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Effect of Rock Phosphate, FYM and Phosphobacteria on Growth, Yield and Economics of Wheat in North Gujarat

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A field experiment was conducted at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during rabi 2010-11 on loamy soil to assess the agronomic feasibility of Udaipur Rock Phosphate (URP) sources (URP 31% and URP 34%), incubation methods (No incubation, incubation with farmyard manure, incubation with phosphate solubilizing bacteria, incubation with farmyard manure + phosphate solubilizing bacteria) and farmyard manure (zero and ten tonnes ha^{-1}) on wheat (*Triticum aestivum* L. emend. Fiori & Paol.) Application of FYM @ 10 tonnes ha^{-1} also had direct significant influence in improving growth attributes, yields (grain and straw) and quality of wheat crop. Application of P_2O_5 @ 40 and 60 kg ha^{-1} was at par, while both the sources of P (i.e. Diammonium phosphate and Udaipur rock phosphate) were found equally effective. In terms of economics, higher net return was recorded with the application of DAP @ 60 kg P_2O_5 ha^{-1} closely followed by incubation of URP with FYM + PSB and incubation of URP with FYM + PSB + 10 t FYM ha^{-1}.

Key words: FYM, phosphate solubilizing bacteria, Udaipur rock phosphate, wheat

Phosphorus is one of the important major nutrients required by the crop and in many soils its availability limits the crop yield due to intensive cropping and adoption of high yielding varieties in irrigated agriculture. The agronomic efficacy of rock phosphate as a direct phosphorus fertilizer along with certain acidulants was evaluated in wheat by Pareek *et al*. (2004) and Soni and Aery (2004). The results indicated that acidulants such as farmyard manure, vegetable waste, saw dust etc. resulted in enhancement in crop production over the absolute control. Therefore, the present investigation was conducted to find out the effect of applied Udaipur rock phosphate in presence and absence of farmyard manure on productivity, quality of wheat and soil available nitrogen and phosphorus status.

Materials and Methods

The field experiment was conducted during *rabi* season of 2010-11 at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat. The soil was loamy sand in texture having available nitrogen 259 and 232 kg ha^{-1}, phosphorus 22.3 and 19.7 kg ha^{-1} and potash 256 and 242 kg ha^{-1} from 0-15 and 15-30 cm depth, respectively. The soil was neutral in reaction (pH 7.2 - 7.7). Eighteen treatments were evaluated, *viz.* two sources of Udaipur rock phosphate (31 and 34%) @ 60 kg P_2O_5 ha^{-1}, four incubation methods (No incubation, incubation with farmyard manure, incubation with phosphate solubilizing bacteria and incubation with farmyard manure + phosphate solubilizing bacteria) and two farmyard manure levels (zero and ten tonnes ha^{-1}) along with two checks (40 and 60 kg P_2O_5 ha^{-1} through diammonium phosphate). Recommended doses of nitrogen and potash @ 120 and 30 kg ha^{-1} were applied to wheat crop through urea and MOP, respectively.

Before incubation, 300 kg soil of respective field was added to the rock phosphate. The Udaipur rock phosphate (URP) was incubated for 21 days in gunny bags with continuous aeration and wetting before use.

These 18 treatment combinations [(2×4×2)+2] were replicated three times in factorial randomized block design. *Bacillus subtilis var*. *phosphaticum* was used for incubation. A uniform dose of 60 kg N, 30 kg K_2O ha^{-1}, all the phosphorus sources and farmyard manure were applied at sowing of wheat. Remaining 60 kg N ha^{-1} was top-dressed at the time of first irrigation. Wheat was harvested from each experimental plot separately.

The observations were recorded on growth attributes, yield determinates and yields of wheat at harvest. The protein content was evaluated by using (NIR) near infrared spectroscopy and soil samples were drawn from each experimental unit after harvesting of wheat and analyzed for available nutrients as per the following methods; alkaline potassium permanganate method for nitrogen (Subbiah and Asija, 1956), Olsen's method for phosphorus (Olsen *et al*. 1954) and flame photometric method for potash (Jackson, 1973). The economics of different treatment combinations was worked out in terms of net returns ha^{-1} and B:C (benefit cost) ratio.

