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Integrated Nutrient Management for Sustainable Cowpea Production and Nutrient Conservation

Kushal, M. R. Anand., Soumya, K.,T.V. Krishna, Gangadhar Eswar Rao and C. Seenappa

Department of Agronomy, College of Agriculture, UAS, Bangalore 560 065, India

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ABSTRACT

The field experiment entitled "Growth parameters and economics of cowpea as influenced by integrated nutrient management" was carried out at AICRP on Arid Legumes, Gandhi Krishi Vigyan Kendra, University of Agricultural Sciences, Bangalore. The investigation comprised nine treatments that involved combined application of nutrients along with the seed treatment at the time of sowing. Treatments were replicated thrice in randomized complete block design. The growth parameters were significantly varied with the combined application of 100% RDF + seed treatment with *Rhizobium* + PSB + 1% 19:19:19 spraywhich recorded highest plant height (45.9 cm), number of branches plant^{-1} (8.4), leaf area (1033 cm^2), number of nodules plant^{-1} (39.4) and dry matter production (13.8 g plant^{-1}). Treatments receiving 100% RDF + seed treatment with *Rhizobium* + PSB + 2% urea spray and 100% RDF + seed treatment with *Rhizobium* + PSB, respectively recorded significantly on par results. Whereas, lower plant height (32.3 cm), number of branches plant^{-1} (5.1), Leaf area (709 cm^2), number of nodules plant^{-1} (25.6) and dry matter production (8.3 g plant^{-1}) were recorded with the application of 100% RDF(Control). Higher net returns and BC ratio (Rs. 36504 ha^{-1} and 2.31, respectively) recorded with application of 100% RDF + seed treatment with *Rhizobium* + PSB + 1% 19:19:19 spray. However, Lower net returns and BC ratio (Rs. 7384 ha^{-1} and 1.28, respectively) were recorded with 100% RDF (Control).

***Key words**: Cowpea, Rhizobium and Phosphate solubilizing bacteria*

Introduction

Cowpea (*Vigna unguiculata* L. Walp) belongs to family Fabaceae and is one of the most important pulse crop native to Central Africa. It is also known as vegetable meat due to high content of protein in grain with better biological value on dry weight basis. It is mostly farmed for vegetables, grains, and to a lesser extent as a fodder crop, in tropical and subtropical regions of the world. Apart from this, it produces heavy vegetative growth and covers the ground so well that it checks the soil erosion. It serves as a cover crop and improves soil fertility by fixing atmospheric nitrogen. Cowpea yield remains low (less than 1 t ha^{-1}) in majority of the areas mainly due to lack of high yielding varieties, low soil fertility and inappropriate farming techniques (Salih, 2013). Nutritionally, cowpea grains are packed with 23-25 per cent of protein, 50-67 per cent of starch and loaded with vitamins and minerals. Worldwide its production is estimated to be about 6.5 million metric tons annually from an area of 14.5 million hectares. Over the last three decades, global cowpea production grew at an average rate of 5 per cent, with 3.5 per cent annual growth rate in area and 1.5 per cent in yield and the area expansion accounting for 70 per cent of the total growth during this period (Anon., 2013).

Nutrients play a vital role in the growth and yield of cowpea. Application of nutrients through integrated approach reduces the cost of cultivation as well as improves the soil health by increasing the fertility (Mahajan and Sharma, 2005). Integrated Nutrient Management (INM) is a phenomenon that involves the use of chemical fertilizers in conjunction with organic manures and bio-fertilizers. The basic concept of integrated nutrient management is to supply required plant nutrients for sustaining the anticipated crop productivity with minimum or no harm to soil health and ecological balance (Balasubramanian, 1999). Integrated nutrient management acts as the key for boosting crop production as its been proven superior to the use of each component separately. Scientists have been concentrating their efforts on the efficient and sensible use of available resources to enhance total productivity and profitability per unit area in order to. meet up exponentially growing food and other demands.

Materials and Methods

A field experiment was conducted during *kharif* 2020 at All India coordinated research project (AICRP) on Arid Legumes, Gandhi Krishi Vigyana Kendra (GKVK), University of Agricultural Sciences, Bangalore, the centre falls under Agro-climatic Zone-V: Eastern Dry Zone of Karnataka. Soil of the experimental plot was red sandy loam (pH6.2; OC0.46%) with low available nitrogen (239.04 kg ha^{-1}), phosphorus (26.2 kg ha^{-1}) and potassium (248.3 $kgha^{-1}$). The experiment was laid out in randomized complete block design (RCBD) with nine treatment combinations each replicated thrice.

