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Assessment of Integrated Nutrient on Soil Properties and Yield of Cowpea (*Vigna unguiculata* L.)

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A B S T R A C T

The present investigation was carried out at research farm, department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) during the *Kharif* season of 2019 with the objective to evaluate response of different levels of organic and inorganic fertilizers on soil health, growth and yield attributes of cowpea [*Vigna unguiculata* (L.)] Cv. Kashi Kanchan. The experiment was laid out in a Randomized Block Design with nine treatment combinations, *i.e.* N2V2, N1V2, N2V1, N1V1, N2R2, N1R2, N2R1, N1R1 and control. It was observed that for post-harvest, treatment T9 (100 % RDF + 100 % *Rhizobium*) was best in terms of growth, yield and economic parameters with maximum plant height 64.40 cm, pods per plant 19.00, pod length 34.15, seeds per pod 10.67 and total yield 164.13 q ha-1. Treatment T9 (100 % RDF + 100 % *Rhizobium*) was best in terms of economic parameters with maximum gross return of Rs. 1,64,130.00 and net profit was Rs. 1,10,240.00 with benefit-cost ratio 1: 3.05.

Introduction

The advantage of combining organic and inorganic sources of nutrients in integrated nutrient management has been proved superior to the use of each component separately (Palaniappan and Annadurai, 2007). *Rhizobium* inoculation increased the root nodulation through better root development and more nutrient availability, resulting in vigorous plant growth and dry matter production which resulted in better flowering, fruiting and pod formation and ultimately there was beneficial effect on seed

yield (Sardana *et al*., 2006*).* Vermicompost has been emerging as an important source in supplementing chemical fertilizer in agriculture in view of sustainable development after Rio Conference, vermicompost is a bio-fertilizer enriched with all beneficial soil microbes and also contains all the essential plant nutrients like N, P and K. Since vermicompost helps in enhancing the activity of microorganisms in soil which further increase solubility of nutrients and their consequent availability to plants is known to be altered by microorganism by reducing soil pH at microsites, chelating action of organic acids produced by them and intraphyl mobility in the fungal filaments (Parthasarathi *et al.,* 2008). Nutrient composition - Cowpea is loaded with various types of nutrients. It is rich in fiber, protein, iron, potassium, low in fat and calories. The cup of cowpea possesses 11.1 g fiber, 13.22 g protein, 35.5 g carbohydrate, 4.29 mg iron, 475 mg potassium, 0.91 g fat and 198 calories. Along with that, various amino acids such as 0.612 g of tryptophan, 0.41 g of histidine, 0.188 g of Methionine and 0.894 g of lysine is contained in this seed. The per capita availability of pulses in India is 35.5 g per day as against the minimum requirement of 70 g per day per capita as advocated by Indian Council of Medical Research. It is, therefore, imperative to increase the productivity of pulse crops especially those of minor importance (Anonymous, 2013-2014). About Variety - This is dwarf and bush type (height 50-60 cm), photo-insensitive, early flowering (40-45 days after sowing) and early picking (50-55 days after sowing) variety suitable for growing in both spring-summer and rainy seasons. Pods are about 30-35 cm long, dark green, soft, fleshy and free from parchment. The cultivar gives green pod yield of about 150-175 q ha^{-1} and is resistant to golden mosaic virus and *Pseudocercospora cruenta*. This has been released and notified during the XIII meeting of Central Sub-Committee on Crop Standard Notification and Release of Varieties for Horticultural Crops for cultivation in U.P., Punjab, Bihar, Chhattisagarh, Orissa, A.P., M.P. and states. Area and Distribution - Almost 33 m t of dry cowpea grains are produced world over, of which Nigeria alone produces 2.1 million ton, followed by Niger (0.65 m t) and Mali (0.11 m t), making Nigeria therefore, World's single largest grower total global area of cowpea grown is almost 13.0 m ha, of the same nearly 93 m ha is grown in Africa only. In India cowpea is grown in almost 1.3 m ha particularly in Western, Central and penmsular regions in some of Indian states including Maharashtra, this crop is grown in all three seasons. The total world acreage under pulses is about 85.40 (M ha) with production of 87.40 (Mt) at 1023 kg ha^{-1} yields level. India, with >29 M ha pulses cultivation area, is the largest pulse producing country in the world. It ranks first in area and production with 34 per cent and 26 per cent respectively. During 2017-18 the country's productivity at 835 kg ha^{-1}, is a significant increase over Eleventh (662 kg ha^{-1}) and Twelfth plans (745 kg ha^{-1}). In India, total pulse area and production during 2017-18 has been >293 lakh hectares (L ha) and 245 lakh tonnes (L t) respectively. Out of the total area, >73 Lakh ha is in Madhya Pradesh alone, earning a prime status in pulse production commodity registering a remarkable 25% of the country's pulse area with 33% production, thereby ranking first both in area and production. This is followed by Rajasthan in respect of area (16 per cent) and Maharashtra in case of total production (13 per cent). Compared to normal production, the estimated production during 2017-18 is 30% higher in case of total pulses, 32% gram, 27% arhar, 58% uradbean, 18% mungbean and 40% higher lentil production. More than 90 per cent of total pulse production has been the contribution of 10 states namely, Madhya Pradesh, Maharashtra,