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Results and Discussion

Udaipur Rock Phosphate Sources

While assessing the comparative efficacy of URP (31 & 34%) in respect of growth parameters, yield attributes and yields (grain and straw), protein content of wheat and soil available nitrogen and phosphorus status, both the URP sources were proved equally effective (Table 1). The better efficacy of URP sources might be due to absence of carbonate gangue and the acidity generated by organic acidulating materials helps in bringing phosphorus into available forms, the agronomic efficacy of rock phosphate as a direct fertilizer was also evaluated on wheat by Pareek *et al.* (2004) and Soni and Aery (2004) and they observed rock phosphate as a better source of phosphorus.

Incubation Methods

Incubation of URP with FYM, PSB and FYM+PSB recorded significant improvement in yields (grain and straw), protein content of wheat and soil available nitrogen and phosphorus status over no incubation (Table 1). Incubation of URP with FYM + PSB increased the grain and straw yields by 14.24 and 11.29 per cent over no incubation. The corresponding increase with FYM incubated URP were to the tune of 8.77 and 6.25 per cent respectively, over no incubation. Further, significantly higher protein content (12.70 per cent) of wheat grain was recorded under incubation of URP with FYM+PSB which was found at par to incubation of URP with FYM alone. Similarly, incubation of URP with FYM+PSB recorded the highest available phosphorus (11.08 per cent more) status of soil compared to no incubation which was found statistically similar to incubation of URP with FYM alone. These results might be due to better nutritional environment for wheat under incubation of URP with FYM and FYM+PSB treated plots, which have increased the solubility and availability of phosphorus from URP and yield attributes of wheat. The results are in close conformity with Shaktawat *et al.* (2004).

Table 1. Effect of rock phosphate sources, incubation methods and FYM on plant height at harvest (cm), 1000 grain weight (g), grain and straw yield (kg ha^{-1}), protein content (%) of wheat and post harvest available nitrogen, phosphorus and potash status of soil

Treatment	Plant height at harvest (cm)	1000 grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Protein content (%)	Available Nutrients (kg ha^{-1})		
						Nitrogen	Phosphorus	Potash
URP sources (60 kg P_2O_5ha^{-1})								
URP (31%)	90.41	36.36	4412	6460	11.01	275	23.6	268
URP (34%)	92.37	37.68	4525	6591	11.26	276	24.4	268
SEm±	2.91	1.10	96.29	129.31	0.26	4.03	0.48	5.21
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Incubation								
No incubation	90.11	36.14	4185	6227	10.55	275	22.9	254
Incubation with FYM	91.89	37.21	4552	6616	11.52	276	24.5	273
Incubation with PSB	90.40	36.62	4357	6331	10.57	275	23.2	260
Incubation with FYM+PSB	93.14	38.12	4781	6930	11.89	277	25.5	284
SEm ±	4.11	1.56	136	182	0.36	5	0.6	7
CD 5%	NS	NS	391	525	1.04	NS	1.9	21
FYM (t ha^{-1})								
0	86.84	35.22	4299	6327	10.72	270	22.9	261
10	95.93	38.82	4638	6724	11.55	282	25.1	276
SEm±	2.91	1.10	96	129	0.26	4	0.4	5
CD 5%	8.36	3.17	276	371	0.74	11	1.3	14
Check (P_2O_5kg ha^{-1})								
40	92.13	36.11	4324	6242	10.65	274	25.5	264
60	95.17	38.65	4736	6849	11.81	276	28.3	268
'F' test	NS	NS	NS	NS	NS	NS	NS	NS
Check vs. Rest treatments								
Check (DAP)	93.65	37.38	4530	6546	11.23	275	26.9	266
Rest treatments	91.39	37.02	4469	6526	11.13	276	24.0	268
'F' test	NS	NS	NS	NS	NS	NS	S	NS
CV (%)	15.55	14.58	10	9.0	11.25	7.1	9.6	9.2

NS : Non Significant S : Significant

Farmyard Manure (FYM)

The growth parameters *viz.* plant height and yield attributes were influenced due to farmyard manure application to wheat, thereby grain and straw yields also increased significantly by 7.89 and 6.27 per cent over no FYM. Protein content was again influenced by the presence of FYM as the soil available nitrogen and phosphorus status were significantly improved to the tune of 4.33 and 9.29 per cent respectively, compared to no FYM (Table 1). In general, it can be attributed to their efficient extraction of nutrients per translocation in the plant system due to enhanced activities of roots on account of pivotal role of farmyard manure on maintenance of better physico-chemical and biological properties of soil. The results are in close conformity with the findings of Singh *et al.* (1998) and Chaplot (2000).

