RESEARCH ARTICLE Legume Research- An International Journal, Volume 45 Issue 2: 227-231 (February 2022)

Influence of Varieties and Integrated Nutrient Management Practices on Growth and Yield of Seed in Cowpea (*Vigna unguiculata* L.)

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10.18805/LR-4475

ABSTRACT

Background: Cowpea is one of the most important leguminous vegetable crops. It has a unique ability of biological nitrogen fixation and mobilization of insoluble soil nutrient and bringing qualitative changes in soil. The basic concept of integrated nutrient management system is to maintain of plant nutrients supply to achieve a good level of crop production by optimizing the benefits from all possible sources of plant nutrients in an integrated manner, appropriate to each farming system. Considering these aspects, a field experiment was conducted to boost up productivity of cowpea seed.

Methods: A field experiment was carried out during *Rabi* season, 2015-16 at Research Field of the Department of Vegetable Science, College of Horticulture, Mandsaur (Madhya Pradesh). The experiment was arranged in factorial randomized block design with twenty treatment combinations comprising four cowpea varieties, *viz*. V_1- Pusa Sukomal, V_2- Kashi Unnati, V_3- Kashi Kanchan and V_4- Kashi Shyamal and five integrated nutrient management (INM) practices, *viz*. N_1-Vermicompost 2.5t + *Rhizobium* (10 g/kg seeds) + PSB (10 g/kg seeds) + N (0 kg) + P_2O_5 (90 kg) + K_2O (70 kg)/ha; N_2 -Vermicompost 2.5 t + *Rhizobium* (10 g/kg seeds) + PSB (10 g/kg seeds) + N (15kg) + P_2O_5 (90kg) + K_2O (70 kg)/ha; N_3 -Vermicompost 2.5t + *Rhizobium* (10 g/kg seeds) + PSB (10 g/kg seeds) + N (20 kg) + P_2O_5 (90 kg) + K_2O (70 kg)/ha; N_4 -Vermicompost 2.5 t + *Rhizobium* (10 g/kg of seeds) +PSB (10 g/kg seeds) + N (25 kg) + P_2O_5 (90 kg) + K_2O (70 kg)/ha and N_5-Vermicompost 2.5 t + *Rhizobium* (10 g/kg seeds) + PSB (10 g/kg seeds) + N (30 kg) + P_2O_5 (90 kg) + K_2O (70 kg)/ha.

Result: In present experiment the cowpea variety V_1-Pusa Sukomal recorded superior performance for growth attributes, yield and yield attributes and quality attributes. This variety had taken minimum days to first flowering, days to 50% flowering and days to harvesting. Among the nutrient levels, application of Vermicompost 2.5 t + *Rhizobium* (10 g/kg seeds) + PSB (10 g/kg seeds) + N (30 kg) + P_2O_5 (90 kg) + K_2O (70 kg)/ha resulted in the highest growth parameters, yield and yield parameters of cowpea seed.

Key words: Biofertilizer, Cowpea, Nitrogen, Seed, Variety, Vermicompost, Yield attributes.

INTRODUCTION

Cowpea (*Vigna unguiculata* L.) is one of the most important leguminous vegetable crops. Leguminous crops play an important role in Indian Agriculture having unique ability of biological nitrogen fixation, deep root system, mobilization of insoluble soil nutrient and bringing qualitative changes in soil. It is originated from Central Africa and mainly cultivated in Asia, Africa, Central and South America. The countries like Bangladesh, China, India and Indonesia are the major cowpea growing countries in Asia. In India it is grown in the states like Rajasthan and adjoining part of Himachal Pradesh have a good acreage (Das *et al.,* 2011).

In India, cowpea is grown widely throughout the year for all forms- tender pods, dry seeds, fodder, green manure and cover crops both as sole and mixed crop. Cowpea fixes atmospheric N up to 240 kg/ha and leaves about 60-70 kg residual N for succeeding crops. Thus, cowpea is one of the most important vegetable crops in organic farming systems as it improves soil fertility even in marginal lands through provision of ground cover, plant residue, nitrogen fixation and suppressing weed and contributes to the sustainability of cropping systems. Besides plant nutrients, the presence of enzymes and hormones in manure make them essential for improvement of soil fertility and productivity. Cowpea requires good quantity of nutrients throughout the growth periods especially P for better development of roots, better nodulation and N-fixation. Moreover, in early stages, plant requires N for better germination, production of more branches and peduncles resulting in greater number of pods, seeds and significantly higher yields (Abayomi *et al.*, 2008).

