EFFECT OF FOLIAR NUTRITION ON GROWTH AND YIELD OF PIGEONPEA [*Cajanus cajan.* (L.) *Mill sp*.]

Abstract

Pigeonpea is most important rainfed pulse cropof Karnataka. Yield of pigeonpea is fluctuating due to variation in climate causing flower drop and poor pod set. Thefield experiment was conducted to study growth and yield of pigeonpeaas influenced by foliar nutrition. The experiment consisted of foliar application of twotypes of nutrients (19:19:19 and Pulse magic), two growth promoters (NAA, and N- Triacontanol)and their combinations at flowering and pod formation stages. The growth and yield attributesvaried significantly and RDF + foliar application of 1% pulse magic at flowering and pod formation stage recorded significantly higherplant height (144.6 cm), number of branches (16.8 plant^{-1}), leaf area (3218 cm^{2} plant^{-1}),total dry matter accumulation (135.5 g plant^{-1}), absolute growth rate (0.812 g plant^{-1} day^{-1},), crop growth rate (5.19 g m^{-2} day^{-1}) and relative growth rate (0.01gg^{-1} day^{-1}) as compared to control (122.2 cm, 12.9,2421 cm^{2} plant^{-1},89.4 g plant^{-1},0.633 g plant^{-1} day^{-1}, 4.24 g m^{-2}day^{-1} and 0.007 gg^{-1} day^{-1},respectively) at harvest. Higher seed yield(1590 kg ha^{-1}), stalk yield (4308 kg ha^{-1}) and harvest index (0.26)recorded with the application ofRDF + foliar application of 1% pulse magic at flowering and pod formation stage and lower seedyield,stalk yield and harvest index (1104 kg ha^{-1}, 3416 kg ha^{-1}and 0.23, respectively) wasrecorded with control treatment.

***Keywords*:** Pigeonpea, pulse magic, NAA, N-Triacontanol, foliar nutrition

Introduction

"Pigeonpea, the major kharif pulse crop and is the second most important pulse crop in the country. It accounts for about 11.8% of the total pulse area and 17% of total pulse production of the country, which is the major source of dietary protein for most of the vegetarian population".(Giri et al., 2018), It is mainly eaten in the form of split pulse as 'dal'. Seeds of pigeonpea are also rich in iron, iodine, essential amino acids like lysine, tyrosine, cystine and arginine. Because of the poor source-sink relationship and indeterminate growth habit, the yield of pigeonpea is quite low. It is well recognized that plant growth regulators affect the source-sink relationship and promote photo assimilate translocation, which aids in flower formation, fruit and seed development and eventually increases crop output.

“In pigeonpea vegetative and reproductive stage, occurs side by side and hence there is competition for available assimilates between vegetative and reproductive sinks. On the other hand, always there is a limitation of source (leaves) particularly at flowering and pod development stages.Mineral nutrient deficiencies limit nitrogen fixation by the legume-rhizobium symbiosis, resulting in low legume yields. Nutrient limitations to legume production result from deficiencies of not only major nutrients but also micronutrients” (Bhuiyan *et al*., 1999).“Apart from its genetic makeup, the major physiological constraints limiting pigeonpea’s yield are flower and fruit drop” (Ojeaga and Ojehomon, 1972).“There is possibility to overcome these constraints by agronomic strategies. Among several strategies to boost the productivity of pigeonpea, application of nutrients and plant growth regulators (PGR) may serve as one of the important strategies which plays diverse and vital role in plant growth and development.Among the methods of nutrient application, foliar application is credited with the advantage of quick and efficient utilization of nutrients by eliminating the losses through leaching, fixation and regulating the uptake of nutrients by plants” (Manonmani and Srimathi 2009, Rahman *et al*., 2014). “Application of nutrients through foliar spray at appropriate stages of growth becomes important for their utilization and better performance of the crop” (Anandhakrishnaveni*et al*., 2004).“Foliar application of nutrients and plant growth regulators at critical stages like flowering and pod formation are known to improve physiological efficiency including photosynthetic ability of plant, enhance the source sink relationship and stimulate the translocation of photo assimilates, thereby increase the productivity” (Thakur *et al*., 2017). Keeping the above background, the present investigation was taken up on growth and yield of pigeonpea as influenced by nutrients and plant growth regulators.

