

Integrated phosphorus management on yield and nutrient uptake of urdbean under rainfed conditions of southern Rajasthan

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ABSTRACT

A field experiment was conducted during 2003-04 and 2004-05 on Typic Haplustept at Maharana Pratap University of Agriculture and Technology, Udaipur to assess the effect of P application through different sources on yield and nutrient uptake by urdbean. Application of FYM @ 5 t/ha, 40 kg P₂O₅/ha and dual seed inoculation with PSB + VAM significantly increased the seed and stover yield and uptake of N, P and K by urdbean. Combined effect of 5 t FYM/ha + 40 kg P₂O₅/ha, 5 t FYM/ha + dual inoculation with PSB + VAM, and 40 kg P₂O₅/ha + dual inoculation with PSB + VAM produced significantly higher yield and uptake of N, P and K by urdbean. Maximum net returns (Rs. 31835) were obtained with 5 t FYM/ha + 40 kg P₂O₅/ha + dual inoculation with PSB + VAM followed by 5 t FYM/ha + 30 kg P₂O₅/ha + dual inoculation with PSB + VAM.

Key words: FYM, Net returns, Nutrient uptake, Phosphorus, PSB, Urdbean, VAM

Urdbean (*Phaseolus mungo* L.) is important pulse crop of India. It is cultivated mostly on marginal lands in mono/mixed cropping system without any fertilizers under rainfed conditions of southern Rajasthan. Its productivity is very low as compared to yield potential. This wide gap is minimized through the use of adequate and balanced fertilization. Phosphorus is an important mineral element for grain legumes as it helps in root development, participates in synthesis of phosphate and phosphoproteins and takes part in energy fixing and releasing process in plants. Significant response of legumes to phosphate nutrition has been reported by several workers (Namdev and Gupta 1999, Singh and Yadav 2008). Most of the applied P gets fixed and only 10-18% is utilized by the current crop (Subehia and Sharma 2002). Addition of FYM to these soils not only supplies the additional nutrients to the growing plants but also affects the availability of native nutrients from soil and chemical fertilizers due to release of organic acids and other microbial products during the decomposition (Stevenson 1967). Production of organic acids during decomposition of FYM lowers the pH due to which stable complexes with cations like Ca²⁺, Mg²⁺, Fe²⁺ and Al³⁺ of greater stability and releases water soluble phosphates. Due to this chelating effect, the organic acid solubilizes more P than inorganic acids at the same pH (Pattanayak *et al.* 2009).

Besides, FYM also maintains a congenial hydro-thermal regime for optimum crop production. Biofertilizers enhance soil fertility and crop yield by solubilizing unavailable sources of elemental nitrogen and bound phosphate into available forms in order to facilitate the plant to absorb them. Inoculants of efficient phosphate solubilizing bacteria (PSB) and vesicular arbuscular mycorrhiza (VAM) which have established their capability in augmenting the productivity of pulses may fulfil the P needs considerably. Inoculation of phosphorus solubilizing micro-organism with legume crops has been found to substitute around 20 per cent P requirement by P solubilization (Singh *et al.* 1998). It is well known that vesicular arbuscular mycorrhizal (VAM) fungi improve plant growth through increased availability of phosphorus by remobilization of fixed phosphate under low fertility conditions (Taraftar and Rao 2001). Their activity was better reflected under FYM application (Qureshi *et al.* 2005; Pattanayak *et al.* 2009). Thus, the present study was undertaken to study the effect of FYM, phosphorus and biofertilizers on yield and nutrient uptake (N, P and K) by urdbean under rainfed conditions of southern Rajasthan.

MATERIALS AND METHODS

The experiment was conducted during *kharif* season of 2003-04 and 2004-05 at the instructional research farm of Rajasthan college of Agriculture, Udaipur. The experimental soil was clay loam in texture with pH 7.8 and EC₂ 1.18 (dSm⁻¹) containing 0.76 per cent organic carbon, 268.4 kg available N/ha, 19.5 kg available P₂O₅/ha and 370.8 kg available K₂O/ha. The phosphorus fixing capacity of these soils is very high (15.6 cmol/kg of soil). The experiment was laid out at the same site during both the years in split plot design keeping FYM levels (0 and 5 t/ha) and phosphorus levels (0, 20, 30 and 40 kg P₂O₅/ha) in main plot and biofertilizers (untreated control, PSB, VAM and PSB + VAM) in sub-plots. The treatments were replicated three times. The FYM was incorporated 20 days before sowing in the soil as per treatment. The recommended dose of N (20 kg/ha) and phosphorus as per treatments were applied as basal. Nitrogen and phosphorus were given through urea and diammonium phosphate. The seeds of urdbean were inoculated with PSB (*phosphorus megatherium* var. *phosphacticum*) before sowing and VAM (*Glomus*

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fasciculatum) was drilled below seed just before sowing as per treatments. Sowing of urdbean was done on July 5, 2003 and July 6, 2004. The total rainfall received during the cropping season was 465.7 mm and 569.6 mm in 2003 and 2004, respectively. The available phosphorus of soil after harvest of crop under all treatments varied from 18.40 to 23.86 kg P₂O₅/ha in the first year and 20.29 to 24.55 kg P₂O₅/ha in the second year of study. N, P and K contents in seed and stover were analysed as per standard methods and their uptakes was calculated by multiplying their contents and respective yield.

