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Effect of Foliar Nutrition on Yield and Economics of Cowpea (*Vigna unguiculata*)

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ABSTRACT

An experiment was conducted at Zonal Agricultural Research Station (ZARS), Gandhi KrishiVigyan Kendra (GKVK), University of Agricultural Sciences (UAS), Bangalore to evaluate the foliar nutrition on growth and yield of cowpea under changing climate. Experiment consists of application of three foliar nutrients and their concentrations (DAP, Pulse magic and Ampoxcilin) at 40 DAS. The experiment consists of thirteen treatments replicated thrice in RCBD. The yield attributes were significantly varied with foliar application of 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxcilin. Higher number of pod plant^{-1} (27.8), Pod length (18.1 cm) and number of seeds pod^{-1} (17.5) were recorded. Whereas, lower number of pod plant^{-1} (20.6), pod length (14.7 cm) and number of seeds pod^{-1} (13.5) were recorded with 75 per cent RDF + Water spray. Higher seed yield, net returns and BC ratio (1357 kg ha^{-1}, Rs. 60534 ha^{-1}and 2.91, respectively) recorded with application of 75 per cent RDF + 2 per cent DAP + 2 per cent pulse magic + 0.2 per cent ampoxcilin and lower seed yield, net returns and BC ratio (Rs.24556 ha^{-1} and 1.71, respectively) were obtained with 100 per cent RDF + Water spray.

Keywords : Cowpea, Foliar nutrition, Pulse magic, Ampoxcilin, Yield and economics

COWPEA (*Vigna unguiculata*) is one of the most important pulse crops among the various green legumes. It is also called as vegetable meat due to high amount of protein in grain and better biological value on dry weight basis. Besides being a rich source of protein, they maintain soil fertility through biological nitrogen fixation in soil and thus play a vital role in furthering sustainable (Salih, 2013). India is the largest producer and consumer of pulses in the world accounting for 33.6 per cent of the world area and 24 per cent of the world production of pulses. The area under pulse crop is increasing continuously but productivity is decreasing year by year. The reasons for decreasing productivity are due to decreasing soil fertility especially macro and micronutrients, imbalanced use of fertilizer and occurrences of physiological disorders such as inefficient partitioning of assimilates, poor pod setting, excessive flower abscission and lack of nutrients during the critical stages of crop growth leads to nutrient stress, poor growth and productivity were found to be some of the yield barriers of pulse crop. These nutrients are more important because in pulse crop synchronized flowering altered the source-sink relationship due to rapid translocation of nutrients from leaves to the developing pods (Chandrasekhar and Bangarusamy, 2003). To overcome these constraints, additional nutrition through foliar feeding play a vital role in pulse production by stimulating root development, nodulation, energy transformation, various metabolic processes and increasing pod setting and thereby increasing the yield.

