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Effect of foliar application of nutrients on growth, yield and economics of *summer* black gram (*Vigna mungo* L.) under south Gujarat condition

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Abstract

An experiment was conducted during summer season of the year 2022 at the College Farm, Department of Agronomy, Navsari Agricultural University, Navsari to study the “Response of *summer* black gram (*Vigna mungo* L.) to nutrient management practices under south Gujarat condition”. The experiment was laid out in randomized block design with ten treatments and replicated thrice. Plant height of 32.55 and 32.47 cm at 60 DAS, 53.47 and 52.27 cm at harvest, number of branches plant⁻¹ at harvest of 5.47 and 6.07, dry matter accumulation plant⁻¹ of 34.63 and 37.47 g, number of pods plant⁻¹ 50.07 and 50.03 and pod length of 5.15 and 5.16 cm being at par, but found significantly superior with the application of either 75% RDF + 1% Novel spray at flowering + pod setting stage or 75% RDF + 1% urea spray at flowering + pod setting stage over control, respectively. Number of seeds pod⁻¹ and test weight were also found non-significantly but numerically higher under the same treatments. An application of 75% RDF + 1% urea spray at flowering + pod setting was produced significantly higher seed yield of 1133 kg ha⁻¹ and haulm yield of 2972 kg ha⁻¹, which was at par with 75% RDF + 1% Novel spray at flowering + pod setting stage, the same treatment secured maximum gross returns (85,549 ₹ ha⁻¹), net returns (52,265 ₹ ha⁻¹) and B: C ratio (2.57). The finding suggested that an application of 75% RDF + 1% spray of either urea or Novel at flowering and pod setting stage of *summer* black gram has recorded higher growth and yield attributes, seed yield, haulm yield, net income and B: C ratio.

Keywords: Foliar spray, black gram, yield, net returns, benefit cost ratio

Introduction

Pulses play a significant role in Indian agriculture as they provide protein rich components in balanced human diet. Food is complete and balanced only when, the basic ingredients are included. Pulses contain 20-24 per cent *i.e.*, about 2.5 times more amount of protein than in cereal grains and hence, offers the most practical means of eradicating malnutrition. Pulses also contain calcium and phosphorus. Besides the rich sources of protein and vitamins, pulses maintain soil fertility through biological nitrogen fixation in soil and thus play vital role in furthering sustainable agriculture (Kanniyan, 1999) ^[10]. India is currently claimed as the largest producer of black gram accounting for more than 70% of the world production followed by Myanmar and Pakistan. In the India, the production of pulses during 2020-21 of 25.58 million tonnes (Anon, 2021_b) ^[2] which is higher by 3.64 million tonnes than the last five years average production of 21.93 million tonnes. More than 90% of black gram production comes from nine states of Madhya Pradesh (18.04 lakh ha), Uttar Pradesh (6.14 lakh ha), Rajasthan (5.40 lakh ha), Andhra Pradesh, Tamil Nadu, Maharastra, Jharkhand, Gujarat and West Bengal. In Gujarat, cultivated area under black gram reported 1.17 lakh hectares, production of 87.6 lakh tones and productivity of 746 kg ha⁻¹ during 2020-21. (Anon, 2021_a) ^[1]. A crop can express it full yield potential under favourable management conditions and optimum level of required inputs.

Chemical fertilizers are playing crucial role to meet the nutrients requirements of crop. An application of major nutrients particularly N and P play key role in growth and development of crops and ultimately enhanced the yield. Nitrogen plays an important role in various metabolic processes of plant growth. N is essential constituent of protein and chlorophyll. Apply of nitrogenous fertilizers during early growth periods promote vegetative growth and create

conditions favoring high yield. Phosphorous is second most important major nutrients essential for the growth and development of plants. Phosphorous have a stimulating effect on root activity and rooting pattern of crop. Phosphorous is also utilized for plant metabolism and is a constituent of various organic substances, it plays an important role in photosynthesis, respiration and other physiological process of plant. Foliar feeding is one of the most efficient ways of supplying essential nutrients to a growing crop. Nitrogen due to leaching and volatilization losses and phosphorus due to fixation may not be adequately available at flowering and pod formation stages of crop and result in flower and pod shedding. Therefore, foliar application of major nutrients had specially advantage of quick and efficient utilization of nutrients, elimination of losses through leaching and fixation and helps in regulation the uptake by plants (Manonmani and Srimathi, 2009) [21]. Foliar application of essential nutrients plays a vital role in pulse production by stimulating root development, nodulation, energy transformation, various metabolic process, translocation activity in plants and increasing pod setting, hasten maturity and thereby increases the yield. Hence, present investigation was planned to study the effect of foliar application of nutrient on growth and yield of summer black gram under south Gujarat condition.