Material and Methods

The field experiment wasconducted during *Kharif*2022at ‘K’ Block, Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru.The experimentalsite belongs to Eastern Dry Zone(Zone-V)ofKarnataka and located between 12º 51' N Latitude and 77º 35' E Longitude at an altitude of 930mabovemeansealevel(MSL). The soil of the experiment site is red sandy loam (Soil pH 6.08; EC 0.19 dSm^{-1}). The available soil nitrogen, phosphorus and potassium were 280.2, 26.1 and 257.5 kg ha^{-1}, respectively. The experiment was laid out in Randomized Complete Block Design (RCBD) with 8 treatments. The treatments viz.,foliar application of 0.5 % pulse magic at flowering stage (T_1), foliar application of 0.5% pulse magic at flowering and pod formation stage (T_2), foliar application of 1% pulse magic at flowering stage (T_3), foliar application of 1% pulse magic at flowering stage (T_4), foliar application of 2% water soluble fertilizer (19:19:19) + 0.05% NAA at flowering stage (T_5), foliar application of 2% water soluble fertilizer (19:19:19) + 0.05% NAA at flowering and pod formation stage (T_6), foliar application of 2% water soluble fertilizer (19:19:19) + 200 ppm N- Triacontanol at flowering stage (T_7) and Control (T_8) with 3 replications using BRG-5 variety with spacing of 90×15 cm. The recommended dose of fertilizer (NPK 25:50:25 kg ha^{-1})is common for all the treatments.

Pulse magic is a product developed and released by UAS, Raichur for increasing the yield of pulse crops. It contains 10 percent nitrogen, 40 percent phosphorous, 3 percent micronutrients and 20 ppm plant growth regulator. The two sprays were taken up at 2 stages *viz*., at flowering and pod formation stage. Five plants were tagged at random in net plot area for recording growth parameters and growth indices such as Absolute growth rate (g plant^{-1} day^{-1}), Crop growth rate (g m^{-2} day^{-1}) and Relative growth rate (g g^{-1} day^{-1}) and also recorded the seed yield (kg ha^{-1}) and stalk yield (kg ha^{-1}) and compared with the control (RDF).

Result and Discussion

At 45 and 90 DAS, there was no significant difference among the treatments with respect to plant height, number of branches per plant, leaf area and total dry matter accumulation per plantbecause of the basal dose of RDF was common for all the treatments and treatment imposition were taken after the flowering stage.

At 135 DAS and at the time of harvest, significantly higher plant height (142.1 and146.6 cm, respectively) and number of branches per plant (14.9 and 16.8, respectively) were observed with the foliar application of 1% pulse magic at flowering and pod formation stage and which were on par with thefoliar application of 1 % pulse magic spray at flowering stage (137.4 & 141.4 cm and 14.9 & 16.8, respectively). The significant increase in plant height after 90 DAS to harvest, may be attributed to foliar application of pulse magic which provides both macro and micro nutrients and also growth promotors to the plant thereby enhanced the availability of nutrients to the crop and which helps the osmotic turgor of cell, cell division and cell elongation in pigeonpea.The adequate supply of nutrients and growth regulators through foliar spray of pulse wonder helped to sustain a higher auxin level, resulting in enhanced plant height, number of branches chlorophyll content in black gram (Kiruthika *et al*., 2021).The present findings are similar with that of findings of Venkatesh and Basu (2011) in chickpea and Akshata *et al.* (2015) in black gram and Mudalagiriyappa*et al*. (2016) in chickpea.

Table 1: Plant height at different growth stages of pigeonpea as influenced by foliar nutrition

Treatments	Plant height (cm)			
	45 DAS	**90 DAS**	**135 DAS**	**At harvest**
T_1: RDF + FA of 0.5 % pulse magic @ flowering stage	32.5	113.4	126.2	129.1
T_2: RDF +FA of 0.5 % pulse magic @flowering and pod formation stage	33.2	114.1	133.1	137.2
T_3: RDF + FA of 1 % pulse magic @ flowering stage	33.3	115.2	137.4	141.4
T_4: RDF + FA of 1 % pulse magic @ flowering and pod formation stage	33.2	114.8	142.1	146.6
T_5: RDF + FA of 2 % WSF (19:19:19)+ 0.05% NAA@ flowering stage	32.8	112.5	117.3	121.7
T_6: RDF + FA of 2 % WSF (19:19:19)+ 0.05 % NAA @ flowering andpod formation stage	32.5	111.7	128.6	132.5
T_7: RDF + FA of 2 % WSF (19:19:19)+ 200 ppm N-Triacontanol@ flowering stage	32.4	110.2	121.8	125.9
T_8: RDF (Control)	32.6	112.1	119.6	122.2
S.Em. ±	1.0	3.6	4.2	4.4
CD at 5%	-	-	13.0	13.4

Significantly higher leaf area of 3218.5 cm^2 per plant was recorded with the foliar application of 1% pulse magic at flowering and pod formation stage at 135 DAS.This might be due to the balanced supply of nutrients to plant which promoted the plant growth process. Pulse magic's foliar spray of nutrients and growth regulators helped to maintain a greater auxin level, which in turn led to improved leaf area and chlorophyll content of plant. These results are also in line with earlier findings of Dixit and Elamathi (2007) in green gram,Deotale*et al*. (2015) in green gram and Vighnesh *et al*. (2022) in pigeonpea.

