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Effect of foliar nutrition on yield and nutrient uptake of cowpea (*Vigna unguiculata*)

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Abstract
The experiment was conducted at Zonal Agricultural Research Station (ZARS), Gandhi Krishi Vigyan Kendra (GKVK), University of Agricultural Sciences (UAS), Bangalore. To evaluate the of 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 consist of thirteen treatments replicated thrice in RCBD. The yield attributes were significantly varied with foliar application of 75% RDF + 2% DAP + 2% Pulse magic + 0.2% 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% 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% RDF + 2% DAP + 2% Pulse magic + 0.2% Ampoxcilin and lower seed yield, net returns and BC ratio (Rs. 24556 ha^{-1} and 1.71, respectively) were obtained with 100% RDF + Water spray.

Keywords: Cowpea, DAP, pulse magic, Ampoxcilin, yield and nutrient uptake

Introduction
Cowpea (*Vigna unguiculata*) is one of the most important pulse crop 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) [10]. India is the largest producer and consumer of pulses in the world accounting for 33.6 percent 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 factors 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 to synchronized flowering altered the source-sink relationship due to rapid translocation of nutrients from leaves to the developing pods (Chandrasekhar and Bangarusamy, 2003) [1]. To overcome these constraints, additional nutrition through foliar feeding is 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 is slightly acidic in reaction (pH 6.05) with medium electrical conductivity (0.30 dS m^{-1}) and organic carbon content (0.43%). It has 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 of thirteen treatments laid out in randomized complete block design with three replications. Treatments involved of application of foliar nutrients.T_1 100% RDF (Control), T_2 100% RDF + 2% DAP at 40 DAS, T_3 100% RDF + 2% Pulse magic at 40 DAS, T_4 100% RDF + 0.2% Ampoxcilin at 40 DAS, T_5 75% RDF + 2% DAP at 40 DAS, T_6 75% RDF + 2% Pulse magic at 40 DAS, T_7 75% RDF + 0.2% Ampoxcilin at 40 DAS, T_8 75% RDF + 2% DAP + 2% Pulse magic at 40 DAS, T_9 75% RDF + 2% DAP + 0.2% Ampoxcilin at 40 DAS, T_{10} 75% RDF + 2% Pulse magic + 0.2% Ampoxcilin at 40 DAS, T_{11} 75% RDF + 2% DAP + 2% Pulse magic + 0.2% Ampoxcilin at 40 DAS, T_{12} 100% RDF + Water spray and T_{13} 75% 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 murate of potash respectively, and labour input for all the operations. Samples were dehydrated in hot air oven at 70 ºC and powdered by using Willey mill to permit through 40 mm mesh sieve.

The powdered material was collected in paper bags and examined for nitrogen, phosphorus and potassium (Micro Kjeldhal method, Vanadomolybdo phosphoric yellow colour method and flame photometer method, respectively) and subsequently, the uptake per hectare was computed. Nutrient uptake (kg ha^{-1}) by crop and weed was calculated for each treatment separately using the following formula.

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient concentration (\%)}}{100} \times \text{Dry matter (kg ha}^{-1})$$

Results and Discussion

The experiment results were discussed in the subsequent sub-headings:

Effect on yield

Among different foliar nutrition treatments, application of 75% RDF + 2% DAP + 2% Pulse magic + 0.2% 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% RDF + 2% Pulse magic + 0.2% Ampoxicilin at 40 DAS, (1285 and 3231 kg ha^{-1}) and 75% RDF + 2% DAP + 2% 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 result were in conformity with the findings of Subba Rami Reddy *et al.* (2011) [13], EL – Habbasha *et al.* (2012) [3] and Mishra *et al.* (2012) [7]. Whereas, the lower seed yield (859 kg ha^{-1}) and haulm yield (2153 kg ha^{-1}) was noticed in 75% RDF + Water spray (Table 1).

Table 1: Plant height, Number of branches Plant^{-1}, Seed yield and haulm yield of cowpea influenced by foliar nutrition

Treatments	Plant height (At 60 DAS)	Number of branches Plant^{-1} (At harvest)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
T_1: 100% RDF (Control)	51.5	7.9	869	2172
T_2: 100% RDF + 2% DAP at 40 DAS	63.7	9.6	1135	2813
T_3: 100% RDF + 2% Pulse magic at 40 DAS	64.0	9.6	1141	2820
T_4: 100% RDF + 0.2% Ampoxicilin at 40 DAS	60.7	9.4	1102	2634
T_5: 75% RDF + 2% DAP at 40 DAS	63.6	9.6	1126	2763
T_6: 75% RDF + 2% Pulse magic at 40 DAS	64.0	9.9	1149	2823
T_7: 75% RDF + 0.2% Ampoxicilin at 40 DAS	60.1	9.3	1084	2580
T_8: 75% RDF + 2% DAP + 2% Pulse magic at 40 DAS	68.5	10.7	1271	3101
T_9: 75% RDF + 2% DAP + 0.2% Ampoxicilin at 40 DAS	64.0	10.0	1160	2868
T_{10}: 75% RDF + 2% Pulse magic + 0.2% Ampoxicilin at 40 DAS	68.7	11.0	1285	3231
T_{11}: 75% RDF + 2% DAP + 2% Pulse magic + 0.2% Ampoxicilin at 40 DAS	69.4	11.5	1357	3550
T_{12}: 100% RDF + Water spray	52.9	7.9	872	2204
T_{13}: 75% RDF + Water spray	50.1	7.5	859	2153
S. Em. ±	1.8	0.4	52	168
C.D. (P=0.05)	5.3	1.3	151	489