RESULTS AND DISCUSSION

Effect of FYM: Perusal of data (Table 1 and 2) revealed that

the application FYM @ 5 t/ha increased the seed and stover yield and uptake of N, P and K by urdbean and could be attributed to the release of macro and micro nutrients during the course of microbial decomposition (Singh and Ram 1982). The increase in uptake of N, P and K due to application of organic matter could be attributed to higher availability of these nutrients and increased utilization of native P (Shrikanth *et al.* 2000).

Effect of Phosphorus: Application of phosphorus upto 40 kg/ha increased the seed and stover yield and uptake of N, P and K by urdbean (Table 1 and 2). Application of phosphorus improved the nutrient availability in soil, resulting into greater uptake which might have increased the photosynthesis and

Table 1. Effect of FYM, phosphorus levels and biofertilizers on yield of urdbean (pooled over two years)

Treatments	No FYM					5 t FYM/ha				
	Phosphorus levels (kg P ₂ O ₅ /ha)					Phosphorus levels (kg P ₂ O ₅ /ha)				
	0	20	30	40	Mean	0	20	30	40	Mean
	<i>Seed yield (q/ha)</i>									
Control	7.10	7.68	8.08	8.85	7.93	8.31	9.29	10.25	10.58	9.61
PSB	7.32	7.93	8.34	9.13	8.18	8.91	9.96	10.99	11.35	10.31
VAM	7.42	8.03	8.45	9.25	8.29	9.16	10.23	11.29	11.66	10.59
PSB + VAM	7.86	8.50	9.10	9.80	8.78	9.64	10.78	11.88	12.26	11.15
Mean	7.43	8.04	8.46	9.26	8.30	9.01	10.07	11.11	11.47	10.41
	<i>Stover yield (q/ha)</i>									
Control	13.23	14.54	15.39	17.14	15.01	15.46	17.61	19.51	20.14	18.18
PSB	13.64	14.99	15.86	17.67	15.47	16.60	18.91	20.95	21.63	19.52
VAM	13.83	15.20	16.09	17.92	15.69	17.04	19.41	21.50	22.20	20.04
PSB + VAM	14.68	16.13	17.07	19.01	16.65	17.98	20.48	22.68	23.42	21.14
Mean	13.85	15.22	16.11	17.94	15.71	16.77	19.10	21.16	21.85	19.72
CD (P=0.05)	<i>FYM</i>	<i>P</i>	<i>BF</i>		<i>FYM x P</i>		<i>FYM x BF</i>		<i>P x BF</i>	
Seed yield	0.138	0.195	0.179		0.276		0.253		0.358	
Stover yield	0.264	0.374	0.343		0.529		0.485		0.686	

Table 2. Effect of FYM and phosphorus levels and biofertilizers on N, P and k uptake by urdbean (Pooled over two years)

Treatment	No FYM					5 t FYM/ha				
	Phosphorus level (kg/ha)					Phosphorus level (kg/ha)				
	0	20	30	40	Mean	0	20	30	40	Mean
	<i>N uptake (Kg/ha)</i>									
Control	43.80	49.79	51.66	58.95	50.80	53.49	60.82	69.93	74.05	64.58
PSB	46.92	52.27	55.35	61.16	54.43	58.75	66.81	76.81	81.34	70.93
VAM	46.76	52.09	55.16	62.94	54.24	61.14	69.52	79.93	84.64	73.81
PSB + VAM	52.06	58.00	61.41	70.08	60.39	65.91	74.94	86.16	91.24	79.57
Mean	47.39	52.79	55.90	63.79	54.97	59.68	67.86	78.02	82.62	72.05
	<i>P uptake (kg/ha)</i>									
Control	3.82	4.54	4.88	5.72	4.74	4.88	5.93	6.66	7.22	6.17
PSB	4.33	5.14	5.53	6.48	5.37	5.75	6.99	7.85	8.50	7.27
VAM	4.48	5.32	5.72	6.71	5.56	5.94	7.22	8.11	8.79	7.51
PSB + VAM	4.87	5.78	6.22	7.29	6.04	6.54	7.95	8.93	9.67	8.27
Mean	4.38	5.20	5.59	6.55	5.43	5.77	7.02	7.88	8.54	7.30
	<i>K uptake (kg/ha)</i>									
Control	19.13	20.40	21.76	24.00	21.32	21.25	25.45	28.33	29.44	26.11
PSB	20.22	21.57	23.00	25.37	22.54	23.17	27.75	30.89	32.10	28.48
VAM	20.26	21.61	23.04	25.41	22.58	23.76	28.46	31.69	32.93	29.20
PSB + VAM	21.56	23.00	24.52	27.04	24.03	25.52	30.56	34.03	35.36	31.36
Mean	20.22	21.57	23.00	25.37	22.54	23.42	28.05	31.23	32.45	28.78
CD (P=0.05)	<i>FYM</i>	<i>P</i>	<i>BF</i>		<i>FYM x P</i>		<i>FYM x BF</i>		<i>P x BF</i>	
N uptake	1.01	1.42	1.41		2.01		2.00		2.83	
P uptake	0.11	0.15	0.15		0.21		0.22		0.31	
K uptake	0.54	0.77	0.64		0.21		0.90		1.27	