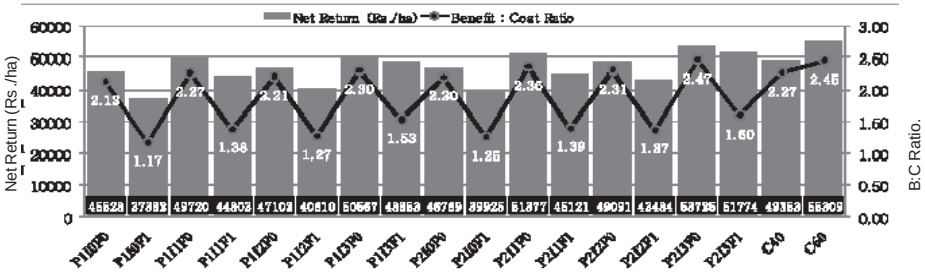

Fig .1. Effect of rock phosphate sources, incubation methods and FYM on net return and B:C ratio of wheat

P1 = URP (31%) I0 = No incubation F0¬ = No FYM C40¬ = DAP @ 40 kg P2O5 ha-1
P2 = URP (34%) I1 = Incubation with FYM F1¬ = FYM 10 t ha-1 C60¬ = DAP @ 60 kg P2O5 ha-1
I2 = Incubation with PSB
I3 = Incubation with FYM+PSB

Effect of Phosphorus Levels

The results presented in table 1 revealed that increase in application of phosphorus from 40 and 60 kg P_2O_5 ha^{-1} through diammonium phosphate did not significantly influenced the growth parameters, yield attributes, yields (grain and straw), protein content of wheat and soil available nitrogen, phosphorus and potash status. Since both the doses of phosphorus were remained at par to each other. This might be due to medium phosphorus status of the experimental soil and higher extraction capacity of wheat plants to utilize the native phosphorus present in soil.

Comparison of Check vs. Rest treatments

Use of Udaipur rock phosphate to wheat crop found equally effective to that of diammonium phosphate (Check) in influencing growth parameters, yield attributes, productivity and protein content of wheat grain as well as soil available nitrogen and phosphorus status. The equal performance of Udaipur rock phosphate to that of Check (DAP) was probably due to solubilization of phosphorus from Udaipur rock phosphate in presence of phosphate solubilizing bacteria and farmyard manure. Similar findings were reported by Shaktawat *et al.* (2001) and Rajput *et al.* (2007).

Economics

The economic evaluation of different treatments (Fig. 1) indicated that application of DAP at the rate of 60 kg P_2O_5 ha^{-1} (C_{60}) fetched maximum net monetary return of ₹55314 ha^{-1} with B:C ratio of 2.45 followed by $P_2I_3F_0$ (URP-34% + incubated with FYM+PSB) with net return of ₹53732 and B:C ratio of 2.47.

Conclusion

It is inferred that application of 60 kg P_2O_5 ha^{-1} through Udaipur rock phosphate (34%) incubated with FYM+PSB along with addition of 10 t FYM ha^{-1} and recommended dose of nitrogen (120 kg ha^{-1}) and potash (30 kg ha^{-1}) to wheat crop is the most appropriate nutrient management strategy for getting higher seed yield. However, looking into the net return, due to higher cost of FYM it was found inferior as compared to the application of 60 kg P_2O_5 ha^{-1}through DAP and $P_2I_3F_0$ (URP-34% + incubation with FYM+PSB) under prevailing condition of North Gujarat. With regards to B:C ratio, $P_2I_3F_0$ (URP-34% + incubation with FYM+PSB) recorded higher B:C ratio followed by C_{60} (60 kg P_2O_5 ha^{-1} through DAP) and $P_2I_1F_0$ (URP-34% + incubation with FYM).

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