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M Madhu
Scientist (Agronomy), AICRP on Kharif Pulses RARS, Warangal, PJTAU, Telangana, India

N Sandhyakishore
Scientist (GPB), AICRP on Kharif Pulses RARS, Warangal, PJTAU, Telangana, India

CH Pallavi
Scientist (Agronomy), DAATTC, Tornala, PJTAU, Telangana, India

G Padmaja
Scientist (Plant Pathology), AICRP on Kharif Pulses RARS, Warangal, PJTAU, Telangana, India

D Veeranna
Scientist (Entomology), AICRP on Kharif Pulses RARS, Warangal, PJTAU, Telangana, India

P Jaganmohan Rao
Director (Seeds) SRTC, Rajendranagar, RARS, Warangal, PJTAU, Telangana, India

R Uma Reddy
Associate Director of Research RARS, Warangal, PJTAU, Telangana, India

Corresponding Author:
M Madhu
Scientist (Agronomy), AICRP on Kharif Pulses RARS, Warangal, PJTAU, Telangana, India

Influence of foliar nutrition on growth, yield and economics of pigeonpea under rainfed conditions in Telangana

M Madhu, N Sandhyakishore, CH Pallavi, G Padmaja, D Veeranna, P Jaganmohan Rao and R Uma Reddy

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Abstract
A field experiment was conducted at Regional Agriculture Research Station, Warangal, PJTAU, Telangana during kharif season 2018-2020 to study the effect of foliar application of mineral nutrients in pigeonpea. Application of RDF +Urea spray @ 2% at 50% flowering stage recorded significantly more number of pods/ plant, number of seeds/pod and higher grain yield (1709 kg/ha) with a BC ratio of 3.20, when compared to application RDF alone (1261 kg/ha and BC ratio of 2.3). However, RDF +Urea spray was statistically on par with application of RDF +Pulse magic @1% (grain yield 1658 kg/ha, BC ratio of 3.13) and application of RDF +19: 19: 19 @ 0.5% (1643 kg/ha, 3.01 grain yield and BC ratio respectively).

Keywords: Pigeonpea, pulse magic, mono ammonium phosphate, urea, foliar application, iron, zinc, flower drop, yield attributes and economics

Introduction
Among pulses, pigeonpea is one of the important pulse crops as a major source of protein in the diets of large section of vegetarian population in the developing countries in general and India. Yield of pigeonpea remains low due to excessive vegetative growth, indeterminate growth habit and poor source-sink relationship. Nitrogen (N), phosphorus (P) and potassium (K), collectively known as NPK, are essential macronutrients crucial for plant growth, supporting key physiological and biochemical processes such as photosynthesis, protein synthesis, and energy transfer. (Nagalaxmi *et al*., 2024) [2]. Fertilizer is a vital input in agriculture to boost the crop yields. Among the methods of fertilizer application, foliar nutrition is recognized as an important method of fertilization. Since foliar nutrients usually penetrate the leaf cuticle or stomata and enters the cells facilitating easy and rapid utilization of nutrients. Application of plant nutrients in balanced proportion and appropriate quantities is absolutely essential for improving the productivity of pulses. Nutrient elements are needed in relatively very small quantities for adequate plant growth and production. Their deficiency may cause great disturbances in the physiological and metabolic processes, involved in the plant. It has been well established that most of the plant nutrients are absorbed through the leaves and absorption would be remarkably rapid and nearly complete. Foliar nutrition reduces the cost of cultivation which in turn reduces the amount of fertilizer thereby reducing the loss and also economizing crop production.
Nationally, pigeonpea ranks second in pulse production, after chickpea. India is the world's largest producer of pulses, with 37% of the area (28.9 million hectares) and 29% (26.58 million tonnes) of the production. India's average productivity is 851 kg/ha during 2023. In India, pigeonpea is grown in an area of 4.04 million hectares with the production of 2.80 million tonnes with the productivity of 826 kg ha^{-1}. In Telangana, pigeonpea is grown on 1.78 lakh hectares, yielding 1.44 lakh tonnes with a productivity of 809 kg ha^{-1}. (DES, Ministry of Agriculture & Farmers Welfare, GoI, 2023-24) [1].
Pulses are considered to be the major sources of protein among the vegetarians in India and complement the staple cereals in the diet with proteins, essential amino acids, vitamins and minerals. It contains 22-24% protein, which compares well with that of other important grain

legumes which is almost twice the protein in wheat and thrice that of rice. Pulses provide significant nutritional and health benefits (Jukanti *et al*., 2012) [4].

