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Effect of rock phosphate, biofertilizers and FYM on growth, yield and economics of wheat *(Triticum aestivum* L.) under North Gujarat condition

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ABSTRACT : A field experiment was conducted at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *Rabi* 2010-11 on loamy sand 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. The agronomic efficacy of the sources of URP 31 per cent and 34 per cent was not found significant in all the aspects. However, effect of incubation methods influenced the productivity, quality of wheat and available nutrient status of soil after harvest of the crop. Application of FYM @ 10 tonnes ha^{-1} also had direct significant influence in improving growth attribute, yields (grain and straw) and quality of wheat crop. Application of P_2O_5 @ 40 and 60 kg ha^{-1} was found to be at par, while both the sources of P (*i.e.* Diammonium phosphate and Udaipur rock phosphate) were found equally effective. In terms of economics, highest 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

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Wheat is the World's single most important cereal crop not only in quantitative but in qualitative terms too and considered to be integral component of food security system of several nations and to feed the increasing population production is to be increased. 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, present investigation was conducted to find out the effect of applied Udaipur rock phosphate sources incubated through various methods in presence and absence of farmyard manure on productivity, quality of wheat and soil available nitrogen and phosphorus status.

RESEARCH PROCEDURE

The field experiment was conducted during the *Rabi* season of 2010-11 at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat (INDIA). The soil was loamy sand in texture having available nitrogen (Jackson, 1978 Method) 149 and 138 kg ha^{-1} and available phosphorus (Olsen method, Jackson. 1978) 29.35 and 31.20 kg ha^{-1} from 15 cm and 30 cm depth, respectively. The soil was slightly saline 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 dose of nitrogen @ 120 kg ha^{-1} was applied to wheat crop through urea.

Before incubation a fixed quantity of 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 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 nitrogen and phosphorus as per the alkaline permanganate method (Jackson, 1978) and Olsen's method (Olsen *et al*., 1954), respectively. The economics of different treatment combinations was worked out in terms of net returns ha^{-1} and B:C (benefit cost) ratio.

RESEARCH ANALYSIS AND REASONING

The results obtained from the present investigation have been duscussed below:

Udaipur rock phosphate sources:

While assessing the comparative efficacy of URP (31 and 34%) in respect of growth parameter, yield attribute 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

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 (q ha^{-1}), protein content (%) of wheat and available nitrogen and phosphorus status of soil after harvest of the crop

Treatments	Plant height at harvest (cm)	1000 grain weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Protein content (%)	Available nutrients (kg ha^{-1})	
						Nitrogen	Phosphorus
URP sources (60 kg P_2O_5 ha^{-1})							
URP (31%)	90.41	36.36	44.12	64.60	11.01	275.62	23.61
URP (34%)	92.37	37.68	45.25	65.91	11.26	276.49	24.40
S.E.±	2.91	1.10	0.96	1.29	0.26	4.03	0.48
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS
Incubation							
No incubation	90.11	36.14	41.85	62.27	10.55	275.49	22.92
Incubation with FYM	91.89	37.21	45.52	66.16	11.52	276.37	24.45
Incubation with PSB	90.40	36.62	43.57	63.31	10.57	275.15	23.18
Incubation with FYM+PSB	93.14	38.12	47.81	69.30	11.89	277.19	25.46
S.E.±	4.11	1.56	1.36	1.83	0.36	5.69	0.67
C.D. (P=0.05)	NS	NS	3.91	5.26	1.04	NS	1.94
FYM (t ha^{-1})							
0	86.84	35.22	42.99	63.27	10.72	270.21	22.94
10	95.93	38.82	46.38	67.24	11.55	281.90	25.07
S.E.±	2.91	1.10	0.96	1.29	0.26	4.02	0.48
C.D. (P=0.05)	8.36	3.17	2.77	3.72	0.74	11.57	1.37
Check (P_2O_5 kg ha^{-1})							
40	92.13	36.11	43.24	62.42	10.65	274.59	25.46
60	95.17	38.65	47.36	68.49	11.81	275.79	28.29
'F' test	NS	NS	NS	NS	NS	NS	NS
Check vs. rest treatments							
Check (DAP)	93.65	37.38	45.30	65.46	11.23	275.19	26.87
Rest treatments	91.39	37.02	44.69	65.26	11.13	276.05	24.00
'F' test	NS	NS	NS	NS	NS	NS	S
CV (%)	15.55	14.58	10.54	9.70	11.25	7.14	9.61

NS = Non-significant S : Significant

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 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 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 in plant under incubation of URP with FYM and FYM+PSB treated plots, which have increased the solubility and availability of phosphorus from URP and yield forming components of crop. The results are in close conformity with Shaktawat *et al.* (2004).

