

Original Research Article

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Effect of Chemical Fertilizer, Organic Manure and Bio-Fertilizer on Growth and Yield of Summer Cowpea (*Vigna unguiculata* L. Walp)

Dhwani Bartwal and R. A. Patel*

Department of Agronomy, B. A. college of Agriculture, Anand Agricultural University,
Anand, Gujarat, India

*Corresponding author

ABSTRACT

Keywords

Cowpea, Castor cake, FYM, Vermicompost, *Rhizobium*, PSB

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A field experiment was conducted during summer season of the year 2018 on loamy sand soil at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand to evaluate the effect of chemical fertilizer, organic manure (Castor cake, Vermicompost and FYM) and bio-fertilizers (*Rhizobium* and PSB) on growth and yield of summer cowpea (*Vigna unguiculata* L. Walp). Significantly higher growth attributes (plant height (cm) and higher number of branches/plant⁻¹) was recorded under application of recommended dose of chemical fertilizer 20-40-00 NPK kg ha⁻¹ and remained at par with application of 4 t FYM along with 5 ml PSB kg⁻¹ seed. Application of recommended dose of chemical fertilizer 20-40-00 NPK kg ha⁻¹ recorded significantly higher yield attributes (numbers of pod plant⁻¹ and numbers of seeds pod⁻¹) and seed and stover yield (kg ha⁻¹) over rest of the treatments. However, it was at par with application of 4 t FYM along with 5 ml PSB kg⁻¹ seed.

Introduction

Pulses are the second most important group of crop after cereals. To heighten the public awareness of nutritional benefits of pulses as a part of sustainable food security and nutrition, year 2016 was declared as “International Year of Pulses” by the United Nation. Pulses accounts for around 20 % of the area under food grains and contribute around 7 to 10 % of total food grain production in the country (Mohanty and Satyasi, 2015). In India pulses are grown in an area of 25.21 million ha with total production of 19.78 million tons with

productivity of 763 kg/ha. While in Gujarat, it is grown over an area of 6.54 million ha with an annual production of 5.99 lakh tons with average productivity of 916 kg/ha in the year 2014-15 (Anonymous, 2016). About a dozens of pulse crops viz., chickpea, pigeon pea, mung bean, urdbean, lentil, field pea, lathyrus, cowpea, common bean, mothbean horse gram and rice bean are generally cultivated under varied agro-ecological conditions. Among them, cowpea (*Vigna unguiculata* L. Walp) has its origin from India and Ethiopia and is widely grown all over the world. Cowpea serves as a dual purpose food at both green shell and dry stage. In the

current context with the advancement in the knowledge, technology and concern about the ecosystem, more emphasis is being given to the alternative sources of nutrients than fertilizers alone for maintaining the sustainability of environment. In view of this liquid biofertilizers and various organics supplements are also being focused along with chemical fertilizers.

Materials and Methods

A field experiment was conducted at College Agronomy Farm, B.A College of Agriculture, Anand Agricultural University, Anand (Gujarat) during summer season of the year 2018. The soil of experimental site was loamy sand in texture, having low in organic carbon and available nitrogen ($124.85 \text{ kg ha}^{-1}$), medium in available P_2O_5 (29.23 kg ha^{-1}) and high in available K_2O ($286.76 \text{ kg ha}^{-1}$). Cowpea variety Gujarat cowpea 4 (GC 4) was used as a test crop in the study. The experiment was arranged in randomized block design with four replications, consisting of twelve treatments T_1 : No fertilizer (control), T_2 : RDF 20-40-00 kg ha^{-1} (NPK), T_3 : Castor cake @ 0.5 t ha^{-1} , T_4 : Vermicompost @ 1 t ha^{-1} , T_5 : FYM @ 4 t ha^{-1} , T_6 : Castor cake @ 0.5 t ha^{-1} + PSB @ 5 mL kg^{-1} seed, T_7 : Vermicompost @ 1 t ha^{-1} + PSB @ 5 mL kg^{-1} seed, T_8 : FYM @ 4 t ha^{-1} + PSB @ 5 mL kg^{-1} seed, T_9 : Rhizobium @ 5 mL kg^{-1} seed + PSB @ 5 mL kg^{-1} seed, T_{10} : Castor cake @ 0.25 t ha^{-1} + Rhizobium @ 5 mL kg^{-1} seed + PSB @ 5 mL kg^{-1} seed, T_{11} : Vermicompost @ 0.5 t ha^{-1} + Rhizobium @ 5 mL kg^{-1} seed + PSB @ 5 mL kg^{-1} seed and T_{12} : FYM @ 2 t ha^{-1} + Rhizobium @ 5 mL kg^{-1} seed + PSB @ 5 mL kg^{-1} seed, each plot being $3.60 \text{ m} \times 5.00 \text{ m}$. Chemical fertilizer were applied through urea and DAP as per treatment. Organic manure comprising of castor cake and FYM were applied well in advance for proper decomposition whereas, vermicompost was applied on the day of sowing. The seeds were