Table 2: Number of branches per plant at different growth stages of pigeonpea as influenced by foliar nutrition

Treatments	Number of branches $plant^{-1}$			
	45 DAS	**90 DAS**	**135 DAS**	**At harvest**
T_1: RDF + FA of 0.5 % pulse magic @ flowering stage	1.87	9.4	12.5	14.0
T_2: RDF +FA of 0.5 % pulse magic @ flowering and pod formation stage	1.96	10.1	13.7	15.8
T_3: RDF + FA of 1 % pulse magic @ flowering stage	1.97	10.3	14.2	16.3
T_4: RDF + FA of 1 % pulse magic @ flowering and pod formation stage	1.90	10.1	14.9	16.8
T_5: RDF + FA of 2 % WSF (19:19:19) + 0.05% NAA@ flowering stage	1.93	9.8	11.3	13.0
T_6: RDF + FA of 2 % WSF (19:19:19) + 0.05% NAA @ flowering and pod formation stage	1.89	9.5	12.8	14.6
T_7: RDF + FA of 2 % WSF (19:19:19) + 200 ppm N-Triacontanol@ flowering stage	1.92	9.8	11.4	13.5
T_8: RDF (Control)	1.95	9.6	10.1	12.9
S.Em. ±	0.06	0.3	0.4	0.5
CD at 5%	-	-	1.3	1.5

"At 135 DAS and at the time of harvest, foliar application of 1% pulse magic at flowering and pod formation stage recorded significantly higher dry matter accumulation (89.3 and 135.5 g $plant^{-1}$), followed by foliar application of 1% pulse magic at flowering stage (80.4 and 121.6 g $plant^{-1}$, respectively). Foliar spray of macro and micronutrients increases the availability of plant assimilates which improves the metabolism of crop and has positive effect on dry matter accumulation in pigeonpea" (Kailas *et al*., 2017). "Plant metabolic activities increased due to proper supply of nutrients and accumulation of dry matter in leaves helped the photosynthetic area to remain active for longer period and was responsible for overall growth of plant in terms of dry matter production in pigeonpea" (Saakshi *et al*., 2020).

Table 3: Leaf area per plant at different stages of pigeonpea as influenced by foliar

nutrition

Treatments	Leaf area (cm^2 plant^{-1})		
	45 DAS	**90 DAS**	**135 DAS**
T_1: RDF + FA of 0.5 % pulse magic @ flowering Stage	220.7	2447.2	2745.2
T_2: RDF +FA of 0.5 % pulse magic @flowering and pod formation stage	225.4	2454.9	2891.4
T_3: RDF + FA of 1 % pulse magic @ flowering Stage	218.5	2436.4	2926.9
T_4: RDF + FA of 1 % pulse magic @flowering and pod formation stage	224.0	2514.5	3218.5
T_5: RDF + FA of 2 % WSF (19:19:19)+ 0.05 % NAA@ flowering stage	231.6	2492.3	2584.0
T_6: RDF + FA of 2 % WSF (19:19:19)+ 0.05 % NAA @ flowering andpod formation stage	227.3	2451.2	2779.2
T_7: RDF + FA of 2 % WSF (19:19:19)+ 200 ppm N-Triacontanol@flowering stage	219.3	2448.1	2635.8
T_8: RDF (Control)	215.6	2338.8	2421.3
S.Em. ±	7.21	79.8	93.9
CD at 5 %	-	-	284.8

During 135 DAS to harvest, significantly higher absolute growth rate (0.812 g plant^{-1} day^{-1}), crop growth rate (5.19 g m^{-2} day^{-1}) and relative growth rate (0.01g g^{-1} day^{-1}) were recorded with foliar application of 1 % pulse magic at flowering and pod formation stage, is might be due to the fact that those plants had balanced supply of nutrients at the critical stages which enabled them to have higher leaf area, leaf area index and photosynthetic rate is an index of amount of light interception. Thus, enhancing the crop growth.These findings are in conformity with the results obtained by Sritharan *et al.* (2015) in black gram, Gagandeep *et al.* (2015) in pigeonpea and Lyngdoh *et al.* (2019) in soybean.

