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Studies on Yield, Yield Attributes and Nutrient uptake of Cowpea as Influenced by Integrated Nutrient Management

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ABSTRACT

The field experiment entitled 'Studies on yield, yield attributes and nutrient uptake of cowpea as influenced by integrated nutrient management' was conducted during *kharif*-2020 at AICRP on Arid Legumes, Gandhi Krishi Vigyan Kendra, University of Agricultural Sciences, Bangalore. Experiment consists combined application of nutrients (Urea, SSP, MOP used as a NPK sources) along with the seed treatment at the time of sowing. Totally there are nine treatments replicated thrice in randomized block design. The yield and yield attributes were significantly varied with the combined application of 100 per cent RDF + seed treatment with *Rhizobium* + PSB + 1 per cent 19:19:19 spray recorded higher number of pods plant^{-1} (27.1), pod length (17.0 cm) and number of seeds pod^{-1} (16.9) and it was on par with 100 per cent RDF + seed treatment with *Rhizobium* + PSB + 2 per cent urea spray and 100 per cent RDF + seed treatment with *Rhizobium* + PSB, respectively. Whereas, lower number of pods plant^{-1} (21.4), pod length (10.4 cm) and number of seeds pod^{-1} (10.3) were recorded with the application of 100 per cent RDF(Control). Higher seed yield, net returns and BC ratio (1384 kg ha^{-1}, Rs.38952 ha^{-1} and 2.53, respectively) recorded with application of 100 per cent RDF + seed treatment with *Rhizobium* + PSB + 1 per cent 19:19:19 spray. Whereas, lower seed yield, net returns and BC ratio (735 kg ha^{-1}, Rs.9584 ha^{-1} and 1.39, respectively) were recorded with 100 per cent RDF (Control).

Keywords : Cowpea, RDF, Rhizobium, Phosphate solubilizing bacteria, Urea, 19:19:19

COWPEA (*Vigna unguiculata* L. Walp) is one of the most important pulse crop native to Central Africa, belongs to family fabaceae. Cowpea is called as 'vegetable meat' due to high content of protein in grain with better biological value on dry weight basis. It is mainly grown in tropical and subtropical regions in the world for vegetable and grains and to lesser extent as a fodder crop. 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 contain 23-25 per cent of protein, 50-67 per cent of starch and several vitamins and minerals, while immature green cowpea pods are reported to contain 17-25 per cent of protein and abundant essential minerals. Green cowpea pods are often harvested and consumed as fresh vegetables.

Cowpea production worldwide 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 in area and 1.5 per cent growth in yield and the area expansion accounting for 70 per cent of the total growth during this period (Anonymous., 2013).

Nutrients are directly related with the growth and yield of cowpea. Application of nutrients through integrated approach reduce the cost of cultivation and also maintain as well as improve soil health by increasing the fertility (Mahajan and Sharma, 2005), whereas, non-monetary inputs like spacing also play an important role for boosting the yield by increasing the plant population per unit area.

Integrated Nutrient Management (INM) is a phenomenon that involves the use of chemical fertilizers in conjunction with organic manures and bio-fertilizers (Mahajan and Sharma, 2005). The basic concept of integrated nutrient management is supply of required plant nutrients for sustaining the anticipated crop productivity with a minimum harmful effect on soil health and environment (Balasubramanian, 1999). The combined effect of organic and inorganic nutrient sources used as integrated nutrient management has been proved superior to the use of each component separately (Palaniappan and Annadurai, 2007).

For boosting crop production, nutrient balance in the soil is the key component. Scientists have been concentrating their efforts on the efficient and sensible use of available resources to boost the total productivity and profitability per unit area in order to meet the food and other demands of an ever-increasing population.

Keeping these points in view, the present investigation on 'Studies on yield, yield attributes of cowpea as influenced by integrated nutrient management under changing climate' was under taken during *kharif* 2020 at All India Co-ordinated Research Project on Arid Legumes, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru.

