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EFFECT OF PHOSPHORUS SOURCES, LEVELS AND BIOFERTILIZERS ON YIELD ATTRIBUTES, YIELD AND ECONOMICS OF BLACK GRAM (*PHASEOLUS MUNGO* L.)

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ABSTRACT

An experiment was carried out during *kharif* season of 2009 It consisted of thirteen treatment combinations comprising of two phosphorus levels (20 and 40 kg P_2O_5 ha^{-1}), three phosphorus sources (DAP, SSP and PROM), two biofertilizers (PSB and *Rhizobium*) and one absolute control. The experiment was conducted in factorial randomized block design and it was replicated three times. To evaluate the effect of phosphorus sources, levels and biofertilizers on black gram. Among the different sources of phosphorus DAP produce significantly higher pods $plant^{-1}$(46.02), grain $pods^{-1}$ (8.20), 1000 grain weight (40.63gm) and seed weight pod^{-1} (0.83gm), seed (10.20 q ha^{-1}), haulm (21.40 q ha^{-1}) and biological(31.61 q ha^{-1}) yields. Further, DAP also recorded highest net returns (Rs. 25112.60 ha^{-1}) with benefit cost ratio of 2.77. Similar trend also observed in case of phosphorus levels. Application of 40 kg P_2O_5 ha^{-1} gave significantly higher yield attributes, seed (10.65 q ha^{-1}), haulm (23.00 q ha^{-1}),biological (33.66 q ha^{-1}) yields, net returns (Rs. 26315.54 ha^{-1}) and benefit cost ratio (2.80) over 20 kg P_2O_5 ha^{-1} and control. Seed inoculation with PSB markedly enhanced yield attributes, seed yield, (10.11 q ha^{-1}), haulm (20.88 q ha^{-1}), biological (30.98 q ha^{-1}) yields net return (Rs 24529.87 ha^{-1}) with benefit cost ratio 2.65 over *Rhizobium* and control of black gram. With regards to interaction effects application of 40 kg P_2O_5 though DAP along with PSB brought significant effect on seed yield on Black gram.

Key words: Biofertilizer, Black gram, DAP, Net returns, Phosphorus sources, Seed yield.

India has made an impressive progress to achieve self sufficiency in food grain production and reached a growth rate which is sufficient to meet the requirement of increasing population, the pulses production has remained stagnant around 18 M.T. (Anonymous, 2011-12), our country being predominantly vegetarian, pulses are the main source of quality protein and essential amino acids. Due to low and unstable production and increasing population pressure, per capita availability of pulses has come down from 69 g in 1961 to about 31.6 g in 2010-11, against the minimum requirement of 80 g per capita per day (Anonymous, 2011-12). Biofertilizers are organic products containing a specific micro-organism (microbial inoculants) which is derived from the nodules of plant or from soil of root zone (rhizosphere). Biofertilizer offer a cheaper, low capital intensive and ecofriendly route to boost farm productivity depending upon their activity of mobilizing nutrients. They possess, unique ability to fix atmospheric nitrogen either by living symbiotically or non-symbiotically or to transform native soil nutrient such as phosphorus from the unavailable to available form through biological processes. Rapid increase in the cost of conventional fertilizers like single super phosphate (SSP) and Diammonium Phosphate (DAP) has restricted their use by sizeable farming community. The use of indigenous rock phosphate has thereby, become imperative to save precious fore. With the

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development of technology for the production of Phosphate Rich Organic Manure (PROM) has been increased in many fold and has made cheap, eco-friendly and equally effective as water soluble sources of phosphorus, irrespective of soil types. PROM is prepared from high grade rock phosphate (34/74) and organic matter. The organic matter releases organic acids, which converts unavailable phosphate into available phosphate. Keeping these facts in view, it was considered appropriate to carry out present investigation.

