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Effect of foliar nutrition on growth, yield attributes, yield, quality parameters and economics of cowpea [*Vigna unguiculata* (L.) Walp.] under rainfed condtition

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Abstract
A field experiment was carried out at College farm, College of Agriculture, Navsari Agricultural University, Campus Bharuch during the *kharif* 2023 to study the effect of foliar nutrition in cowpea [*Vigna unguiculata* (L.) Walp.] under rainfed condition. The soil of experimental plot was clayey (*Vertisols*) with low in available N (240.42 kg/ha), medium in P_2O_5 (39.58 kg/ha) and high in K_2O (338.28 kg/ha). The soil reaction (pH) was slightly alkaline (7.68). The experiment was arranged in a randomized block design (RBD) with nine treatments, which included: T_1 (Control), T_2 (RDF 20-40-00 NPK kg/ha), T_3 (RDF + 2% Panchagavya), T_4 (RDF + 2% Cow urine), T_5 (RDF + 2% Vermi bed wash), T_6 (RDF + 1% Novel), T_7 (RDF + 2% Urea), T_8 (RDF + 1% 19-19-19) and T_9 (RDF + Nano urea 2 ml/lit). Foliar nutrition apllied at branching and flowering stages of cowpea. Result revealed that growth parameters *viz.* plant height at 60 DAS (71.33 cm) and at harvest (75.38 cm), number of branches/plant at 45 (8.65) and 60 DAS (9.64), dry matter accumulation/plant at 45 DAS (20.80 g) and at harvest (32.24 g), yield attributes *viz.* number of pods/plant (25.55), number of seeds/pod (17.41) and length of pod (18.24 cm) as well as seed yield (1625 kg/ha) and stover yield (3004 kg/ha), quality parameter including protein yield (354.61 kg/ha) recorded significantly the highest with T_6 (RDF + 1% Novel), which was statistically at par with T_3 (RDF + 2% Panchagavya) and T_8 (RDF + 1% 19-19-19).

Keywords: Cowpea, foliar nutrition, growth parameters, novel, panchagavya, yield attributes

Introduction
Grain legumes are the most important crop species after the cereals in worldwide. Pulses play vital role in human diet as vegetables protein being an essential supplement to cereal-based diet per capita. These pulses being legumes fix atmospheric nitrogen into the soil and play important role in crop rotation, mixed cropping, animal husbandry and agro-forestry etc. Pulses are commonly known as food legumes which are secondary to cereals in production and consumption in India. Pulses are an important source of dietary protein, energy, minerals and vitamins for the mankind. Pulses provide 25 per cent of protein requirements of predominantly vegetarian population. Pulses restore soil fertility by fixing atmospheric nitrogen through their nodules. These are drought resistant and prevent soil erosion due to their deep root system and good ground coverage, because of these good characters of pulses are called as "Marvel of Nature". Among the grain legumes, cowpea is one of the most prominent grain legume and fodder crop belongs to family *Fabaceae*. Cowpea is one of the ancient crops to man. Its cultivation is at least 5000 to 6000 years old. Cowpea commonly known in Indian as *lobia* and in Gujarat as *chowli*, belogs to family *Leguminosae* with subfamily *Papilionaceae*. It is also known as '*Black eye pea', 'Southern pea', 'China pea', Kharif pea'* and *'Marble pea'*. West Africa and India are the centers of diversity of cowpea. As per the record, first evidence of cultivation was found in West Africa (Mandaliya *et al*. 2022) [6]. Similar to all pulse crops it has the unique ability of maintaining and restoring the fertility of soil through active biological nitrogen fixation and addition of huge amount of mature to the soil with the help of *Rhizobium leguminosarum* (Xavier *et al*. (2023) [13].

According to the Agriculture Ministry, India's pulses production in 2023-2024 was estimated to be 234 lakh tonnes, which is a decrease from 261 lakh tonnes in 2022-2023. India has historically faced a shortage in pulses production and has relied on imports, averaging 25 lakh tonnes per year over the past five years. In 2023-2024, India's pulse imports almost doubled, and the country is expected to import more than 4.5 million tonnes of tur, urad, and masoor in 2024. To support domestic supplies and control price spikes, the government extended duty-free imports of these pulses until the end of 2025 (Anon., 2023) [1].