Material 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 (UAS), Bangalore, the centre is situated in the Agro-climatic Zone-V: Eastern Dry Zone of Karnataka at 12°58' North latitude and 77°35' East longitude with an altitude of 924 m above mean sea level (MSL). Soil of the experiment was red sandy loam soil (pH 6.2; OC 0.46%) with low available nitrogen (239.04 kg ha^{-1}), phosphorus (26.2 kg ha^{-1}) and potassium (248.3 kg ha^{-1}) respectively. The experiment was laid out in randomized complete block design (RCBD), replicated thrice with nine treatments. In the experimental site Horsegram (PHG-9) was grown during the *kharif* season of year 2019 and later kept fallow in *rabi* and *summer* seasons.

The land was prepared by using tractor drawn disc plough once followed by cultivator twice. The seeds were treated with *Rhizobium* and PSB culture and shade dried before sowing. The treated seeds were dibbled 2-3 cm in the furrows opened at 45 cm spacing with the help of hand hoe. Two seeds were dibbled per hill at 10 cm spacing. Sowing was done on 5th August, 2020 by using UAS Bangalore released variety KBC-9 (Arka Garima × VS389) and maintaining spacing as per the treatments using seed rate of twenty-five kg ha^{-1}. FYM was applied before 15 days of sowing to all the treatment plots at the rate of 2.5 tonnes ha^{-1}. Urea, single super phosphate and muriate of potash were used as a source of NPK. Fertilizers were applied 25:50:25 kg N, P_2O_5 and K_2O ha^{-1} and 2.5 t ha^{-1} FYM was applied as per the recommendation of package of practices (UAS, Bangalore). Thinning was done at 15 DAS by pulling out the extra seedlings in each hill and retaining only one seedling per hill. Hand weeding was done at 25 DAS to keep plots free from weeds. Earthing up was done at 30 DAS to encourage for rapid growth and to prevent lodging. Dimethioate @ 2 ml L^{-1} of water was given as spray to manage aphids and others sucking pests, during the period of 50 per cent of flowering stage at 55 DAS foliar nutrients were sprayed to the respective plots in three replications. The crop has attained the maturity at 85 DAS, the crop was harvested on 11th November, 2020 Subsequently, the pods from net plot area was harvested and allowed for sun drying for about a 4-5 days. After five days of sun-drying, threshing was done manually by beating the pods with a stick their after seeds were cleaned manually. Plot wise seed and haulm weight were recorded separately from each net plot after completion of threshing.

By using Fisher's method of analysis of variance technique which was given by Gomez and Gomez (1984) the analysis and interpretation of data were done.

Treatment details include, $T_{1:}$100 per cent RDF (Control), $T_{2:}$ 100 per cent RDF + foliar spray of urea @ 2 per cent, $T_{3:}$ 100 per cent RDF+ seed treatment with *Rhizobium* + PSB, $T_{4:}$ 100 per cent RDF + seed treatment with *Rhizobium* + PSB + 2 per cent urea spray, $T_{5:}$ 100 per cent RDF + seed treatment with *Rhizobium* + PSB+ 1 per cent 19:19:19 spray, $T_{6:}$ 100 per cent RDF + 1 per cent 19:19:19 spray, $T_{7:}$ 50 per cent RDF + 2.5 tonnes ha^{-1} FYM + 2 per cent urea spray, $T_{8:}$ 50 per cent RDF + 2.5 tonnes ha^{-1} FYM + 1 per cent 19:19:19 spray, $T_{9:}$ 50 per cent RDF +2.5 tonnes ha^{-1} FYM.

The Recommended dose of fertilizer is 25 kg N + 50 kg P_20_5 + 25 kg K_2O, for seed treatment 200 gram of *Rhizobium* and PSB used for 10 kg of seeds. All the foliar sprays were given at 50 per cent flowering stage.

Results and Discussion

Yield Attributes

The data presenting in (Table 1 and Fig. 1, respectively) revealed that maximum number of yield attributes *viz.,* No. of pods $plant^{-1}$ (27.1), No. of seeds pod^{-1} (16.9), Pod length (17.0 cm) and Test weight (10.9 grams) were recorded with the application of 100 per cent RDF + seed treatment with

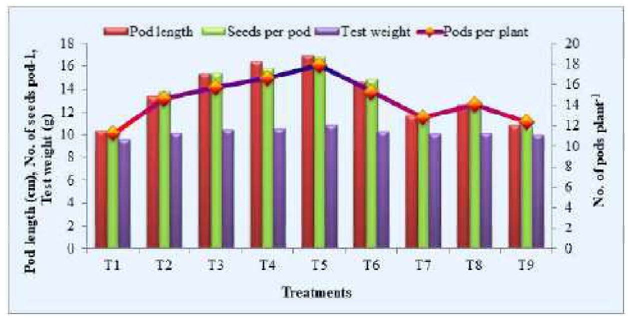

Fig. 1: Yield attributes of cowpea as influenced by integrated nutrient management