inoculated with respective strains of *Rhizobium* and PSB according to the treatment. Crop was harvested in second week of May. The data recorded during the course of investigation were subjected to statistical analysis as per method of analysis of variance (Panse and Sukhatme, 1978). Cowpea was sown on 21st February with seed rate of 25 kg ha^{-1} .

Results and Discussion

Effect on growth attributes

Data presented in Table 1 indicated that different treatments had a significant influence on growth attributes of cowpea such as plant height, number of branches plant^{-1} and number of root nodules plant^{-1} . Application of RDF 20-40-00 kg NPK ha^{-1} (T_2) recorded significantly higher plant height (43.83 cm) and higher number of branches per plant (6.10) being at par with treatment FYM 4 t ha^{-1} + PSB 5 mL kg^{-1} seed, which might be due to the availability of nutrients from chemical fertilizer and favorable condition created in uptake of plant nutrients by the crop. Initial boost of nitrogen must have benefited the crop as nitrogen is also known to contribute for cell elongation. As nitrogenous fertilizer might have helped and the enhanced the development of strong cell walls and therefore stiffer branches which might resulted into profuse branches of cowpea. Application of phosphorus which must have helped in better proliferation of roots and increased nodulation resulted in to increased phosphorus availability, which must have encouraged the formation of new cells, promoted plant vigor and hastened leaf development, which helped in harvesting more solar energy and better utilization of nitrogen which resulted in to higher growth. Phosphorus is also known to encourage cell division and hence contributed to taller plants.

Table.1 Effect of chemical fertilizer, organic manure and bio-fertilizers on growth and yield attributes and yield of cowpea

Treatments		Plant height (cm)	Number of branches plant ⁻¹	Number of root nodules plant ⁻¹	Number of pods plant ⁻¹	Number of seeds pod ⁻¹	Seed yield (Kg ha ⁻¹)	Haulm yield (Kg ha ⁻¹)	Seed index (g)	Harvest index (%)
T ₁	Control	32.40	3.80	18.50	17.00	9.25	747	922	15.58	44.69
T ₂	RDF (20-40-00 NPK kg ha ⁻¹)	43.83	6.10	21.30	21.70	11.70	972	1362	16.39	41.65
T ₃	Castor cake @ 0.5 t ha ⁻¹	35.85	4.95	20.65	17.98	10.05	825	1052	16.00	47.38
T ₄	Vermicompost @ 1 t ha ⁻¹	35.80	4.40	21.00	17.88	10.05	824	1034	15.98	45.16
T ₅	FYM @ 4 t ha ⁻¹	36.90	5.03	20.75	18.20	10.15	825	1078	16.06	44.03
T ₆	Castor cake @ 0.5 t ha ⁻¹ + PSB @ 5 mL kg ⁻¹ seed	37.65	5.10	21.75	18.45	10.40	848	1096	16.12	43.02
T ₇	Vermicompost @ 1 t ha ⁻¹ + PSB @ 5 mL kg ⁻¹ seed	37.20	5.05	20.00	18.28	10.40	842	1081	16.06	43.07
T ₈	FYM @ 4 t ha ⁻¹ + PSB @ 5 mL kg ⁻¹ seed	39.88	6.10	21.25	20.30	10.90	942	1201	16.20	39.68
T ₉	<i>Rhizobium</i> @ 5 mL kg ⁻¹ seed + PSB @ 5 mL kg ⁻¹ seed	33.50	3.80	21.83	17.55	9.55	784	979	15.79	44.24
T ₁₀	Castor cake @ 0.25 t ha ⁻¹ + <i>Rhizobium</i> @ 5 mL kg ⁻¹ seed + PSB @ 5 mL kg ⁻¹ seed	34.80	4.25	21.85	17.82	9.83	812	997	15.92	45.81
T ₁₁	Vermicompost @ 0.5 t ha ⁻¹ + <i>Rhizobium</i> @ 5 mL kg ⁻¹ seed + PSB @ 5 mL kg ⁻¹ seed	34.50	3.83	24.85	17.75	9.75	800	994	15.92	45.33
T ₁₂	FYM @ 2 t ha ⁻¹ + <i>Rhizobium</i> @ 5 mL kg ⁻¹ seed + PSB @ 5 mL kg ⁻¹ seed	34.90	4.30	26.60	17.85	9.95	818	1000	15.96	45.23
S.Em. ±		1.85	0.24	0.73	0.89	0.37	42	56	0.33	1.97
C.D. at 5%		5.33	0.69	2.11	2.56	1.07	121	163	NS	NS
C.V. %		10.16	10.08	6.76	9.69	7.36	10.06	10.59	4.19	8.92