Farmers are continuously using heavy dose of chemical fertilizers without considering organic manures that creates nutrient imbalance in soil resulting a negative effect on soil, environment and human health (Meena *et al.* 2020) [7]. The productivity of crops has shown decline trends. Many insects and pests are becoming resistant to pesticides. The use of organic liquid manures such as cow urine, panchagavya, vermi bed wash, novel (banana pseudostem sap) represents an environmentally, agronomically and economically sound alternative since it provides a locally available source of nutrients. Foliar spray technique helps the nutrients to reach the site of food synthesis directly, leading to no wastage and quick supply of food and thereby reduce the requirement of fertilizers. It also credited with the advantage of quick and efficient utilization of nutrients, elimination of losses through leaching, fixation and regulating uptake of nutrients by the plant.

Hence, the present study was conducted to evaluate effect of foliar nutrition spray of growth yield, yield attributes and yield of cowpea [*Vigna unguiculata* (L.) Walp.] under rainfed condtition.

Materials and Methods

A field experiment was carried out at College farm, College of Agriculture, Navsari Agricultural University, Campus Bharuch during *kharif* 2023. The soil of experimental plot was clayey (*Vertisols*) with low in available N (240.42 kg/ha), medium in P_2O_5 (39.58 kg/ha) and high in K_2O (338.28 kg/ha). The soil reaction (pH) was slightly alkaline (7.68). The experiment was arranged in a randomized block design (RBD) with nine treatments, which included: T_1 (Control), T_2 (RDF 20-40-00 NPK kg/ha), T_3 (RDF + 2% Panchagavya), T_4 (RDF + 2% Cow urine), T_5 (RDF + 2% Vermi bed wash), T_6 (RDF + 1% Novel), T_7 (RDF + 2% Urea), T_8 (RDF + 1% 19-19-19) and T_9 (RDF + Nano urea 2 ml/lit). Foliar nutrition apllied at branching and flowering stages of cowpea. The cowpea *var*. Gujarat cowpea 3 was used for experimental perpose and sown on 6th July, 2023 at 45 x 10 cm spacing, by adopting the recommended seed rate 20 kg/ha and RDF (20-40-00 NPK kg/ha) given through urea and single super phosphate. The crop was harvested during 18th September 2023. Weeds were managed by herbicides and plant protection measures were taken up as and when required. In each plot five plants were randomly selected and tagged to record experimental observations on growth, yield attributes, yield and quality. At maturity, pods/plant, seeds/pod, 100-seed weight, biological yield and seed yield were recorded. The results were statistically analyzed using standard ANOVA techniques as suggested by (Panse and Sukhatme, 1985) [8] to draw appropriate inferences.

Results and Discussion

Growth attributes: Application of T_6 (RDF + 1% Novel) at branching and flowering stages of cowpea recorded significantly the highest growth attributes *viz*., plant height at 60 DAS (71.33 cm) and at harvest (75.38 cm), number of branches / plant at 45 (8.65) and 60 DAS (9.64), dry matter accumulation / plant at 45 DAS (20.80 g) and at harvest (32.24 g) was significantly higher with T_6 (RDF + 1% Novel). However, it was statistically at par with T_3 (RDF + 2% Panchagavya) and T_8 (RDF + 1% 19-19-19). While number of root nodules/plant at 45 DAS did not show significant differences due to various foliar nutritions, but the highest number of root nodules (28.21) was observed under treatment T_6 (RDF + 1% Novel).

The reason for the potential increase in growth attributes due to the application of Novel, growth-promoting substances or nutrients through spraying on the leaves. Spraying these nutrients during a critical stage of crop growth, such as when the plants are branching out and flowering, helps in promoting cell division, elongation and the development of leaves and other parts of the plant. The sap from banana pseudostem contains plant growth hormones like auxins and cytokinins, which are known to stimulate plant growth. When cowpea plants absorb these growth-promoting substances through foliar spraying, it's contribute to the increase in growth attributes. Similar findings have been reported by Singhal *et al*. (2015) [12], Champaneri *et al.* (2021) [4], Parmar *et al*. (2022) [9], Asari (2023) [2] and Sindha (2023) [11].