Materials and Methods

A field experiment was conducted at Regional Agriculture Research Station, Warangal during three years (*Vanakalam*, 2018 to 2020). The experimental site is situated in the Central Telangana agro-climatic zone. The soil at the site exhibited a high pH level (7.5), an electrical conductivity (EC) of 0.62 dsm^{-1}, low available nitrogen (215.8 kg ha^{-1}), medium range of phosphorus (29.7 kg ha^{-1}), high potassium levels (324 kg ha^{-1}) and medium organic carbon content (0.64%). The experimental trial was laid out in Randomized block design, consisted of eight treatments, T_1: RDF only, T_2: RDF + 19: 19: 19 @ 0.5%, T_3:RDF + Mono Ammonium Phosphate (MAP) @ 1%, T_4: RDF + Pulse magic @ 1%, T_5:RDF + Urea 2%, T_6:RDF + $ZnSO_4$ @ 0.5%, T_7:RDF + $FeSO_4$ @ 0.5%, T_8:RDF + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and replicated thrice with a spacing of 120 x 20 cm. (Pulse magic is a biproduct for increasing the yield of pulse crops. It contains 10 percent nitrogen, 40 percent phosphorous, 3 percent micronutrient and 20 PPM plant growth regulator).

A recommended NPK fertilizer application rate of 20-50-00 kg/ha was implemented using urea and single superphosphate. Entire dose of N and P_2O_5 were applied basally. The foliar spraying of nutrients was done as per treatment schedule at 50% flowering stage using Knapsack Sprayer. The spray fluid used per hectare was 500 lit. ha¹. The observations on growth characters, yield attributes and yield were recorded. The economics were worked out based on the prevailing market price. Appropriate plant protection measures were proactively implemented as required. Total rainfall during the crop's growth period in three years was 705 mm, 1254 mm and 1726.4 mm in 2018-19, 2019-20, and 2020-21 respectively. Statistical analysis of the data, collected using a randomized block design, was performed via ANOVA.

Results and Discussion

Growth characters

Growth characters of pigeonpea were not significantly influenced by different foliar application, but however higher plant height (217 cm) was observed with T_4 (RDF + Pulse magic @ 1%) and T_8 (RDF + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5%) treatments (Table 1).

Yield attributes and yield

Foliar application of different nutrients along with basal application of RDF increased the yield attributes and yield (Table 1 & 2). Pooled data of 3 years indicated that, application of RDF+Urea spray@2% at 50% flowering stage recorded significantly maximum number of pod palnt^{-1} (228), higher grain yield (1709 kg/ha) which was statistically on par with application of RDF +Pulse magic @ 1% (1658 kg/ha) and RDF +19: 19: 19 @ 0.5% (1643 kg/ha), when compared to application RDF alone (1261 kg/ha). The findings in the present study were similar with Patil *et al*, 2021 [6] and Das *et al*, 2015 [5]. Application of at RDF +Urea spray @ 2% at 50% flowering stage in pigeonpea crop for obtaining 15-20% higher yields when compared with RDF application alone. By application of foliar nutrition synchronized flowering altered the source-sink relationship due to rapid translocation of nutrients from leaves to the developing pods. And also application of nutrients might have been easily absorbed by plant system and translocated more effectively and efficiently into developing pods and might have resulted in proper seed filling, which ultimately reflected with higher seed yield.

Economics

Among the different foliar nutrition practices, application of RDF + Urea spray@2% at 50% flowering stage recorded higher gross return, net returns and BC ratio (Rs. 95934 ha^{-1}, Rs. 68471 ha^{-1}, 3.2 respectively) which is closely followed by application of RDF + Pulse magic@1% at 50% flowering stage (Rs. 94882 ha^{-1}, Rs. 67025 ha^{-1}, 3.13 respectively) and application of RDF +19: 19: 19 @ 0.5% (Rs. 91326 ha^{-1}, Rs. 63727 ha^{-1}, 3.01), when compared to application RDF alone (Rs. 70681 ha^{-1}, Rs. 43624 ha^{-1}, 2.3). The findings in the present study are in conformity with Patil *et al*, 2021 [6].

Table 1: Influence of foliar nutrition on plant height, number of pods/plant and number of fruiting branches/ plant of *kharif* pigeonpea under rainfed condition pooled data of three years