Nitrogen is an essential constituent of protein and chlorophyll (Meena *et al.,* 2014) and metabolic process of

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How to cite this article: Pardhi, S., Sharma, R.K., Kushwah, S.S. and Gallani, R. (2022). Influence of Varieties and Integrated Nutrient Management Practices on Growth and Yield of Seed in Cowpea (*Vigna unguiculata* L.). Legume Research. 45(2): 227-231. DOI: 10.18805/LR-4475.

Submitted: 08-08-2020 **Accepted:** 10-08-2021 **Online:** 27-08-2021

the plant growth. In addition, N and P have a stimulating effect on root activity and rooting pattern of the crop. Available nitrogenous compound (also through a starter dose) enables seedlings to make a good start even before nitrogen fixation. Phosphorus plays an important role in the plant metabolism and is a constituent of various organic substances. Similarly, potassium has a direct and indirect impact on the plant growth. Using potassium directly causes the reduced transpiration, increasing water absorption or creating internal condition in order to endure the dryness.

Bio-fertilizer promotes fertilizer use efficiency. The seed inoculation with *Rhizobium* increases their number in rhizosphere and enhances microbial activities. When seed of pulses are inoculated with phosphate solubilizing bacteria (PSB) secret acetic substance which acts as solubilizer to unsoluble soil phosphorus (Khandelwal *et al.,* 2012). Vermicompost as an organic compost and substitute for chemical fertilizer is advised by pioneer workers of organic farming. Considering these aspects, a field experiment was conducted to find out growth and yield of seed in cowpea as influenced by varieties and nutrient levels.

MATERIALS AND METHODS

A field experiment was conducted during *Rabi* season, 2015-16 at Research Field of the Department of Vegetable Science, College of Horticulture, Mandsaur (Madhya Pradesh). Soil of the experimental field was light alluvial having sandy loam texture with low (192 kg/ha) nitrogen, medium (19.30 kg/ha) phosphorus, high (694 kg/ha) available potassium, 0.46 dSm^{-1} electrical conductivity and slightly alkaline in reaction (pH 7.5). The experiment was laid out in factorial randomized block design with twenty treatment combinations comprising four cowpea varieties, *viz.* V_1 (Pusa Sukomal), V_2 (Kashi Unnati), V_3 (Kashi Kanchan) and V_4 (Kashi Shyamal) and five integrated nutrient management (INM) practices, *viz.* N_1-Vermicompost 2.5 t + *Rhizobium* (10 g/kg seeds) + PSB (10 g/kg seeds) + P_2O_5 (90 kg) + K_2O (70 kg)/ha; N_2-Vermicompost 2.5 t + *Rhizobium* (10 g/kg seeds) + PSB (10 g/kg seeds) + N (15 kg) + P_2O_5 (90 kg) + K_2O (70 kg)/ha; N_3- Vermicompost 2.5 t + *Rhizobium* (10 g/kg seeds) + PSB (10 g/kg seeds) + N (20 kg) + P_2O_5 (90 kg) + K_2O (70 kg)/ha; N_4- Vermicompost 2.5 t + *Rhizobium* (10 g/kg seeds) +PSB (10 g/kg seeds) + N (25 kg) + P_2O_5 (90 kg) + K_2O (70 kg)/ha and N_5- Vermicompost 2.5 t + *Rhizobium* (10 g/kg seeds) + PSB (10 g/kg seeds) + N (30 kg) + P_2O_5 (90 kg) + K_2O (70 kg)/ha.