Rajasthan, Uttar Pradesh, Karnataka, Andhra Pradesh, Gujarat, Jharkhand, Tamil Nadu and Telangana.

Material and Methods

The experiment was conducted at the crop Research farm of the Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. which is located on the south of the Prayagraj city. It is situated at 250o SW, 25024'23''N latitude and 81° 50'38'' E longitude and 98 m above the mean sea level. One control and eight nutrient management practices were used as a treatment with 3x3 Randomized block design having three different factors with level of N P K @ 50 and 100 % kg ha-1, Level of *Rhizobium* @ 50 and 100 % ha^{-1}, level of vermicompost @ 50 and 100 % ha^{-1} respectively. At the first amount of nutrient and N P K supplied by *Rhizobium*, Vermicompost, Urea, SSP and MOP respectively (Table 1 and 2). Scraping the crust of soils following by weeding was done three times at 20, 40 and 60 days after sowing. Irrigation was done as required by crop after sowing. Five plants were tagged from each plot for recording data. Row to row distance was maintained at 30 cm and plant to plant distance was 10 cm, at the depth of 5 cm during the course of experiment, observations were recorded as mean values of the data.

Pre- harvest observations

Plant height (cm) - Height of crop plants under different treatments was recorded at 20, 35 and 50 days interval. For this, five plants were randomly selected from each plot and tagged for observation to be recorded. Height of plants in cm. recorded from ground level up to the base of the last fully opened leaf of the main shoot. No. of pods per plant - Total no. of pods per plant under different treatments were recorded at 50 days of crop maturity. For this, five plants were randomly selected from each plot and tagged for observation to be recorded.

Post - harvest observations

Pod Length (cm) - Length of pod under different treatments was recorded at maturity of crop. For this, five plants were randomly selected from each plot and tagged for observation to be recorded. Length of pod in centimeter recorded from shoot tip to end point of pod**.** No. of seeds per pod - No. of seeds per pod under different treatments was recorded at crop maturity. For this, five plants were randomly selected from each plot and tagged for observation to be recorded. Pod yield (q ha^{-1}) - The pod yield from the net plot area was recorded in kg $plot^{-1}$ and figure converted into q ha^{-1}.

Dose of fertilizer

1) 100% NPK = (100% N:P:K =20:60:40 kg)
2) 50% NPK = (50% N:P:K =10:30:20 kg)
3) 100% *Rhizobium* = 20 g kg^{-1} seed *Rhizobium*
4) 50% *Rhizobium* = 10 g kg^{-1} seed *Rhizobium*
5) 100% Vermicompost = 2 q ha^{-1} Vermicompost
6) 50% Vermicompost = 1 q ha^{-1} Vermicompost

The tables show the interaction effects of N P K, *Rhizobium*, and Vermicompost are generally influenced growth and yield of cowpea. The statistically analyzed data presented in tables 3–7. The result of the data shows that plant height, no. of pod per plant, length of pod, no. of seed per pod, yield of cowpea. From the data presented in the treatment combination T_9 - (100 % RDF+20 g

kg^{-1} seed *Rhizobium)* was recorded maximum 64.40 cm plant height at 50 DAS. While it was recorded at par 43.63 cm at 50 DAS in treatment combination T_1 - (Control). This may be due to application of major and minor nutrients, through different levels of organic manure and chemical fertilizers, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the plant height and no. of branches per plant.