Effect on nutrient uptake

Among the different treatments foliar application with combinations of 75% RDF + 2% DAP + 2% Pulse magic + 0.2% Ampoxcilin at 40 DAS shows significantly higher nitrogen, phosphorus and potassium uptake (115.2 N, 17.4 P_2O_5 and 128.8 K_2O kg ha^{-1}) (Table 2), and it was on par with foliar application of 75% RDF + 2% Pulse magic + 0.2% Ampoxcilin (110.9 N, 17.0 P_2O_5 and 17.0 K_2O kg ha^{-1}). Whereas, the lower nitrogen, phosphorus and potassium uptake was recorded in 75% RDF + Water spray (76.3 N, 12.8 P_2O_5 and 86.2 K_2O kg ha^{-1}), respectively. Foliar application with 75% RDF + 2% DAP + 2% Pulse magic + 0.2% Ampoxcilin increased nitrogen uptake might be due to increased availability of nitrogen to the crop and higher biomass production and retarded the loss of chlorophyll and leaf nitrogen with increased photosynthesis and increase in nitrogen supply during flowering and pod filling stages of cowpea. The increase in uptake of phosphorous and potassium has been attributed to the foliar spray of micro and macro nutrients and growth hormone increase the uptake of nutrients from soil and also increases metabolic activity in the plant cell. The increased in nutrient uptake with foliar application because of increased balance supply of nutrients and good response by the plants resulted in enhanced translocation of nutrients to reproductive structure *viz*., pods, seeds and other plant parts. Since, foliar application of fertilizers had higher N, P and K content in seed and straw, therefore, it can be inferred that nutrient absorption mechanism also got stimulated under these treatments. The significant effect of foliar nutrition on nutrient uptake might

be due to its easy availability and absorption of nutrients under foliar spray without spending much energy for their transport and without any loss in transit. The results were in corroboration with Srivastava and Srivastava (1994) [12], Sathyamoorthi *et al.* (2007) [11], Geetha and Velayutham (2009) [2], Venkatesh and Basu (2011) [14], and Mondal *et al.* (2011) [8].

Table 2: Seed crude protein content, nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) uptake by cowpea influenced by foliar nutrition

Treatments	Crude Protein (%)	N uptake (kg ha^{-1})	P_2O_5 uptake (kg ha^{-1})	K_2O uptake (kg ha^{-1})
T_1: 100% RDF (Control)	26.1	78.1	13.1	88.2
T_2: 100% RDF + 2% DAP at 40 DAS	26.6	102.1	15.8	116.5
T_3: 100% RDF + 2% Pulse magic at 40 DAS	26.4	102.8	15.9	116.7
T_4: 100% RDF + 0.2% Ampoxcilin at 40 DAS	26.4	95.2	15.0	110.6
T_5: 75% RDF + 2% DAP at 40 DAS	26.5	102.1	15.7	115.3
T_6: 75% RDF + 2% Pulse magic at 40 DAS	27.0	102.8	15.9	116.5
T_7: 75% RDF + 0.2% Ampoxcilin at 40 DAS	26.2	94.7	14.6	108.8
T_8: 75% RDF + 2% DAP + 2% Pulse magic at 40 DAS	27.2	110.0	16.9	126.8
T_9: 75% RDF + 2% DAP + 0.2% Ampoxcilin at 40 DAS	27.0	103.2	16.0	116.9
T_{10}: 75% RDF + 2% Pulse magic + 0.2% Ampoxcilin at 40 DAS	27.3	110.9	17.0	127.2
T_{11}: 75% RDF + 2% DAP + 2% Pulse magic + 0.2% Ampoxcilin at 40 DAS	27.7	115.2	17.4	128.8
T_{12}: 100% RDF + Water spray	26.3	79.6	13.2	90.7
T_{13}: 75% RDF + Water spray	25.8	76.3	12.8	86.2
F- test	NS	*	*	*
S. Em. ±	0.4	3.4	0.5	4.1
C.D. (P=0.05)	-	9.8	1.3	11.9

Economics

The data pertaining to economics of cowpea cultivation influenced by foliar nutrition presented in Table 3. The higher gross returns and B: C ratio (Rs. 92276 ha^{-1} and 2.91, respectively) in cowpea were obtained with application of 75% RDF + 2% DAP + 2% Pulse magic + 0.2% Ampoxicilin and lowest gross returns (Rs. 58412 ha^{-1}) with 75% RDF + Water spray. The higher net returns (Rs. 60534 ha^{-1}) of cowpea was obtained with application of 75% RDF + 2% DAP + 2% Pulse magic + 0.2% Ampoxicilin and lowest net returns and B:C ratio (Rs. 24556 and 1.71, respectively) were obtained with 100% RDF + Water spray. The gross returns, net returns and B: C ratio are 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. The similar results were reported by Martin Stanley (2013) [6], Rajeshkumar *et al.* (2017) [9] and Kumar and Simaiya, (2019) [5].

Table 3: Cost of cultivation, gross returns, net returns and BC ratio of cowpea influenced by different foliar nutrition

Treatments	Total 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)	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

Summary

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

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