Materials and Methods

A field experiment was conducted during summer season of the year 2022 at the College Farm, Department of Agronomy, N. M. College of Agriculture, Navsari Agricultural University, Navsari. The Navsari city is located at the southeastern region of Gujarat near the sea soars of historical place Dandi. It is situated at 9.0 meter above the mean seal levels and coordinated at 20.070-21.000 N latitude 72.430-73.000 E longitude. The experimental field was clayey in texture, low in organic carbon content (0.46%), low in available N (229.26 kg ha⁻¹), medium in available P₂O₅ (30.23 kg ha⁻¹) and high in available K₂O (349.25 kg ha⁻¹). Total ten treatments viz., T₁: Control, T₂: RDF (20:40:00 NPK kg ha⁻¹), T₃: 75% RDF + 1% Novel spray at flowering, T₄: 75% RDF + 1% Novel spray at flowering + pod setting, T₅: 50% RDF + 1% Novel spray at flowering, T₆: 50% RDF + 1% Novel spray at flowering + pod setting T₇: 75% RDF + 1% Urea spray at flowering, T₈: 75% RDF + 1% Urea spray at flowering + pod setting, T₉: 50% RDF + 1% Urea spray at flowering, T₁₀: 50% RDF + 1% Urea spray at flowering + pod setting were tested in randomized block design (RBD) with three replications. The black gram variety Gujarat Urad-3 was sown with seed rate of 20 kg ha⁻¹. The seeds were sown manually with spacing of 30×10 cm. All the recommended package of practices were followed to raise the crop successfully. The data collected from various parameters were subjected to analysis of variance (ANOVA) appropriate for Randomized Block Design. Treatment means were compared at the 5% level of significance (P=0.05) using Critical Difference (CD) values outlined by Panse and Sukhatme (1985) [25]. Standard error of mean (SEM±) was also computed to assess the precision of experimental results.

Results and Discussion

Effect on growth attributes

Plant height

The mean data presented in Table 1 clearly indicated that the different nutrient management practices exerted significant effect on plant height at 60 DAS and harvest only. An application of 75% RDF + 1% urea spray at flowering + pod setting stage was found non-significant but, numerically higher

plant height (14.65 cm) at 30 DAS. Plant height (33.44 cm) at 60 DAS recorded remarkably higher due to application of 100% RDF (20:40:00 NPK kg ha⁻¹) over control, treatments T₅(50% RDF + 1% Novel spray at flowering), T₆(50% RDF + 1% Novel spray at flowering + pod setting) and T₉ (50% RDF + 1% Urea spray at flowering). Whereas, shorter plant height (28.25 cm) was recorded in control treatment. Similarly, plant height at harvest was observed significantly higher under the application of 75% RDF + 1% Novel spray at flowering + pod setting (53.47 cm) over control, which remain at par with all other treatments, except, the treatment T₅ (50% RDF + 1% Novel spray at flowering). There was increase in the plant height up to the tune of 10.99 and 15.22 per cent and 19.01 and 23.97 per cent due to application of 100% RDF and 75% RDF + 1% Novel spray at flowering + pod setting over control, respectively.

The increase in plant height at different crop stages might be due to availability of sufficient amount of nutrients from inorganic fertilizer and foliar application of nutrients improve cell activities, cell multiplication and luxurious growth of plant results in increase of plant height. Similar types of results were also observed by Kannan *et al.* (2014), Vitnor *et al.* (2015), Kumar *et al.* (2016), Jadhav *et al.* (2017), Kumar *et al.* (2018), Pandey *et al.* (2019), Tyagi and Singh (2019), Barkha *et al.* (2020), Karthikeyan *et al.* (2020) and Sruthi *et al.* (2020) [3, 7, 11, 12, 24, 31, 32, 33, 15, 16].

