www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(4): 854-857

www.thepharmajournal.com
Received: 15-02-2022
Accepted: 25-03-2022

Pushpa K
Assistant Professor, Department of Agronomy, UAS, GKVK, Bangalore, Karnataka, India

Rudraswamy P
Retired Professor and Head AICRP on Arid Legumes, UAS, GKVK, Bangalore, Karnataka, India

Pruthviraj N
Senior Research Fellow, AICRP on Weed Management, UAS, GKVK, Bangalore, Karnataka, India

Corresponding Author
Pushpa K
Assistant Professor, Department of Agronomy, UAS, GKVK, Bangalore, Karnataka, India

Resource use efficiency and productivity of cowpea by agronomic interventions

Pushpa K, Rudraswamy P and Pruthviraj N

Abstract
Field experiments were conducted at Bengaluru during 2016, 2017 and 2018 with 9 treatments under RCBD and replicated thrice to evaluate the resource use efficiency and productivity of cowpea by agronomic interventions. The results showed that among different agronomic interventions, foliar spray of water-soluble fertilizer (WSF) 19:19:19 @ 1 % concentration during vegetative stage recorded higher growth parameters including plant height (30.07 cm) and the number of branches per plant (4.7 branches plant^{-1}) similarly yield parameters like higher number of pods plant^{-1} (9.0 pods plant^{-1}), number of seeds pod^{-1} (15.6 seeds pod^{-1}) and seed yield (1669 kg ha^{-1}). The same treatment also recorded higher gross returns (54941 Rs ha^{-1}), net returns (37850 Rs ha^{-1}) and B: C ratio (3.18) (pooled data of 3 years) but seed treatment with *Rhizobium* + PSB recorded on par results concerning pod length (16.7cm), number of seeds per pod (15.3 seeds) and seed yield (1616kg ha^{-1}). Providing the nutrients at the peak nutrient demand stage will improve the growth, yield parameters and economic returns to the farmers.

Keywords: Water-soluble fertilizer, plant population and micronutrients

Introduction
Cowpea [*Vigna unguiculata* (L.) Walp.] is an annual leguminous crop belongs to family Leguminoseae (Mackie and Smith, 1935) [6]. It is native to India (Vavilov, 1949) [16] but tropical and central Africa is also considered as secondary centre of origin where wild races are found even now.

Cowpea as a grain legume crop is an important source of food, income and livestock feed and forms a major component of tropical farming systems because of its ability to improve marginal lands through nitrogen fixation and as cover crop. The grain is also a good source of human protein, while the haulm is an important source of livestock protein (Fatokun, 2002) [4]. Cowpea has been referred to as “Poor man’s meat” because of its high protein content (20-25%). Cowpea considered as one of agriculture’s oldest legume used as protein source for humans and livestock (Steele, 1972) [14]. Seeds contains high amount of quality protein (23.4%), carbohydrate (60.3%), fat (1.8%) and sufficient amount of calcium (76mg/100gm), iron (57mg/100gm) and vitamins such as thiamine (0.92mg/100g.), riboflavin (0.18mg/100g.) and nicotinic acid (1.9mg/100g.) (Chatterjee and Bhattaacharya, 1986) [2].

The off-take crop of cowpea for fodder makes an important contribution to feed supplies for ruminants to maintain their health in dry season (Quin, 1997) [11]. Like other legumes, cowpea fixes atmospheric nitrogen (N) through Biological Nitrogen Fixation (BNF), a symbiotic association between soil dwelling bacteria, commonly known as rhizobia, and legume host plants. This symbiosis results in nitrogen replenishment as evidenced in many experimental findings that have illustrated increasing soil N levels following cowpea cultivation (Thies *et al*., 1995; Mulongoy and Ayanaba, 1985) [15, 10]. It has been estimated that cowpea can fix up to 200 kg N under field conditions (Giller, 2001) [5]. However, for cowpea to provide an adequate supply of N through BNF, grain legumes require rhizobia to be provided to the host plant either through the presence of effective native rhizobia, or through inoculation.