Plant height:

The data presented in table 3 clearly shows the response of plant height of pea recorded at 20 DAS, 35 DAS and 50 DAS as influenced by different levels of N P K, *Rhizobium* and vermicompost. The plant height of cowpea was found to be increased significantly with the increase in levels of N P K, *Rhizobium* and vermicompost. The maximum plant height was recorded as 24.49 cm, 34.38 cm and 64.40 cm in T_9 (100 % RDF + 100 % *Rhizobium*) at 20 DAS, 35 DAS and 50 DAS respectively and the plant height was recorded at par 10.30 cm, 18.63 cm and 43.63 cm in T_1 (control) at 20 DAS, 35 DAS and 50 DAS respectively. Increase in plant height due to increase in N P K, *Rhizobium* and vermicompost may be due to adequate supply of nutrients which in turn helps in vigorous vegetative growth of plants and subsequently increase the plant through cell elongation, cell division, photosynthesis and turbidity of plant cell. The increase in nodulation and nitrogen fixation leads to more plant height. Similar findings were reported by Ashwani *et al.*, (2016), Yadav *et al*., (2017), Abdel *et al.*, (2012) and Maurya *et al*., (2017).

Table.1 Details of treatment of cowpea

Treatment	Dosage ha^{-1} in percentage	Symbol
Level of N, P & K		
	100% NPK as SSP and MOP	N_1
	50% NPK as SSP and MOP	N_2
Level of *Rhizobium*		
	100% *Rhizobium*	R_1
	50% *Rhizobium*	R_2
Level of Vermicompost		
	100% Vermicompost	V_1
	50% Vermicompost	V_2

Table.2 Treatment combination of cowpea

Symbol	Treatment Combination
(T_1= Control)	(Control)
(T_2=N_2 + V_2)	(@ 50 % RDF + 1 q ha^{-1} Vermicompost)
(T_3=N_1 + V_2)	(@ 100 % RDF + 1 q ha^{-1} Vermicompost)
(T_4=N_2 + V_1)	(@ 50 % RDF + 2 q ha^{-1} Vermicompost)
(T_5=N_1 + V_1)	(@ 100 % RDF + 2 q ha^{-1} Vermicompost)
(T_6= N_2+ R_2)	(@ 50 % RDF + 10 g kg^{-1} seed *Rhizobium*)
(T_7= N_1+ R_2)	(@ 100 % RDF + 10 g kg^{-1} seed *Rhizobium*)
(T_8= N_2+ R_1)	(@ 50 % RDF + 20 g kg^{-1} seed *Rhizobium*)
(T_9= N_1+ R_1)	(@ 100 % RDF + 20 g kg^{-1} seed *Rhizobium*)

Table.3 Effect of different levels of N P K, *Rhizobium* and vermicompost on the Plant height (cm) 20, 35 and 50 DAS of Cowpea

Treatment	Plant height (cm)		
	20 DAS	35 DAS	50 DAS
T_1	10.30	18.63	43.63
T_2	11.16	21.17	45.37
T_3	13.37	23.38	47.79
T_4	14.73	24.73	51.19
T_5	16.37	26.37	53.71
T_6	18.77	28.80	55.78
T_7	20.53	30.56	58.07
T_8	22.22	33.22	61.19
T_9	24.49	34.38	64.40
F-test	S	S	S
SE. d **(±)**	0.31	0.32	0.28
C.D. (P= 0.05)	0.67	0.69	0.58

Table.4 Effect of different levels of N P K, *Rhizobium* and vermicompost on the number of pods^{-1} plant at 50 DAS of Cowpea

Treatment	Number of pods^{-1} plant
T_1	9.33
T_2	10.42
T_3	12.00
T_4	13.30
T_5	14.47
T_6	15.53
T_7	16.70
T_8	17.80
T_9	19.00
F-test	S
SE. d (±)	0.12
C.D. (P= 0.05)	0.26

Table.5 Effect of different level of N P K, *Rhizobium* and vermicompost on the pod length of Cowpea

Treatment	Pod length (cm)
T_1	14.01
T_2	18.71
T_3	23.87
T_4	19.97
T_5	21.80
T_6	26.77
T_7	21.70
T_8	27.67
T_9	34.15
F-test	S
SE. d (±)	1.06
C.D. (P= 0.05)	2.25

Table.6 Effect of different level of N P K, *Rhizobium* and vermicompost on the seeds pod^{-1} of cowpea

Treatment	Seeds per pod
T_1	6.00
T_2	6.67
T_3	7.67
T_4	6.67
T_5	8.67
T_6	9.67
T_7	7.67
T_8	10.00
T_9	10.67
F-test	S
SE. d (±)	0.84
C.D. (P= 0.05)	1.77

Table.7 Effect of different level of N P K, *Rhizobium* and vermicompost on the yield of Cowpea

Treatment	yield (q ha^{-1})
T_1	132.33
T_2	146.00
T_3	153.33
T_4	138.33
T_5	144.17
T_6	154.20
T_7	156.27
T_8	159.07
T_9	164.13
F-test	S
SE. d **(±)**	1.32
C.D. (P= 0.05)	2.80