Number of branches plant-1

A perusal of data present in Table 1 clearly showed that an application of different nutrient management practices had significant effects on number of branches plant-1 at harvest of summer black gram. Number of branches plant-1 at harvest (6.07) of summer black gram was produced significantly higher due to the application of 75% RDF + 1% urea spray at flowering + pod setting (T₈) over control and it was statistically at par with treatments T₄ (5.47), T₂ (5.33), T₇ (5.07) and T₁₀ (5.07). Absolute control had recorded significantly lower number of branches plant-1 (3.40) over rest of the treatments, except treatment T₅.

The increase in number of branches plant-1 could be possible because the application of nutrients particularly phosphorus at initial crop growth stage improves soil fertility level which helps in enhancement of root activity in rhizosphere thereby better uptake of nutrients from soil and overall growth of crop due to their synergistic effect. The results are in close vicinity with those obtained by Kumar *et al.* (2016), Jadhav *et al.* (2017), Maheswari and Karthik (2017), Devaraju and Senthivel (2018), Kumar *et al.* (2018), Bute *et al.* (2019), Pandey *et al.* (2019), Beulah *et al.* (2020), Mandre *et al.* (2020) and Patil *et al.* (2021) [5, 7, 19, 20, 24, 26, 15, 16].

Dry matter accumulation plant-1

The mean data furnished in Table 1 clearly indicated that dry matter accumulation plant-1 was influenced significantly by various treatments. The dry matter accumulation plant-1 (37.47 g) at harvest was recorded significantly higher with the treatment of T₈ (75% RDF + 1% urea spray at flowering + pod setting) over control, which was at par with the treatments T₂ (35.17 g), T₇ (34.92 g) and T₄ (34.73 g). The control treatment was recorded significantly the lowest dry matter accumulation plant-1 over rest of the treatments.

The significant increase of dry weight plant-1 was due to the fact that application of nutrients plays significant role in cell division, cell differentiation and development, translocation of photosynthates and growth regulators from source to sink.

Further foliar spray of nutrients particularly nitrogen helps in maintaining higher auxin level which might have resulted in better plant height, leaf area and more chlorophyll content of the leaves. Besides, it's overall efficiency the better utilization of nutrients, other resources and better interception of light paves more production of photosynthates during the crop period. The pronounced effect of foliar application of nutrients along with soil application on DMP. The similar types of results were also in accordance with Kannan *et al.* (2014), Kumar *et al.* (2016), Maheswari and Karthik (2017), Devaraju and Senthivel (2018), Jeyajothi *et al.* (2018), Bute *et al.* (2019), Kunjammal and Sukumar (2019), Mandre *et al.* (2020), Sruthi *et al.* (2020) and Patil *et al.* (2021) [5, 9, 11, 17, 19, 20, 26, 31, 15, 16].

Effect on yield attributes and yield

Number of pods plant-1: The data narrated in Table 2 showed that an application of various nutrient management practices manifest their significant effect on number of pods plant-1 at harvest. The number of pods plant-1 at harvest (35.20) was recorded significantly the lowest in control compared to all other treatments. Whereas, it was found significantly higher with the application of 75% RDF + 1% urea spray at flowering and pod setting (T₈) over control, and it was statistically at par with treatments T₄ (50.07), T₂ (49.80), T₇ (48.87) and T₃ (46.00).

The number of pods per plant increased might be due to higher supply of all nutrients through soil as basal and foliar at flowering and pod setting stage of crop growth might have cause efficient translocation of photosynthates from source to sink which helps in increase the number of floral buds, prevented the floral shedding by maintaining optimum bio-physiological conditions in plants. Moreover, adequate and continuous nutrient availability through soil and foliar nutrition promotes the supply of assimilates to sink or yield container, thus increasing the number of pods plant-1. The results obtained were corroborated with those findings of Kuttimani and Velayutham (2011), Shashikumar *et al.* (2013), Dhakal *et al.* (2016), Geetha and Velayutham (2016), Kumar *et al.* (2016), Jadhav *et al.* (2017), Maheswari and Karthik (2017), Meena *et al.* (2017b), Devaraju and Senthivel (2018), Bute *et al.* (2019), Kumar *et al.* (2019), Kunjammal and Sukumar (2019), Mandre *et al.* (2020) and Sruthi *et al.* (2020) [5, 6, 7, 8, 17, 18, 19, 20, 23, 29, 31, 14-16].