Table 1

Yield attributes of cowpea as influenced by integrated nutrient management

Treatments	No. of pods $plant^{-1}$	Pod length (cm)	No. of seeds pod^{-1}	Test weight (g)
T_1: 100% RDF (Control)	21.4	10.4	10.3	9.6
T_2: 100% RDF + foliar spray of urea @ 2%	24.8	13.4	13.8	10.2
T_3: 100% RDF+ seed treatment with *Rhizobium* + PSB	25.9	15.4	15.4	10.5
T_4: 100% RDF+ seed treatment with *Rhizobium* + PSB+ 2% urea spray	26.7	16.4	15.8	10.6
T_5: 100% RDF + seed treatment with *Rhizobium* + PSB + 1% 19:19:19 spray	27.1	17.0	16.9	10.9
T_6: 100% RDF + 1% 19:19:19 spray	25.2	14.6	14.8	10.3
T_7: 50% RDF + 2.5 tonnes ha^{-1} FYM + 2% urea spray	23.0	11.7	11.3	10.1
T_8: 50% RDF + 2.5 tonnes ha^{-1} FYM + 1% 19:19:19 spray	23.9	12.7	13.0	10.2
T_9: 50% RDF +2.5 tonnes ha^{-1} FYM	22.6	10.9	10.7	10.0
S. Em. ±	0.62	0.70	0.67	0.61
C.D. (P=0.05)	1.85	2.10	2.08	-

Rhizobium + PSB + 1 per cent 19:19:19 spray it is statistically on par with the application of 100 per cent RDF + seed treatment with *Rhizobium* + PSB + 2 per cent urea spray (26.7, 15.8, 16.4 and 10.6, respectively) and 100 per cent RDF + seed treatment with *Rhizobium* + PSB (25.9, 15.4, 15.4 cm and 10.5 g, respectively), Whereas minimum number of yield attributes *viz.,* No. of pods plant^{-1} (21.4), No. of seeds pod^{-1} (10.3 cm), Pod length (10.4) and Test weight (9.6 g.) were recorded in 100 per cent recommended dose of fertilizer (control).

The yield attributes are the symbol of vigorous plant growth and development. The optimum application of nutrients through soil as well as foliar nutrition offered easy availability for the absorption of macro nutrients in cowpea. It might be due to the efficient utilization of nitrogen helped for chlorophyll metabolism and boost of the production of carbohydrate. Phosphorus is essential for respiratory mechanism, which favoured more photosynthesis and vital for seed formation. Potassium plays important role in translocation of starch and protein synthesis. This was reflected in production of higher number of pods per plant of cowpea. The results are in closely associated with the findings of Manasa (2013), Malesha *et al.* (2014) and Sharma *et al.* (2015).

A reference to data in (Table 2 and Fig. 2), shows that, the maximum seed yield (1384 kg ha^{-1}), haulm yield (3267 kg ha^{-1}) and harvest index (29.8%) were recorded in treatment T_5 it is significantly on par with the treatment T_4 (1343,3176 and 29.7%) and T_3 (1291,3067 and 29.6%). However, minimum number of seed yield (735 kg ha^{-1}), haulm yield (1904 kg ha^{-1}) and harvest index (27.9%) were recorded in

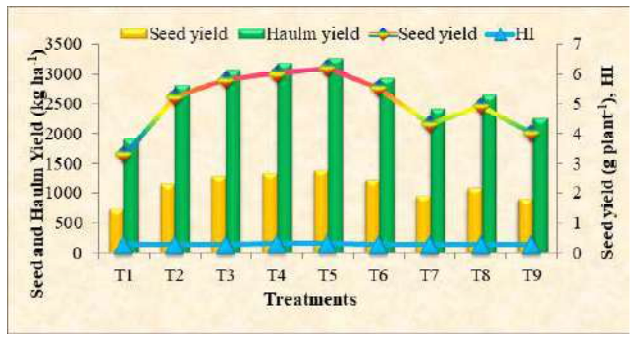

Fig. 2: Seed yield and haulm yield of cowpea as influenced by integrated nutrient management

