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Influence of biofertilizers and inorganic sources of nutrients on seed yield and yield components of rice bean (*Vigna umbellata* L.)

J. S. ARUN KUMAR AND N. MURTHY

University of Agricultural Sciences, GKVK, Bengaluru – 560 065, India

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ABSTRACT

A Field experiment was conducted to assess the impact of biofertilizers Rhizobium and Phosphorus Solubilizing Bacteria (PSB) in combination with inorganic sources of nutrients, on growth and yield of Rice Bean (Vigna umbellate L.). The results shows that application 100 % Recommended Dose of Fertilizers (RDF) in combination with Rhizobium and PSB increased the plant height, number of clusters plant^{-1}, number of pods plant^{-1}, hundred seed weight and seed yield significantly as compared to recommended dose of fertilizers applied through chemical fertilizers. It was on par with 75 % RDF + Rhizobium + PSB without significant effect on seed yield. Integrated use of inorganic fertilizers and the best combination of biofertilizers (Rhizobium and Phosphorus Solubilizing Bacteria) reduces the use of inorganic fertilizers to 75 per cent without affecting the yield of Rice Bean.

Keywords **:** Biofertilizers, inorganic PSB, rice bean, rhizobium

Continuous use of only chemical fertilizer in intensive cropping system is leading to imbalance of nutrients in soil, which has an adverse effect on soil health and also on crop yields. Furthermore, it is estimated that currently the consumption of chemical fertilizers in the country exceeds the production. Moreover, due to decontrol and escalation of the prices of phosphate (P) and potassium (K) fertilizers, the farmers are using much less than the optimum levels of these two nutrients (currently the N:P:K: ratio is 9.5:3.2:1 against earlier ratio of 5.4:2.4:1). Use of inorganic fertilizer alone is injurious to soil health and soil productivity. Use of organic and bio-fertilizers enhances crop production and sustain soil heath (Akbari *et al*., 2011).The use of these sub-optimal doses of nutrients by the farmers has also led to severe depletion of nutrient reserves of the soil resulting in multiple nutrient deficiencies. These factors together suggest a need for reduced consumption of chemical fertilizers and increase use of organic manure, crop residues and biofertilizers. On the other hand, continuous use of organics helps to build up soil humus and beneficial microbes besides improving the soil physical properties. Bio-fertilizer acts as complimentary and supplementary source of plant nutrients. Application of organic manure along with *Azospirillum* enhances N fixation to the tune of 10-20 kg ha^{-1}year^{-1} (Shroff, 1990). Nutrient management is the key technology in maintaining and sustaining the production potential. Therefore, a substitution and/or supplementation of major nutrients with a considerable proportion from organic manures and biofertilizers for sustaining higher yield, is of urgent necessity.

Rice bean is one of the potential crops, its benefits have not been harnessed to fuller extent. In the recent past its cultivation is gradually extending in many parts of India. Rice bean, a nonconventional grain legume, has high production potential. In India, its cultivation is confined to a limited area. Its production can be increased to a greater extent by using balanced nutrient application. Beneficial effects due to presence of some microorganisms make the soils a living and active system thereby leading to enhanced productivity of crops. These microbes play a significant role in the life cycle of plants through number of processes such as decomposition, solubilization, fixation and supply of plant nutrients. In view of the above facts, the present study was planned to find out the effect of combined use of chemical and biofertilizers on the growth and yield of Rice Bean.

MATERIALS AND METHODS

The field experiment was conducted at Main Research Station, University of Agricultural Sciences, Hebbal, Bengaluru, for two consecutive *kharif* seasons during the years 2010 and 2011. The experimental site is situated at an altitude of 12^0 58' North, longitude of 77^0 35' East and altitude of 899 meters above mean sea level. The normal annual rainfall is 862.95mm. The soil type is sandy loam with a pH of 6.55, Electrical Conductivity of 0.26 dS m^{-1}, organic carbon 0.62% available N-236, P_2O_5-27.2 and K-176.2 kg ha^{-1}. The experiment was laid out in Randomized Block Design with 12 treatments replicated thrice. Among the treatments, Control (No fertilizer), RDF (N:P:K 60:40:40 kg ha^{-1}), Phosphorus Solubilizing Bacteria (PSB), Rhizobium culture, 50% P + 100% N + PSB, 50% N+100% P + Rhizobium, 100% RDF+ PSB, 100% RDF + Rhizobium, PSB + Rhizobium, 50% RDF + PSB + Rhizobium, 75% RDF + PSB + Rhizobium, 100% RDF + PSB + Rhizobium. The experiment was laid out in

Email: arungowda63@gmail.com

Randomized Block Design with three replications with plot size of 4.0 x 3.0 m. Rice bean variety RBL-50 with seed rate of 15 kg ha^{-1} was sown in the rows spacing of 30 cm. Five plants were randomly selected for recording growth parameters observations.