The field was ploughed thoroughly to a fine tilth with cultivator. There after field was leveled properly with heavy wooden plank by tractor and plots were prepared. The size of plot was 2.7 m × 2.4 m. The calculated quantities of fertilizers were applied to the each plot with the use of nitrogen (DAP, urea), phosphorus (DAP), potash (MOP). Half dose of nitrogen and full dose of phosphorus and potash were applied as basal dose prior to sowing of cowpea seeds, while the rest of nitrogen was given at 30 days after sowing. Vermicompost was applied as basal at the time of sowing. PSB and 1 strain of *Rhizobium phaseoli* were mixed and applied through seed treatment. Other intercultural operations and crop management practices were carried out in accordance with the recommended package of practices. The pure, healthy, disease and insect free vigorous and good quality cowpea seeds were used for sowing. Seed were treated with Mancozeb 2 g + Carbendazim 1 g per kg seeds. Seeds were sown at a depth of 3-4 cm in lines at a spacing of 45 × 15 cm. Weeding was done thrice manually at 25, 45 and 60 days after sowing. Irrigations were applied as per the requirement of the crop. The crop was sprayed with systemic insecticide at 15 days interval to control jassids, aphids and white flies *etc.* The data obtained on various observations for each treatment were statically analyzed as per the standard procedure.

RESULTS AND DISCUSSION

Growth parameters

There was increase in plant height with advancement of growth period (Table 1). Among varieties, V_1 (Pusa Sukomal) recorded maximum plant height (58.31 cm) followed by V_4 (Kashi Shyamal), V_2 (Kashi Unnati) and V_3 (Kashi Kanchan). The difference in plant height in different varieties of cowpea may be due to their genetic makeup. Bahadur *et al.* (2008) and Ramana *et al.* (2010) bean also reported significant influence of varieties on plant height. Nutrient level N_5 has registered maximum plant height (55.54 cm) followed by N_4. The minimum plant height (47.56 cm) was observed in case of nutrient level N_1. Hasan *et al.* (2010) and Jadhav *et al.* (2011) also obtained similar results in plant height due to increasing N fertilizer in cowpea.

The number of leaves and leaf area per plant was influenced significantly due to different treatments of varieties and nutrient levels (Table 1). Among the varieties, maximum number of leaves per plant (38.46) and leaf area per plant (2440.09 cm^2) was observed in variety V_1- (Pusa Sukomal), followed by variety V_4 (Kashi Shyamal) and V_2 (Kashi Unnati). Minimum number of leaves per plant (31.19) and leaf area per plant (2034.59 cm^2) was observed with variety V_3 (Kashi Kanchan). The plants of various varieties responded differently to environmental factors based on their genetic makeup and their adaption capability. These findings are in agreement with the finding of Alhaji (2008) and Agbogidi and Egho (2012). Significantly highest number of leaves (38.30) and leaf area per plant (2452.48 cm^2) were reported under nutrient level N_5 followed by N_4 (Table 1). Lower number of leaves (31.69) and leaf area per plant (1991.89 cm^2) were reported under nutrient level N_1. The additional supply of nitrogen by nitrogen fixing bacteria appeared to have increased the number of leaves and thereby, greater supply of food materials through increased photosynthesis, which ultimately gave significant increase in yield parameters (Jadhav *et al.,* 2011). These findings are in agreement with finding of Abdelhamid *et al.* (2011).

More branching (10.00) in cowpea were observed by variety V_1 (Pusa Sukomal) followed by V_4. Cultivar V_3 (Kashi Kanchan) recorded minimum number of branches per plant (8.01). These findings corroborates with those of Imran *et al.* (2012) and Babaji *et al.* (2011). Nutrient levels had exerted significant effect on number of branches per plant during all the growth stages. Highest number of branches per plant (10.58) was observed with nutrient level N_5. These findings are in agreement with Satodiya *et al.* (2015) and Hasan *et al.* (2010).

Average fresh and dry weight of plant was significantly affected with varieties and nutrient levels (Table 1). Maximum fresh weight (117.23 g) and dry weight of plant (32.02 g) was recorded in variety V_1 (Pusa Sukomal) followed by variety V_4 (Kashi Shyamal). Variety V_3 (Kashi Kanchan) has registered minimum fresh weight (98.24 g) and dry weight of plant (26.21 g). Higher plant height, number of leaves and number of branches might have resulted in more photosynthesis and accumulation of food material in variety V_1 (Pusa Sukomal) resulting in higher fresh weight and dry weight. Similar findings have been reported by Ramana *et al.* (2010). Nutrient levels indicated significant effect on fresh weight and dry weight of plant. Maximum fresh weight (118.80 g) and dry weight of plant (32.98 g) was observed with nutrient level N_5 at all the growth stages, followed by N_4, N_3 and N_2 in descending order. Minimum fresh weight and dry weight of plant was found under N_1 at all the stages of crop growth. These results are in conformity with the findings of Kumar *et al.* (2009).

