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Influence of bio-fertilisers and fertility levels on growth and quality of vegetable cowpea (*Vigna unguiculata* (L.) Walp.)

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Abstract

The experiment was conducted at Horticulture farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during *kharif*,
2011 to study influence of bio-fertilisers and fertility levels on growth and quality attributes of cow pea (*Vigna unguiculata* (L.) Walp.) Results indicated that application of 75 % RDF (15 kg N and 30 kg P_2O_5 ha^{-1}) and Seed inoculation with PSB + *Rhizobium* significantly increased the growth and quality attributes. Whereas, PSB alone and dual inoculation with PSB + *Rhizobium* proved superior to *Rhizobium* alone and without inoculation, with respect to phosphorus concentration in green pod, however, *Rhizobium* alone and PSB + *Rhizobium* proved superior to PSB and without inoculation with respect to nitrogen concentration and protein content in green pod.

Keywords : Bio-fertilisers, Vegetable cowpea, Semi-arid regions, PSB, *Rhizobium*, Nitrogen, Phosphorus

Introduction

Vegetable cowpea [*Vigna unguiculata* (L.) Walp.], is an annual legume and has great importance because of its short crop duration, high yielding and quick growing nature. Green tender pods contain moisture (84.6%), protein (4.3%), carbohydrate (8.0%), fats (0.2%) and rich source of calcium, phosphorus, iron, etc. (Aykroyd, 1963). Vegetable cowpea is highly responsive to fertilizer application and application of higher dose of nitrogen may reduce nodule number and growth and thus adversely affects the nitrogen fixation capacity (Singh and Nair, 1995). Use of bio-fertilisers can have a great role in increasing fertilizer use efficiency. The inoculation of seeds with suitable *Rhizobium* culture increased the green pod yield over un- inoculated (Vaisya *et al.,* 1983). The inoculation with phosphate solubilizing bacteria may increase yield of crops by 10-30 per cent by increasing availability of phosphorus to plants (Tilak and Annapurna, 1993). Therefore, there may be a substantial saving of applied nitrogen and phosphorus when seeds are inoculated with *Rhizobium* and phosphate solubilizing bacteria inoculants. Hence experiment was conducted to find out the influence of bio-fertilisers and fertility levels on growth and quality attributes of vegetable cowpea (*Vigna unguiculata* (L.) Walp.) under semi-arid conditions.

Materials and Methods

The experiment was conducted during 2011 at Horticulture farm, S.K.N. College of Agriculture, Jobner (Jaipur) during *kharif* season. The soil of experimental field was alkaline loamy sand in texture at *p*H 8.1, poor in organic carbon (0.135 %), available N (134.70 kg/ha), P (16.85 kg/ha), K (151.65 kg/ha) and Zn (0.42 mg/kg soil). The experiment was laid out in randomized block design (RBD) and comprised of 16 treatment combinations consisting four fertility levels (Control, 50%, 75% and 100% of RDF (Recommended Dosage of Fertilisers)) and four bio-fertiliser (Control, *Rhizobium*, PSB (Phosphorus Solubilising Bacteria) and PSB + *Rhizobium*). Randomization of the treatments was done with the help of random number table as advocated by Fisher (1950). The plot size was 3.0 x 2.7 m^2 with 30 cm × 15 cm spacing between rows and plants accommodating 180 plants per plot. Phosphorus and nitrogen were applied in form of Diammonium phosphate (DAP) containing 46% P_2O_5 and 18% N and urea containing 46% N as basal dose at sowing as per treatment requirement. Seeds were inoculated with *Rhizobium*, PSB culture or both as per treatments, by dissolving the culture and dipping the seed

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of the vegetable cowpea in the solution for 10-20 minutes and dried in shade before sowing (Paul *et al*., 1971). Growth attributes like plant stem girth (cm), plant spread (cm), leaf area per plant (cm^2), total and effective root nodules per plant of five tagged plants were counted from each plot and the average of leaves per plant and leaf area were calculated. Total chlorophyll content was estimated with the method as recommended by Arnon (1949). Nitrogen content was estimated by wet digestion of pod samples with H_2SO_4 and H_2O_2 and then colorimetric determination was performed after development of yellow colour with Nessler's reagent (Snell and Snell, 1949). Nitrogen content is multiplied with 6.25 factor to calculate crude protein content in pod (A.O.A.C., 1960). Phosphorus content in the pods was determined by 'Vanadomolybdo' phosphoric acid yellow colour method. Digestion of samples was done by tri-acid mixture and the intensity of colour was measured by Spectrophotometer (Jackson, 1973). The 'F-test' and critical difference (CD) calculated to test significance of difference among the treatments, wherever the results were significant.

