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Effect of fertilizer levels and foliar application of nutrients on growth and flowering of cowpea [*Vigna unguiculata* (L.) Walp.]

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Abstract
An experiment entitled "Effect of fertilizer levels and foliar application of nutrients on cowpea [*Vigna unguiculata* (L.) Walp.]" was carried out at Vegetable Research Farm, Regional Horticultural Research Station, ASPEE College of Horticulture, Navsari Agricultural University, Navsari during Summer-2023. It was taken out with two factors having fertilizer levels *viz*., F_1: 100% RDF (20-40-00 NPK kg ha^{-1}), F_2: 80% RDF (16-32-00 NPK kg ha^{-1}), F_3: 60% RDF (12-24-00 NPK kg ha^{-1}) and foliar application of nutrients namely N_1: No spray, N_2: 2% Novel Organic Liquid Nutrient, N_3: 3% *panchagavya*, N_4: 0.5% Water soluble fertilizer (19:19:19 NPK). All the treatment combinations were replicated thrice and laid out in a randomized block design with factorial concept in Gujarat Navsari Cowpea 9 variety. T_2 [100% RDF (20-40-00) + 2% Novel Organic Liquid Nutrient] was recorded with the superior results on flowering and growth parameters as compared to the other treatments.

Keywords: 19:19:19, cowpea, novel organic liquid nutrient, *Panchagavya*, RDF

Introduction
Cowpea [*Vigna unguiculata* (L.) Walp.] has been cultivating since 5000 to 6000 years (Vavilov, 1951) [15]. The first evidence of cultivation, according to the record, was discovered in West Africa where it was intimately related to the growing of Sorghum and Pearl Millet (Ng and Marechal, 1985) [8]. Cowpea is widely grown in Africa, Latin America, South East Asia and in the Southern United States. Cowpea covers an area of 0.34 lakh hectare with the production of 3.53 lakh MT having productivity of 10.25 MT ha^{-1} in Gujarat (Anon., 2022) [3].

Cowpea is one of the most significant legume vegetable cultivated in India. It is an annual, herbaceous, warm-season crop that is grown throughout the India. Tender marketable pods contain 83.3% moisture, 3.5% protein, 2.0% fibre, 8.1% carbohydrates, 0.09% mineral matter, 0.5% niacin and 14.0 mg vitamin C 100 g^{-1} of pods (Gopalkrishnan, 2007) [5]. The root nodules of cowpea can fix the atmospheric nitrogen. It only needs a little amount of inputs, making it a desirable crop for farmers with limited resources and suitable for intercropping with the other crops.

Cowpea being a leguminous crop, is able to fix atmospheric nitrogen with small amount of nitrogenous fertilizer implemented as basal dose. Phosphorous is critical to cowpea crop because it increases the plant growth, initiate nodule formation, root growth as well as influence the efficiency of the *rhizobium*-legume symbiosis (Haruna and Aliyu, 2011) [6].

Foliar spray is the modern method of fertilizer application in vegetable crops due to nature of heavy feeder of nutrients (Vibhute, 1998) [15]. An application of nutrients through foliar spray has several advantages in supplementing the nutritional requirement of crops. Because of higher uptake efficiency, foliar application of nutrients can increase photosynthetic efficiency by delaying the leaf senescence *viz*., Novel Organic Liquid Nutrient, *Panchagavya*, 19:19:19 NPK are the products which are used as plant flowering and growth enhancing substances. They are abundant in helpful microflora that promote and encourage plant growth and aid in achieving greater vegetative growth as well as high quality and yield.

Materials and Methods

A field experiment on cowpea var. GVC-9 was conducted at Vegetable Research Farm, Regional Horticultural Research Station, ASPEE College of Horticulture, Navsari Agricultural University, Navsari during Summer-2023. The experiment was laid out in Randomized Block Design with Factorial Concept with total twelve treatments comprising of two factors *viz*., fertilizer levels F_1: 100% RDF (20-40-00 NPK kg ha^{-1}), F_2: 80% RDF (16-32-00 NPK kg ha^{-1}), F_3: 60% RDF (12-24-00 NPK kg ha^{-1}) and foliar application of nutrients namely N_1: No spray, N_2: 2% Novel Organic Liquid Nutrient, N_3: 3% *panchagavya*, N_4: 0.5% Water soluble fertilizer (19:19:19 NPK).