Length of pods

A perusal of data presented in Table 2 showed that the different nutrient management treatments had significant effect on the length of pods of black gram at harvest. Treatment T₈ (75% RDF + 1% urea spray at flowering + pod setting) produced significantly higher length of pods (5.16 cm) over control, and it was statistically at par with treatments T₄ (5.15 cm), T₇ (4.97 cm), T₂ (4.89 cm) and T₃ (4.82 cm). Whereas, significantly lower pod length (4.28 cm) at harvest was recorded in control.

The increase in length of pods might due to higher leaf area up to maturity and the leaves become active due to adequate and continuous availability of all nutrients through soil and foliar nutrition promotes the supply of assimilates to sink or yield container, thus enlarging the yield structure. Similar findings were reported by Shashikumar *et al.* (2013), Dhakal *et al.* (2016), Geetha and Velayutham (2016), Kumar *et al.* (2016), Meena *et al.* (2017b), Raj *et al.* (2018), Bute *et al.* (2019) and Kunjammal and Sukumar (2019) [6, 7, 17, 23, 29].

Number of seeds pod-1

The data presented in Table 2 clearly indicated that the different nutrient management practices did not exert any significant

effect on number of seeds pod-1 of summer black gram. However, non-significantly but numerically higher number of seeds pod-1 was found under the treatment T₈ (6.87) and T₄ (6.87) and lower seeds pod-1 under control (5.80). There was 18.45 per cent increasing in seeds pod-1 under both the treatment T₈ and T₄ over control. Similar types of results were also reported by Devaraju and Senthivel (2018), Sreemathi *et al.* (2019) and Raushan *et al.* (2020) [5, 28, 30].

Test weight

The mean data recorded in Table 2 indicated that test weight of summer black gram was not influenced significantly by various nutrient management practices. However, an application of 75% RDF along with 1% either Novel spray (T₄) or urea spray (T₈) at flowering and pod setting were observed non-significantly but, numerically higher test weight of 43.70 g and 43.50 g, respectively. The lowest test weight (40.75 g) of black gram was found in control. Similar types of results were also observed with Raj *et al.* (2018), Raushan *et al.* (2020) and Krishnaveni *et al.* (2021) [13, 28].

Seed yield

An appraisal of the data presented in Table 2 showed that the seed yield of black gram was significantly influenced due to the different nutrient management practices. Seed yield (1133 kg ha⁻¹) was observed significantly higher in treatment T₈ (75% RDF + 1% urea spray at flowering + pod formation stage) over rest of all the treatments, except the application of T₄ (75% RDF + 1% Novel spray at flowering + pod formation stage) (1077 kg ha⁻¹). Significantly the lowest seed yield (579 kg ha⁻¹) was recorded in the absolute control (T₁). There was increase the seed yield up to the tune of 95.68 and 86.01 per cent under the application of 75% RDF + 1% urea spray at flowering + pod formation stage and 75% RDF + 1% Novel spray at flowering + pod formation stage over control, respectively.

Yield of crop depend on pattern of nutrient supply during the growth cycle, vegetative and reproductive growth as combination of soil and foliar application of nutrients may ensure the optimum nutrient supply throughout the crop cycle. The vegetative as well as reproductive growth will proper and it has been evidenced by higher plant height, more branches and pods and pod length in those over the control. Secondly, this might be due to maintaining optimum plant population, reduction in flower dropping improve the pod formation and seed setting percentage. Collectively all these parameters are responsible for higher grain yield of black gram. The results obtained are in close vicinity with those obtained by Kuttimani and Velayutham (2011), Shashikumar *et al.* (2013), Das and Jana (2015), Geetha and Velayutham (2016), Kumar *et al.* (2016), Maheswari and Karthik (2017), Meena *et al.* (2017b), Jeyajothi *et al.* (2018), Bute *et al.* (2019), Kunjammal and Sukumar (2019), Pandey *et al.* (2019), Sruthi *et al.* (2020) and Patil *et al.* (2021) [7, 9, 17, 18, 19, 23, 24, 26, 29, 31, 16].