Results and Discussions

Effect of fertility levels on growth attributes

The results revealed that application of 75% recommended dose of fertilizers (15 kg N and 30 kg P_2O_5/ha) have favourable effect on growth. All the growth parameters *viz*., plant stem girth, plant spread, total chlorophyll content, leaf area per plant and total and effective nodules per plant increased linearly with the corresponding increase in levels of recommended dose of N and P. This increment was statistically significant over control and 50% RDF (Table 1). Probably the increase in auxin supply with increased levels of nitrogen brought about increase in the plant stem girth and plant spread and leaf area per plant. Phosphorus being indispensable mineral nutrient for pulse crops helps in better root growth and development and thereby making them more efficient in biological nitrogen fixation (BNF) (Prasad, 2006). Thus, application of recommended dose of fertilizers (N and P) at optimum level increased the plant stem girth, plant spread, total chlorophyll content, leaf area per plant and total and effective nodules per plant in the present investigation over their lower doses. The observed improvement in overall vegetative growth of the crop with the application of N and P in the investigation is in conformity with those of Patel *et al*. (2007), Rathore *et al*. (2007), Tiwari and Kumar (2009), Choudhary and Yadav (2011), who supported increased total chlorophyll content, leaf area and total and effective nodules per plant.

Effect of fertility levels on quality attributes

Results revealed that increasing levels of N and P significantly increased N and P concentration in green pod (Table 2). This might be due to improved nutritional environment in the rhizosphere as well as in the plant system leading to enhanced translocation of N and P in plant parts. Since the nutrient uptake is a function of its content in crop plant and green pod yield of the crop. The increase in these parameters due to N and P fertilization led to an increased uptake of nutrient in the present study. Significant increase in protein content from 3.40 per cent in control to 4.06 per cent with 75% RDF (15 kg N and 30 kg P_2O_5/ha) (Table 2) have been observed in the present investigation because of increase in N concentration in green pod, which might be the result of increased availability of nitrogen to plants or due to increased activity of nitrate reductase enzyme. These results are in close conformity with the findings of Singh *et al*. (2006) and Pandya and Bhatt (2007).

Effect of bio-fertilisers on growth attributes

A significant increase in plant stem girth, plant spread, total chlorophyll content, leaf area per plant and total number and effective nodules per plant were observed by seed inoculation with *Rhizobium* and PSB alone as well as their combined inoculation, over control (Table 1), due to increased the concentration of an efficient and healthy strain of *Rhizobium* in rhizosphere, which in turn resulted in greater fixation of atmospheric nitrogen in soil for use by the plants and consequently resulting in higher growth. PSB also produces organic acids like gluconic, succinic, lactic, oxalic, citric and a-ketogluconic acid, which render the insoluble phosphate to soluble one and also synthesizes growth promoting substances which support plant growth (Gaind and Gaur, 1991). The results obtained in present investigation are in line with the findings of Mathur (2000), Chattopadhyay and Dutta (2003) and Vikram and Hamzehzarghani (2008), who reported more growth parameters and nodulation in cowpea due to application of phosphorus.

The combined inoculation of PSB + *Rhizobium* proved significantly superior over *Rhizobium*, PSB and no inoculation in terms of growth parameters *viz.*, plant stem girth, plant spread, total chlorophyll content, leaf area per plant and total number and effective nodules per plant (Table 1). PSB + *Rhizobium* might have improved both nitrogen and available phosphorus in rhizosphere as they are symbiotic nitrogen fixers and phosphate solubilizers, respectively. These results are in close conformity with the findings Singh and Pareek (2003).

Effect of bio-fertilisers on quality attributes

Seed inoculation with PSB, *Rhizobium* and PSB + *Rhizobium* significantly enhanced the nitrogen and phosphorus concentration in green pod and protein content in pod over control. Inoculation of seed with PSB + *Rhizobium* proved superior to other treatments (Table 2). The increase in these values due to inoculation of seed with *Rhizobium* was probably due to more nitrogen fixation, resulting in to better utilization of nutrients by plants, which led to more chlorophyll formation and ultimately nitrogen and phosphorus concentration in green pod and protein content in pod. Significant increase in nitrogen and phosphorus concentration of green pod was also observed with PSB inoculation (Table 2). These results corroborate the findings of Tanwar *et al.* (2003), Jain and Trivedi (2005) and Vikram and Hamzehzarghani (2008).

Table 1. Influence of bio-fertilisers and fertility levels on growth attributes of vegetable cowpea (*Vigna unguiculata* (L.) Walp.)

Treatments	Plant stem girth (cm)		Plant spread (cm)		Total chlorophyll content at flowering stage (mg/g)	Leaf area per plant (cm^2)	Number of Nodules per plant	
	30 DAS	At harvest	30 DAS	At harvest			Total	Effective
Fertility levels (N-P)								
Control	1.48	2.10	41.84	59.44	1.73	375.87	19.27	16.30
50% RDF	1.63	2.39	46.82	65.20	2.01	396.13	21.18	18.42
75% RDF	1.94	2.61	50.52	69.81	2.30	418.28	23.60	21.20
100% RDF	2.01	2.72	52.16	73.89	2.34	426.96	24.56	22.21
SEm±	**0.04**	**0.05**	**0.64**	**1.51**	**0.04**	**5.66**	**0.45**	**0.46**
CD (P = 0.05)	**0.12**	**0.15**	**1.85**	**4.35**	**0.12**	**16.35**	**1.30**	**1.32**
Bio-fertilisers								
Control	1.57	2.25	41.53	60.54	1.93	384.16	19.57	16.94
PSB	1.73	2.42	44.78	65.98	2.07	401.13	21.68	19.03
Rhizobium	1.80	2.48	46.01	68.70	2.13	407.49	22.61	19.94
PSB + *Rhizobium*	1.95	2.67	49.81	73.13	2.26	424.45	24.75	22.22
SEm±	**0.04**	**0.05**	**0.64**	**1.51**	**0.04**	**5.66**	**0.45**	**0.46**
CD (P = 0.05)	**0.12**	**0.15**	**1.85**	**4.35**	**0.12**	**16.35**	**1.30**	**1.32**