A field experiment was conducted at Agronomy Instructional Farm, Rajasthan College of Agriculture, Udaipur during *Kharif* season 2009. The soil of experimental field was clay- loam in texture, slightly alkaline in reaction(pH 8.2), medium in available nitrogen (260 kg ha^{-1}), medium in available P (20.10 kg P ha^{-1}), high in potassium (326 kg ha^{-1}), medium in organic carbon (0.65 %), Ec of soil (0.06-2.24 dS m^{-1}) and water (2.25 dS m^{-1}). Maximum temperature during the crop season fluctuated between 36.3 and 28.1^{0}C and minimum temperature between 26.6 to 20.4°C. The maximum relative humidity ranged during the crop season fluctuated between 95.4 to 74.4 per cent and minimum relative humidity between 85.9 to 43.4 per cent. The total actual rainfall received 420.4 mm during 2009. The experiment consisted of thirteen treatment combinations comprising of two phosphorus levels (20 and 40 kg P_2O_5 ha^{-1}), three phosphorus sources (DAP, SSP and PROM), two biofertilizers (PSB and *Rhizobium*) and one absolute control. The experiment was conducted in factorial randomized block design and it was replicated three times. Black gram var. T-9 was sown on 2nd July 2009 with recommended seed rate 15 kg ha^{-1} and row spacing of 30 cm x 10 cm under rainfed conditions.

Effect of phosphorus sources

Application of DAP produced significantly higher pod plant $plant^{-1}$ grains pod^{-1}, 1000 grain weight (gm) and seed weight (gm) pod^{-1} over PROM in tune of 11.30, 15.66, 9.57 and 33.87 per cent respectively which result in concomitant increase in seed, haulm and biological yield ha^{-1} by 29.11, 27.91 and 29.28 per cent respectively (Table 1). These results corroborate with the findings of Meena (2005) and Sharma *et al.* (2004). The higher seed and haulm yield registered by DAP over SSP, PROM and control appear to be a resultant of remarkable improvement in their different yield components, which was brought about due to adoption of different sources. It was further confirmed by the fact that seed yield was found closely related with different yield components (Table 1 & 2) and seed yield, related with pod $plant^{-1}$, grains pod^{-1},1000 grains weight and

TABLE 1: Effect of Phosphorus sources, levels and biofertilizers on yield attributes of black gram.

Treatments	No. of pods $plant^{-1}$	No. of grains pod^{-1}	1000 grain weight(gm)	Seed weight pod^{-1}(gm)
Phosphorus sources				
DAP	46.02	8.20	40.63	0.83
SSP	44.37	8.20	40.36	0.76
PROM	41.32	7.09	37.08	0.62
CD at 5%	3.55	0.50	1.79	0.05
Phosphorus levels (kg ha^{-1})				
20	41.47	7.38	35.43	0.57
40	46.34	8.27	43.29	0.90
CD at 5%	2.90	0.41	1.46	0.04
Biofertilizers				
PSB	45.71	8.66	40.79	0.78
Rhizobium	42.10	7.00	37.93	0.70
CD at 5%	2.90	0.41	1.46	0.04
Control v/s Rest				
Control	13.70	4.33	33.17	0.27
Rest	43.90	7.83	39.36	0.74
F test at 5%	Significant	Significant	Significant	Significant

TABLE 2: Effect of phosphorus sources, levels and biofertilizers on yield (q ha^{-1}), harvest index (%), net returns and B: C of Black gram.

Treatments	Yield (q ha^{-1})			Harvest Index (%)	Net Returns (' ha^{-1})	B : C
	Seed	Haulm	Biological			
Phosphorus sources						
DAP	10.20	21.40	31.61	32.46	25112.60	2.77
SSP	9.66	19.27	28.93	33.56	23183.35	2.58
PROM	7.90	16.73	24.64	33.28	16783.33	1.72
CD at 5%	0.57	1.69	1.96	NS	1834.94	0.20
Phosphorus levels (kg ha^{-1})						
20	7.86	15.27	23.12	32.00	17070.65	1.91
40	10.65	23.00	33.66	34.20	26315.54	2.80
CD at 5%	0.47	1.38	1.60	1.50	1498.22	0.16
Biofertilizers						
PSB	10.11	20.88	30.98	32.25	24529.87	2.65
Rhizobium	8.40	17.40	25.80	32.95	18856.32	2.06
CD at 5%	0.47	1.38	1.60	NS	1498.22	0.16
Control v/s Rest						
Control	5.91	10.85	16.76	35.41	12021.05	1.60
Rest	9.25	19.14	28.39	33.10	21693.09	2.36
F test at 5%	Significant	Significant	Significant	NS	Significant	Significant

seed weight pod^{-1}. Such close association ship of seed yield with different yield components was also observed by Yadahalli and Palled (2004). Further, biological yield is a function of seed and haulm yield representing reproductive and vegetative growth of the crop. The results of the present investigation indicated that higher productivity of Black gram is in close conformity with findings of Yadahalli and Palled (2004).