MATERIAL AND METHODS

The experiment was conducted at Zonal Agricultural Research Station (ZARS), Gandhi Krishi Vigyan Kendra (GKVK), University of Agricultural Sciences (UAS), Bangalore. The center 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 930 m above mean sea level. The soil of the experimental site was red sandy loam in texture, classified under the order *Alfisols*. The composite soil samples from 0 to 30 cm depth were collected randomly in experimental area before sowing from each replication. The moisture content at field capacity was 18.63 per cent with a bulk density of 1.43 g cc^{-1}. The soil of the site was slightly acidic in reaction (pH 6.05) with medium electrical conductivity (0.30 dS m^{-1}) and organic carbon content (0.43%). It had low available nitrogen (242.04 kg ha^{-1}), medium phosphorus (26.13 kg ha^{-1}) and medium potassium (281.31 kg ha^{-1}), respectively. The experiment included thirteen treatments laid out in randomized complete block design with three replications. Treatments involved of application of foliar nutrients.T_1 100 per cent RDF (Control), T_2 100 per cent RDF + 2 per cent DAP at 40 DAS, T_3 100 per cent RDF + 2 per cent Pulse magic at 40 DAS, T_4 100 per cent RDF + 0.2 per cent Ampoxcilin at 40 DAS, T_5 75 per cent RDF + 2 per cent DAP at 40 DAS, T_6 75 per cent RDF + 2 per cent Pulse magic at 40 DAS, T_7 75 per cent RDF + 0.2 per cent Ampoxicilin at 40 DAS, T_8 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic at 40 DAS, T_9 75 per cent RDF +2 per cent DAP + 0.2 per cent Ampoxicilin at 40 DAS, T_{10}75 per cent RDF + 2 per cent Pulse magic + 0.2 per cent Ampoxicilin at 40 DAS, T_{11} 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxicilin at 40 DAS, T_{12} 100 per cent RDF + Water spray and T_{13}75 per cent RDF + Water spray. The cowpea variety KBC-2 seeds were sown in lines at the rate of 25 kg ha^{-1} at a depth of 2-3 cm, maintaining 45 cm row to row and 10 cm plant to plant spacing. The crop was fertilized with 25 kg N, 50 kg P_2O_5 and 25 kg K_2O through urea, single super phosphate and muriate of potash, respectively and labour input for all the operations. The predominant market prices of the cowpea after harvest was attained from the Zonal Agricultural Research Station, GKVK, Bengaluru was used for the calculation of gross returns. Gross returns, net returns and benefit cost ratio were worked out by using the following formulae and expressed in rupees per hectare.

Gross return = [Seed yield x market rate of seed]

Net returns = Gross returns – total cost of cultivation

$$\text{Benefit cost ratio} = \frac{\text{Gross returns (Rs. ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs. ha}^{-1}\text{)}}$$

Results and Discussion

The experimental results are discussed in the subsequent sub-headings :

Effect on Plant Growth

Plant height was significantly influenced by different foliar nutrition. At 60 DAS, application of 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxcilin spraying at 40 DAS recorded significantly higher plant height (69.4 cm) but, it was on par with 75 per cent RDF + 2 per cent Pulse magic + 0.2 per cent Ampoxicilin at 40 DAS and 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic at 40 DAS (68.7 cm and 68.5 cm, respectively). Whereas, lower plant height (50.1 cm) was recorded with 75 per cent RDF + Water spray. At harvest, significantly maximum number of branches $plant^{-1}$ (11.5) were recorded by application of 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxcilin at 40 DAS. However, it was on par with 75 per cent RDF + 2 per cent Pulse magic + 0.2 per cent Ampoxicilin at 40 DAS and 75 per cent RDF + 2 per cent, respectively). Minimum number of branches $plant^{-1}$ (7.5) were recorded with 75 per cent RDF + Water spray. At harvest, significantly higher dry matter production (14.1 g $plant^{-1}$) were recorded by application of 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxcilin at 40 DAS. However, it was on par with 75 per cent RDF + 2 per cent Pulse magic + 0.2 per cent Ampoxicilin at 40 DAS and 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic at 40 DAS (13.9 and 13.7 g $plant^{-1}$, respectively). Whereas, lower dry matter production (8.6 g $plant^{-1}$) was recorded with 75 per cent RDF + Water spray (Table 1). The increase in plant height number of branches $plant^{-1}$ and dry matter production, it might be due to foliar application of DAP, Pulse magic and Ampoxcilin provides both macro and micro nutrients to the plant and also enhanced the optimum availability of nutrients to the crop resulting osmotic turgor of cell, cell division and cell elongation in cowpea. These finding were well supported by the work of Khalilzadeh *et al*. (2015), Naidu *et al*. (2015) and Mudalagiriyappa *et al*. (2016). Lyngdoh *et al*. (2019).

