17.54 + 0.61X |
| Grain yield (q/ha) | 1,000-grain weight (g) | 0.795** | Y=–42.77 + 2.01X |
| Grain yield (q/ha) | Grains/ear | 0.932** | Y=–24.31 + 1.78X |

results and role of residual P levels in increasing yield component. These parameters had significant bearing on grain yield as evinced by their positive and strong interrelationship with grain yield (Table 2). The increasing residual P levels might have complementary effect and maintained a balanced N and P medium conducive for higher tiller production and later on in ensuring healthy plumpy grain, thereby, increased grain yield. The results are in close confirmity with the findings of Rao *et al.* (1995). Grains/ear, straw yield and harvest index of wheat were not significantly affected due to levels of P fertilization.

### *Phosphorus sources*

Residual effect of PARP and PARP+PSB was found significantly higher than that of SSP and URP on yield attributes, viz. effective tillers/m, 1,000-grain weight, dry matter/m row, and ultimately grain yield (Table 1). The marked increase in yield components and thereby grain yield of wheat owing to PARP and PARP+PSB might be attributed to the exchangeable P pool of soil at a relatively stable concentration for extended period, possibly due to lower rate of P retention and continuous dissolution of the rock phosphate of PARP owing to 'secondary acidulation' (Lindsay and Stephenson, 1959). Grains/ear, straw yield and harvest index of wheat were not remarkably affected due to residual effect of various P sources.

### *Farmyard manure*

All the yield-attributing characters, viz. effective tillers/m, grains/ear and 1,000-grain, and thereby grain as well as straw yields of wheat in comparison to no FYM (Table 1). This could be ascribed to enrichment of the soil with N and P at the end of soybean cropping and subsequently adequate and sustained availability to succeeding wheat. Brady (1996) generalized that one-half of N and one-fifth of P may be recovered from organic manure applied. Thereafter, the rest nutrients available at slower rate to subsequent crops. Results of this investigation are in close agreement with findings of Rao *et al.* (1995).

Thus phosphorus fertilization to soybean (90 kg $P_2O_5$/ha) had significant residual effect in enhancing subsequent wheat grain yield. A significant improvement in grain yield of wheat was observed due to residual

effect of FYM, PARP alone or along with PSB in comparison to SSP and URP.

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