Farm Yard Manure (FYM):

The growth parameter *viz.*, plant height and yield attributes 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 (Table 1). Protein content was again influenced by 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. In general, it can be attributed to their efficient extraction 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).

Effect of phosphorus levels:

The results revealed that increased application of phosphorus from 40 and 60 kg P_2O_5 ha^{-1} through diammonium phosphate proved similar effect on growth parameter, yield attribute, yields (grain and straw), protein content of wheat and soil available nitrogen and phosphorus status. This might be due to medium phosphorus status of the experimental soil and higher extraction capacity of wheat plants to utilize the

Table 2 : Economics of the treatments in wheat crop

Treatments	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Gross return (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C Ratio
$P_1I_0F_0$	40.57	60.17	66872	21344	45528	2.13
$P_1I_0F_1$	42.01	63.11	69323	31944	37379	1.17
$P_1I_1F_0$	43.49	64.09	71640	21924	49716	2.27
$P_1I_1F_1$	47.08	67.07	77330	32524	44805	1.38
$P_1I_2F_0$	41.57	61.04	68457	21357	47100	2.21
$P_1I_2F_1$	44.10	64.17	72569	31957	40612	1.27
$P_1I_3F_0$	44.00	65.05	72506	21938	50568	2.31
$P_1I_3F_1$	50.12	72.11	82392	32538	49854	1.53
$P_2I_0F_0$	41.27	61.07	68018	21243	46775	2.20
$P_2I_0F_1$	43.53	64.73	71769	31843	39926	1.25
$P_2I_1F_0$	44.41	65.34	73143	21772	51371	2.36
$P_2I_1F_1$	47.12	68.13	77492	32372	45120	1.39
$P_2I_2F_0$	42.70	62.97	70341	21256	49085	2.31
$P_2I_2F_1$	45.89	65.05	75347	31856	43491	1.37
$P_2I_3F_0$	45.91	66.45	75517	21785	53732	2.47
$P_2I_3F_1$	51.20	73.59	84163	32385	51778	1.60
C_{40}	43.24	62.42	71108	21749	49359	2.27
C_{60}	47.36	68.49	77894	22580	55314	2.45

Shelling price of produce:
Wheat grain : 1500 q^{-1}
Wheat straw : 100 q^{-1}

P_1 = URP (31%) I_0 = No incubation F_0 = No FYM C_{40} = DAP @ 40kg P_2O_5 ha^{-1}
P_2 = URP (34%) I_1 = Incubation with FYM F_1 = FYM @10 t ha^{-1} C_{60} = DAP @ 60kg P_2O_5 ha^{-1}
I_2 = Incubation with PSB
I_3 = Incubation with FYM+PSB

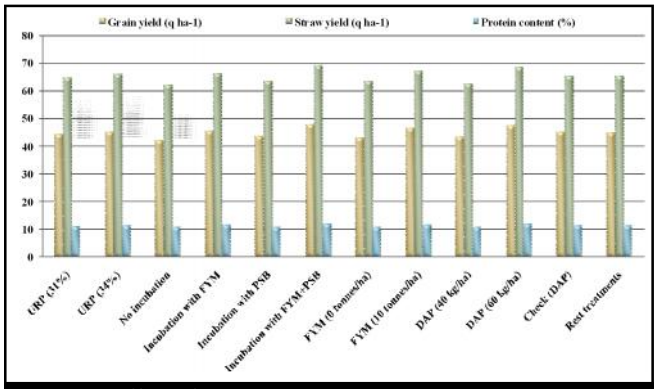

Fig. 1 : Effect of rock phosphate sources, incubation methods and FYM on grain and straw yield (q ha^{-1}) and protein content (%) of wheat

native phosphorus present in soil (Table 1).

Check vs. rest treatments:

Use of Udaipur rock phosphate to wheat crop found equally effective to that of diammonium phosphate (Check) in influencing growth parameter, yield attribute, productivity and protein content of wheat grain as well as soil available nitrogen and phosphorus status (Table 1). 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 indicated that application of DAP at the rate of 60 kg P_2O_5 ha^{-1} (C_{60}) fetched maximum net monetary return of Rs. 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 Rs. 53732 and B:C ratio of 2.47 (Table 2).

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} ($P_2I_3F_1$) and recommended dose of nitrogen (120 kg ha^{-1}) to wheat crop was most appropriate nutrient management system for getting higher seed yield. However, looking to the net return due to high cost FYM ranked at 3rd position. It was found inferior in terms of net return as compared to 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. So far B:C ratio is concern the treatment combination $P_2I_3F_0$ (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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