Haulm yield

The data presented in Table 2 clearly found that the different treatments show their significant effect on the haulm yield of summer black gram. An application of 75% RDF + 1% urea spray at flowering + pod formation stage (T₈) produce remarkably higher haulm yield (2972 kg ha⁻¹) over all other treatments, except treatments 75% RDF + 1% Novel spray at flowering + pod formation stage (2806 kg ha⁻¹) and 75% RDF + 1% urea spray at flowering (2661 kg ha⁻¹). The haulm yield (1665 kg ha⁻¹) of black gram was recorded significantly lower

in the control (T_1). The haulm yield was increase up to the tune of 78.50, 68.53 and 59.82 per cent under the treatment of T_8 , T_4 and T_7 over control (T_1).

The increase in haulm yield is directly related to vegetative growth of plant. Further, application of foliar nutrition along with soil helps in continuous supply of nutrients which could have increased the leaf area and dry matter accumulation resulting in higher haulm yield. The results are in agreement with those found by Kuttamani and Velayutham (2011), Shashikumar *et al.* (2013), Dhakal *et al.* (2016), Kumar *et al.* (2016), Jeyajothi *et al.* (2018), Bute *et al.* (2019), Pandey *et al.* (2019), Sruthi *et al.* (2020) and Patil *et al.* (2021) [6, 9, 18, 24, 26, 29, 31, 16].

Harvest index

A perusal of data presented in Table 2 shows that different nutrient management practices did not exhibit any significant effect on the harvest index of summer black gram. However, numerically higher value of harvest index (28.00%) was obtained with the application of 100% RDF (20:40:00 NPK kg

ha⁻¹) followed by treatment T_4 (27.73%) and T_{10} (27.65%). Similar type of result also found by Devaraju and Senthivel *et al.* (2018), Jeyajothi *et al.* (2018), Raj *et al.* (2018), Mandre *et al.* (2020) and Patil *et al.* (2021) [5, 9, 20, 26].

Effect on economics

A mean of data presented in the Table 3 revealed that the maximum gross returns (85,549 ₹ ha⁻¹), net returns (52265 ₹ ha⁻¹) and B: C ratio (2.57) was recorded with the application of 75% RDF + 1% urea spray at flowering + pod setting (T_8) and it was closely followed by the treatment (T_4) 75% RDF + 1% Novel spray at flowering + pod setting in terms of net returns (46625 ₹ ha⁻¹) and B: C ratio (2.35). Whereas, control treatment found minimum gross returns (44294 ₹ ha⁻¹), net returns (13469 ₹ ha⁻¹) and B: C ratio (1.44). Higher gross returns, net returns and B: C ratio under these treatments were probably due to higher seed yield and haulm yield was recorded under the same treatments. Similar type of results was also reported by Meena *et al.* (2017a), Bute *et al.* (2019), Kumar *et al.* (2019) and Sruthi *et al.* (2020) [22, 31, 14].

Table 1: Effect of different nutrient management practices on growth attributes of summer black gram