Yield attributes and yield

Significantly yield attributes of cowpea *viz*., higher number of pods/plant (25.55), seeds/pod (17.41) and length of pod (18.24 cm) were recorded with T_6 (RDF + 1% Novel) and found statistically at par with T_3 (RDF + 2% Panchagavya) and T_8 (RDF + 1% 19-19-19). While, 100 seed weight and harvest index was not significantly influenced by different treatments. Foliar spray of Novel twice during branching and flowering stages significantly increase yield attributers of cowpea. This might be due to enhanced photosynthetic activity and higher uptake of nutrients and there by increased plant dry matter production in the pod setting phase which might have improved the pod development.

Significantly the highest seed yield (1625 kg/ha) and stover yield (3004 kg/ha) of cowpea was observed under T_6 (RDF + 1% Novel), which was statistically at par with T_3 (RDF + 2% Panchagavya), T_8 (RDF + 1% 19-19-19) in case of stover yield which was statistically at par with T_3 (RDF + 2% Panchagavya), T_8 (RDF + 1% 19-19-19) and T_7 (RDF + 2% Urea). On the other hand, significantly lowest seed yield (1197 kg/ha) and stover yield (2268 kg/ha) was noted with T_1 (Control).

The overall improvement in all the growth and yield attributing components may be due to adequate supply of nutrients with easy availability to plant at most critical growth period resulted into better growth and yield attributing characters. The better growth of crop ultimately diverted more energy under sink source relationship which helped in providing more yield. The present findings are found in agreement with Singhal *et al*. (2015) [12], Bhagariya *et al*. (2020) [3], Fernando and Karunarathna (2020) [5], Champaneri *et al*. (2021) [4], Mandaliya *et al*. (2022) [6] Parmar *et al*. (2022) [9], Asari (2023) [2] and Sindha (2023) [11].

Table 1: Effect of foliar nutrition spray of growth attributes of cowpea

Treatments	Plant height (cm)		Number of branches/plant		Dry matter accumulation (g/plant)		Number of root nodules/plant
	60 DAS	At harvest	45 DAS	60 DAS	45 DAS	At harvest	45 DAS
T_1: Control	59.07	60.14	5.52	7.97	15.77	24.26	26.35
T2: RDF (20-40-00 NPK kg/ha)	60.60	62.73	5.93	8.06	16.40	26.19	26.73
T_3: RDF + Panchagavya (2%)	69.87	74.36	7.79	9.17	19.16	30.47	27.62
T_4: RDF + Cow urine (2%)	63.08	67.22	7.26	8.25	17.03	27.97	27.21
T_5: RDF + Vermi bed wash (2%)	61.89	66.89	7.00	8.16	16.78	27.39	27.07
T_6: RDF + Novel (1%)	71.33	75.38	8.65	9.64	20.80	32.24	28.21
T_7: RDF + Urea (2%)	65.35	70.09	7.46	8.32	18.25	28.38	27.23
T_8: RDF + 19-19-19 (1%)	68.29	71.54	7.81	9.13	18.78	30.38	27.28
T_9: RDF + Nano Urea (2ml/lit)	62.99	64.56	6.92	8.11	16.66	26.79	26.86
SEm (±)	2.59	2.63	0.31	0.38	0.85	1.40	1.30
CD at 5%	7.76	7.87	0.93	1.13	2.56	4.20	NS
CV (%)	6.93	6.68	7.51	7.65	8.33	8.59	8.26

Quality Parameters

Based on the data provided in Table 3, it can be concluded that different foliar nutrition did not result in any significant changes in the protein content of cowpea. However, it is worth nothing that the numerically the highest protein content (21.83%) recorded T_6 (RDF + 1% Novel) and lowest protein content (19.32%) were recorded with treatment T_1 (Control). According to Singhal *et al*. (2015) [12] the enhancement in protein content by application of Novel organic liquid nutrients supposedly attributed to higher uptake of nitrogen during growth period as well as availability of macro elements and hormones in Novel, which enhanced photosynthetic activity, carbohydrate transformation of enzymes and synthesis of protoplasm, which ultimately increase the protein content in cowpea.