Significantly higher seed yield (1590 kg ha^{-1}) and stalk yield (4308 kg ha^{-1}) were recorded with foliar application of 1 % pulse magic at flowering and pod formation stage, followed foliar application of 1 % pulse magic at flowering stage (1438 and 4060 kg ha^{-1}, respectively). Foliar nutrition during critical stages of crop growth enhanced photosynthetic activity and higher uptake of nutrients and there by increased plant dry matter production in

Table 4: Total dry matter accumulation at different growth stages of pigeonpea as influenced by foliar nutrition

Treatments	Total dry matter accumulation (g plant^{-1})			
	45 DAS	90 DAS	135 DAS	At harvest
T_1: RDF + FA of 0.5 % pulse magic @ flowering stage	3.2	30.0	71.0	108.4
T_2: RDF +FA of 0.5 % pulse magic @ flowering and pod formation stage	3.2	28.2	78.8	115.3
T_3: RDF + FA of 1 % pulse magic @ flowering stage	3.6	30.8	80.4	121.6
T_4: RDF + FA of 1 % pulse magic @ flowering and pod formation stage	3.4	29.5	89.3	135.5
T_5: RDF + FA of 2 % WSF (19:19:19)+ 0.05 % NAA@ flowering stage	3.0	26.3	69.1	101.0
T_6: RDF + FA of 2 % WSF (19:19:19)+ 0.05 % NAA @ flowering andpod formation stage	3.5	29.8	76.4	111.3
T_7: RDF + FA of 2 % WSF (19:19:19)+ 200 ppm N-Triacontanol@flowering Stage	3.5	28.3	70.3	105.2
T_8: RDF (Control)	3.4	28.2	64.6	89.4
S.Em. ±	0.2	0.9	2.5	3.6
CD at 5 %	-	-	7.7	11.1

Table 5: Absolute growth rate, crop growth rate and relative growth rate of pigeonpea as influenced byfoliar nutrition

Treatments	AGR (g plant^{-1} day^{-1})	CGR (g m^{-2} day^{-1})	RGR (g g^{-1} day^{-1})
T_1: RDF + FA of 0.5 % pulse magic @ flowering stage	0.831	5.12	0.009

T_2: RDF +FA of 0.5 % pulse magic @ floweringand pod formation stage	0.719	5.14	0.008
T_3: RDF + FA of 1 % pulse magic @ flowering stage	0.740	5.16	0.009
T_4: RDF + FA of 1 % pulse magic @ floweringand pod formation stage	0.812	5.19	0.010
T_5: RDF + FA of 2 % WSF (19:19:19)+ 0.05%NAA@ flowering stage	0.709	4.35	0.008
T_6: RDF + FA of 2 % WSF (19:19:19)+ 0.05% NAA @ flowering andpod formation stage	0.776	5.12	0.008
T_7: RDF + FA of 2 % WSF (19:19:19)+ 200 ppm N-Triacontanol@flowering stage	0.776	5.02	0.009
T_8: RDF (Control)	0.633	4.24	0.007
S.Em. ±	0.02	0.16	0.0003
CD at 5 %	0.07	0.49	0.0008

the pod setting phase which might have improved the pod development and number of pods per plantand finally contributed for higher productivity. These results are in confirmation with the results of Jayarani *et al.* (2004). “The application of foliar nutrition on pigeonpea harvest index was found non-significant. A slight increase in harvest index was observed in foliar nutrition applied treatments. Considerably higher harvest index (0.26) was observed in T_4. The higher harvest index mainly attributed to higher biological yield and economic yield.The increased harvest index might be due to the increased mobilization of nutrients and plant growth regulator in pulse magic might have governed the various physiological characters that ultimately increased the dry matter production at various stages of crop growth by increasing the various growth indices and it was more at harvest due to more dry accumulation in pods” (Thakur *et al.*, 2017)

Table 6: Influence of foliar nutrition on seed yield, stalk yield and harvest index of pigeonpea

Treatments	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index
T_1: RDF + FA of 0.5 % pulse magic @ flowering stage	1286	3810	0.24

T_2: RDF +FA of 0.5 % pulse magic @ floweringand pod formation stage	1411	3984	0.25
T_3: RDF + FA of 1 % pulse magic @ flowering stage	1438	4060	0.25
T_4: RDF + FA of 1 % pulse magic @ floweringand pod formation stage	1590	4308	0.26
T_5: RDF + FA of 2 % WSF (19:19:19)+ 0.05% NAA@ flowering stage	1226	3541	0.25
T_6: RDF + FA of 2 % WSF (19:19:19)+ 0.05% NAA @ flowering andpod formation stage	1351	3876	0.25
T_7: RDF + FA of 2 % WSF (19:19:19)+ 200 ppm N-Triacontanol@flowering Stage	1274	3591	0.25
T_8: RDF (Control)	1104	3416	0.23
S.Em. ±	45.4	93.93	0.01
CD at 5 %	137.7	284.91	-

Conclusion

The major problem in pigeonpea is flower drop and it occurs due to unavailability of major and micro nutrients at critical stages like flowering and pod formation which contributes much reduced potential yield of pigeonpea. The present study was carried out to understand the influence of foliar nutrition on morphology and yield of pigeonpea. Based on above findings of results it may be concluded that soil application of RDF along with foliar application of 1% pulse magic at flowering and pod formation stage improves the growth and reduces the flower drop which in turn improves the pod setting, number of pods per plant and enhances the yield of pigeonpea.

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