The land was prepared by using tractor drawn disc plough followed by cultivator. The seeds were treated with *Rhizobium* and PSB culture and shade dried before sowing. Variety chosen for the experiment was KBC-9 (Arka Garima × VS389) released by UAS Bangalore. Two treated seeds per hill were dibbled at 10 cm * 45 cm spacing and at 3-5 cm depth by a hand hoeon 5th August, 2020 using seed rate of 25 kg ha^{-1}.

Nutrient management was done according to treatment details: T_1-100% RDF(Control), T_2-100% RDF + foliar spray of urea @ 2%, T_3-100% RDF+ Seed treatment with *Rhizobium* +PSB, T_4-100% RDF + Seed treatment with *Rhizobium* + PSB + 2% urea spray, T_5-100% RDF + Seed treatment with *Rhizobium* + PSB + 1% 19:19:19 spray, T_6-100% RDF + 1% 19:19:19 spray, T_7-50% RDF +2.5 tonnes ha^{-1} FYM + 2% urea spray, T_8-50% RDF + 2.5 tonnes ha^{-1} FYM + 1% 19:19:19 spray, T_9-50% RDF +2.5 tonnes ha^{-1} FYM.

RDF according to package of practice (UAS, Bangalore) of 25:50:25 kg N, P_2O_5 and K_2O ha^{-1} through Urea, single super phosphate and muriate of potash were used. Thinning was done at 15 DAS and plots were kept weed free by taking up hand weeding at 25 DAS. Earthing up was done at 30 DAS to encourage for rapid growth. Spray of Dimethioate @ 2 ml L^{-1} of water was given to manage aphids and others sucking pests during 50 per cent of flowering stage and at 55 DAS. Crop attained maturity at 85 DAS and was harvested on 11th November, 2020. Subsequently, the pods from net plot area was harvested and allowed for sun drying for about 4-5 days, threshing was done manually and cleaned. The data analysis and interpretation were done by using ANOVA technique (Gomez and Gomez, 1984). However, the predominant market prices of the cowpea after harvest were attained and used for the calculation of gross returns.net returns and benefit cost ratio were worked out.

Results and Discussion

Growth parameters

From the data presented in Table 1, it is evident that treatment T_5 recorded significantly higher plant height (45.9 cm), number of branches $plant^{-1}$ (8.4), leaf area $plant^{-1}$ (1033 cm^2) and number of nodules $plant^{-1}$ (39.4) which was statistically on par with the treatment T_4 and T_3. However, lower plant height (32.3 cm), number of branches $plant^{-1}$ (5.1), leaf area $plant^{-1}$ (709 cm^2) and number of nodules $plant^{-1}$ (25.6) were recorded with the application of 100% RDF application (Control). This might occur as a result of the crop receiving a balanced supply of nutrients and having improved access to light and moisture. Moreover, seed treatment of cowpea with Rhizobium and PSB confers resistance to seedborne illnesses and benefits plants by supplying ambient nitrogen and converting the insoluble phosphorus into accessible form (Mudalagiriyappa *et al*., 2016) and entry of nutrients through foliar spray resulted in the entry of water into the cell causing cell elongation and cell division which leads to better growth and development of crop which ultimately increases the plant growth parameters. Results are in line with

Table 1. Growth parameters of cowpea as influenced by integrated nutrient management

Treatments	Growth parameters			
	Plant height (cm)	No. of branches Plant^{-1}	Leaf area (cm^2 plant^{-1})	No. of nodules plant^{-1} at 60 DAS
T_1	32.3	5.1	709	25.6
T_2	37.5	6.0	848	35.1
T_3	39.8	6.8	920	36.2
T_4	41.9	7.5	976	37.7
T_5	45.9	8.4	1033	39.4
T_6	38.2	6.3	860	32.9
T_7	35.7	5.7	800	30.7
T_8	36.7	6.0	840	31.6
T_9	34.5	5.6	756	27.2
SE(m)±	2.03	0.49	51.0	1.42
C.D. (P=0.05)	6.09	1.47	153.0	4.25

Jadhav *et al*. (2017) and Takankhar *et al*. (2017).

Growth Attributes

Among the different treatments significantly higher leaf area index (2.30), AGR, CGR and NAR (0.331 g day^{-1}, 7.35 g m^{-2} day^{-1} and 7.38g dm^{-2} day^{-1}, respectively) were recorded in the treatment T_5. Whereas Lower leaf area index (1.58), AGR, CGR and NAR (0.203 g day^{-1}, 4.52 g m^{-2} day^{-1} and 4.16 g m^{-2} day^{-1} respectively) were observed in the control as indicated in Table 2.

Higher leaf area was associated directly to the leaf area index. The LAI also depends on how much and how easily nitrogen is delivered to plants, as it's necessary for the production of chlorophyll (Mishra 2016). Combined nutrient administration's positive effects on cell division and cell elongation, which support better crop growth and development (Nitu Kumari *et al*., 2019), may also contribute to higher LAI.