TABLE 1

Plant height number of branches plant^{-1} and dry matter production (g plant^{-1}) of cowpea as influenced by foliar nutrition

Treatment	Plant Height (cm)		Number of branches Plant^{-1}		Dry matter production (g plant^{-1})		
	30 DAS	60 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T_1 : 100 % RDF (Control)	15.2	51.5	7.6	7.9	4.2	9.9	9.1
T_2 : 100 % RDF + 2 % DAP at 40 DAS	15.1	63.7	9.3	9.6	4.4	12.0	11.5
T_3 : 100 % RDF + 2 % Pulse magic at 40 DAS	15.8	64.0	9.3	9.6	4.6	12.5	11.8
T_4 : 100 % RDF + 0.2 % Ampoxicilin at 40 DAS	15.5	60.7	9.0	9.4	4.8	11.5	11.0
T_5 : 75 % RDF + 2 % DAP at 40 DAS	15.5	63.6	9.2	9.6	5.0	12.5	11.9
T_6 : 75 % RDF + 2 % Pulse magic at 40 DAS	15.0	64.0	9.4	9.9	4.8	12.6	12.2
T_7 : 75 % RDF + 0.2 % Ampoxicilin at 40 DAS	15.6	60.1	8.9	9.3	4.2	11.5	10.9
T_8 : 75 % RDF + 2 % DAP + 2 % Pulse magic at 40 DAS	15.4	68.5	10.3	10.7	4.5	14.5	13.7
T_9 : 75 % RDF + 2 % DAP + 0.2 % Ampoxicilin at 40 DAS	15.6	64.0	9.5	10.0	4.1	12.8	12.4
T_{10} : 75 % RDF + 2 % Pulse magic + 0.2 % Ampoxicilin at 40 DAS	15.6	68.7	10.4	11.0	4.5	14.6	13.9
T_{11} : 75 % RDF + 2 % DAP + 2 % Pulse magic + 0.2 % Ampoxicilin at 40 DAS	15.0	69.4	10.9	11.5	4.1	14.9	14.1
T_{12} : 100 % RDF + Water spray	15.4	52.9	7.6	7.9	4.2	10.0	9.4
T_{13} : 75 % RDF + Water spray	14.8	50.1	7.3	7.5	4.0	9.8	8.6
S.Em. ±	0.4	1.8	0.4	0.4	0.4	0.5	0.5
C.D. (P=0.05)	NS	5.3	1.2	1.3	NS	1.4	1.5

There was no significant variation observed in chlorophyll content (SPAD meter readings) at 30 DAS and 60 DAS and days to 50 per cent flowering. At 60 DAS, significant difference was observed in number of nodules plant^{-1} due to different foliar nutrition. The higher number of nodules plant^{-1} (39.1) were recorded with application of 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxcilin at 40 DAS followed by 75 per cent RDF + 2 per cent Pulse magic + 0.2 per cent Ampoxcilin at 40 DAS and 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic at 40 DAS (38.7 and 38.5, respectively) and lower number of nodules plant^{-1} (28.1) were recorded with 75 per cent RDF + Water spray (Table 2). Maximum number of root nodules plant^{-1} were recorded by the application of 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxcilin because, nitrogen and phosphorus influenced on root development of the plant and it might profuse nodulation on account of increase in the rhizobial activity in the rhizosphere which in turn resulted in the formation of active and more number of nodules. The foliar application of DAP, Pulse magic and Ampoxcilin provides both macro and micro nutrients to the plant in that molybdenum is an essential trace element and is vital for synthesis and activity of molybdoenzymes such as nitrogen assimilation, enzyme-nitrate reductase and the nitrogen fixing enzyme-nitrogenase, the key regulatory component for initiation of nodulation and maintenance of nitrogen fixation in legumes. Again phosphorus plays an important role in the plant's root development, facilitating the earlier formation of nodules, enhancing the activity of Rhizobia, increasing their numbers and

TABLE 2

SPAD reading, days to 50 per cent flowering and number of nodules plant^{-1} in cowpea influenced by foliar nutrition

