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Foliar Nutrition in Spring Blackgram [*Vigna mungo* (L.) Hepper] in Lower Gangetic Plains of West Bengal

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ABSTRACT

Background: Blackgram is an important pulse crop having potential to meet up nutritional security. It is mainly grown in rice-fallow condition under receding soil moisture, thus facing moisture deficit at critical growth stages. As a consequence, this crop suffers from reduced nutrient uptake from soil that results in reduction of productivity. A suitable way to nourish the crop under such circumstances is through foliar nutrition.

Methods: An experiment to assess the role of foliar nutrition on overall performance of spring blackgram was conducted at "AB" block farm, Kalyani, Nadia of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India in 2018 and 2019 spring seasons. Eight foliar nutrition schedules [control, water spray, $CaCl_2$ @ 0.1%, KCl @ 0.2%, KNO_3 @ 0.2%, salicylic acid @100 ppm, complex NPK (19:19:19) @ 2% and DAP @ 2% at initiation of flower and pod] were allocated in a randomized complete block design with three replications.

Result: Complex fertilizer NPK (19:19:19) @ 2% improved crop growth attributes like, LAI, CGR, chlorophyll content and nodules $plant^{-1}$. Yield components, yield along with net return increased with complex NPK (19:19:19) @2%. The protein content was also the highest with complex NPK (19:19:19) @2%. So, foliar nutrition with 2% NPK (19:19:19) at initiation of flower and pod may be recommended for maximizing productivity of spring blackgram.

Key words: Blackgram, Chlorophyll content, Foliar nutrition, Protein content, Yield.

INTRODUCTION

One of the popular food legumes of tropical India is blackgram. Consumer response to this widely grown food legume reflects its contribution in food and nutritional security. Blackgram and its resilience in difficult weather condition makes it a good choice in spring or *summer* rice fallows (Kumar *et al*., 2015). Therefore, the crop also fits well in rice-pulse cropping system under receding soil moisture. The main productivity constraint emerges from the fact that it predominantly suffers growing in marginal lands under rainfed condition. Farmers have an inclination to spend less on legumes and end up with poor management practices. Moreover, indeterminate growth habit subjects the crop to constant competition between vegetative stage and sink partitioning for photo assimilates in the respective period (Marimuthu and Surendran, 2015) and this has been an identified major impediment to productivity. Owing to all these reasons for a short duration indeterminate crop, scheduling soil nutrients do not always have pronounced response. At the onset of reproductive growth marked by declined nodulation, there is need of proper fertilization. Unavailability of sufficient nutrients at the critical phenophase of flowering and pod development observed nutrient stress (Thanunathan *et al*., 2018) together with flower and fruit drop (Ganapathy *et al*., 2008). Consequently, though blackgram produces large number of flowers, a smaller number of flowers convert into pods. Excessive flower abscission followed by poor pod setting occurs due to less efficient partitioning of assimilates and aggravated nutrient demand at the pod stage which may be attended by replenishing macro and micronutrients.

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Soil application of fertilizers entails heavy cost in production, transport and mobilization which the farmer has to bear. Credit worthiness of small holding farmer is coming down and with emerging policies, enterprising agriculture and corporate farming leaves the farmer less room for grain production. Rationalization of costs in plant nutrition led to studies in foliar application of major nutrients.

Foliar nutrition has better efficacy in faster uptake and significant less amount of losses (Karuku *et al*., 2017). Time lag observed between application and absorption of nutrients by plants is very less. Foliar nutrition is less contributing to environmental concerns. While soil applications have reported 30-60% efficiency the same for foliar application can reach values upto 85% subject to nutrient formulations. Foliar application has an edge in economics, quality and yield. Sink partitions are more favoured by foliar nutrition (Maheswari and Karthik, 2017). Potentially, foliar nutrition provides a simple solution for nutrient administration in pulse crops, more so, in the later stage of plant growth when soil application is either ineffective or expensive (Kuepper, 2003).

Identifying stages of crops responding more to foliar nutrition holds the key for better and efficient utilization by the crop (Krishnaveni *et al*., 2004). So, foliar application of nutrients not only alleviates the nutrient deficiency but it improves the reproductive efficiency (Shankarappa *et al*., 2020). With this background, the present experiment aimed to investigate the efficacy of foliar nutrition towards growth and yield of spring blackgram in the lower Gangetic plains of West Bengal, India.

