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Influence of inorganic and organic foliar nutrition on growth and yield of irrigated blackgram (*Vigna mungo*. L)

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Abstract

Black gram yield is low due to various reasons includes physiological, biochemical as well as inherent factors associated with the crop. Insufficient partitioning of assimilates, flower dropping and poor pod setting. More over, lack of nutrients during critical stages of crop growth also resulted in poor yield. To improve the productivity of black gram, foliar spray of nutrients and growth hormones at critical stages helped nutrients and hormones to reach the site of food synthesis, leading quick accumulation in sink. Field experiments were conducted at Agricultural College and Research Institute, Madurai, India during 2022 to 2023 to study the effect of supplemental foliar nutrition of organic and inorganic sources in irrigated blackgram using variety VBN-8. The experiment was laid out in randomized block design and replicated thrice. The treatments comprises foliar application (FA) of inorganic (urea, DAP and Pulse wonder) and organic (panchagavya, egg amino acid and fish amino acid) sources of nutrients viz., T₁-FA of 1% urea at flower initiation and 15 days later, T₂-FA of 2% Di Ammonium Phosphate (DAP) at flowering and 15 days later, T₃-FA of 2% egg amino acid at flowering and 15 days later, T₄-FA of 3% panchagavya at 30 and 45 DAS, T₅-FA of 5% fish amino acid at flowering and 15 days later, T₆-FA of 1% TNAU pulse wonder at flowering and 15 days later and T₇-control (No spray). Foliar application of pulse wonder resulted in higher values in plant height (41.5 to 41.8 cm), DMP (dry matter production) (3055 to 3175 kg ha⁻¹) and seed yield (875 to 905 kg ha⁻¹) than the other sources of nutrient. Among inorganic chemical supplementation, TNAU pulse wonder performed better than 2% DAP and 1% Urea application in terms of seed yield, net income and BCR where as 3% panchagavya spray performed better among the organic sources of nutrients followed by 5% FAA and 2% EAA spray.

Keywords: Blackgram, foliar nutrition, TNAU pulse wonder, fish amino acid, egg amino acid

1. Introduction

Pulse crops are an important source of dietary protein, mineral and vitamins in the common man food. Blackgram is one of the extensively grown grain legume from the point of food and nutritional security in the world (Thakur *et al.*, 2017) [26]. Blackgram is a perfect combination of all nutrients which include 20 to 25% proteins, 40 to 47% starch, ash fats, carbohydrates and essential vitamins (Manjri Singh *et al.*, 2018) [13]. India is the largest producer and consumer of pulses in the world, accounting for 25 per cent of total production and around 30 per cent of total world consumption. India accounts for 30.73 million hectare (mha) of pulses, 27.3 metric tonne of pulses production, 888 kg ha⁻¹ productivity with a gap of 8% Anon, 2023) [2]. World Health Organization (WHO) and Indian Council of Medical Research (ICMR) recommended the daily per capita consumption as 80 g and 45 g, respectively. The increasing demand-supply gap is a problem led to inaccessible to the poor as good source of vegetarian protein. It is inevitable that if there is no rise in the pulse production level in India, rural common people tend to face deficiency of protein and minerals related health issues (Thakur *et al.*, 2017) [26].

The supplementation of essential nutrients through soil application is a common agronomic practice in all the crops. Foliar feeding of nutrients today plays an important role in crop production. Almost all crops, foliar feeding will eventually play important role in their nutrition at any point of their development. Foliar application is rapidly work against specific deficiencies and which may occur during the growth of most of the crops. Nutrient sprays like fertilizer