Table 3. Effect of FYM, phosphorus levels and biofertilizers on monetary returns and B : C ratio of urdbean (mean of two years)

Treatments	No FYM				5 t FYM/ha			
	Phosphorus levels (kg P ₂ O ₅ /ha)				Phosphorus levels (kg P ₂ O ₅ /ha)			
	0	20	30	40	0	20	30	40
	<i>Net returns (Rs/ha)</i>							
No inoculation (control)	16668.6	18922.0	18817.7	19565.1	18784.8	22228.4	24222.9	24896.7
PSB	16956.0	18534.8	19565.0	21964.5	20198.3	24515.2	26706.3	27501.3
VAM	16924.9	18560.1	19900.2	22484.3	21303.7	25376.4	27250.7	27940.1
PSB + VAM	18086.9	19176.5	21554.6	25332.6	23272.1	23698.1	30105.3	31835.3
	<i>B : C ratio</i>							
No inoculation (control)	2.72	2.93	2.84	2.89	2.54	2.88	3.08	3.10
PSB	2.75	2.86	2.95	3.23	2.73	3.17	3.38	3.42
VAM	2.70	2.81	2.94	3.25	2.83	3.23	3.40	3.42
PSB + VAM	2.87	2.90	3.18	3.65	3.08	3.01	3.75	3.88

translocation of assimilates to different parts of plants. In later stages, more assimilates are diverted to storage compounds resulting into increased seed yield. Yadav and Jakhar (2001) and Singh and Pareek (2003) also found significant effect of phosphorus on yield and N, P and K contents in grain of mungbean.

Effect of Biofertilizers: Seed inoculation with biofertilizers proved superior to untreated control with respect to yield and nutrients uptake (Table 1 and 2). Dual inoculation with PSB and VAM recorded highest values of all these parameters studied and proved its superiority to untreated control, PSB or VAM alone. PSB and VAM solubilizes native phosphorus bringing more phosphorus to soil solution. Thus, dual inoculation of PSB and VAM improved N (282.60 to 293.42 kg/ha), P (19.89 to 23.27 kg P₂O₅/ha) and K (344.40 to 352.61 kg K₂O/ha) status of soil and ultimately increased N, P and K uptake which enhanced growth and yield of crop. Similar results were also reported by Singh and Pareek (2003).

Interaction effect: Interaction effect of FYM and phosphorus on yield and nutrient uptake was found significant (Table 1 and 2). In general, combined effect of 5 t/ha FYM and 40 kg P₂O₅/ha gave higher seed and stover yield and values of N, P and K uptake by urdbean and this combination was found significantly superior over other combinations. It may be due to sufficient supply of nutrients by applied FYM and P fertilizers (Rao *et al.* 1987). The results clearly indicated that legume cropping helped to increase the available nitrogen. This might be attributed to nitrogen fixation by legume crop (Rao 2003). Incorporation of FYM along with inorganic P increased the availability of P and this was attributed to reduction in fixation of water soluble P, increased mineralization of organic P due to microbial action and enhanced availability of P (Varalakshmi *et al.* 2005).

In general, combined effect of 5 t FYM/ha + dual inoculation of PSB + VAM and 40 kg P₂O₅/ha + dual inoculation of PSB + VAM gave higher seed and stover yield as well as uptake of N, P and K by urdbean and these combinations were found significantly superior over other combinations. It might be attributed to the response of urdbean to the effect of

nutrient management on account of balanced supply of inorganic P fertilizers, FYM and biofertilizers. These results are in line with the findings of Anil Kumar *et al.* (2003) and Singh and Yadav (2008).

Economics: The maximum net returns (Rs. 31835.3/ha) was recorded with 5 t FYM/ha + 40 kg P₂O₅/ha + dual inoculation of PSB + VAM combination followed by 5 t FYM/ha + 30 kg P₂O₅/ha + dual inoculation of PSB + VAM (Rs. 30105.3/ha) with B:C ratio of 3.88 and 3.75, respectively (Table 3).

This study indicated that application of FYM @ 5 t/ha + 40 kg P₂O₅/ha along with dual inoculation of PSB + VAM was not only improved the productivity of urdbean but also gave maximum monetary benefits.

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