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Effect of different levels of NPK on growth and yield attributing characters of Cowpea (*Vigna unguiculata* L. Walp *var.* Kashi Kanchan)

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Abstract
A field experiment was conducted during Kharif season 2019 to know the effect of different fertility levels on growth and yield attributing characters of cowpea (*Vigna unguiculata* L. Walp var. Kashi Kanchan). Data revealed that higher growth and yield parameters were recorded under the treatment (T_2) 150% RDF *i.e.* plant height (97.26 cm), branches number (7.5), leaves number (30.67), pod number per cluster (3.6), pod number per plant (14.43), pod length (22.7cm), yield of pod per plot (3.18 kg), pod yield in (q/ha) (66.41 q/ha). The nutrient application of NP_0K (T_5) was most effective for higher pericarp weight (3.08g). The restricted nitrogenous fertilizer application was most appreciated for nodule count at the time of harvesting of the crop 18.8 nodules/plant. Higher protein content in 150% RDF T_2 (28.3%).
B:C ratio is an important parameter to understand the economics of any treatment among the treatments evaluated, application of 50% RDF (T_3) was most impressive with higher B:C ratio (5.58) followed by 100% RDF (T_1) with (5.52).

Keywords: Cowpea, fertility levels, growth, yield, economics

Introduction
India is world's second largest producer of vegetables next to China. In India, total area under vegetable production is 2582190 ha and production is 34.43 MT. Vegetables and pulses are cheap source of protein.
Cowpea (*Vigna unguiculata* L. Walp) belongs to family leguminaceae, sub family fabaceae, having chromosome number 2n=22 or 24. India is the center of origin (Vavilov 1939) [27]. Cowpea is an annual herb having tap root system with various growth habits i.e. erect, semi erect, climbing, bushy annual with glabrous stem. This crop has leaves in trifoliate arrangement which arise alternatively and terminal leaflet is longer having larger area than that of lateral leaflets. In addition to green vegetable, it is also grown for grain, fodder, catch crop, mulch crop, mixed and intercrop.
Cowpea is one of the important vegetable crop mainly grown for its pods as green vegetable during both summer and rainy seasons. Cowpea is of great importance due to its short duration, high yield capacity and rapid growth habit. It is a relatively cheap source of vegetable protein (Pareek and Chandra 2003) [20] which is essential for the growth and maintenance of the body. Cowpea is shade tolerant crop therefore, it is compatible as intercrop. It grows and develops well in poor soils with more than 85 per cent sand and with less than 0.2 per cent organic matter and rainfall of 760- 1520 mm during its growth period. (Singh *et al.*, 2003) [23]
Based on FAO data, worldwide area under cowpea is over 12.49 million ha, with over 7.23 million tonnes annual production. In India, peas has occupied an area of 997735 ha with a total production of 920473 tonnes. (Anon, 2018b) [1] In Chattisgarh, total area under cultivation is 16609 hectare with 233115 MT production. (Anon, 2018c) [2]
Growth and yield of plants are mostly affected by wide range of nutrients. There are many reason for its low productivity like weed growth, pest attacks, plant population and improper nutrient management. The dose of fertilizer depends on the initial soil fertility status and moisture conditions. Cowpea being a leguminous crop is able to fix atmospheric nitrogen with small amount of nitrogenous fertilizer implemented as starter dose.

Phosphorous is critical to cowpea crop because it is reported to stimulate growth, initiate nodule, root growth as well as influence the effeciency of the rhizobium-legume symbiosis (Haruna and Aliyu 2011) [8]. Legumes are phosphorous loving plants, they require phosphorous for growth and seed development and most specifically in nitrogen fixation. Phosphorous is needed for the transfer of energy in carbohydrate and fat metabolism inside plant system and has beneficial impact on early root development. (Yawalker *et al.*, 1996) [28].

Potassium also plays a vital role in crop production. It increases plant vigour and disease resistance and serves as an activator of various enzymes. Indian soil is characterized as poor to medium nitrogen status and available phosphorous so, balanced fertilizer is required for maximum yield and growth. Since, India's productivity of cowpea is very low so it is necessary to apply good agronomical practices with appropriate level of fertilizer for higher yield and productivity. Intensive agriculture leads to overwhelming withdrawal of nutrients from the soil furthermore, imbalanced utilization of chemical fertilizer has disintegrated soil health. Therefore, utilization of balanced of fertilizer can contribute to high yield and increment of soil health.