solutions applied maintaining crops at an optimal rather than at a suboptimal or marginal productivity status of soil. The soil applied nutrients may or may not be available to plants due to several soil physico-chemical reactions and the entire fertilizer is not utilized by the crop within the season especially relating to short duration crops. Hence, supplying small amounts through foliage improved the quality of produce by reaching the site of sink directly and preserved the crop yields with low environmental impact (Jeevana Lakshmi *et al.*, 2017) ^[10]. The positive effect of foliar nutrition in blackgram was demonstrated and reported additional yield due to supplemental nutrition (Nath *et al.*, 2016) ^[14]. The use of different chemicals viz., DAP, Urea, chelated Zn and Fe (Shashikumar *et al.*, 2013 and Uma Maheswari and Karthik, 2017) ^[23, 27]. TNAU pulse wonder (Devaraju and Senthivel, 2018) and growth promoters viz., panchagavya and cow urine (Shashikumar *et al.*, 2013) ^[23] used as source of plant nutrients through foliar application in blackgram for yield increment. In the line of organics viz., panchagavya, fish amino acid (FAA), egg amino acid (EAA) were also used for improving crop growth and development in rice and greengram (Priyanka *et al.*, 2019a and 2019b) ^[18, 19]. Among these organic preparations, panchagavya was scientifically evaluated for its physical, chemical and biological properties as well as effect on growth and development of many crops. But in case of FAA and EAA, research findings on its growth effects on crops are very meager. The fish amino acid is liquid organic manure made from fish waste. Fish amino acid is of great value to both plants and microorganisms in their growth, because it contains various nutrients and types of amino acids. Foliar application or a soil drenching of FAA could maximize uptake and minimize runoff or leaching, providing enough N to the plant for the production of chlorophyll to maintain plant health (Aung and Flick, 1980; Prasath *et al.*, 2022; Priyanka *et al.*, 2019a) ^[3, 17, 18]. The present study was planned and conducted to study the effect of foliar applied inorganic and organic sources of nutrients for boosting blackgram yield.

2. Materials and Methods

Field experiment was conducted at Central Farm, Department of Agronomy, Agricultural College and Research Institute, Madurai during 2022 (January to May) and 2023 (August to September) to study the effect of supplemental nutrition through foliar application (FA) of inorganic sources viz., Urea, DAP (Di Ammonium Phosphate) and Pulse wonder developed by TNAU (Tamil Nadu Agricultural University); organic sources viz., Pachagavya, Egg Amino Acid (EAA) and Fish Amino Acid (FAA) sources of nutrients on irrigated blackgram (*Vigna mungo* L.). The experimental field soil was sandy clay loam in texture. The composite soil sample from the field was gathered before the start of the experiment from five different places at the depth of 0-15 cm and analyzed for the physico-chemical properties by quadrant method. The pH and EC of soil are 7.05 to 7.10 and 0.38 to 0.40 d Sm⁻¹, respectively. The nutrient status of experiment soil was medium in available nitrogen (232 to 220 kg ha⁻¹), Medium in available phosphorus (16.2 to 17.0 kg ha⁻¹) and high in available potassium (355 to 372 kg ha⁻¹). The organic carbon content was 0.38 to 0.41 g kg⁻¹. The field experiment was laid out in randomized block design and replicated thrice. The treatments comprises foliar application (FA) of inorganic (urea, DAP and Pulse wonder) and organic (pachagavya, egg amino acid and fish amino acid) sources of nutrients viz., T₁-FA of 1% urea at flower initiation and 15 days later, T₂-FA of 2% Di Ammonium Phosphate (DAP) at flowering and 15 days later, T₃-FA of 2% egg amino acid at

flowering and 15 days later, T₄-FA of 3% panchagavya at 30 and 45 DAS, T₅-FA of 5% fish amino acid at flowering and 15 days later, T₆-FA of 1% TNAU pulse wonder at flowering and 15 days later and T₇-control (No spray).