RESULTS AND DISCUSSION

Plant Height

Application of 100 % RDF along with Rhizobium + PSB recorded significantly increased plant height (40.23 cm) over control (27.17 cm) and RDF alone (33.98 cm), it was at par with application of 75 % RDF + Rhizobium + PSB (35.93 cm), 100 % RDF + Rhizobium (36.62 cm) and 100 % RDF + PSB (35.37 cm) (Table 1). This emphasized that at least 25 per cent economy on fertilizer use could be affected through conjunctive use of biofertilizers along with 75 per cent recommended level of fertilizer nutrients. Similar work on the influence of biofertilizers on different crops has been reported by (Shroff *et al.,* 1995 and Patel *et al.,* 1998). The positive response of inorganic fertilizer on the growth parameters was attributed due to supply of adequate nutrients which increase the vegetative growth and subsequently increased the growth parameters through cell division, cell elongation and cell expansion. Similar results were also reported by (Ali and Ishtiaq, 2003).

Table 1: Plant height as influenced by biofertilizers and inorganic fertilizers in rice bean pooled data of two years.

Sl. No.	Treatments	Plant height (cm)		
		1st yr.	2nd yr.	Pooled
T_1	Control (No fertilizer)	27.73	26.60	27.17
T_2	RDF	33.77	34.20	33.98
T_3	PSB	29.40	27.30	28.35
T_4	Rhizobium culture	30.83	30.10	30.47
T_5	50% P + 100% N + PSB	31.57	33.90	32.73
T_6	50% N+100% P + Rhizobium	30.17	34.70	32.43
T_7	100% RDF+ PSB	34.53	36.20	35.37
T_8	100% RDF + Rhizobium	35.10	38.13	36.62
T_9	PSB + Rhizobium	28.60	32.53	30.57
T_{10}	50% RDF + PSB + Rhizobium	32.57	35.13	33.85
T_{11}	75% RDF + PSB + Rhizobium	33.27	38.60	35.93
T_{12}	100% RDF + PSB + Rhizobium	39.30	41.17	40.23
	SEm(±)	**1.4**	**2.1**	**2.00**
	LSD(0.05)	**4.1**	**6.1**	**5.70**
	CV(%)	**7.5**	**10.6**	**10.46**

Yield parameters

As the yield contributing characters reveled that, the application of 100 % RDF + Rhizobium + PSB, increased the number of clusters plant^{-1} (11.02) over control (5.38) and RDF (8.30), more number of pods plant^{-1} (34.60) was found in 100 % RDF + Rhizobium + PSB compared to control (15.43) and PSB alone (19.40) and higher hundred seed weight (8.03 g) was found in 100 % RDF + Rhizobium + PSB compared to control (5.16) and PSB alone (5.67) (Table 2). This may be due to the fact that Rhizobium inoculation is very effective in harnessing atmospheric nitrogen for improving nitrogen status of the soil. It was clear from the results that the application of inorganic fertilizers along with biofertilizers significantly improved the yield attributing characters like clusters per plant, number of pods per plant and hundred seed weight over the control. Increase in yield attributing characters might be due to the fact that Rhizobium inoculation increased root nodulation through better root development and more nutrient availability resulting in vigorous plant growth and dry matter production which resulting in better flowering, fruiting and pod formation (Sardana *et al.,* 2006). Also due to better availability of nutrients at critical growth stages of crop which facilitated improved growth, yield attributes and further translocation of nutrients which ultimately affect pod formation associated with increased pods per plant and hundred seed weight this result is also in conformity with those of (Rakesh and Verma, 2011, Ashwani and Pandita, 2015).

Seed yield

The maximum seed yield (1564.1 kg ha^{-1}) was obtained with the application of 100 % RDF + Rhizobium + PSB, it was found at par with application of 100 % RDF + Rhizobium (1324.8 kg ha^{-1}) over the control (695.0 kg ha^{-1}) and PSB alone (871.8 kg ha^{-1}) (Table 3). The higher seed yield was obtained due to application of Rhizobium with PSB over control by Solubilizing the unavailable phosphorus nutrients to the plants favorably increased the yield and its contributing characters. The results are in conformity with the findings of (Dubey and Shrivastava, 1991. Rajput *et al.,* 2009), in French bean reported that combination of organic and inorganic nutrient sources gave significantly better results than when either was used alone with regard to the growth of cowpea plants. (Senthilkumar and Sivagurunathan, 2012), observed higher number of pods in cowpea by combined inoculation of *Rhizobium*, Phosphobacteria and *Azospirillum*. (Patil *et al*. 2012, Menon *et al*. 2010, Subbarayappa *et al.,* 2009) in cowpea. (Rakesh *et al.,* 2015), reported that application of 50% RDF+50% RDN+PSB produced significantly higher yield attributes, yield, N, P, K uptake by mungbean. It is quite evident from the results that dose of inorganic fertilizers could be reduced to 75 per cent under integrated nutrient management practices of using combination of biofertilizers (Rhizobium + PSB). Similar findings were found with inoculated over uninoculated in field pea (Fozia *et al.,* 2015, Karwasra *et al.,* 2018).