Treatment	Plant height at harvest (cm)				Number of pods/plants				No. of fruiting branches/plant			
	2018-19	2019-20	2020-21	Pooled data	2018-19	2019-20	2020-21	Pooled data	2018-19	2019-20	2020-21	Pooled data
T_1: RDF only	254	166	203	208	206	163.3	175.7	182	11.4	11.2	12.2	11.6
T_2: RDF + 19: 19: 19 @ 0.5%	262	173	207	214	282	179.7	202.7	221	13.0	11.8	12.3	12.4
T_3: RDF + Mono Ammonium Phosphate (MAP) @ 1%	249	181	190	207	283	181.3	198.7	221	11.6	12.5	11.7	11.9
T_4: RDF + Pulse magic @ 1%	263	174	215	217	281	192.3	194.0	222	12.0	11.3	13.2	12.2
T_5: RDF + Urea 2%	266	166	204	212	283	187.3	212.3	228	10.1	11.7	12.5	11.4
T_6: RDF + $ZnSO_4$ @ 0.5%	259	171	216	215	238	169.7	192.3	200	11.4	10.5	12.8	11.6
T_7: RDF + $FeSO_4$ @ 0.5%	253	169	197	206	245	176.3	185.0	202	11.9	11.2	12.2	11.8
T_8: RDF + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5%	261	170	220	217	247	169.7	193.3	203	13.1	12.7	11.5	12.4
S.Em±	5.7	12.1	7.5	4.1	10	7.0	5.8	3.3	0.5	0.6	0.4	0.3
CD P= (0.05)	NS	NS	NS	NS	31	NS	17.9	10.2	0.6	NS	NS	NS

Table 2: Influence of foliar nutrition on 100 Seed weight (g), No. of seeds pod^{-1} Grain yield (kg ha^{-1}) of *kharif* pigeonpea under rainfed condition pooled data of three years

Treatment	100 Seed weight (g)				No. of seeds pod^{-1}				Grain yield (kg ha^{-1})			
	2018-19	2019-20	2020-21	Pooled data	2018-19	2019-20	2020-21	Pooled data	2018-19	2019-20	2020-21	Pooled data
T_1: RDF only	8.80	8.90	8.60	8.8	4.0	4.0	4.0	4.0	1224	1153	1408	1261
T_2: RDF + 19: 19: 19 @ 0.5%	9.05	9.11	8.83	9.0	3.9	3.9	4.1	4.0	1644	1416	1869	1643
T_3: RDF + Mono Ammonium Phosphate (MAP) @ 1%	8.40	9.28	8.87	8.9	3.9	4.0	4.2	4.0	1643	1395	1719	1586
T_4: RDF + Pulse magic @ 1%	8.76	9.03	8.75	8.8	4.0	4.0	4.0	4.0	1744	1486	1744	1658
T_5: RDF + Urea 2%	8.48	9.10	9.03	8.9	4.1	3.9	4.2	4.1	1780	1453	1894	1709
T_6: RDF + $ZnSO_4$ @ 0.5%	8.80	8.90	8.67	8.8	4.0	4.0	4.0	4.0	1443	1238	1592	1425
T_7: RDF + $FeSO_4$ @ 0.5%	8.28	8.62	8.62	8.5	3.9	3.9	4.1	4.0	1431	1294	1618	1448
T_8: RDF + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5%	8.79	9.23	8.68	8.9	3.9	3.7	4.0	3.9	1452	1332	1718	1501
S.Em±	0.23	0.16	0.12	0.1	0.05	0.1	0.4	0.1	107	82.2	36	30
CD P= (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	327	NS	111	92

Table 3: Gross returns (Rs. ha^{-1}), net returns (Rs. ha^{-1}) and benefit cost ratio of *kharif* redgram as influenced by different foliar nutrition

Treatment	Gross returns (Rs. ha^{-1})				Net returns (Rs. ha^{-1})				Benefit cost ratio			
	2018-19	2019-20	2020-21	Pooled data	2018-19	2019-20	2020-21	Pooled data	2018-19	2019-20	2020-21	Pooled data
T_1: RDF only	69462	66861	75720	70681	45731	38221	46920	43624	1.93	2.33	2.63	2.30
T_2: RDF + 19: 19: 19 @ 0.5%	93297	82100	98580	91326	69366	52585	69230	63727	2.90	2.78	3.36	3.01
T_3: RDF + MonoAmmonium Phosphate (MAP) @ 1%	93240	80891	95160	89764	69309	51101	65560	61990	2.90	2.72	3.21	2.94
T_4: RDF + Pulse magic @ 1%	98972	86194	99480	94882	75041	55804	70230	67025	3.14	2.84	3.40	3.13
T_5: RDF + Urea 2%	101015	84248	102540	95934	77084	55038	73290	68471	3.22	2.88	3.51	3.20
T_6: RDF + $ZnSO_4$ @ 0.5%	81890	71829	85440	79720	57959	41439	55740	51713	2.42	2.36	2.88	2.55
T_7: RDF + $FeSO_4$ @ 0.5%	81209	75051	86880	81047	57278	44661	57180	53040	2.39	2.47	2.93	2.60
T_8: RDF + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5%	82401	77266	90060	83242	58470	45626	60860	54985	2.44	2.44	3.08	2.65

Conclusion

Based on the result it is concluded that, foliar application of 2% urea or 1% Pulse magic or 19:19:19 @ 0.5% nutrients at 50% flowering stage along with basal application of RDF is beneficial than sole RDF during sowing to realize 15% additional grain yield in pigeonpea farmers during kharif season in Telangana.

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