Treatment	SPAD reading at 30 DAS	SPAD reading at 60 DAS	Days to 50 % flowering	No. of nodules plant^{-1} at 60 DAS
T_1 : 100 % RDF (Control)	45.6	55.09	52.4	28.9
T_2 : 100 % RDF + 2 % DAP at 40 DAS	45.4	55.33	53.0	34.5
T_3 : 100 % RDF + 2 % Pulse magic at 40 DAS	45.5	55.42	53.0	34.8
T_4 : 100 % RDF + 0.2 % Ampoxcilin at 40 DAS	45.4	55.23	52.4	33.2
T_5 : 75 % RDF + 2 % DAP at 40 DAS	44.6	55.39	52.1	34.8
T_6 : 75 % RDF + 2 % Pulse magic at 40 DAS	45.4	55.77	52.3	34.9
T_7 : 75 % RDF + 0.2 % Ampoxcilin at 40 DAS	45.3	55.21	52.2	33.6
T_8 : 75 % RDF + 2 % DAP + 2 % Pulse magic at 40 DAS	45.3	55.87	53.0	38.5
T_9 : 75 % RDF + 2 % DAP + 0.2 % Ampoxcilin at 40 DAS	44.4	55.97	53.0	34.9
T_{10} : 75 % RDF + 2 % Pulse magic + 0.2 % Ampoxcilin at 40 DAS	46.1	55.91	53.3	38.7
T_{11} : 75 % RDF + 2 % DAP + 2 % Pulse magic + 0.2 % Ampoxcilin at 40 DAS	46.0	55.98	53.8	39.1
T_{12} : 100 % RDF + Water spray	44.8	55.14	52.6	29.1
T_{13} : 75 % RDF + Water spray	44.7	54.99	52.0	28.1
S. Em. ±	0.7	0.29	0.4	1.4
C.D. (P = 0.05)	NS	NS	NS	4.0

enhancing the nitrogen fixation. It also affects plant growth and metabolism through energy storage and transfer in the nodules. These finding were well supported by the work of Srivastava and Varma (1998) and Sarawgi *et al.* (1999).

Effect on Yield

Among different foliar nutrition treatments, application of 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxcilin spraying at 40 DAS, recorded significantly higher seed (1357 kg ha^{-1}) and haulm yield (3550 kg ha^{-1}) compared to all the treatments. However, it was statistically on par with application of 75 per cent RDF+2 per cent Pulse magic + 0.2 per cent Ampoxicilin at 40 DAS, (1285 and 3231 kg ha^{-1}, respectively) and 75 per cent RDF +2 per cent DAP + 2 per cent Pulse magic at 40 DAS, (1271 and 3101 kg ha^{-1}, respectively). Foliar nutrition increased the synthesis and translocation of photosynthates from source to sink which in turn registered higher number of pods plant^{-1}, number of seeds pod^{-1} and hundred seed weight. The cumulative and conjunctive application of nutrients to the crop might have enjoyed with sufficient nutrient condition for a longer period of time and the nutrient uptake there by allowing the plant to perpetuate with all the yield components and yield. These results were in conformity with the findings of Subba Rami Reddy *et al.* (2011), EL - Habbasha *et al.* (2012), Mishra *et al.* (2012) and Sangamesh *et al.* (2020). Whereas, the lower seed yield (859 kg ha^{-1}) and haulm yield (2153 kg ha^{-1}) was noticed in 75 per cent RDF + Water spray (Table 3).

Economics

The data pertaining to economicsof cowpea cultivation influenced by foliar nutrition presented in Table 4. The higher gross returns and B: C (Rs. 92276 ha^{-1} and

TABLE 3

Test weight, seed yield, haulm yield and harvest index of cowpea as influenced by foliar nutrition