Material and Methods

The experimental trial was laid out at the field of Horticulture farm, Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh**.** Raipur's climatic condition is sub-humid to semi-arid. A total rainfall received during crop growth period was 799.1mm in 26 rainy days. A maximum temperature of 33 °C in standard week of 38 and lowest temperature of 21.8 °C in week of 42. The experiment was laid out in Randomized Block Design, with three replication. Experimental details contains 7 treatments of different level of fertilizer doses (T_1- 100% RDF, T_2- 150% RDF, T_3- 50% RDF, T_4- N_0PK, T_5- NP_0K, T_6- NPK_0 and T_7- $N_0P_0K_0$). All the cultural practices were similar for each plot including weeding, irrigation and disease pest control measures. The soil was clay loam in texture with pH of normal (7.4), organic carbon was low (.62), available nitrogen low (133.802), phosphorous was medium in range (16.814) and available potassium was high (303.11). Net plot size of 2.4m × 2m with spacing of 60×20cm. Fertilization of cowpea plant were done as basal dose with 20:60:40 as 100% RDF. Nitrogen, phosphorous and potash were applied in form of urea, SSP and MOP respectively.

The important parameters include in this study were growth, yield and quality attributes viz. Plant height, number of branches, number of leaves, number of pods per cluster, number of pods per plant, pod length, girth of pod, pericarp weight, pod yield per plant, pod yield per plot, pod yield q/ha, nodules number at harvest, protein content and economics of cowpea.

The data collected from five randomly selected plants for above parameters and subjected without transformation for statistically analysis with RBD using OPSTAT.

Result and Discussion

Plant height

The plant height (cm) of crop were recorded at 30, 60 and 90 DAS and data presented in table 1. The treatment T_2 (150% RDF) was found significantly superior as compared to other treatment. At 30, 60 and 90 DAS higher plant height 23.3 cm, 37.40 cm and 97.26 cm was recorded in treatment T_3 and lowest were recorded in T_7 ($N_0P_0K_0$) at 30, 60 and 90 days with 16.77 cm, 28.18 cm and 82.24cm respectively. The result obtained in this investigation for height of plants were also similar to findings, which showed that significant increment in growth of cowpea by application of high level of nitrogenous fertilizer Dart *et al.*, (1997) [6]. This result is in conformity to Nyoki *et al.*, (2013) [16] that phosphorous is required in large quantities in shoots and root tips where metabolism is high.

Number of branches per plant

Data on branches number per plant were observed at 30, 60 and 90 DAS which depicted in table 1. The branches number per plant was significantly differed in all growth of stage of plants. A more branches number per plant was observed in T_2 (150% RDF) at 30, 60 and 90 DAS with 4.22, 6.6 and 7.5 respectively, followed by T_1 (100% RDF) showed 3.9, 5.33 and 6.33, while minimum branches number seen in T_7 (($N_0P_0K_0$) 2.66, 3.8 and 5.3 at 30, 60 and 90 DAS.

The application of 90 Kg P_2O_5/ha as in T_2 affected on number of branches and recorded more branches number per plant. This may be due to cumulative effect of phosphorous on division of cells, balanced nutritions and availability of phosphorous. These results are confirmed with that of Yadav and Yadav (2011). Paliwal *et al*., (1999) [19] who reported the maximum plant height, number of branches and number of leaves when higher dose of nitrogen were applied to cowpea and other vegetables.

Leaves number per plant

Leaves number per plant of various treatment noted at 30, 60 and 90 DAS that illustrated in table 1. At 30, 60 and 90 days after sowing, maximum leaves number observed in T_2 (150% RDF) 14.76, 20.78 and 30.67 at 30, 60 and 90 DAS followed by T_1 (100% RDF) 12.8, 18.41 and 27.50. Lowest number of leaves observed in T_7 ($N_0P_0K_0$) 10.45, 14.49 and 20.60 in 30, 60 and 90 DAS respectively.

These findings are in consensus with report of Baboo and Mishra (2001) and Baboo and Mishra (2004) [3, 4] that, increasing rate of nitrogen up to 40 Kg/ha increased leaves number per plant. Increased in P level up to 90 Kg/ha significantly increased its leaves number. Ofosubodu *et al*., (2008) also concluded that use of 30 Kg P_2O_5 ha^{-1} increased leaf number more than the control.

Pods number per cluster

The data presented in table 2 that shows that with application of 150% RDF in T_2 significantly provided higher pods number per cluster with 3.6 which followed by T_1 (100% RDF) 2.83. Minimum pods number per cluster observed in T_7 ($N_0P_0K_0$) with 1.86.