Table 1: Effect of varieties and nutrient levels on growth parameters of cowpea.

Treatment	Plant height (cm)	No. of leaves /plant	Number of branches /plant	Leaf area per plant (cm^2)	Fresh weight of plant (g)	Dry weight of plant (g)
Varieties						
V_1 (Pusa Sukomal)	58.31	38.46	10.00	2440.09	117.23	32.02
V_2 (Kashi Unnati)	46.26	33.38	8.47	2148.95	102.88	27.26
V_3 (Kashi Kanchan)	45.25	31.19	8.01	2034.59	98.24	26.21
V_4 (Kashi Shyamal)	54.45	35.38	8.86	2277.92	109.18	29.39
S.Em±	1.25	1.02	0.39	44.46	2.76	0.87
CD (P<0.05)	3.58	2.93	1.12	127.30	7.91	2.48
Nutrient levels						
N_1	47.56	31.69	7.23	1991.89	97.10	24.44
N_2	49.11	32.95	7.79	2099.71	100.52	26.96
N_3	50.95	34.30	9.02	2249.25	106.57	28.83
N_4	52.18	35.70	9.54	2333.62	111.42	30.40
N_5	55.54	38.38	10.58	2452.48	118.80	32.98
S.Em±	1.12	0.92	0.35	39.77	2.47	0.78
CD (P<0.05)	3.20	2.62	1.004	113.86	7.07	2.22

Table 2: Effect of varieties and nutrient levels on yield attributes and yields of seed in cowpea.

Treatment	Number of pods/plant	Pod length (cm)	Number of seeds/pod	Seed yield (g/plant)	Seed yield (q/ha)	Harvest index (%)
Varieties						
V_1 (Pusa Sukomal)	20.59	32.69	12.81	12.50	18.48	44.58
V_2 (Kashi Unnati)	17.99	35.39	10.49	10.53	15.57	40.77
V_3 (Kashi Kanchan)	15.73	30.21	10.05	10.25	15.12	39.22
V_4 (Kashi Shyamal)	18.79	31.81	11.41	11.09	16.39	41.67
S.Em±	0.51	0.71	0.37	0.45	0.65	1.06
CD (P<0.05)	1.45	2.02	1.05	1.28	1.87	3.05
Nutrient levels						
N_1	15.93	30.63	9.23	9.66	14.31	39.11
N_2	16.97	31.27	10.06	10.49	15.54	40.05
N_3	18.41	31.94	11.06	10.98	16.27	41.57
N_4	19.38	33.30	11.99	11.57	16.92	42.11
N_5	20.69	35.48	13.62	12.76	18.90	44.96
S.Em±	0.45	0.63	0.33	0.40	0.59	0.95
CD (P<0.05)	1.29	1.81	0.94	1.15	1.68	2.72

Yield parameters and yield

Variety V_1 (Pusa Sukomal) recorded maximum number of pods per plant (Table 2) *i.e*. 20.59 followed by varieties V_4 (Kashi Shyamal) and V_2 (Kashi Unnati). Minimum number of pods per plant (15.73) observed with variety V_3 (Kashi Kanchan). Similar results have been reported by Imran *et al.* (2012) and Kwaga (2014). Nutrient levels exhibited significant effect on number of pods per plant in cowpea. Maximum number of pods per plant (20.69) was found with application of nutrient level N_5. It was followed by N_4, N_3 and N_2 in descending order. Minimum number of pods per plant (15.93) was observed with application of nutrient level N_1. This might be due to optimum supply of N in alleviating nutritional deficiency in plants particularly at reproductive phase which resulted in producing more number of pods per plant. These findings are in close conformity with Patel and Jadav (2010) and Khandelwal *et al.* (2012).