MATERIALS AND METHODS

The two year trial was reported from a study undertaken in the spring seasons of 2018 and 2019 respectively, in "AB" block farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India enjoying bearings of 22.5°N latitude and 89.0°E longitude at an elevation of 9.72 m. The soil of the experimental field was analyzed for physico-chemical properties. The available nitrogen of the experimental field was (301.50 and 321. 61 kg ha^{-1}), phosphorus (32.60 and 35.75 (kg ha^{-1}) and potassium (100.42 and 106.45 kg ha^{-1}).

The experiment had eight foliar treatments (T_1: Absolute control (No spray), T_2: Control (water), T_3: $CaCl_2$ @ 0.1%, T_4: KCl @0.2%, T_5: KNO_3 @ 2%, T_6: Salicylic acid @ 100 ppm, T_7: Complex NPK (19:19:19) 2% and T_8: 2% DAP) fitted in randomized block design (RBD), replicated three times. All the treatments were given as foliar spray at flowering and pod initiation stages.

The test variety of the crop 'Pant Urd-31' was sown in the 3rd week of February, 2018 and 2019. A spacing of 25 cm × 10 cm was maintained. A blanket basal dose of urea, single super phosphate and muriate of potash supplied major nutrients @ 20:40:20 Kg ha^{-1} (N: P: K). The crop was harvested during 2nd week of May, 2018 and 2019. Observations were collected through random sampling of 10 plants from each treatment at 30 DAS, 45 DAS and 60 DAS to record height, dry matter, nodule number and LAI. At the time of harvest, number of pods $plant^{-1}$, seeds pod^{-1}, test weight (g) and finally, the grain yield and stover yield were recorded.

Chlorophyll extraction was done in 80% (v/v) acetone followed by observations at wavelengths 645 nm and 663 nm in UV VIS spectrophotometer. Chlorophyll contents were analyzed from the leaf samples collected at 30 DAS and 60 DAS following Arnon (1949). Protein content of seed was also measured from the seed samples after harvesting.

The cost of production (Rs. ha^{-1}) and the gross monetary return (Rs. ha^{-1}), net revenue (Rs. ha^{-1}) and benefit: cost ratio (B:C) from the produce of various treatments were computed from prevailing market prices of inputs in West Bengal (India) and implied labour cost for incidental and application.

The data were analyzed comparing the means of various treatments on different parameters through the analysis of variance (ANOVA) method to test the significance ($p \leq 0.05$) (Gomez and Gomez, 1984). The data were analyzed by analysis of variance (ANOVA) and significant differences were judged through F test. The F value was compared for the determination of least significant differences (LSD) at $p \leq 0.05$.

RESULTS AND DISCUSSION

Growth parameters

T_6 produced tallest plants (38.97 cm), followed by T_7 (Table 1). Significantly highest values of dry matter (196.82 g m^{-2} and 318.66 g m^{-2} respectively) at 45DAS and 60DAS were recorded with T_7. Crop growth rate (CGR) at 30-45 DAS, varied between 10.33 $g^{-2}day^{-1}$ with the application of T_7 to 7.45 g $m^{-2}day^{-1}$ in T_1. Many researchers reported that foliar nutrition results in higher photosynthesis due to greater absorption, assimilation and translocation of nutrients (Dalei *et al*., 2014). The increments in the total dry matter production (TDM) per unit area which is otherwise known as CGR is the pre-requisite for higher yields as well as a crucial indicator that reflects the crop growth and metabolic activity.

At 45DAS and 60 DAS, maximum number of nodules $plant^{-1}$ (33.70 and 22.65) was recorded in T_7 (Table 1). The nitrogen and phosphorus present in complex 2% NPK (19:19:19) is likely to improve root development and increase activity of *Rhizobium* spp. in the rhizosphere region leading to a greater number of nodules (Geetha and Velayutham, 2009). At 45 DAS, the highest LAI (3.79) was recorded with T_7. At 60DAS, the highest LAI (4.33) was observed in T_7 followed by T_8 (Table 1).

Yield attributes and yield

The maximum pods $plant^{-1}$ (29) was observed in T_7 (Table 2). The maximum seeds pod^{-1} (7) was recorded with T_7 and T_6. The highest test weight (38.71) was recorded in T_7. Enhancement of translocation of assimilates towards the desirable sink i.e., pods with the effective foliar treatment might be another possible reason of more pod development. Increased nutrient absorptions through leaves might improve functional activity of root nodules, leaf area, and biomass production eventually improving seed formation. Shedding of flowers was drastically reduced in foliar treatments which had resulted in greater pods and yield (Maheswari and Karthik, 2017).