Pods per plant

The data presented clearly shows the response of pods per plant of cowpea recorded at 50 DAS as influenced by different levels N P K, *Rhizobium* and vermicompost. The number of pods per plant of cowpea was found to be increased significantly with the increase in levels of N P K, *Rhizobium* and vermicompost. The maximum number of pods was recorded as 19.00 in T_9 (100 % RDF+ 100 % *Rhizobium*) at 50 DAS and the number of leaves were recorded at par 9.33 in T_1 (control) at 50 DAS. Increase in number of pods may be due to adequate nutrients supply which enhanced the vegetative growth of plant and subsequently the number of pods. Similar findings were reported by Ashwani *et al.,* (2016), Yadav *et al*., (2017), Abdel *et al.,* (2012) and Maurya *et al*., (2017).

Pod length

The data presented clearly shows the response of pod length of cowpea recorded as influenced by different levels N P K, *Rhizobium* and vermicompost. The pod length per plant of cowpea was found to be increased significantly with the increase in levels of N P K, *Rhizobium* and vermicompost. The maximum pod length was recorded as 34.15 in T_9 (100 % RDF+ 100 % *Rhizobium*) and the pod length was recorded at par 14.01 in T_1 (control). Increased in pod length may be due to adequate availability of nutrients during reproductive stage of crop results in the increased pod length. Similar results were also reported by Ashwani *et al.,* (2016), Yadav *et al*., (2017), Abdel *et al.,* (2012) and Maurya *et al*., (2017).

Seeds per pod

The data presented clearly shows the response of seeds per pod of cowpea recorded as influenced by different levels N P K, *Rhizobium* and vermicompost. The number of seeds per pods of cowpea was found to be increased significantly with the increase in levels of N P K, *Rhizobium* and vermicompost. The maximum number of seeds per pods was recorded as 10.67 in T_9 (100 % RDF+ 100 % *Rhizobium*) and the number of seeds per pods were recorded at par 6.00 in T_1 (control). Increase in number of seeds per pod may be due to adequate availability of nutrients during reproductive stage of crop results in the formation of more seeds. Similar results were also reported by Ashwani *et al.,* (2016), Yadav *et al*., (2017), Abdel *et al.,* (2012) and Maurya *et al*., (2017).

Pod yield

The data presented clearly shows the response of pod yield of cowpea recorded as influenced by different levels N P K, *Rhizobium* and vermicompost. The pod yield of cowpea was found to be increased significantly with the increase in levels of N P K, *Rhizobium* and vermicompost. The maximum pod yield was recorded as 164.13 in T_9 (100 % RDF+ 100 % *Rhizobium*) and the pod yield was recorded at par 132.33 in T_1 (control). Increase in pod yield may be due to adequate availability of nutrients during reproductive stage of crop results in the formation of more pods. Similar results were also reported by Ashwani *et al.,* (2016), Yadav *et al*., (2017), Abdel *et al.,* (2012) and Maurya *et al*., (2017)

Summary

Application of 100 % RDF+20 g kg-1 significantly enhanced the plant height and number of branches per plant at harvest. Significantly higher number of pods per plant number of seed per pod, seed, straw and biological yield. Each successive dose of N P K**,** *Rhizobium* and Vermicompost**,** resulted in a significant increase in all growth parameters *i.e*. plant height, number of leaves, number of

branches and dry mater accumulation. Maximum growth and dry matter accumulation was recorded at N20 P60 K40 applied as Urea, SSP and MOP + 20 g kg-1 seed *Rhizobium*. Interactive effect of bio-fertilizer and fertility levels significantly influenced seed yields, N and P uptake by seed and net returns and maximum being with 100 % RDF+20 g kg-1 seed *Rhizobium*. Application of 100 % RDF+20 g kg-1 seed *Rhizobium* significantly increased the organic carbon, available N, P2O5 and K2O content in soil. But the maximum available N, P, K and O.C. % in soil was recorded at N20 P60 K40 + 20 g kg-1 seed *Rhizobium*. Maximum net return by seed and straw yield was obtained significantly with *Rhizobium* + N20 P40 K60.

Conclusion

The highest seed yield and plant growth is obtained from T9= N1+ R1 (@ 100 % RDF +20 g kg-1 seed *Rhizobium*) treatment. It is also found that *Rhizobium* and Vermicompost are effectively gave good result comparison to other treatment and control treatment. The treatment T_9f=N1+R1 showed a highest benefit-cost ratio followed by T_8= (N_2+R_1) other treatments so use of *Rhizobium* and vermicompost is the recommended to the farmers and use of bio-fertilizers like *Rhizobium* and manures like vermicompost should be increase.

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