Variety V_2 (Kashi Unnati) had longest pod (35.39 cm) followed by V_1 (Pusa Sukomal) and V_4 (Kashi Shyamal). Minimum pod length (30.21 cm) was found in case of variety V_3 (Kashi Kanchan). These findings are in accordance with Babaji *et al.* (2011) and Imran *et al.* (2012). Nutrient level N_5 was registered maximum value of pod length (35.48 cm) followed by N_4. Lowest value of pod length (30.63 cm) was observed in case of nutrient level N_1. Nutrient level N_1 might have not provided sufficient nitrogen that reduced the pod length in cowpea. Similar results have also been reported by Satodiya *et al*. (2015).

Maximum value for number of seeds (12.81) per pod (Table 2) was observed with variety V_1 (Pusa Sukomal). It was followed by varieties V_4 (Kashi Shyamal) and V_2 (Kashi Unnati). Minimum value for number of seeds per pod (10.05) was recorded with variety V_3 (Kashi Kanchan). The results are agreement with Imran *et al.* (2012) and Jakusko *et al*. (2013). Application of nutrient levels caused significant influence on number of seeds per pod (Table 2). Higher levels of nutrient resulted increase in number of seeds per pod. Maximum number of seeds per pod (13.62) was taken with application of nutrient level N_5 which was significantly higher over other nutrient levels. It was followed by N_4, N_3 and N_2 in descending order. Minimum number of seeds per pod (9.23) was recorded under nutrient level N_1. The increased supply of nitrogen and its higher uptake by plant might have stimulated the rate of various physiological processes in plant and led to increase growth and yield (Khandelwal *et al*., 2012). Similar results have been reported by Patel and Jadav (2010), Jadhav *et al.* (2011) and Salehin and Rahman (2012).

Among varieties, V_1 (Pusa Sukomal) was recorded maximum seed yield per plant (12.50 g) and seed yield per hectare (18.48 q), followed by V_4 (Kashi Shyamal) and V_2 (Kashi Unnati). The lowest seed yield per plant (10.25 g) and seed yield per hectare (15.12 q) were observed with variety V_3 (Kashi Kanchan). These results are in agreement with the observation of Alhaji (2008) and Kwaga (2014). Nutrient levels exerted significant influence on seed yield per plant (g) and seed yield per hectare (q). Highest seed yield per plant (12.76 g) and seed yield per hectare (18.90 q) were taken under the nutrient level N_5 followed by N_4. Nutrient level N_5 recorded 32.07% higher yield over N_1. Minimum seed yield per plant (9.66 g) and seed yield per hectare (14.31 q) were observed in case of nutrient level N_1. Higher photosynthetic area, more dry matter accumulation might have resulted in seed yield per plant and seed yield per hectare in variety V_1 (Pusa Sukomal). Similar results have been reported by Abayomi *et al.* (2008), Patel and Jadav (2010) and Jadhav *et al.* (2011).

Among the varieties, V_1 (Pusa Sukomal) was found maximum harvest index (44.58%) (Table 2), followed by V_4 (Kashi Shyamal) and V_2 (Kashi Unnati). Minimum harvest index (39.22%) was recorded with variety V_3 (Kashi Kanchan). Similar results have been reported by Uma and Salimath (2006). Nutrient levels exhibited significant effect on harvest index in cowpea. Maximum harvest index (44.96%) was found with application of nutrient level N_5. Minimum harvest index (39.11%) was observed with application of nutrient level N_1. These findings are in agreement with the results obtained by Kumar *et al.* (2009) and Abdelhamid *et al.* (2011).

CONCLUSION

On the basis of present experiment, it may be concluded based on present field investigation that varieties as well as integrated nutrient management practices has significantly influenced on growth, yield and yield parameters of cowpea. Among the varieties, V_1 (Pusa Sukomal) was recorded superior performance for growth attributes, yield and yield attributes over other varietie. Among the nutrient levels N_5 {Vermicompost 2.5 t + *Rhizobium* (10 g/kg seeds) + PSB (10 g/kg seeds) + N (30 kg) + P_2O_5 (90 kg) + K_2O (70 kg)/ ha} resulted in the highest growth parameters, yield and yield parameters of cowpea seed.

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