Sr. No	Treatments	Plant height (cm)			Number of branches plant ⁻¹	Dry matter accumulation (g plant ⁻¹)
		30 DAS	60 DAS	At harvest		
T ₁	Control	12.89	28.25	43.13	3.40	25.92
T ₂	100% RDF (20:40:00 NPK kg ha ⁻¹)	14.36	33.44	51.33	5.33	35.17
T ₃	75% RDF + 1% Novel spray at flowering	14.25	31.20	50.53	4.60	31.92
T ₄	75% RDF + 1% Novel spray at flowering + pod setting	14.43	32.55	53.47	5.47	34.63
T ₅	50% RDF + 1% Novel spray at flowering	14.00	29.78	48.13	4.07	31.67
T ₆	50% RDF + 1% Novel spray at flowering + pod setting	14.14	30.56	50.40	4.67	32.42
T ₇	75% RDF + 1% Urea spray at flowering	14.26	31.94	49.60	5.07	34.92
T ₈	75% RDF + 1% Urea spray at flowering + pod setting	14.65	32.47	52.27	6.07	37.47
T ₉	50% RDF + 1% Urea spray at flowering	13.40	30.22	48.67	4.73	32.63
T ₁₀	50% RDF + 1% Urea spray at flowering + pod setting.	14.03	31.08	50.27	5.07	33.40
	S. Em. ±	0.44	0.92	1.75	0.36	1.08
	C.D. (5%)	NS	2.73	5.21	1.06	3.20
	C.V. (%)	5.45	5.10	6.10	12.73	5.66

Table 2: Effect of different nutrient management practices on yield attributes, yield and harvest index of summer black gram

Sr. No	Treatments	Pods plant ⁻¹	Pod length (cm)	Seeds pod ⁻¹	Test weight (g)	Yield (kg ha ⁻¹)		Harvest index (%)
						Seed	Haulm	
T ₁	Control	35.20	4.28	5.80	40.75	579	1665	25.80
T ₂	100% RDF (20:40:00 NPK kg ha ⁻¹)	49.80	4.89	6.60	41.77	964	2478	28.00
T ₃	75% RDF + 1% Novel spray at flowering	46.00	4.82	6.67	42.08	915	2450	27.19
T ₄	75%RDF + 1% Novel spray at flowering + pod setting	50.07	5.15	6.87	43.70	1077	2806	27.73
T ₅	50% RDF + 1% Novel spray at flowering	42.07	4.56	6.47	41.42	723	2048	26.09
T ₆	50% RDF + 1% Novel spray at flowering + pod setting	42.60	4.57	6.73	42.54	798	2264	26.06
T ₇	75% RDF + 1% Urea spray at flowering	48.87	4.97	6.73	42.24	954	2661	26.39
T ₈	75% RDF + 1% Urea spray at flowering + pod setting	50.53	5.16	6.87	43.50	1133	2972	27.60
T ₉	50% RDF + 1% Urea spray at flowering	42.73	4.59	6.67	41.83	739	2017	25.96
T ₁₀	50% RDF + 1% Urea spray at flowering + pod setting.	43.13	4.60	6.80	42.25	847	2216	27.65
	S. Em. ±	1.59	0.18	0.22	0.76	36.06	153.34	1.80
	C.D. (5%)	4.72	0.52	NS	NS	107.13	455.60	NS
	C.V. (%)	6.10	6.38	5.82	3.10	7.15	11.27	11.40

Table 3: Effect of different nutrient management practices on economics of summer black gram

Sr. No	Treatments	Cost of cultivation (₹ ha ⁻¹)	Gross returns (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	B: C ratio
T ₁	Control				
T ₂	100% RDF (20:40:00 NPK kg ha ⁻¹)	30825	44294	13469	1.44
T ₃	75% RDF + 1% Novel spray at flowering	33006	72581	39575	2.20
T ₄	75% RDF + 1% Novel spray at flowering + pod setting	33526	69261	35735	2.07
T ₅	50% RDF + 1% Novel spray at flowering	34591	81216	46625	2.35
T ₆	50% RDF + 1% Novel spray at flowering + pod setting	32981	55217	22236	1.67
T ₇	75% RDF + 1% Urea spray at flowering	34047	60956	26909	1.79
T ₈	75% RDF + 1% Urea spray at flowering + pod setting	32872	72664	39793	2.21
T ₉	50% RDF + 1% Urea spray at flowering	33283	85549	52265	2.57
T ₁₀	50% RDF + 1% Urea spray at flowering + pod setting.	32327	56097	23769	1.74

Conclusion

From fore going discussion, it can be concluded that an application 75% RDF ha⁻¹ along with foliar spray of 1% either urea or Novel (banana liquid organic fertilizers) at flowering and pod setting stage of summer black gram has recorded higher growth and yield attributes, seed yield, haulm yield, gross income, net income and B: C ratio under south Gujarat Agro-climatic condition.

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