As regards to foliar nutrition, significantly higher protein yield (354.61 kg/ha) was registered under treatment T_6 (RDF + 1% Novel), which was statistically at par with T_3 (RDF + 2% Panchagavya) and T_8 (RDF + 1% 19-19-19). Higher protein yield was mainly due to higher grain yield which intern improved the protein yield. The results of present investigation are also related with the findins of Mandaliya *et al*. (2022) [6], Patel *et al*. (2022) and Sindha (2023) [11].

Table 2: Effect of foliar nutrition spray of yield attributes and yield of cowpea

Treatments	Number of pods/plant	Number of seeds/pod	Length of pod (cm)	100 seed weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	HI (%)
T_1: Control	19.98	13.91	14.30	10.62	1197	2268	34.53
T2: RDF (20-40-00 NPK kg/ha)	20.28	14.26	15.18	10.72	1307	2340	35.98
T_3: RDF + Panchagavya (2%)	23.78	16.72	17.44	11.59	1565	2890	35.38
T_4: RDF + Cow urine (2%)	22.17	15.30	16.06	11.28	1340	2370	36.07
T_5: RDF + Vermi bed wash (2%)	22.04	15.27	15.94	10.91	1330	2352	36.15
T_6: RDF + Novel (1%)	25.55	17.41	18.24	11.77	1625	3004	35.11
T_7: RDF + Urea (2%)	22.26	15.37	16.13	11.28	1349	2697	33.47
T_8: RDF + 19-19-19 (1%)	23.96	16.18	17.48	11.51	1531	2768	35.75
T_9: RDF + Nano Urea (2ml/lit)	21.90	15.17	15.68	10.81	1315	2357	35.61
SEm (±)	1.09	0.68	0.70	0.66	87.15	173.25	1.75
CD at 5%	3.27	2.03	2.11	NS	261	519	NS
CV (%)	8.41	7.57	7.49	10.24	10.82	11.72	8.57

Table 3: Effect of foliar nutrition spray of quality parameters and economics of cowpea

Treatments	Quality Parametes		Return (₹/ha)		BCR
	Ptrotein content (%)	Protein yield (kg/ha)	Gross return	Net return	
T_1: Control	19.32	230.80	98217	71324	2.65
T2: RDF (20-40-00 NPK kg/ha)	19.46	254.05	106015	76517	2.59
T_3: RDF + Panchagavya (2%)	21.66	339.60	127735	97682	3.25
T_4: RDF + Cow urine (2%)	20.12	268.78	108430	78782	2.66
T_5: RDF + Vermi bed wash (2%)	19.94	263.96	107618	77820	2.61
T_6: RDF + Novel (1%)	21.83	354.61	132661	101851	3.31
T_7: RDF + Urea (2%)	20.38	274.49	111958	82372	2.78
T_8: RDF + 19-19-19 (1%)	20.78	318.09	124427	93241	2.99
T_9: RDF + Nano Urea (2ml/lit)	19.90	258.82	106688	76852	2.58
SEm (±)	0.57	16.33			
CD at 5%	NS	48.96			
CV (%)	4.82	9.93			

Economics

The data reflected that maximum net return (1,01,851 ₹/ha) was achieved with foliar nutrition of T_6 (RDF + 1% Novel) along with BCR of (3.31). The increase in net return is due to higher seed yield obtained under these treatment as compared to cost involved under these treatments. Similar view in direction of present finding was also expressed by Singhal *et al*. (2015) [12], Champaneri *et al*. (2021) [4], Mandaliya *et al*. (2022) [6], Patel *et*

al. (2022) and Sindha (2023) [11].

Conclusion

Based on one year experimental results, it can be proved that an application of recommended fertilizer dose (20-40-00 kg/ha) along with 1% Novel or 2% Panchavagya or 1% NPK (19-19-19) as foliar application at branching and flowering stages increases the growth, yield attributes, seed yield, stover yield and quality parameters of cowpea *var*., Gujarat cowpea 3 were found remunerative.

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