TABLE 2

Seed yield, haulm yield and harvest index of cowpea as influenced by integrated nutrient management

Treatments	Seed yield (g plant^{-1})	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest Index (%)
T_1: 100% RDF(Control)	3.3	735	1904	27.9
T_2: 100% RDF + Foliar spray of urea @ 2%	5.2	1157	2804	29.2
T_3: 100% RDF+ seed treatment with *Rhizobium* + PSB	5.8	1291	3067	29.6
T_4: 100% RDF+ Seed treatment with *Rhizobium* + PSB + 2% urea spray	6.0	1343	3176	29.7
T_5: 100% RDF + seed treatment with *Rhizobium* + PSB + 1%19:19:19 spray	6.2	1384	3267	29.8
T_6: 100% RDF + 1% 19:19:19 spray	5.5	1222	2926	29.5
T_7: 50% RDF + 2.5 tonnes ha^{-1} FYM + 2% urea spray	4.3	945	2409	28.2
T_8: 50% RDF + 2.5 tonnes ha^{-1} FYM + 1% 19:19:19 spray	4.9	1083	2641	29.1
T_9: 50% RDF +2.5 tonnes ha^{-1} FYM	4.0	896	2265	28.4
S. Em. ±	0.23	50.3	115.2	
C.D. (P=0.05)	0.68	150.7	345.3	

control. It might be due to the dual seed inoculation benefited the plants by providing atmospheric N, increased the root nodulation through better root development and more nutrient availability and rendering the insoluble Phosphorus into available form also the 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 a plant. At critical stages of the crop growth macronutrients were effectively absorbed and translocated to the developing pods which lead to the better filling of seeds in the pod as a result increase in seed yield. The similar findings were reported by Vighnesh *et al.* (2022), Verma *et al.* (2009) and Amany (2007).

Nutrient Uptake

From the data presented in (Table 3 and Fig. 3), significantly higher nitrogen, phosphorous and potassium uptake (134.9 kg N ha^{-1},30.9 kg P_2o_5 and 125.9 K_2o kg ha^{-1}) as well as higher crude protein content (27.5%) were observed with the application of 100 per cent RDF + seed treatment with *Rhizobium* + PSB + 1 per cent 19:19:19 spray and it was statistically on par with the combined application of

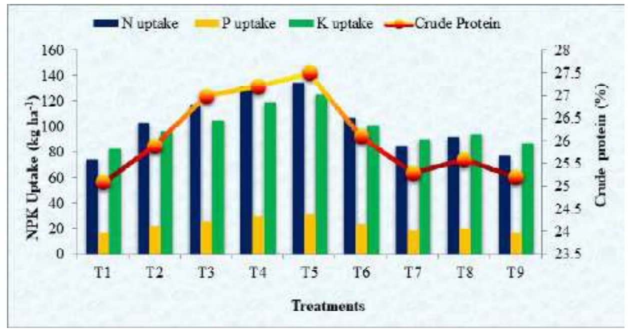

Fig. 3: Nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) uptake by cowpea as influenced by integrated nutrient management

100 per cent RDF+ seed treatment with *Rhizobium* + PSB + 2 per cent urea (131.7, 29.5 and 119.7 kg NPK ha^{-1}, respectively) followed by 100 per cent RDF+ seed treatment with *Rhizobium* + PSB (117.2, 25.7 and 104.9 kg NPK ha^{-1}, respectively). However, the lower nitrogen, phosphorous and potassium uptake (74.3, 16.1 and 83.2 kg NPK ha^{-1}, respectively) recorded in application with the 100 per cent recommended dose of fertililizer alone.