The combination of treatments comprised of 100% RDF(NPK 20:40:00 kg ha-1) + No Spray (T_1), 100% RDF (NPK 20:40:00 kg ha^{-1}) + 2% Novel Organic Liquid Nutrient (T_2), 100% RDF (NPK 20:40:00 kg ha^{-1}) + 3% *Panchagavya* (T_3), 100% RDF (NPK 20:40:00 kg ha^{-1}) + 0.5% Water Soluble Fertilizer (19:19:19) (T_4), 80% RDF (NPK 16:32:00 kg ha^{-1}) + No Spray (T_5), 80% RDF (NPK 16:32:00 kg ha^{-1}) + 2% Novel Organic Liquid Nutrient (T_6), 80% RDF (NPK 16:32:00 kg ha^{-1}) + 3% *Panchagavya* (T_7), 80% RDF (NPK 16:32:00 kg ha^{-1}) + 0.5% Water Soluble Fertilizer (19:19:19) (T_8), 60% RDF (NPK 12:24:00 kg ha^{-1}) + No Spray (T_9), 60% RDF (NPK 12:24:00 kg ha^{-1}) + 2% Novel Organic Liquid Nutrient (T_{10}), 60% RDF (NPK 12:24:00 kg ha^{-1}) + 3% *Panchagavya* (T_{11}) 60% RDF (NPK 12:24:00 kg ha^{-1}) + 0.5% Water Soluble Fertilizer (19:19:19) (T_{12}) replicated thrice.

The experimental soil was loamy sand, with good drainage condition. As per recommended dose, whole quantity of well decomposed FYM (20 t ha^{-1}) applied to the experiment field before sowing and mixed thoroughly with the soil and dose of N:P:K (20:40:00 kg ha^{-1}) out of which half dose of the nitrogen (N) and full dose of phosphorus (P_2O_5) were applied as basal dose in the form of urea, single super phosphate (SSP) respectively as per the treatments. The remaining half dose of nitrogen was applied as top dressing in the form of urea at thirty days after sowing. The planting was done at the spacing of 45 cm × 30 cm with gross plot size 2.7 m × 2.4 m and net plot size 1.8 m × 1.8 m. Foliar application of nutrients was performed at 20, 40 and 60 DAS as per the treatments. Days to 50% flowering was counted from the date of sowing to date on which 50% of the plants flowers in net plot. Days to first picking was counted from the date of sowing to when first harvesting of pods from each plot. The plant height was measured at 30 DAS, 60 DAS and at the time of final harvest in centimeter. Leaf area was measured at final harvest by taking leaves of the three portions of a plant (Upper, middle and lower) calculated by using leaf area meter. The number of primary branches per plant from net plot of each treatment were counted at the time of final harvest. Statistical analysis of the data pertaining to growth and flowering parameters were analyzed as per the methods described by Panse and Sukhatme (1985) [9].

Results and Discussion

Growth parameters

The observation on growth character such as plant height at 30 DAS, 60 DAS and at the time of final harvest, leaf area at final harvest and number of primary branches are depicted in table 2, table 3 and table 4.

Plant height at 30 DAS, 60 DAS and at the time of final harvest

Result of plant height at 30 DAS, 60 DAS and at final harvest found significant by different fertilizer levels. The maximum plant height (18.29 cm, 36.25 cm and 63.82 cm, respectively) at 30 DAS, 60 DAS and at final harvest was recorded with 100% RDF (F_1) whereas, the lower plant height (16.23 cm, 32.49 cm and 57.03 cm, respectively) at 30 DAS, 60 DAS and at final harvest was recorded with 60% RDF (F_3). The data of plant height at 30 DAS, 60 DAS and at final harvest were significantly influenced by foliar application of nutrients. The maximum plant height (18.46 cm, 36.90 cm and 63.27 cm, respectively) at 30 DAS, 60 DAS and at final harvest, respectively were noted in 2% Novel Organic Liquid Nutrient (N_2) whereas the lower plant height (15.30 cm, 31.41 cm and 54.79 cm, respectively) at 30 DAS, 60 DAS and at final harvest were found in no spray (N_1). The treatment combination F_1N_2 (100% RDF with 2% Novel Organic Liquid Nutrient) had recorded maximum plant height (19.73 cm, 38.74 cm and 67.05 cm, respectively) at 30 DAS, 60 DAS and at final harvest. Whereas, the treatment combination F_3N_1 (60% RDF with no spray) had recorded minimum plant height (14.41 cm, 30.46 cm and 52.00 cm, respectively) at 30 DAS, 60 DAS and at final harvest.