Table 2: Yield parameters as influenced by biofertilizers and inorganic fertilizers in rice bean pooled data of two years.

Sl. No.	Treatments	No. of clusters plant^{-1}			No. of pods plant^{-1}		
		1st yr.	2nd yr.	Pooled	1st yr.	2nd yr.	Pooled
T_1	Control (No fertilizer)	6.27	4.50	5.38	16.93	13.93	15.43
T_2	RDF	10.53	6.20	8.37	29.07	27.43	28.25
T_3	PSB	7.00	4.80	5.90	20.57	18.23	19.40
T_4	Rhizobium culture	7.07	5.10	6.08	20.63	22.83	21.73
T_5	50% P + 100% N + PSB	8.40	6.00	7.20	25.03	25.37	25.20
T_6	50% N+100% P +Rhizobium	9.07	5.83	7.45	25.40	26.20	25.80
T_7	100% RDF+ PSB	10.83	6.50	8.67	29.80	27.10	28.45
T_8	100% RDF + Rhizobium	11.20	6.90	9.05	30.73	30.30	30.52
T_9	PSB + Rhizobium	7.43	5.00	6.22	24.43	22.40	23.42
T_{10}	50% RDF + PSB + Rhizobium	8.30	6.40	7.35	26.67	27.73	27.20
T_{11}	75% RDF + PSB + Rhizobium	9.67	7.20	8.43	28.50	32.41	30.46
T_{12}	100% RDF + PSB + Rhizobium	11.73	10.30	11.02	32.67	36.53	34.60
	SEm(±)	**0.4**	**0.5**	**0.51**	**1.3**	**2.3**	**1.90**
	LSD(0.05)	**1.1**	**1.6**	**1.47**	**3.8**	**6.7**	**5.41**
	CV(%)	**7.0**	**13.0**	**11.83**	**8.7**	**12.4**	**12.72**

Table 3: Hundred seed weight and seed yield as influenced by biofertilizers and inorganic fertilizers in rice bean pooled data of two years.

Sl. No.	Treatments	100 Seed weight (g)			Seed yield (kg ha^{-1})		
		1st yr.	2nd yr.	Pooled	1st yr.	2nd yr.	Pooled
T_1	Control (No fertilizer)	5.80	4.52	5.16	850.0	540.0	695.0
T_2	RDF	6.37	5.71	6.04	1467.0	940.0	1203.5
T_3	PSB	5.67	4.90	5.28	1149.6	594.0	871.8
T_4	Rhizobium culture	5.83	5.23	5.53	1132.6	740.0	936.3
T_5	50% P + 100% N + PSB	5.93	5.49	5.71	1283.6	921.0	1102.3
T_6	50% N+100% P +Rhizobium	5.77	5.40	5.58	1350.3	898.0	1124.1
T_7	100% RDF+ PSB	7.83	5.92	6.88	1600.0	995.0	1297.5
T_8	100% RDF + Rhizobium	8.80	6.03	7.42	1599.6	1050.0	1324.8
T_9	PSB + Rhizobium	5.87	5.13	5.50	1249.6	748.0	998.8
T_{10}	50% RDF + PSB + Rhizobium	6.03	5.73	5.88	1384.0	950.0	1167.0
T_{11}	75% RDF + PSB + Rhizobium	6.40	6.11	6.26	1417.0	1125.0	1271.0
T_{12}	100% RDF + PSB + Rhizobium	9.67	6.40	8.03	1733.3	1395.0	1564.1
	SEm(±)	**0.3**	**0.4**	**0.349**	**30.0**	**95.7**	**86.3**
	LSD(0.05)	**0.9**	**1.1**	**0.996**	**87.9**	**280.6**	**245.6**
	CV(%)	**7.8**	**12.1**	**9.925**	**3.8**	**11.2**	**13.2**

From the above results, it clearly shows that the use of inorganic fertilizers can be reduced to 75 per cent without significant effect on seed yield. Integrated use of inorganic fertilizers and the best combination of biofertilizers gave higher seed yield as compare to the control and 100% RDF. It is concluded that combined use of biofertilizers (Rhizobium and Phosphorus Solubilizing Bacteria) and chemical fertilizers increased production of Rice Bean.

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