Macronutrients such as NPK responsible for plant growth and development, were depends on micronutrients availability. (Salwa *et al*., 2011) [12] Stated that micronutrients are used in lower amounts compared to macronutrients, such as N, P and K. But micronutrients play a vital role in cell activity, photosynthesis and enhancement of plant maturity (Zeidan, 2010) [18]. Furthermore, these micronutrients are responsible for CO_2 flowing out, vitamin A improvement and drought resistant mechanisms. So, deficiency of these nutrients can drastically reduce crop’s yield and productivity of the crops.

Row spacing has been reported to be very important agronomic practice which affect the crop yield potential of every crop (Staggenborg *et al*., 1999) [13]. Walker and Buchanan (1982) [17] reported that reducing narrow row spacing improves weed control by increasing crop competition, less availability of space for weeds to grow and reducing light penetration to the soil. To obtain optimum yield potential of the crop, the second formed fleshes also have to be nourished. Nutrients play a pivotal role in increasing the seed yield in pulses (Chandrasekhar and Bangarusamy, 2003) [1]. Foliar application is credited with the advantage of quick and efficient utilization of nutrients, elimination of losses through leaching and fixation and helps in regulating the uptake of nutrient by plants (Manonmani and Srimathi, 2009) [8].

The manipulation of row spacing dimensions, plant populations and the overall special arrangement of crop plants in field has been the subject of considerable discussion among farmers and agronomists for many years. Keeping this in view study was conducted to investigate the resource use efficiency and productivity of cowpea by agronomic interventions

Materials and methods

A Field experiment was conducted at Zonal Agricultural Research Station, GKVK, Bengaluru during 2016, 2017 and 2018. The experiment was laid out in Randomized Complete Block Design with nine treatments (T_1:Sowing recommended spacing;T_2:Reduce 25 % plant population;T_3:Increase 25 % plant population;T_4:Seed treatment with Rhizobium + PSB;T_5:Foliar spray of Urea @ 1 % at vegetative stage along with PP chemicals;T_6:Foliar spray of micronutrients @ 1% (Zinc and Boron) at vegetative stage;T_7:Foliar spray of WSF 19:19:19 @ 1 % at vegetative stage;T_8:Application of FYM @ 2.5 t/ha; T_9:Crop residue retention @ 3 t/ha) treatments replicated thrice.

The cowpea was sown in a plot size of 4.5m × 4 m (25.2m^2) for each treatment. one seed per hill were sowned to a depth of 5 cm on distance between row to row (45 cm) and plant to plant (10 cm) and Recommended dose of fertilizers (RDF) @ 25:50:25 kg N: P_2O_5: K_2O ha^{-1} was applied commonly to all treatments.Soil Characteristics of the experimental site: These soils are classified as fine, kaolinitic, isohyperthermic, Typic Kandiustalf as per USDA classification. The soil has 22 per cent moisture at field capacity 13.5 per cent at permanent wilting point (PWP). The available water content of the soil is 10.46 cm for the first 90 cm depth. Bulk density of the soil is about 1.59 to 1.42 g/cc.

Results and discussion

The results of the field experiment conducted to enhance the resource use efficiency and productivity of cowpea were presented in Table 1, 2 and 3. The experimental results revealed that foliar spray of water soluble fertilizer (WSF) 19:19:19 @ 1 % at vegetative stage recorded higher plant height (30, 30.56 and 29.65 cm in 2016, 2017 and 2018 year respectively). The treatment with 25 per cent increased plant population recorded on par results (29.73, 29.98 and 29.38 cm in 2016, 2017 and 2018 year respectively). The higher plant height was recorded mainly due to easy absorption of foliar applied water soluble N:P:K which increases the growth and development (Mandal *et al*., 2019) [7]. Similar observation were recorded in 25 per cent increased plant population treatment, when plant population increases then competition for light between the plants increases hence plant height was higher in higher plant population treatment (Chatterjee, B. N. and Bhattacharya, K. K. 1986) [2].