These results are in concurrence with result of Kumar *et al.*, (2001) [12] who reported that application of 60 Kg P_2O_5/ha as DAP is best source of getting higher pods per cluster. Baboo and Mishra (2004) [4] reported that the number of pods were highest in high N application with inoculation

Pods number per plant

Data of these parameters presented in table 2, with view of different NPK, highest pods number per plant reported in T_2 (150% RDF) of 14.43 during harvesting followed by T_1 (100% RDF) of 13.08. Lowest pods number per plant observed in T_7 ($N_0P_0K_0$) of 10.61 followed by T_4 (N_0PK) 11.49 mean value of pods per plant.

The similar result were obtained by other research findings. Singh *et al*., (2007) showed that Rhizobium inoculation, 30

Kg N and 60 Kg P_2O_5/ha produced higher number of pods per plant of cowpea over control. Khandelwal *et al*., (2012) [10] reported that the application of 75% of recommended dose of fertilizer i.e. 15 Kg N and 30 Kg P_2O_5 along with inoculation proved superior over rest of treatment combination provided higher pod number per plant.

Pod length (cm)
Pod length were significantly affected by NPK levels. Data of table 2 showed that T_2 (150% RDF) had maximum pod length of 22.7 cm followed by T_1 (100% RDF) 19.23 cm. Minimum pod length was discerned in T_7 ($N_0P_0K_0$) followed by T_4 (N_0PK) 17.25 cm and 17.84 cm respectively.
The result of experiment in pod length may be due to increased supply of nutrients. Nitrogen enhance growth, reproductive stage and protein making, thus encourage pod length. Subbarayappa *et al.*, (2009) [24] reported that the application of 100 per cent RDF + FYM significantly increase pod length (15.85cm). Experimental result also accordance with results observed by Krasilnikoff *et al*., (2003) and Nyoki *et al*., (2013) [11, 16].

Girth of pod (cm)
Observation data presented in table 2. Significantly increase in girth of pod were seen in T_1 (100% RDF) 2.07cm. However, minimum pod girth were found in T_7 ($N_0P_0K_0$) 1.77 cm. Result in T_7 may be due to absence of any nutrients in plants. T_1 (100% RDF) results of pod girth was due to availability of major nutrients. This indicates directly proportional between girth of pod and nitrogen phosphorous fertilizers.

Pericarp weight
Values of pericarp weight depicted in table 2. Pericarp weight were significantly increased in T_5 (NP_0K) 3.08 followed by T_6 (NPK_0) and T_1 (100% RDF) 3.05 g. Minimum weight of pericarp observed in T_7 ($N_0P_0K_0$) 2.6 g. These results may be due to nitrogenous fertilizer which helps to its yield attributes. These result close confirmity with investigation of Dart *et al*., (1997) [6] who reported significantly rise in growth and yield attributes on the application of fertilizers.

Pod yield per plant (g)
Observation of pod yield per plant presented in table 2. The highest green pod yield per plant found in T_2 (150% RDF) 80.70 followed by T_1 (100%RDF) 77.08. The lowest yield of pods per plant reported in T_7 ($N_0P_0K_0$) 52.48. This might be due to NPK levels and availability of high nitrogen phosphorous to produce more reproductive parts (pods). Mokwunye and Batino (2002) [15] have reported that P is essential for photosynthesis, pod development and grain filling in leguminous crops. Thus higher nodulation resulted in high N fixation and eventually pod yield. These results are consensus with result of Subramaniam *et al*., (1977) and Deshbhratar *et al*., (2010) [25, 7].

Pod yield per plot (Kg)
The yield of pod per plot were significantly differed due to various levels of NPK and data illustrated in table 2. The treatment T_2 (150% RDF) had maximum 3.18 Kg pod yield per plot followed by T_1 (100% RDF) 3.11 Kg as compare to rest of treatments while the lowest level 2.09 Kg pod yield /plot was obtained with treatment T_7 ($N_0P_0K_0$). Increased vegetative growth might have provide more sites of translocation of photosynthesis, which ultimately resulted in increased yield. These findings corroborates with result obtained by Choudhary *et al.*, (2002) [10] reported that application of fertilizers up to 100% RDF recorded significantly higher yield (seed and biological) over its preceding levels. Patel *et al*., (2010) [21] reported that growth and yield attributes were significantly influenced due to combined application of N, P, K.