The results obtained in present investigation are in conformity with those of Gupta (2014), Meena *et al.*, (2015) and Pargi *et al.*, (2018). Further data revealed that the differences in number of root nodules plant⁻¹ due to different treatments were found significant. Among different treatments, significantly higher number of root nodule plant⁻¹ (26.60) was recorded under treatment FYM @ 2 t ha⁻¹ + Rhizobium @ 5 mL kg⁻¹ seed + PSB @ 5 mL kg⁻¹ seed and remained at par with treatment Vermicompost @ 0.5 t ha⁻¹ + Rhizobium @ 5 mL kg⁻¹ seed + PSB @ 5 mL kg⁻¹ seed with 24.85 root nodules plant⁻¹. Increase in root nodules might be ascribed to better availability of nutrients through FYM at critical growth stages which facilitated improved nodulation along with inoculation of seeds with symbiotic nitrogen fixers which might have increased the concentration of an efficient and healthy strain of Rhizobium in rhizosphere, which in turn ascribed to stimulatory effect of bacteriods on root curling, bulging infection thread and ultimately the production of more infectious sites or nodules. The PSB liquid biofertilizer might also have enhanced the availability of phosphorus to plants which must have utilized in greater root development and nodulation. The results are in close agreement with the findings reported by Yadav and Malik (2005), Khandelwal (2007), Meena *et al.*, (2015) and Pargi *et al.*, (2018).

Effect on yield attributes and yield

Yield and yield attributes of cowpea were also influenced significantly due to various treatments. (Table 1). Application of RDF (20-40-00 NPK kg ha⁻¹) recorded significantly higher number of pods plant⁻¹ (21.70), number of seeds pod⁻¹, higher seed and haulm yield. Which was remained at par with treatment FYM @ 4 t ha⁻¹ + PSB @ 5 mL kg⁻¹ seed. A close observation on the seed index and harvest index shows that the treatment effect

was incapable to exercise a significant result on the seed and harvest index of cowpea. More number of pods plant⁻¹ might be due to more survival of flowers with high supply of photosynthates under treatment RDF as compared to other treatments. Phosphorus application played its primary role in photosynthesis by way of rapid energy transfer and there by increased photosynthetic efficiency and thus, increased total biomass production and translocation in plant parts. These altogether resulted into overall increase in number of pods. The higher number of seeds pod⁻¹ was obtained probably due to suppling of ample amount of nutrients in form of chemical fertilizer must have increased carbohydrate accumulation and their remobilization to reproductive parts of the plant, being closest sink and hence, resulted into increased flowering, fruiting and seed formation and thus more number of seeds pod⁻¹. The probable reason for the higher yield may be due to combined application of nitrogen and phosphorus must have produced excess of assimilates which are first stored in leaves and later translocated into seeds at the time of senescence, which might have ultimately led to higher seed yield. Application of RDF in form of chemical fertilizer gave the highest haulm yield probably because of the fact that under this treatment the synthesis of photosynthetic is more owing to adequate supply of nitrogen and phosphorus which increased the photosynthetic activity and production of more biomass, which ultimately resulted in higher haulm yield. These results are in conformity with the results of Yadav and Malik (2005), Meena *et al.*, (2015), Joshi *et al.*, (2018), Pargi *et al.*, (2018) and Singh *et al.*, (2018).

In the view of the results obtained from the present investigation, it can be concluded that for securing higher seed yield from summer cowpea (*Vigna unguiculata* L. Walp) raised

on loamy sand soil, the crop should be fertilized either with recommended dose of fertilizer (20-40-00 kg NPK ha⁻¹) or apply 4 ton FYM along with seed treatment of 5 mL PSB kg⁻¹ seed.

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