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Effect of Potassium Humate and Bio-Inoculants on Growth and Yield of Cowpea (*Vigna unguiculata* (L.) Walp)

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Abstract A pot experiment was conducted during *kharif* of 2014. The application of potassium humate @ 10mg/kg soil and seed inoculation with *Rhizobium*+VAM+PSB was recorded the maximum growth attributes viz. plant height, no. of branches per plant, no. of total and effective nodules per plant, dry matter accumulation at flowering and at harvesting stage and yield attributes viz. no. of pods per plant, no. of seed per pod and seed, straw and biological yield.

Keywords Potassium humate, Bio-inoculants, Growth, Yield, Cowpea.

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Introduction

Cowpea [*Vigna unguiculata* (L.) Walp] commonly known in India as *lobia* is one of the important *kharif* pulse crop grown for vegetable, grain, forage and green manuring. Cowpea grains contain 25% protein and several vitamins and minerals. It is known as vegetable meat. Green tender pods are used as vegetable, the vegetable cowpea pods contain moisture 84.6%, protein 4.3%, carbohydrate 8.0% and fat 0.2% it is also rich a source of calcium, phosphorus and iron. In India, cowpea was grown over an area of 25.43 m ha with production of 19.27 mt [1]. In Rajasthan, cowpea covers an area of 0.61 lakh ha with a production of 0.33 lakh tonnes [2].

Potassium humate fertilizer is a kind of highly effective organic potash which is utilization of the crop and also promote crop growth, improve crop resistance inverse ability, improves the crop quality, protect agricultural ecological environment. Increasing root growth, root penetration and chlorophyll density, thus aiding in photosynthesis. It is substantially increasing proteins, fibers and sugars which help improve quality and yields [3].

Table 1. Effects of potassium humate and bio-inoculants on growth attributes of cowpea.

Treatments	Plant height (cm)	Number of branches per plant	Number of total nodules	Number of effective nodules	Dry matter accumulation At flowering (g)	At harvest (g)
Potassium humate						
Control (KH_0)	54.69	6.64	16.24	12.02	1.50	2.94
5 mg/kg (KH_1)	62.78	8.08	21.94	17.42	1.86	3.63
10 mg/kg (KH_2)	66.92	8.90	24.76	19.86	2.13	3.97
SEm±	1.32	0.17	0.44	0.35	0.04	0.07
CD (p=0.05)	3.81	0.50	1.27	1.02	0.11	0.21
Bio-inoculants						
Control (B_0)	54.81	6.88	16.46	12.26	1.51	2.92
Rhizobium + VAM (B_1)	63.11	7.95	21.71	16.94	1.86	3.62
Rhizobium + PSB (B_2)	63.19	8.12	22.23	17.22	1.93	3.73
VAM + PSB (B_3)	60.99	7.56	19.65	15.63	1.74	3.36
Rhizobium + VAM + PSB (B_4)	65.21	8.86	24.86	20.11	2.12	3.94
SEm±	1.70	0.22	0.56	0.45	0.05	0.09
CD (p=0.05)	4.92	0.64	1.64	1.31	0.14	0.27

Bio fertilizers are component of integrate nutrient management and are considered to be cost effective, eco-friendly and renewable source of non-bulky, low cost of plant nutrient supplementing fertilizers in sustainable agriculture system in India. Bio fertilizers stimulating plant growth through the synthesis of growth promoting substances and increased crop yield. The *Rhizobium* as fertilizer inpulses could fix 50–200 kg of N/ha/season and is able to meet 80–90% of the crop requirement for nitrogen. Inoculation in these crops was found to increase the crop yield by about 10–15% under on farm conditions [4]. It includes mainly the nitrogen fixing, phosphate solubilizing and plant growth-promoting microorganisms [5].

Materials and Methods

A pot experiment was conducted in cage house and laboratory analysis of plant and soil samples were analyzed in Department of Soil Science and Agricultural Chemistry, SKN College of Agriculture, Jobner (Rajasthan) during *kharif* season of 2014. Jobner is located at 75.28° East longitude, 26.06° North latitude and altitude of 427 meters above mean sea level. This region comes under agro climatic zone III-A (semi-arid eastern plain). The average rainfall of this region is about 400 to 500 mm, which is mistly received between July and September (monsoon season). The loamy sand soil of the field was used for this pot experiment.

Total fifteen treatments were assigned in complementary block design with three replications. These seeds were planted carefully and five plants from each pot are maintained. The data recorded from five plants were subjected to statistical analysis. The differences among various treatments were analyzed through least significant difference test at alpha 0.05.

Results and Discussion

Effect on growth attribute

Table 1 indicates that with the application of potassium humate, there was a significant increase in plant height, number of branches per plant, number of total and effective root nodules, dry matter accumulation at flowering and at harvesting stage of cowpea under (5 mg/kg soil) KH_1 and (10 mg/kg soil) KH_2 treatments as compared to control (KH_0). This may be due to the presence of humic acids and fulvic acids. Moreover, the role of humic acid is supplying essential nutrients like organic matter and minerals for the plant, whereas, the role of fulvic acid is to transport nutrients and

Table 2. Effects of potassium humate and bio-inoculants on yield attributes and yield of cowpea.