Grain yield of blackgram was influenced by different foliar nutrition. The highest grain yield (1200 kg ha^{-1}) was recorded with T_7 followed by T_6 (Fig 1). The stover yield was found to be highest (2234 kg ha^{-1}) in T_2. The maximum harvest index was observed in T_7. Foliar nutrition of NPK might have delayed leaf senescence with high

Table 1: Effect of different foliar sprays on plant height (cm), DMA (g m^{-2}), CGR (g m^{-2}day^{-1}), nodule no. plant^{-1}and LAI of blackgram.

Treatments	Plant height (cm)	No. of branches plant^{-1}	Dry matter accumulation (g m^{-2})			CGR (g m^{-2} day^{-1})		Nodule no. plant^{-1}			LAI		
			30 DAS	45 DAS	60 DAS	30-45 DAS	45-60 DAS	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
T_1	29.16	4.26	40.68	152.45	244.58	7.45	6.14	9.87	18.70	10.35	2.47	2.58	2.92
T_2	31.29	5.06	40.92	161.21	245.80	8.00	5.64	13.05	24.66	12.50	2.52	2.66	2.99
T_3	30.86	4.26	41.62	167.31	266.55	8.37	6.61	11.04	27.62	13.75	2.57	2.77	3.22
T_4	34.29	4.26	41.45	182.25	310.54	9.38	7.95	11.51	28.56	16.56	2.53	2.84	3.45
T_5	34.29	5.06	40.97	180.51	283.42	9.30	6.85	13.11	30.54	18.47	2.48	3.40	3.85
T_6	38.97	4.53	41.12	192.75	315.64	10.10	8.19	14.19	32.48	19.70	2.56	3.65	4.06
T_7	35.24	5.60	41.84	196.82	318.66	10.33	8.12	15.15	33.70	22.65	2.59	3.79	4.24
T_8	33.33	3.73	41.08	185.02	290.33	9.59	7.02	10.66	20.67	11.68	2.54	3.48	4.33
SEm (±)	0.11	0.12	0.24	0.15	0.26	0.043	0.018	0.90	0.12	0.16	0.02	0.008	0.06
LSD ($P \leq 0.05$)	0.35	0.37	NS	0.47	0.81	0.131	0.056	NS	0.39	0.49	NS	0.023	0.20

T_1: Absolute control (No Spray), T_2: Control (water spray), T_3: $CaCl_2$ @ 0.1% spray, T_4: KCl @ 0.2% spray, T_5: KNO_3 @ 2% spray, T_6: Salicylic acid @ 100 ppm spray. T_7: Complex NPK (19:19:19) 2% spray, T_8: 2% DAP- all foliar applications were done at initiation of flower and pod.

photosynthetic rate during pod development, thereby led to higher yield. The increased HI under foliar nutrition might be due to enhanced assimilate translocation to sink (Thakur *et al.*, 2017).

Chlorophyll content

The highest value (2.91) of chlorophyll content was observed in T_7 (Table 2). Chlorophyll synthesis depends on mineral nutrition (Li *et al.*, 2018). Foliar application of nitrogen is reported to improve leaf chlorophyll content since it is a structural component of chlorophyll (Tucker, 2004). Phosphorus also has influence in the formation as well as stability of the pigment in plants (Bojovic *et al.*, 2005). Many researchers found out that potassium has a vital role in increasing chlorophyll content in the crops (Gairola *et al.*, 2009). Potassium helps in the uptake of iron and magnesium; those are associated with chlorophyll synthesis. In this way, foliar nutrition with 2% N: P: K-19:19:19 resulted in increased chlorophyll content.

Correlation analysis

An attempt has also been made to recognize the parameters that are most significantly associated with grain yield and/or harvest index of blackgram under the influence of foliar nutrition (Table 3). The results revealed that final grain yield ha^{-1} was highly correlated (at $p \leq 0.01$) with several growth or physiological parameters like dry matter accumulation (DMA) both at 45 and 60 DAS, CGR both at 30-45 DAS and 45-60 DAS, nodule number plant^{-1} at 60 DAS. Besides, high positive correlations of harvest index with DMA both at 45 and 60 DAS, CGR at 30-45 DAS, and nodule numbers plant^{-1} both at 45 DAS and 60 DAS were found.