Leaf area at the time of final harvest

Higher leaf area (143.96 cm2) at the time of final harvest was recorded with the treatment of 100% RDF (F_1) whereas, the lower leaf area (141.19 cm^2) at the time of final harvest was recorded with 60% RDF (F_3). 2% Novel Organic Liquid Nutrient (N_2) reported highest leaf area (144.20 cm^2) at the time of final harvest whereas the lowest leaf area (140.55 cm^2) at the time of final harvest were found in no spray (N_1). The treatment combination F_1N_2 (100% RDF with 2% Novel Organic Liquid Nutrient) had reported maximum leaf area (145.24 cm^2) at the time of final harvest. Whereas, the treatment combination F_3N_1 (60% RDF with no spray) had recorded minimum leaf area (138.25 cm^2) at the time of final harvest.

Number of branches per plant

The value regarding number of branches per plant at final harvest was found significant by different fertilizer levels. The higher number of branches per plant (4.55) at final harvest was recorded with 100% RDF (F_1) whereas, the lower number of branches per plant (4.08) at final harvest was recorded with 60% RDF (F_3). Data revealed that the number of branches per plant at final harvest were significantly influenced by foliar application of nutrients. The highest number of branches per plant (4.82) at final harvest were found with 2% Novel Organic Liquid Nutrient (N_2) whereas the lowest number of branches per plant (3.39) at final harvest were found in no spray (N_1). The treatment combination F_1N_2 (100% RDF with 2% Novel Organic Liquid Nutrient) had recorded maximum number of branches per plant (4.90) at final harvest whereas, the treatment combination F_3N_1 (60% RDF with no spray) had recorded minimum number of branches per plant (2.71) at final harvest.

Growth parameters of cowpea was significantly influenced by different levels of RDF. Increase in growth parameter with 100% RDF (F_1) might be due to increased availability of nutrients to plant initially through chemical fertilizers

which increase photosynthesis activity and more production of photosynthates led to increase in plant height (cm) at 30 DAS, 60 DAS and at final harvest, leaf area (cm^2) and number of branches at the time of final harvest. Another probable reason might be due to an application of available phosphorus under treatment RDF, which might help in root elongation and better nutrients from soil. Phosphorus is also known to encourage cell division and hence contributed to taller plants. This result is in line with finding of Anisha Tirkey *et al.* (2020) [1], Joshi *et al.* (2016) [7] in cowpea, Gamit *et al.* (2022) [4], Sammauria *et al.* (2019) [11] in cluster bean.

Increase in growth parameters with application of Novel Organic Liquid Nutrient might be due to increase in meristematic activities which was catalyzed by growth regulator in Novel Organic Liquid Nutrient viz., gibberellic acid, naphthalic acetic acid and cytokinin which leads to enhance cell division and cell elongation, ultimately enhanced photosynthesis led to increases plant height (cm) at 30 DAS, 60 DAS and at final harvest, leaf area (cm2) and number of branches at the time of final harvest. These results are in conformity with results in Savaliya (2020) [12] in cowpea, Champaneri (2020) [3] in Indian bean and Salunkhe *et al.* (2013) [10] in onion.

Supply of higher level of fertilizers with Novel Organic Liquid Nutrient increase in number of branches per plant due to higher uptake of nutrients and water, that results in more photosynthesis. This may also be due to cumulative effect of phosphorous and different growth regulators viz. gibberellic acid, naphthalic acetic acid and cytokinin on division of cells, cell elongation which helps to increase number of branches per plant. The same marked effect in terms of above mentioned parameter have also been reported by Shah (2020) [13] in sweet potato.

Table 1: Effect of fertilizer levels and foliar application of nutrients on plant height of cowpea (*Vigna unguiculata* (L.) Walp.)