Table 2. Influence of bio-fertilisers and fertility levels on quality attributes of vegetable cowpea (*Vigna unguiculata* (L.) Walp.)

Treatments	N concentration (%)	P concentration (%)	Protein content (%)	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)
Fertility levels (N-P)					
Control	0.544	0.058	3.402	121.85	15.16
50% RDF	0.599	0.064	3.742	128.25	16.28
75% RDF	0.651	0.072	4.068	136.62	17.53
100% RDF	0.681	0.077	4.254	144.80	18.95
SEm±	**0.014**	**0.002**	**0.093**	**2.66**	**0.39**
CD (P = 0.05)	**0.039**	**0.005**	**0.269**	**7.67**	**1.13**
Bio-fertilisers					
Control	0.576	0.061	3.600	123.80	15.98
PSB	0.591	0.071	3.696	131.68	17.25
Rhizobium	0.636	0.065	3.972	136.38	16.80
PSB + *Rhizobium*	0.672	0.074	4.198	139.66	17.88
SEm±	**0.014**	**0.002**	**0.093**	**2.66**	**0.39**
CD (P = 0.05)	**0.039**	**0.005**	**0.269**	**7.67**	**1.13**

Fig. 1 Influence of bio-fertilisers and fertility levels on quality attributes of vegetable cowpea (*Vigna unguiculata* (L.) Walp.)

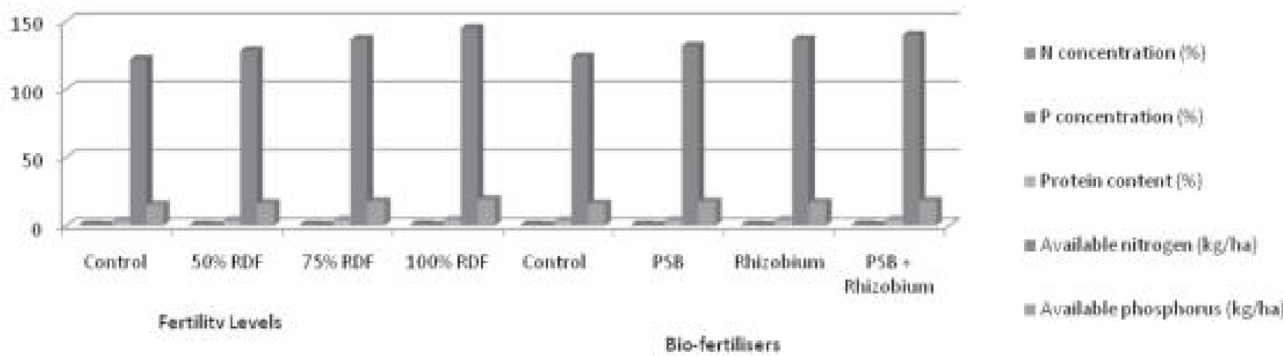
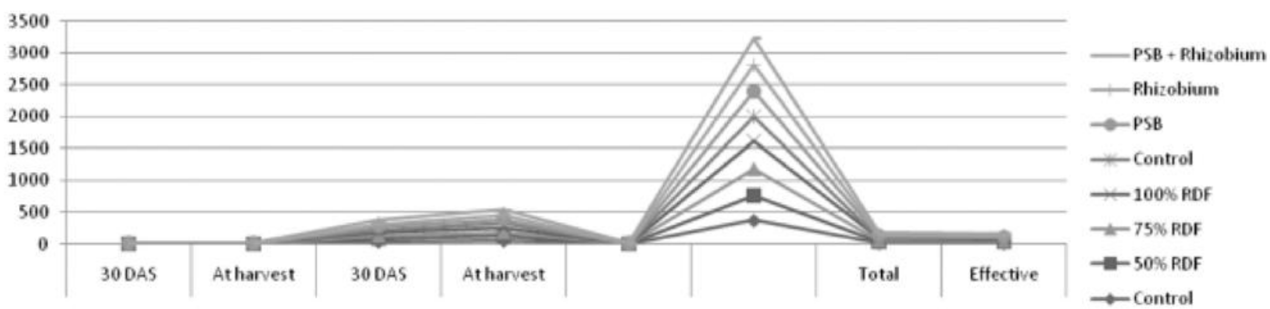


Fig 2. Influence of bio-fertilisers and fertility levels on growth attributes of vegetable cowpea (*Vigna unguiculata* (L.) Walp.)



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