High positive correlation of grain yield or harvest index with dry matter production both at 45 and 60 DAS might indicate that high dry matters were produced during this period due to foliar nutrition and at latter stage significant amount of stored photosynthates partitioned towards grain. Further, the higher positive correlation between CGR and grain yield might be due to increased dry matter production emerging from improved physiological processes like regulation of stomatal opening, chlorophyll synthesis, enzymatic activity and biochemical processes in response to foliar nutrition (Marschner, 2012).

Further, most interestingly high positive correlations of both grain yield and harvest index with nodules plant^{-1} particularly at 60 DAS (0.939 and 0.934, respectively) might indicate the necessity of balanced nutrition at latter growth stages of this crop. Foliar nutrition at proper crop growth stages might also result in spreading of root system and as such it helps in forming more effective nodules by providing more site for rhizobia infection and increasing their proliferation in rhizosphere (Raj *et al.*, 2018). Positive correlation between grain yield and nodule number plant^{-1} has been reported by earlier researchers (Goni, 2000).

Protein content

The maximum value (24.85%) of protein content was observed with T_7 (Fig 2). Greater protein content is generally associated with increasing N content as it is the key constituent of amino acids *i.e.* building blocks of proteins. Hence, improved N uptake and assimilation of foliar applied N is therefore likely to improve the seed protein content (Fageria *et al.*, 2009).

Economics

The data (Table 4) revealed that the highest cost of cultivation was required for T_3. But the maximum economic benefits were obtained with T_7 followed by T_6. The highest B:C ratio was observed in T_7.

Table 2: Effect of different foliar nutrients on yield attributing characters and harvest index in spring blackgram.

Treatments	Chlorophyll content (mg g^{-1})		Yield attributes		
	30 DAS	60 DAS	Pods plant^{-1}	Seeds pod^{-1}	Test weight (g)
T_1	1.28	1.67	17	4	34.74
T_2	1.29	1.80	20	4	35.84
T_3	1.27	1.93	23	6	38.25
T_4	1.30	1.86	24	6	40.27
T_5	1.29	1.77	27	7	38.93
T_6	1.33	2.21	27	7	39.96
T_7	1.31	2.91	29	7	40.86
T_8	1.32	1.97	23	5	37.06
SEm (±)	0.013	0.04	0.19	0.14	0.02
LSD (P≤0.05)	NS	0.12	3.60	0.42	0.07

T_1: Absolute control (No Spray), T_2: Control (water spray), T_3: $CaCl_2$ @ 0.1% spray, T_4: KCl @ 0.2% spray, T_5: KNO_3 @ 2% spray, T_6: Salicylic acid @ 100 ppm spray. T_7: Complex NPK (19:19:19) 2% spray, T_8: 2% DAP- All foliar applications were done at initiation of flower and pod.

Table 3: Correlation coefficients of different growth or physiological parameters with grain yield or harvest index of spring blackgram.

		Grain yield (kg ha^{-1})	Harvest index (%)
Plant height (cm)		0.894**	0.744
Branches		0.479	0.488
Dry (g m^{-2})	30 DAS	0.594	0.738
	45 DAS	0.944**	0.865**
	60 DAS	0.903**	0.866**
CGR (g m-2 day^{-1})	30-45 DAS	0.942**	0.859**
	45-60 DAS	0.838**	0.818
Nodule no. plant^{-1}	30 DAS	0.820	0.718
	45 DAS	0.899**	0.917**
	60 DAS	0.939**	0.934**
Leaf area index	30 DAS	0.580	0.569
	45 DAS	0.775	0.659
	60 DAS	0.390	0.297
Chlorophyll content	30 DAS	0.640	0.406
	60 DAS	0.722	0.690

** Correlation is significant at p≤0.01 (N=8).

Table 4: Effect of different foliar nutrition on economics of spring blackgram (Mean data of 2 years).