The treatment foliar spray of water soluble fertilizer (WSF) 19:19:19 @ 1 % at vegetative stage recorded early flowering (52, 56 and 51 days in 2016, 2017 and 2018 year respectively) and maturity (102, 105 and 103 days in 2016, 2017 and 2018 year respectively). Fatokun in 2002 recorded similar results with foliar application of all macro nutrients at peak nutrient demand stage in cowpea triggers the early flowering and it also mature in faster rate. The treatment foliar spray of water soluble fertilizer (WSF) 19:19:19 @ 1 % at vegetative stage recorded higher number of branches (4.5, 5.6 and4.7 branches per plant in 2016, 2017 and 2018 year respectively) and higher number of pods per plant (8.9, 9.8 and 8.4 in 2016, 2017 and 2018 year respectively), but the treatment with 25 per cent reduced population recorded on par results with respect to number of branches and also number of pods per plant.

Optimum plant population for a crop depends on situation and condition, variety, cultivar, availability of water, nutrients and sunlight; length of growing season; potential plant size; and the plant's capacity to change its form in response to varying environmental conditions (Mandal *et al*., 2019) [7]. Wider spacing leads to higher number of branches due to higher foraging area per plant (Steele, 1972) [14]. If spacing between the plants is increased then higher number of branches can be observed in both determinate and indeterminate crops (Dakal *et al*., 2016). The treatment foliar spray of water soluble fertilizer (WSF) 19:19:19 @ 1 % at vegetative stage recorded higher pod length (16.3, 18.6 and 15.7 cm in 2016, 2017 and 2018 year respectively), higher number of seeds per pod (15.2, 17.1 and 14.4 number of seeds per pod in 2016, 2017 and 2018 year respectively) and higher seed yield (1574, 2072 and1362 kg ha^{-1} in 2016, 2017 and 2018 year respectively) but seed treatment with *Rhizobium* + PSB recorded on par results with respect to pod length (cm), number of seeds per pod and seed yield (kg ha^{-1}).

Mandal *et al*., in 2019 [7] recorded *Rhizobium* + PSB as nitrogen is directly involved in vegetative growth and reduces the disease and insect incidence which reduces the biological stress for plant growth. Similarly seed treatment with *Rhizobium* + PSB improves the number branches through their nutrient fixation and mobilization which makes easy availability of nutrients for growth. Similar observations recorded under influence of biofertilizers on growth and yield of pigeonpea (Singh *et al*., 2008). The higher amount of yield recorded with foliar application of macro nutrients at vegetative stage these nutrients play important role in plant metabolism and photosynthesis which improves the yield of the plant. Similar effect recorded under biofertilizer treatment in pulse crops (Meena *et al*., 2014) [9], INM practices in cowpea conducted by Dhakal and his associates (Dhakal *et al*., 2016) [3] and influence of biofertilizers on growth and yield of pigeonpea (Singh *et al*., 2008).

The treatment foliar spray of water soluble fertilizer (WSF) 19:19:19 @ 1 % at vegetative stage recorded higher gross returns (55106, 57460 and 52256 Rs ha^{-1} in 2016, 2017 and 2018 year respectively), net returns (37618, 40165 and 35766 Rs ha^{-1} in 2016, 2017 and 2018 year respectively) and Benefit cost ratio (3.25, 3.37 and 2.93 in 2016, 2017 and 2018 year respectively) but seed treatment with *Rhizobium* + PSB recorded on par results with respect to gross returns, net returns and B:C ratio.

Table 1: Enhancing resource use efficiency and productivity of cowpea by agronomic interventions (2016 data)