Effect of phosphorus levels

Data on yield attributes of the crop under the influenced of levels revealed that various yield attributes *viz.* number of pods $plant^{-1}$, number of grains pod^{-1}, 1000 grain weight, and seed weight pod^{-1} (gm) were significantly increased under 40 kg P2O5 ha^{-1} condition which consequently produced significantly higher seed, haulm and biological yield by 35.49, 50.62, and 45.58 percent compared to 20 kg P_2O_5 ha^{-1} conditions (Table 1& 2). The marked improvement in various yield attributes of the crop seems to be on account of increased capacity of the 40 kg P_2O_5 ha^{-1} to exploit environmental resources (above and below ground) for yield synthesis. Biological yield is a function of seed and haulm yield. While increased seed and haulm yield under normal levels condition resulted in production of higher biological yield. It is reported earlier that the depressing effect of levels on seed yield may be due to significantly lower 1000 grains weight, pods $plant^{-1}$ and seed yield. Similar result was reported by Singh and Singh (2006).

Effect oif biofertilizers

Inoculation of PSB significantly improved pods $plant^{-1}$, grains pod^{-1}, 1000 grain weight and seed weight pod^{-1}(gm) over *Rhizobium* and control (Table 1). The productivity recorded in terms of seed, haulm and biological yield only showed significant response with PSB (Table 2). Significant increase

TABLE 3: Interaction effect of phosphorus sources, levels and biofertilizers on seed yield (q ha^{-1}) of Black gram.

Treatments	Phosphorus levels		Biofertilizers	
	20 kg P_2O_5 ha^{-1}	40 kg P_2O_5 ha^{-1}	PSB	*Rhizobium*
Phosphorus sources				
DAP	8.40	12.01	10.84	9.57
SSP	8.58	10.73	10.00	9.31
PROM	6.59	9.22	9.48	6.32
CD at 5%	0.81		0.81	

TABLE 4: Interaction effect of phosphorus levels and biofertilizers on seed yield (q ha^{-1}) of Blackgram.

Treatments	Biofertilizers	
Phosphorus Levels	PSB	*Rhizobium*
20 kg P_2O_5 ha^{-1}	7.90	7.81
40 kg P_2O_5 ha^{-1}	12.31	9.00
CD at 5 %	0.66	

in seed and haulm yield under the influence of fertilizer application with PSB by 20.36 and 20.0 per cent,71.06 and 92.44 per cent over *Rhizobium* and control, respectively. The higher biological yield under the influence of PSB could be ascribed to its positive influence on both vegetative and reproductive growth of crop, which led to increase in seed and haulm yield. These results are also with the conformity of findings of Tomar *et al.,* (2001).

Interaction effect

Interaction effects of phosphorus sources and levels and biofertilizers with sources on seed yield of black gram were significant. Highest and significantly higher yield was obtained with application of 40 kg P_2O_5 through DAP (12.01 q ha^{-1}) along with PSB inoculation (10.84 q ha^{-1}) (Table 3). Maximum seed yield of black gram of was obtained with application of 40 kg P_2O_5 ha^{-1} with PSB inoculation 12.3 q ha^{-1} (Table 4).

Hence it was concluded that application of 40 kg phosphorus ha-1 to black gram through DAP with PSB found superior in terms of growth, yield and nutrient utilization under clay-loam soils of southern Rajasthan.

Economics

The data showed in (Table 2) that application of DAP obtained highest net returns (Rs. 25112.60 ha^{-1}) with benefit cost ratio of 2.77 as compared to SSP, PROM and control. Comparison of various phosphorus levels indicated that 40 kg P2O5 ha-1 gave significantly higher net returns (Rs. 26315.54 ha^{-1}) and benefit cost ratio (2.80) over 20 kg P2O5 ha^{-1} and control. The comparison of biofertilizers indicated that PSB gave significantly higher net returns and benefit cost ratio over *Rhizobium* and control. Maximum net return (Rs. 24529.87 ha-1) and benefit cost ratio (2.65) were obtained under PSB, which were significantly superior over *Rhizobium* and control. These results are also with the conformity of findings of Tomar *et al.,* (2001).

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