Pod yield (q/ha)
Any crop yield shows success or failure of crop of any experiment. Data of parameters depicted in table 2. A highest pod yield (q/ha) reported in T_2 (150% RDF) 66.41 q/ha followed by T_1 (100% RDF) 64.86 q/ha while, lowest pod yield evaluated in T_7 ($N_0P_0K_0$) 43.60 q/ha. This might be due to availability of major nutrients NPK. Lower nitrogen also significantly increased yield because of cowpea nitrogen fixation as in T_1 (20 Kg N/ha). Cowpea can fix more than 50% of its nitrogen from atmosphere nitrogen fixation (Khan *et al*., 2002) [9]. This result is in concurrence with work of Singh *et al*., (2011) who recorded highest crop yield at 60 Kg/ha phosphorous. Swaroop and Rathore (2002) [26] reported that the treatment combination of $P_2K_1N_3$ (80Kg P, 60 Kg K and 20 Kg N/ha with rhizobium) contributed to the maximum yield of green pods in cowpea variety Arka Garima.

Nodules number per plant
Nodules number per plant presented in table 2. At harvest of cowpea nodules of selected plants were recorded and observed that maximum number of nodules. At harvest of cowpea nodules of selected plants were recorded and observed that maximum number of nodules found in T_4 (N_0PK) with 18.8 while lowest number of nodules seen in T_7 ($N_0P_0K_0$) with 12.67. This may be due to phosphorous fertilizer application which increased nodules number and weight.
Significantly raised in nodulation was also recorded by Okeleye and Okelana (2000), Mokwunye and Bationo (2002) [18, 15]. Observation are truly confirmative because of phosphorous initiate nodules formations as well as affect symbiosis (Haruna and Aliyu, 2011) [8]. Results are in accordance with report of earlier worker who showed that application of N fertilizer depressed nodule number (Ofori, 1973; Rhodes, 1981; Olson *et al*., 1981 and Chowdhary *et al*., 2000) [17, 22, 5].

Protein content (%)
Non significant variation on protein content of seed was noticed in different level of NPK and data portrayed in table 2. The higher protein content 28.3% in cowpea seed was observed in T_2 (150% RDF) followed by T_1 (100% RDF) 28.29% which was at par. Data of protein content changed non significantly in treatment. Lowest protein content evaluated in T_7 ($N_0P_0K_0$) and T_4 (N_0PK) with 28%.
This might be due to raise in functions of nitrate reductase enzymes. Higher N in green pods directly associate for higher protein content because it is primary component of amino acids which make up the basis of protein content. Similar results were obtained by Mishra (2003), and Kurdikeri *et al*., (1973) [14, 13].

Economics of cowpea cultivation
Studies on economics of different treatments are very important as it is farmer's first priority concerned to monetary returns and cost of cultivation. Higher value of money and low cost of cultivation is desirable character for getting higher

returns. Data of economics illustrated in table 3. Value of gross returns changed significantly and highest gross returns observed in T_2 (150% RDF) Rs.66410.00 followed by T_1 (100% RDF) Rs.64860.00 while lowest gross return observed inT_7 ($N_0P_0K_0$) Rs.43600.00

Total expenditure of different treatment are depicted in table 3 The highest total cost of cultivation Rs.12368.00 seen in T_2 (150% RDF) whereas lowest cost of cultivation observed in T_7 ($N_0P_0K_0$) of Rs.10500.00. Net monetary returns are significantly differ between each treatment. A highest net returns were reported in T_2 (150% RDF) of Rs. 54042.00 this treatment was found to be most remunerative with return while minimum net returns of cowpea were observed in T_7 ($N_0P_0K_0$) Rs.33100.00

The B: C ratio of different levels of NPK treatments are evaluated and presented in table 4.4 and fig.4.18. The B:C ratio ranged from 5.58 to 4.15 depending upon its levels of nutrient. Maximum B:C ratio obtained in T_3 (50% RDF) with 5.58 while lowest B:C ratio observed with treatment of T_7 ($N_0P_0K_0$) 4.15.

The obtained result might be due to yield and less cost of cultivation in T_3 (50%RDF). Naidu *et al.*, (2001) reported by use of 100: 50: 50 Kg NPK + 20 t FYM /ha found maximum B:C ratio 1.272. This result also conformity with Swaroop and Rathore (2002) [26].