Treatments	Plant height (cm)	Days to 50 % flowering	Days to maturity	No. of branches/ plant	No. of pods /plant	Pod length (cm)	No. of seeds/pod	Seed Yield kg/ha	Gross Returns (Rs./ha)	Net Returns (Rs./ha)	B:C ratio
T_1:Sowing recommended spacing	22.53	57	109	3.3	7.6	14.7	13.0	1,352	47,310	28,147	2.93
T_2:Reduce 25 % plant population	23.60	54	103	4.3	8.6	14.6	12.0	1,396	48,848	30,185	3.12
T_3:Increase 25 % plant population	29.73	54	104	3.5	8.1	14.1	12.6	1,373	48,038	31,375	2.88
T_4:Seed treatment with Rhizobium + PSB	27.00	54	106	3.4	7.4	16.1	14.9	1,521	52,333	35,970	3.15
T_5:Foliar spray of Urea @ 1 % at vegetative stage along with PP chemicals	26.40	53	106	3.3	8.1	14.2	13.4	1,386	50,995	31,212	2.80
T_6:Foliar spray of micronutrients @ 1% (Zinc and Boron) at vegetative stage	25.27	54	104	2.9	7.6	14.5	13.1	1,413	49,958	30,495	2.87
T_7:Foliar spray of WSF 19:19:19 @ 1 % at vegetative stage	30.00	52	102	4.5	8.9	16.3	15.2	1,574	55,106	37,618	3.25
T_8:Application of FYM @ 2.5 t/ha	23.60	54	105	2.9	6.3	14.7	11.3	1,346	47,125	28,687	2.56
T_9:Crop residue retention @ 3 t/ha	21.80	54	104	2.8	7.0	14.3	12.3	1,319	46,148	28,885	2.67
S.Em. ±	0.7	0.4	0.9	0.3	0.4	0.5	0.5	26	1240	1845	0.08
CD (p=0.05)	2.1	1.2	2.7	0.9	1.2	1.5	1.5	78	3720	5535	0.24
CV	11.29	7.1	8.6	14.5	18.3	15.2	18.0	16.2	20.1	18.6	8.9

Note: T_2: by increased intra row spacing, T_3: by reduced intra- row spacing

Table 2: Enhancing resource use efficiency and productivity of cowpea by agronomic interventions (2017 data)

Treatments	Plant height (cm)	Days to 50 % flowering	Days to maturity	No. of branches/ plant	No. of pods /plant	Pod length (cm)	No. of seeds/pod	Seed Yield kg/ha	Gross Returns (Rs./ha)	Net Returns (Rs./ha)	B:C ratio
T_1:Sowing recommended spacing	22.84	61	112	4.4	8.5	17.0	14.9	1,850	49,664	30,694	3.05
T_2:Reduce 25 % plant population	24.60	58	106	5.4	9.5	16.9	13.9	1,894	51,202	32,732	3.24
T_3:Increase 25 % plant population	29.98	58	107	4.6	9.0	16.4	14.5	1,871	50,392	33,922	3.00
T_4:Seed treatment with Rhizobium + PSB	26.70	58	109	4.5	8.3	18.4	16.8	2,019	54,687	38,517	3.27
T_5:Foliar spray of Urea @ 1 % at vegetative stage along with PP chemicals	26.50	57	109	4.4	9.0	16.5	15.3	1,884	53,349	33,759	2.92
T_6:Foliar spray of micronutrients @ 1% (Zinc and Boron) at vegetative stage	25.89	58	107	4.0	8.5	16.8	15.0	1,911	52,312	33,042	2.99
T_7:Foliar spray of WSF 19:19:19 @ 1 % at vegetative stage	30.56	56	105	5.6	9.8	18.6	17.1	2,072	57,460	40,165	3.37
T_8:Application of FYM @ 2.5 t/ha	23.80	58	108	4.0	7.2	17.0	13.2	1,844	49,479	31,234	2.68
T_9:Crop residue retention @ 3 t/ha	22.80	58	107	3.9	7.9	16.6	14.2	1,817	48,502	31,432	2.79
S.Em. ±	0.7	0.3	0.8	0.3	0.4	0.4	0.5	21	1184	984	0.07
CD (p=0.05)	2.1	1.1	2.5	0.9	1.2	1.4	1.5	63	3552	3462	0.22
CV	10.19	7.5	8.2	13.2	16.3	14.7	12.6	18.2	18.6	19.2	8.8

Table 3: Enhancing resource use efficiency and productivity of cowpea by agronomic interventions (2018 data)