Treatment	Test weight (g)	Seed yield (g plant^{-1})	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest Index (%)
T_1 : 100 % RDF (Control)	9.6	4.5	869	2172	28.6
T_2 : 100 % RDF + 2 % DAP at 40 DAS	10.0	6.7	1135	2813	28.7
T_3 : 100 % RDF + 2 % Pulse magic at 40 DAS	10.0	6.8	1141	2820	28.8
T_4 : 100 % RDF + 0.2 % Ampoxcilin at 40 DAS	9.9	6.2	1102	2634	29.5
T_5 : 75 % RDF + 2% DAP at 40 DAS	10.1	6.6	1126	2763	29.0
T_6 : 75 % RDF + 2 % Pulse magic at 40 DAS	10.1	6.8	1149	2823	28.9
T_7 : 75 % RDF + 0.2 % Ampoxcilin at 40 DAS	9.8	6.1	1084	2580	29.6
T_8 : 75 % RDF + 2 % DAP + 2 % Pulse magic at 40 DAS	10.1	7.5	1271	3101	29.1
T_9 : 75 % RDF + 2 % DAP + 0.2 % Ampoxcilin at 40 DAS	10.0	6.9	1160	2868	28.8
T_{10} : 75 % RDF + 2 % Pulse magic + 0.2 % Ampoxcilin at 40 DAS	10.2	7.6	1285	3231	28.5
T_{11} : 75 % RDF + 2 % DAP + 2 % Pulse magic + 0.2 % Ampoxcilin at 40 DAS	10.4	7.7	1357	3550	27.7
T_{12} : 100 % RDF + Water spray	9.7	5.0	872	2204	28.3
T_{13} : 75 % RDF + Water spray	9.5	4.4	859	2153	28.5
S. Em. ±	0.2	0.3	52	168	
C.D. (P = 0.05)	NS	0.7	151	489	

TABLE 4

Cost of cultivation, gross returns, net returns and B: C of cowpea as influenced by different foliar nutrition

Treatment	Total cost of cultivation (Rs. ha^{-1}) (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)	33490	59092	25602	1.76
T_2 : 100 % RDF + 2 % DAP at 40 DAS	34980	77180	42200	2.21
T_3 : 100 % RDF + 2 % Pulse magic at 40 DAS	36690	77588	40898	2.11
T_4 : 100 % RDF + 0.2 % Ampoxicilin at 40 DAS	36040	74936	38896	2.08
T_5 : 75 % RDF + 2 % DAP at 40 DAS	28493	76568	48076	2.69
T_6 : 75 % RDF + 2 % Pulse magic at 40 DAS	30203	78132	47930	2.59
T_7 : 75 % RDF + 0.2 % Ampoxicilin at 40 DAS	29553	73712	44160	2.49
T_8 : 75 % RDF + 2 % DAP + 2 % Pulse magic at 40 DAS	30443	86428	55986	2.84
T_9 : 75 % RDF + 2 % DAP + 0.2 % Ampoxicilin at 40 DAS	29793	78880	49088	2.65
T_{10} : 75 % RDF + 2 % Pulse magic + 0.2 % Ampoxicilin at 40 DAS	31503	87380	55878	2.77
T_{11} : 75 % RDF + 2 % DAP + 2 % Pulse magic + 0.2 % Ampoxicilin at 40 DAS	31743	92276	60534	2.91
T_{12} : 100 % RDF + Water spray	34740	59296	24556	1.71
T_{13} : 75 % RDF + Water spray	28253	58412	30160	2.07

2.91, respectively) in cowpea were obtained with application of 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxicilin and lowest gross returns (Rs.58412 ha^{-1}) with 75 per cent RDF + Water spray. The higher net returns (Rs.60534 ha^{-1}) of cowpea was obtained with application of 75 per cent RDF + 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxicilin and lowest net returns and B:C (Rs.24556 and 1.71, respectively) were obtained with 100 per cent RDF + Water spray. The gross returns, net returns and B: C was higher from higher seed yield with foliar nutrition because of greater availability of essential nutrients to plant, better translocation of photosynthates leads to higher haulm and grain yield. Similar results were reported by Martin Stanley (2013); Rajeshkumar*et al.* (2017) and Kumar and Simaiya, (2019).

Combined application of 75 per cent RDF + 2 per cent DAPS + 2 per cent Pulse magic + 0.2 per cent Ampoxicilin contributes higher seed yield and income. Foliar application of 2 per cent DAP + 2 per cent Pulse magic + 0.2 per cent Ampoxicilin along with 75 per cent RDF resulted into 57 per cent increase in grain yield (1357 kg ha^{-1}) over 75 per cent RDF alone (859 kg ha^{-1}) besides reduction in required fertilizers and cost of cultivation.

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