Conclusions

- Experimental result revealed that T_2-150% RDF was most effective to maximize the overall growth, development and yield of cowpea, var. "Kashi Kanchan".
- The economical evaluation inferred us that substantial increment in nutrient doses may increase growth and yield of the crop, but its higher quantity may not be economical for the crop like cowpea.
- The low dose of nutritional application i.e. T_3-50% RDF was most economical and for yield optimization, it may be increase further up to 70% RDF

Table 1: Effect of different levels of NPK on height of plant, branches number and leaves number at different growth stages

S. No.	Treatments	Plant Height (cm)			Number of Branches			Number of Leaves		
		30th days	60th days	90th days	30th days	60th days	90th days	30th days	60th days	90th days
1.	T_1-(RDF)	20.83	33.65	89.00	3.9	5.33	6.33	12.8	18.41	27.50
2.	T_2-(150% RDF)	23.3	37.40	97.26	4.22	6.6	7.5	14.76	20.78	30.67
3.	T_3-(50% RDF)	19.2	32.41	87.33	3.36	5.1	5.93	11.8	16.47	25.75
4.	T_4- (N_0PK)	18.00	29.06	83.92	2.96	4.83	5.46	11.26	15.61	22.13
5.	T_5-(NP_0K)	18.35	30.68	85.2	3.73	4.92	6.00	11.63	15.71	23.70
6.	T_6-(NPK_0)	18.48	31.16	86.67	3.6	5.16	6.23	11.66	16.19	24.30
7.	T_7-($N_0P_0K_0$)	16.77	28.18	82.24	2.66	3.8	5.3	10.45	14.49	20.60
	Mean	19.27	31.79	87.37	3.49	5.10	5.39	12.04	16.80	24.95
	C.D	0.787	1.315	2.84	0.696	0.554	0.428	0.504	1.357	2.269

Table 2: Effect of different level of NPK on no. of pods per cluster, no. of pods per plant, pod length, girth of pod, pericarp weight, pod yield per plant, pod yield per plot, pod yield (q/ha), nodules number and protein content of cowpea

S.N.	Treatments	Number of pods/ cluster	Number of pods/ plant	Pod length At harvest (cm)	Girth of pod (cm)	Pericarp Weight (g)	Pod yield / plant (g)	Pod yield /plot (Kg)	Pod yield (q/ha)	Nodules no. at harvest	Protein content (%)
1.	T_1-(100%RDF)	2.83	13.08	19.23	2.07	3.05	77.08	3.11	64.86	15.67	28.29
2.	T_2-(150% RDF)	3.6	14.43	22.7	1.87	2.91	80.70	3.18	66.41	17.53	28.30
3.	T_3-(50% RDF)	2.64	12.34	18.46	1.99	3.03	74.69	2.98	62.14	13.93	28.10
4.	T_4- (N_0PK)	2.2	11.49	17.84	1.79	2.99	70.69	2.82	58.88	18.8	28.00
5.	T_5-(NP_0K)	2.5	11.85	18.14	1.94	3.08	71.90	2.87	59.85	14.73	28.20
6.	T_6-(NPK_0)	2.6	12.53	18.29	1.87	3.05	72.97	2.91	60.69	16.93	28.10
7.	T_7-($N_0P_0K_0$)	1.86	10.61	17.25	1.77	2.6	52.48	2.09	43.60	12.67	28.00
	Mean	2.60	12.33	18.84	1.9	2.95	65.69	2.85	59.49	15.75	28.14
	C.D	0.272	2.481	1.16	0.195	0.363	2.15	0.116	2.249	1.318	0.184

Table 3: Effect of different levels of NPK on economics of cowpea crop production

S. No.	Treatments	Yield (q/ha)	Cost of cultivation (Rs./ha)				Sale price (Rs./q)	Gross returns (Rs./ha)	Net monetary returns (Rs./ha)	B:C ratio
			Seed	Fertilizer	Cultivation	Total				
1.	T_1 - (100%RDF)	64.86	2500.00	1243.00	8000.00	11743.00	1000.00	64860.00	53117.00	5.52
2.	T_2 - (150% RDF)	66.41	2500.00	1868.00	8000.00	12368.00	1000.00	66410.00	54042.00	5.36
3.	T_3 - (50% RDF)	62.14	2500.00	622.00	8000.00	11122.00	1000.00	62140.00	51018.00	5.58
4.	T_4 - (N_0PK)	58.88	2500.00	1126.00	8000.00	11626.00	1000.00	58880.00	47254.00	5.06
5.	T_5 - (NP_0K)	59.85	2500.00	853.00	8000.00	11353.00	1000.00	59850.00	48497.00	5.27
6.	T_6 - (NPK_0)	60.69	2500.00	508.00	8000.00	11008.00	1000.00	60690.00	49682.00	5.51
7.	T_7 - ($N_0P_0K_0$)	43.60	2500.00	0.00	8000.00	10500.00	1000.00	43600.00	33100.00	4.15

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