The increased nutrient uptake with integrated nutrient management because of increased balance supply of nutrients and good response by the plants resulted in

TABLE 3

Nutrient uptakes Nitrogen (N), Phosphorous (P_2o_5) and Potassium (K_2o) of cowpea as influenced by integrated nutrient management

Treatments	Nutrient uptakes		
	N uptake (kg ha^{-1})	P_2o_5 uptake (kg ha^{-1})	K_2o uptake (kg ha^{-1})
T_1: 100% RDF(Control) 25:50:25 kg ha^{-1} NPK	74.3	16.1	83.2
T_2: 100% RDF + foliar spray of urea @ 2%	103.2	22.1	96.9
T_3: 100% RDF+ seed treatment with Rhizobium + PSB	117.2	25.7	104.9
$T_{4:}$ 100% RDF + seed treatment with Rhizobium + PSB + 2% urea spray	131.7	29.5	119.7
T_5: 100% RDF + seed treatment with Rhizobium+ PSB + 1% 19:19:19 spray	134.9	30.9	125.9
T_6: 100% RDF + 1% 19:19:19 spray	107.4	23.6	101.2
T_7: 50% RDF + 2.5 tonnes ha^{-1} FYM + 2% urea spray	84.9	17.8	90.6
T_8: 50% RDF + 2.5 tonnes ha^{-1} FYM + 1% 19:19:19 spray	92.0	19.4	94.2
T_9: 50% RDF + 2.5 tonnes ha^{-1} FYM	77.2	16.6	87.7
SE(m)±	3.83	0.24	4.32
C.D. (P=0.05)	11.49	0.73	12.94

TABLE 4

Economics of cowpea as influenced by integrated nutrient management

Treatments	Cost of cultivation (A)	Gross returns (Rs. ha^{-1}) (B)	Net return (Rs. ha^{-1}) (C=B-A)	B:C Ratio (D=B/A)
T_1: 100% RDF (Control)	24602	34186	9584	1.39
T_2: 100% RDF + foliar spray of urea @ 2% spray	25202	53797	28595	2.13
T_3: 100% RDF + seed treatment with *Rhizobium* + PSB	24782	60021	35239	2.42
T_4: 100% RDF+ seed treatment with *Rhizobium* + PSB + 2% urea	25382	62431	37049	2.46
T_5: 100% RDF + seed treatment with *Rhizobium* + PSB +1% 19:19:19 spray	25382	64334	38952	2.53
T_6 : 100% RDF + 1% 19:19:19 spray	25202	56833	31631	2.26
T_7: 50% RDF + 2.5 tonnes ha^{-1} FYM + 2% urea spray	27789	43937	16148	1.58
T_8: 50% RDF + 2.5 tonnes ha^{-1} FYM + 1% 19:19:19 spray	27789	50364	22575	1.81
T_9: 50% RDF + 2.5 tonnes ha^{-1} FYM	27189	41678	14489	1.53

enhanced translocation of nutrients to reproductive structure *viz*., pods, seeds and other plant parts as well as continuous availability of N, P and nutrients throughout the crop growth period as the nutrients from inorganic sources were available to the crop in the early stages and the nutrients released from the organic sources become available in the later stages of crop growth. It also might be due to dual inoculation of seed treatments with *Rhizobium* and PSB. This dual inoculation benefited the plants by providing atmospheric N and rendering the insoluble phosphorus into available form which also resulted in improved nodulation and higher leghemoglobin content of root nodules along with an increase in nitrogen uptake, available soil nitrogen content and dry matter production in cowpea. 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 plant. The results were in colloboration with Venkatesh and Basu (2011), Bhoye (2016) and Mudalagiriyappa *et al*. (2016).

Economics

It is evident from the data presented in (Table 4 and Fig. 4), that the B:C ratio was found maximum in

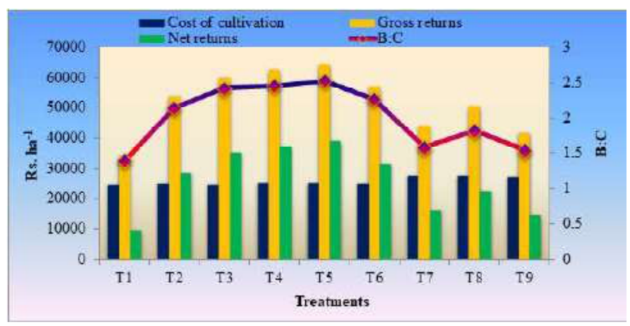

Fig. 4: Economics of cowpea cultivation influenced by integrated nutrient management

treatment T_5 (2.53). Whereas the minimum B:C ratio was recorded in treatment T_1 (1.39). It might happen due to high cost of cultivation. The benefit cost ratio is the 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 Sangamesh (2020), Jadhav and Kulkarni (2016) and Channabasavanna *et al.* (2017).

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