Treatments	Plant height (cm)	Days to 50 % flowering	Days to maturity	No. of branches/ plant	No. of pods /plant	Pod length (cm)	No. of seeds/ pod	Seed Yield kg/ha	Gross Returns (Rs./ha)	Net Returns (Rs./ha)	B:C ratio
T_1:Sowing recommended spacing	22.18	56	110	3.5	7.1	14.1	12.2	1,140	44,460	26,295	2.61
T_2:Reduce 25 % plant population	23.25	53	104	4.5	8.1	14.0	11.2	1,184	45,998	28,333	2.80
T_3:Increase 25 % plant population	29.38	53	105	3.7	7.6	13.5	11.8	1,161	45,188	29,523	2.56
T_4:Seed treatment with Rhizobium + PSB	26.65	53	107	3.6	6.9	15.5	14.1	1,309	49,483	34,118	2.83
T_5:Foliar spray of Urea @ 1 % at vegetative stage along with PP chemicals	26.05	52	107	3.5	7.6	13.6	12.6	1,174	48,145	29,360	2.48
T_6:Foliar spray of micronutrients @ 1% (Zinc and Boron) at vegetative stage	24.92	53	105	3.1	7.1	13.9	12.3	1,201	47,108	28,643	2.55
T_7:Foliar spray of WSF 19:19:19 @ 1 % at vegetative stage	29.65	51	103	4.7	8.4	15.7	14.4	1,362	52,256	35,766	2.93
T_8:Application of FYM @ 2.5 t/ha	23.25	53	106	3.1	5.8	14.1	10.5	1,134	44,275	26,835	2.24
T_9:Crop residue retention @ 3 t/ha	21.45	53	105	3.0	6.5	13.7	11.5	1,107	43,298	27,033	2.35
S.Em. ±	0.6	0.3	0.5	0.3	0.4	0.4	0.5	32	1254	984	0.07
CD (p=0.05)	1.8	1.1	1.5	0.8	1.2	1.3	1.4	96	3762	2952	0.21
CV	12.19	7.5	10.4	15.4	10.3	12.7	11.6	15.2	18.6	19.2	9.2

Pooled data

Table 4: Enhancing resource use efficiency and productivity of cowpea by agronomic interventions

Treatments	Plant height (cm)	Days to 50 % flowering	Days to maturity	No. of branches/ plant	No. of pods /plant	Pod length (cm)	No. of seeds/pod	Seed Yield kg/ha	Gross Returns (Rs./ha)	Net Returns (Rs./ha)	B:C ratio
T_1:Sowing recommended spacing	22.52	58	110	3.7	7.7	15.3	13.4	1447	47145	28379	2.86
T_2:Reduce 25 % plant population	23.82	55	104	4.7	8.7	15.2	12.4	1491	48683	30417	3.05
T_3:Increase 25 % plant population	29.70	55	105	3.9	8.2	14.7	13.0	1468	47873	31607	2.81
T_4:Seed treatment with Rhizobium + PSB	26.78	55	107	3.8	7.5	16.7	15.3	1616	52168	36202	3.08
T_5:Foliar spray of Urea @ 1 % at vegetative stage along with PP chemicals	26.32	54	107	3.7	8.2	14.8	13.8	1481	50830	31444	2.73
T_6:Foliar spray of micronutrients @ 1% (Zinc and Boron) at vegetative stage	25.36	55	105	3.3	7.7	15.1	13.5	1508	49793	30727	2.80
T_7:Foliar spray of WSF 19:19:19 @ 1 % at vegetative stage	30.07	53	103	4.9	9.0	16.9	15.6	1669	54941	37850	3.18
T_8:Application of FYM @ 2.5 t/ha	23.55	55	106	3.3	6.4	15.3	11.7	1441	46960	28919	2.49
T_9:Crop residue retention @ 3 t/ha	22.02	55	105	3.2	7.1	14.9	12.7	1414	45983	29117	2.60
S.Em. ±	0.6	0.3	0.4	0.2	0.3	0.4	0.5	30	1128	902	0.06
CD (p=0.05)	1.8	1.2	1.3	0.7	1.1	1.2	1.5	90	3384	2706	0.20
CV	13.59	8.1	13.4	12.6	11.3	13.6	12.5	14.2	17.6	20.2	8.7

Conclusion

Cowpea crop responds very well for foliar application of macro nutrients at vegetative stage compared to all other treatments. Providing the nutrients at peak demand nutrient stage will enhance the enzymatic activity inturn it improves the growth and yield parameters. Foliar feeding for the crops will reduces the nutrient losses hence it reduces the cost of cultivation inturn it improves the economic returns. Wider spacing enhances branching but it reduces yield per area similarly if population increases then competition for resources increases then yield per plant reduces hence optimum population plant stand should be maintained. Seed treatment with bio fertilizers improves the nutrient uptake and reduces disease and pest incidence to the crop it is one of the low cost technology to improve the yield.