	30 DAS					60 DAS					Final harvest				
N / F	**N_1**	**N_2**	**N_3**	**N_4**	**Mean**	**N_1**	**N_2**	**N_3**	**N_4**	**Mean**	**N_1**	**N_2**	**N_3**	**N_4**	**Mean**
F_1	16.11	19.73	18.92	18.39	18.29	32.56	38.74	37.21	36.50	36.25	56.72	67.05	66.08	65.43	63.82
F_2	15.38	18.44	17.43	16.99	17.06	31.21	37.52	36.28	34.34	34.84	55.64	62.92	60.82	60.04	59.86
F_3	14.41	17.21	16.79	16.53	16.23	30.46	34.44	33.01	32.07	32.49	52.00	59.85	58.42	57.86	57.03
Mean	15.30	18.46	17.71	17.30		31.41	36.90	35.50	34.30		54.79	63.27	61.77	61.11	
	F	N	F × N			F	N	F × N			F	N	F × N		
S.Em. ±	0.540	0.623	1.079			0.962	1.111	1.924			1.800	2.078	3.599		
C.D. at 5%	1.583	1.828	NS			2.821	3.258	NS			5.278	6.094	NS		
C.V.%	10.87					9.65					10.34				

Table 2: Effect of fertilizer levels and foliar application of nutrients on leaf area (cm^2) of cowpea

	N_1	**N_2**	**N_3**	**N_4**	**Mean**
F_1	141.92	145.24	144.47	144.20	143.96
F_2	141.48	144.53	143.43	141.73	142.79
F_3	138.25	142.84	142.02	141.66	141.19
Mean	140.55	144.20	143.30	142.53	
	F	N	F×N		
S.Em. ±	0.680	0.785	1.359		
C.D. at 5%	1.994	2.302	NS		
C.V.%	1.65				

Table 3: Effect of fertilizer levels and foliar application of nutrients on number of branches per plant of cowpea

	N_1	**N_2**	**N_3**	**N_4**	**Mean**
F_1	4.12	4.90	4.72	4.48	4.55
F_2	3.36	4.84	4.62	4.47	4.32
F_3	2.71	4.71	4.49	4.42	4.08
Mean	3.39	4.82	4.61	4.45	
	F	N	F×N		
S.Em. ±	0.09	0.10	0.18		
C.D. at 5%	0.26	0.31	0.53		
C.V.%	7.23				

Flowering parameters

The data on flowering attributing character such as days to 50% flowering and days taken for first picking are depicted in Table 1.

Days to 50% flowering

Different fertilizer levels and foliar application of nutrients produced non-significant effect on days to 50% flowering. Numerically minimum days (53.22) for 50% flowering was observed with 100% RDF (F_1) whereas, maximum days (53.78) for 50% flowering was recorded with 60% RDF (F1). Minimum days for 50% flowering (52.58) was observed with the treatment of 2% Novel Organic Liquid Nutrient (N_2) whereas, maximum days for 50% flowering (54.51) was recorded with no spray (N_1).

Days to first picking

The data reveals that the days taken to first picking was non-significantly influenced by different fertilizer levels and foliar application of nutrients. Treatment 100% RDF (F_1) recorded minimum days to first picking (62.02), whereas maximum days to first picking (62.82) found under treatment 60% RDF (F_3). Application of 2% Novel Organic Liquid Nutrient (N_2) resu6lted minimum days to first picking (61.49), whereas no spray (N_1) was noticed maximum days to first picking (63.67).

Table 4: Effect of fertilizer levels and foliar application of nutrients on flowering parameters of cowpea (*Vigna unguiculata* (L.) Walp.)

	Days to 50% flowering					Days to first picking				
N / F	**N_1**	**N_2**	**N_3**	**N_4**	**Mean**	**N_1**	**N_2**	**N_3**	**N_4**	**Mean**
F_1	54.33	52.13	52.93	53.47	53.22	63.27	61.07	61.60	62.13	62.02
F_2	54.53	52.60	53.20	53.80	53.53	63.60	61.40	61.87	62.53	62.35
F_3	54.67	53.00	53.33	54.13	53.78	64.13	62.00	62.33	62.80	62.82
Mean	54.51	52.58	53.16	53.80		63.67	61.49	61.93	62.49	
	F	**N**	**F×N**			**F**	**N**	**F×N**		
S.Em. ±	0.425	0.491	0.850			0.523	0.604	1.046		
C.D. at 5%	NS	NS	NS			NS	NS	NS		
C.V.%	2.75					2.90				

Conclusions

By considering scenario of present experiment, it can be concluded that the 100% RDF along with 2% Novel Organic Liquid Nutrient is the best in terms of flowering and growth parameters in cowpea.

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