Higher growth indices like AGR, CGR and NAR were recorded with the application of 100% RDF + seed treatment with *Rhizobium* + PSB + 1% 19:19:19 spray treatment. This is because plants that had a balanced supply of nutrients at important growth phases were able to have bigger leaf areas, leaf area indices, and photosynthetic rates. Leaf angle also serves as a measure of how much light is intercepted by a leaf- increasing the growth of the crop. These findings are in conformity with the results obtained

Table 2. Growth attributes Absolute growth rate (AGR), Crop growth rate (CGR), Relative growth rate (RGR) and Net assimilation rate (NAR) of cowpea as influenced by integrated nutrient management

Treatments	Growth attributes		
	AGR (gday^{-1})	CGR (g m^{-2} day^{-1})	NAR (g dm^{-2} day^{-1})
T_1	0.203	4.52	4.16
T_2	0.280	6.22	4.99
T_3	0.290	6.44	5.49
T_4	0.326	7.25	6.88
T_5	0.331	7.35	7.38
T_6	0.282	6.26	6.17
T_7	0.249	5.54	5.15
T_8	0.276	6.13	5.27
T_9	0.217	4.81	4.76
SE(m) ±	0.015	0.334	0.395
C.D. (P=0.05)	0.045	1.002	1.185

Table 3. Total dry matter production at different growth stages of cowpea as influenced by integrated nutrient management

Treatments	Total dry matter production		
	30 DAS (g plant^{-1})	60 DAS (g plant^{-1})	At harvest (g plant^{-1})
T_1	3.6	9.7	8.3
T_2	4.1	12.5	11.2
T_3	4.5	12.8	12.2
T_4	4.5	14.3	13.6
T_5	4.8	14.8	13.8
T_6	4.2	12.6	11.6
T_7	3.9	11.5	9.4
T_8	4.0	12.5	10.1
T_9	3.8	10.0	8.6
SE(m) ±	0.23	0.69	0.62
C.D. (P=0.05)	-	2.09	1.87

by Rajavel and Vincent (2009) and Kumar and Pandita (2012).

The data presented in Table 3 indicates that at 30 DAS, there was no significant difference observed in total dry matter production of cowpea. Whereas, at 60 DAS and at harvest T_5 treatment outperformed with significantly higher dry matter production (14.8 and 13.8 g plant^{-1}, respectively) which was statistically on par with the treatment T_4(14.3 and 13.6 g plant^{-1}, respectively) and T_3(12.8 and 12.2 g plant^{-1}, respectively). However, Lower dry matter production (9.7 and 8.3 g plant^{-1}, respectively) was recorded in the control.

The consequence of photosynthetic activity is the total amount of dry matter produced by each plant. Because dry matter is a function of leaf area, number of branches, and number of leaves, which was maximum at 60 DAS and then declined in leaf area due to leaf senescence, the accumulation of dry matter during the initial crop growth period was very low due to initial slow growth and progressively increased up to 60 DAS and increased with diminishing rate up until harvest. An increase in dry matter output is achieved by improved nutrient availability for luxuriant growth and effective photosynthetic activity in the source. Above results are inconformity with that of Kumar *et al*. (2008)**.**

Economics

From the data presented in Table 4 it is evident that higher gross returns and B: C ratio (Rs. 64334.ha^{-1} and 2.53, respectively) in cowpea were obtained in treatment T_5 and the same treatment also recorded high net returns (Rs. 38952 ha^{-1}). lowest gross returns (Rs. 34186 ha^{-1}) net returns (Rs. 9584) and B:C (1.39) in control. The gross returns, net returns and B: C ratio were result of higher seed yield with the combined application of different nutrients in integrated manner because of greater availability of essential nutrients to plant, better translocation of photosynthates leads to higher haulm and seed yield. The results are in close vicinity with the findings of Mamathashree *et al.* (2014) and Jadhav and Kulkarni (2016)

Table 4. Economics of cowpea as influenced by integrated nutrient management

Treatments	Cost of cultivation Rs ha^{-1}	Gross returns Rs ha^{-1}	B:C ratio
T_1	24602	34186	1.39
T_2	25202	53797	2.13
T_3	24782	60021	2.42
T_4	25382	62431	2.46
T_5	25382	64334	2.53
T_6	25202	56833	2.26
T_7	27789	43937	1.58
T_8	27789	50364	1.81
T_9	27189	41678	1.53

Conclusion

Combined application of 100% RDF along with seed treatment of *Rhizobium* and PSB and spray of 1% 19:19:19 at 50 % flowering stage obtains higher productivity and profitability. This practice reduces quantity of required fertilizers for the crop their by reduces pressure on non-renewable resources and lowers cost of cultivation for the farmers.

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