Reference

1. Chandrasekhar CN, Bangarusamy U. Maximizing the yield of mung bean by foliar application of growth regulating chemicals and nutrients. Madras Agricul. J. 2003;90(1-3):142-145.
2. Chatterjee BN, Bhattacharya KK. Principle and practices of grain legume production. Oxford and IBH publishing Co. Ltd., New Delhi, 1986.
3. Dhakal Y, Meena RS, Kumar S. Effect of INM on nodulation, yield, quality and available nutrient status in soil after harvest of green gram. Legum res. 2016;39(4):590-594.
4. Fatokun AC. Breeding cowpea for resistance to insect pest; attempted crosses between cowpea and Vigna vexillata. In: challenges and opportunities for enhancing sustainable cowpea production, Fatokun, C.A,S.A. Tawawali, B.B. Singh, P. M. Kormawa and M.Tamo (Eds). International Institute For Tropical Agriculture (IITA) Ibadan, Nigeria, 2002, 52-61
5. Giller KE. Nitrogen Fixation in Tropical Cropping Systems. 2nd ed. Wallingford, 2007, UK: CAB International.
6. Mackie WW, Smith FL. Evidence of field hybridization in beans. J American Soci. Agrono. 1935;27:903-908.
7. Mandal RK, Pal AK, Singh R, Abha R. Effect of integrated nutrient management on vegetative growth of cowpea [*Vigna unguiculata* (L.) Walp.]. J. Pharmacognosy and Phytochemistry. 2019;8(6):1560-1566.
8. Manonmani V, Srimathi P. Influence of mother crop nutrition on seed and quality of blackgram. Madras Agricul. J. 2009;96(16):125-128.
9. Meena JS, Verma HP, Pancholi P. Effect of fertility levels and biofertilizers on yield, quality and economic of cowpea. Agriculture for Sustainable Development. 2014;2(2):162-164.
10. Mulongoy K, Ayanaba A. Dynamics of the population sizes of cowpea and soybean rhizobia at three locations in West Africa. World J Microbiology. 1985;2(2):301-308.
11. Quin FM. Introduction. In: Advan. Cowpea Res., Singh, B.B., Ral., Mohan, Deshiell,K. and Jackai, L.E.N. (Eds.). IITA/JIRCAS, IITA, 1997, Ibadan, Nigeria, IX-XV.
12. Salwa ABA, Movahhedi M, Dehnavi, Yadavi AR, Adhami E. Effects of Zn and K foliar application on physiological traits and yield of spring safflower under drought stress, EJCP, 2011;4(1):75-95.
13. Staggenborg S, Fjell D, Devlin D, Gordon W, Marsh B. Grain sorghum response to row spacings and seeding rates in Kansas. Journal of Production Agriculture. 1999;12:390-395.
14. Steele WM. Cowpea in Africa. Doctroal Thesis, University of Reading, United Kingdom, 1972.
15. Thies JE, Woomer PL, Singleton PW. Enrichment of Bradyrhizobium sp populations in soil due to cropping of the homologous host legume. Soil Biology and Biochemistry. 1995;27(415):633-636.
16. Vavilov NI. The origin, variation, immunity and breeding of cultivated plants. Chronica Botanica. 1949;13:1-54.
17. Walker RH, Buchanan GA. Crop manipulation in integrated weed management systems. Weed Science. 1982;30:17-24.
18. Zeidan MS. Effect of Foliar Fertilization of Fe, Mn and Zn on Wheat Yield and Quality in Low Sandy Soils Fertility, World J Agricultural Sciences. 2010;6(6):696-69.