Treatments	Total cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
T_1	12300	21375	9075	1.74
T_2	14268	24225	9957	1.70
T_3	16643	24825	8182	1.49
T_4	15268	27150	11882	1.78
T_5	16143	27825	11682	1.72
T_6	15049	29175	14126	1.94
T_7	14710	30000	15290	2.04
T_8	14568	25625	11057	1.76

T_1: Absolute control (No Spray), T_2: Control (water spray), T_3: $CaCl_2$ @ 0.1% spray, T_4: KCl @ 0.2% spray, T_5: KNO_3 @ 2% spray, T_6: Salicylic acid @ 100 ppm spray. T_7: Complex NPK (19:19:19) 2% spray, T_8: 2% DAP- all foliar applications were done at initiation of flower and pod.

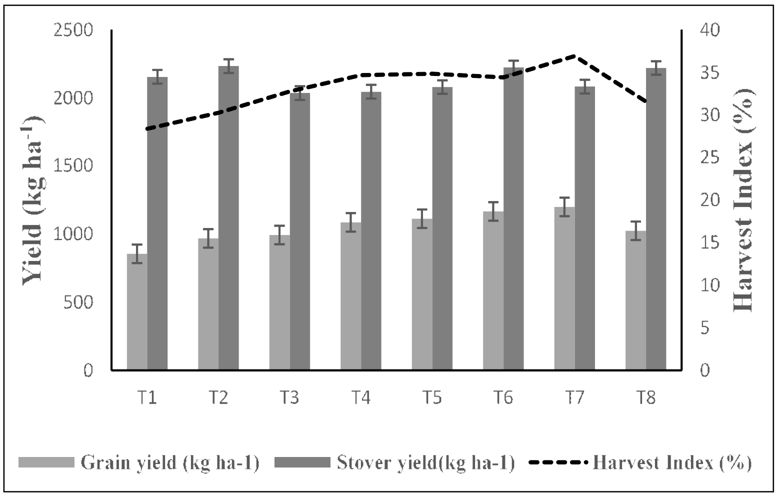

Fig 1: Effect of different foliar nutrition on grain and stover yield of spring blackgram. Error bar indicates standard error of means (±) at p≤0.05.

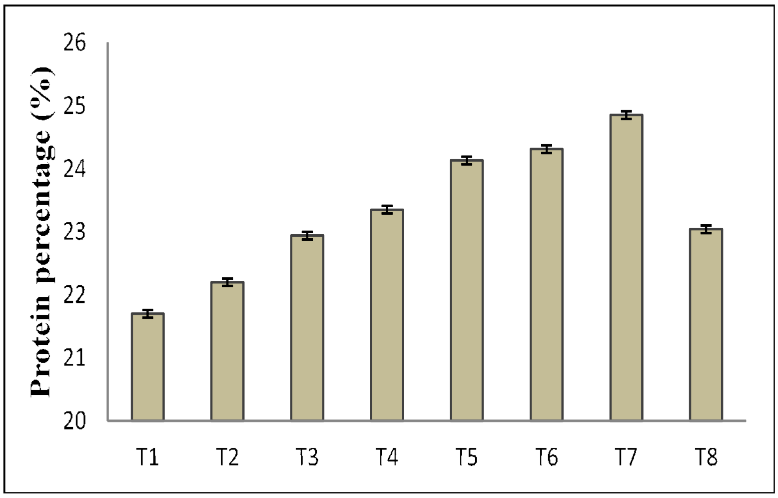

Fig 2: Influence of different foliar nutrition on protein content (%) in *spring* blackgram. Error bar indicates SEm(±) at p≤0.05.

CONCLUSION

In conclusion, foliar nutrition is effective in improving crop growth, grain yield, and quality of blackgram. The improvement of dry matter production and yield of blackgram would be attributed to enhanced nodulation as well as better mobilization of nutrients or partitioning of photosynthates due to foliar application of combined nutrients. It is evident that spraying of complex NPK 19:19:19 @ 2% at flowering and commencement of pod development can improve the overall performance of spring blackgram and therefore promote its adoption in the rice-based cropping systems by fetching satisfactory yield and economic benefits.

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REFERENCES

Arnon, D.I. (1949). Copper enzymes in isolated chloroplasts. Polyphenoloxidase in *Beta vulgaris*. Plant Physiology 24: 1.

Bojovic, B.M., Stojanovic, J. and A. Markovic. (2005). Effects of fertilization on chloroplasts pigments content, leaf surface and dry matter weight in some wheat cultivars. Acta Agriculturae Serbica. 10(20): 29-37.