Treatments	Number of pods per plant	Number of seed per pod	Test weight (g)	Seed yield (g/pot)	Straw yield (g/pot)	Biological yield (g/pot)
Potassium humate						
Control (KH_0)	8.32	6.61	74.82	3.26	5.18	8.44
5 mg/kg (KH_1)	10.46	8.24	76.14	4.56	6.59	11.15
10 mg/kg (KH_2)	12.36	8.97	76.71	5.10	7.01	12.11
SEm±	0.22	0.16	1.45	0.09	0.13	0.22
CD (p=0.05)	0.63	0.46	NS	0.26	0.37	0.63
Bio-inoculants						
Control (B_0)	8.67	6.82	74.96	3.23	5.19	8.42
Rhizobium + VAM (B_1)	10.42	8.13	76.13	4.46	6.38	10.84
Rhizobium + PSB (B_2)	10.78	8.26	76.21	4.62	6.54	11.16
VAM + PSB (B_3)	9.73	7.64	75.61	4.11	6.07	10.18
Rhizobium + VAM + PSB (B_4)	12.28	8.86	76.54	5.12	7.12	12.24
SEm±	0.28	0.21	1.87	0.12	0.16	0.28
CD (p=0.05)	0.81	0.60	NS	0.34	0.47	0.81

hence improve the growth parameters, earlier workers [6, 7] reported that humic acid influences the growth of sorghum plants. The results find support from the work of earlier reporters [3, 8–11] who also observed an increase in growth parameter with an increase in potassium humate.

Table 1 also revealed that due to inoculation of cowpea seed with *Rhizobium* + VAM, *Rhizobium* + PSB, VAM + PSB and Rhizobium + VAM + PSB, three was a significant increase in plant height, number of branches per plant, number of total and effective root nodules per plant, dry matter accumulation at flowering and at harvesting stage of cowpea in comparison to no inoculation. The increase in number of branches per plant, number of total and effective root nodules per plant, dry matter accumulation at flowering and at harvesting stage with *Rhizobium* + VAM + PSB was also significantly higher over *Rhizobium* + VAM, *Rhizobium* + PSB as well as VAM + PSB inoculations. Inoculation of seed with symbiotic nitrogen fixers might have increased the number of efficient and healthy root nodules, which in turn resulted in greater fixation of atmospheric nitrogen, consequently resulting into higher growth. Andrade et al. [12] and Singh et al. [13] obtained significantly higher total and effective nodules and dry matter accumulation due to *Rhizobium* inoculation over control. Thus, PSB increased the availability of phosphorus in root zone, which in turn resulted in better growth and development of roots as well as shoots and also helped in better nodulation. The results obtained in present investigation are in line with the findings by Basu et al. [14] VAM inoculation significant increase of dry matter accumulation, number of total and effective nodules per plant with VAM were mainly attributed to mobilization of phosphorus to plant which might have helped in easy uptake. Similar results were reported by Rabie and Humiany [15] in cowpea and Pramanik and Bera [16] in chickpea.

Effect on yield attribute

Table 2 indicates that with the application of potassium humate, there was a significant increase in number of pods per plant, number of seeds per pod, seed yield and straw yield per (g/pot) and biological yield of cowpea under KH_1 and KH_2 treatments as compared to control (KH_0). The results corroborate the finding of Several workers [17—20] who also reported that use of potassium humate could increase yield attributes and yield.

It is evident from Table 2 that due to inoculation of cowpea seed with *Rhizobium* + VAM, *Rhizobium* + PSB, VAM + PSB and *Rhizobium* + VAM + PSB;

there was a significant increase in number of pods per plant, number of seeds per pod, seed yield and straw yield (g/pot) of cowpea in comparison to control. The increase in number of pods per plant, number of seed per pod, seed yield and straw yield (g/pot) with *Rhizobium* + VAM + PSB was significantly higher over *Rhizobium* + VAM, *Rhizobium* + PSB as well as VAM + PSB inoculations. However, the increase in number of pods per plant, number of seeds per pod, seed yield and straw yield (g/pot) with inoculation of *Rhizobium* + VAM was statistically at par with that of *Rhizobium* + PSB. The beneficial effects of *Rhizobium* might have increased the availability of nitrogen and ultimately increased the pod yield as well as haulm yield. These finding corroborate the result of Kumawat et al. [21] in cowpea. Inoculation of PSB also significantly enhanced the yield and yield attributes of cowpea. The beneficial effect of phosphate solubilizing bacteria as explained earlier increased the availability of phosphorus, secondary nutrient and helped in improving the yield attributes (number of pods per plant, number of seeds per pod, test weight) finally the grain as well as straw yield. Hussain et al. [22] in blackgram, Rudresh et al. [23] and Balachandran et al. [24] in greengram also reported similar results. VAM inoculation in soil significantly plays an important role in P cycling, mobilization and uptake by plants. The earlier P availability, greater root extension, higher nutrient uptake, higher photosynthesis and balanced portioning are the main factors of significant increase in yield attributes and yield.

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