Dalei, B.B., Kheroar, S., Mohapatra, P.M., Panda, S. and Deshmukh, M.R. (2014). Effect of foliar sprays on seed yield and economics of niger (*Guizotia abyssinica* L.). J. Agri. Sci. 6(6): 143-147.

Fageria, N.K., Barbosa Filho, M.P., Moreira, A. and Guimaraes, C. M. (2009). Foliar fertilization of crop plants. Journal of Plant Nutrition. 32: 1044-1064.

Gairola, S., Umar., S. and S. Suryapani. (2009). Nitrate accumulation, growth and leaf quality of spinach beet (*Beta vulgaris* Linn.) as affected by NPK fertilization with special reference to potassium. Ind. J. Sci. Technol. 2: 35-40.

Ganapathy, M., Baradhan, G. and Ramesh, N. (2008). Effect of foliar nutrition on reproductive efficiency and grain yield of rice fallow pulses. Legume Research-An International Journal. 31(2): 142-144.

Geetha, P. and Velayutham, A. (2009). Refinement of nutrient management techniques for growth, yield and nutrient uptake of rice fallow blackgram. Madras Agricultural Journal 96: 163-166.

Gomez, K.A. and Gomez, A. A. (1984). Duncan's Multiple Range test. Statistical Procedures for Agricultural Research. 2: 540-4.

Goni, M.O. (2000). Genetic control of the growth of root nodules and their relation with yield in blackgram [*Vigna mungo* (L.) Hepper]. M.Phil thesis, Department of Genetics and Breeding, University of Rajshahi. p. 70.

Karuku, G.N., Kimenju, J.W. and Verplancke, H. (2017). Farmers' perspectives on factors limiting tomato production and yields in Kabete, Kiambu County, Kenya. East African Agricultural and Forestry Journal. 82: 70-89.

Krishnaveni, S., Palchamy, A. and Mahendran, S. (2004). Effect of foliar spray of nutrients on growth and yield of green gram (*Vigna radiata* L.). Legume Res. 27(2):149-150.

Kuepper, G. 2003. Foliar Fertilizatiom. NCAT Agriculture Specialist, Published 2003, ATTRA Publication #CT135.

Kumar, A., Parihar, A.K. and Gupta, S. (2015). Urdbean for Sustainable Agriculture and Nutritional Security in India. Pop. Kheti 3(3): 2-4.

Li, Y., He, N., Hou, J., Xu, L., Liu, C., Zhang, J., Wang, Q., Zhang, X., and Wu, X. (2018). Factors influencing leaf chlorophyll content in natural forests at the biome scale. Frontiers in Ecology and Evolution. 6: 64.

Maheswari, U.M. and Karthik, A. (2017). Effect of foliar nutrition on growth, yield attributes and seed yield of pulse crops. Adv. Crop Sci Technol. 5: 1-3.

Marimuthu, S. and Surendran, U. (2015). Effect of nutrients and plant growth regulators on growth and yield of blackgram in sandy loam soils of Cauvery new delta zone, India. Cogent Food and Agriculture 1(1): 1010415.

Marschner, P. (2012). Marschner's Mineral Nutritional of Higher Plants. 3rd Edition, Academic Press, London, UK.

Raj, M.A., Sathya, P., and Vignesh, S. (2018). Effect of foliar nutrition for maximizing the productivity of blackgram (*Vigna mungo* L.). International Journal of Science. Environment and Technology. 7(6): 2026-2032.

Shankarappa, S.K., Muniyandi, S.J., Chandrashekar, A.B., Singh, A.K., Nagabhushanaradhya, P., Shivashankar, B., El-Ansary, D.O., Wani, S.H., and Elansary, H.O. (2020). Standardizing the hydrogel application rates and foliar nutrition for enhancing yield of lentil (*Lens culinaris*). Processes. 8(4): 420.

Thakur, V., Patil, R.P., Patil, J.R., Suma, T.C. and Umesh, M.R. (2017). Influence of foliar nutrition on growth and yield of blackgram under rainfed condition. Journal of Pharmacognosy and Phytochemistry. 6(6): 33-37.

Thanunathan, K., Thiruppathi, M. and Shobana, M. (2018). Effect of foliar application of chelated nutrient on the growth, yield attributes and yield of irrigated green gram. European Journal of Biotechnology and Bioscience. 6(1): 56-58.

Tucker, M. (2004). Primary Nutrients and Plant Growth. In: Essential Plant Nutrients, North Carolina Department of Agriculture.