Blackgram seeds were treated with carbendazim at 2 g kg⁻¹ to prevent seed borne diseases before one day of sowing; the seeds were soaked in water overnight and then treated with rhizobium. In leveled seed beds, seeds were dibbled directly at the spacing of 30 × 10 cm on 05.05.2022 and 24.08.2023. Irrigation was applied immediately after sowing and life-saving irrigation was given on the third day after sowing. Gap filling was done on 7 DAS (days after sowing) where germination of previously sown seeds was failed. Thinning was done at 10 DAS for maintaining the recommended plant population. Pre emergence application of pendimethalin 30 EC at 0.75 kg ha⁻¹ was applied after 3 DAS followed by hand weeding on 25 DAS in order to maintain field weed free condition. All the cultural practices for irrigated blackgram cultivation other than foliar application treatments were followed as per the recommendations of Crop Production Guide (2020) of Tamil Nadu Agricultural University. Fish amino acid was prepared from fish waste obtained from local fish market as suggested by Anon, 2022^[1]. Egg amino acid was prepared as described by Anon. 2015. Five plants were selected randomly and tagged for recording biometric observation ie plant height in each experimental plot. The data pertaining to plant height and No. of pods per plant were recorded in all the treatments on 50 DAS. The SPAD readings were recorded by using chlorophyll meter as described by Peng *et al.* (1993) ^[16]. The observations of seed yield was recorded at the time of harvest. The crop harvested manually in each treatment threshed, cleaned separately and then sundried to 14 per cent moisture content and weighed for yield calculation. The seed weight was expressed in kg ha⁻¹. The economical analysis was carried out based on the prevailing price of inputs and products. Analysis of variance (ANOVA) was performed for collected data and comparison of means were done with critical difference (CD) at 5% probability level (Gomez and Gomez, 1984) ^[8].

3. Results and Discussion

3.1 Growth and yield of blackgram

The results of the study indicated that foliar application of nutrient solutions (inorganic and organic) increased the crop growth and yield parameter viz., plant height, DMP, No. of pods per plant and seed yield (Table 1 and 2). Among the different organic formulations, 5% FAA spray recorded higher values followed by 3% panchagavya and 2% FAA spray for plant height, DMP, No. of pods per plant and seed yield. Among the inorganic sources 1% TNAU pulse wonder spray significantly produced higher plants, higher DMP, more No. of pods per plant and seed yield than 1% of Urea spray but they are on par with 2% DAP spray treatment. Foliar application of pulse wonder resulted in higher values in plant height (41.5 to 41.8 cm during 2022 and 2023, respectively), DMP (dry matter production) (3055 to 3175 kg ha⁻¹ during 2022 and 2023, respectively), No. of pods per plant (18 to 19 during 2022 and 2023, respectively) and seed yield (875 to 905 kg ha⁻¹ during 2022 and 2023, respectively) than the other sources of nutrient. Among inorganic chemical supplementation, TNAU pulse wonder performed better than 2% DAP and 1% Urea application in terms of DMP, No. of pods per plant and seed yield where as 3% panchagavya spray performed better among the organic sources of nutrients followed by 5% FAA and 2% EAA spray. Among the difference sources of foliar nutrition, the effect of 1% TNAU pulse wonder spray (T₆) was significant when compared to T₇,

T₃ and T₅, but comparable with T₂, T₄ and T₁. The percentage increase in seed yield was ranged from 10.2 to 19.0 (2022) and 11.0 to 20.3 (2023) per cent when compared to control. The lower increment was observed in plants sprayed with 2% EAA (T₃) when compared to control (T₇). The foliar application of nutrients resulted in a higher yield and its qualities, which is an extra benefit in the crop's development. Pathway of foliar applied nutrients relies on penetration of nutrients to the outer cuticles then the wall of the underlying epidermal cell and further by entering to the cytoplasm of a cell in leaf (Roemheld and El-Fouly, 1999) [20]. Once penetration has occurred, nutrient absorption is taken as similar to absorption by the roots. Foliar application has proven to be an excellent method of supplying plant requirements for micronutrients (zinc, manganese, iron, copper, boron, and molybdenum). The enhancement in seed yield because of foliar application of different chemicals formulations was mostly owing to nutrient absorption without loss during foliar application and higher activity of root nodules, which would have fixed atmospheric nitrogen into the soil, resulting in higher dry matter production and nutrient accumulation. The foliar application increases grain yield which can be attributed through reduction in flower droppings and a rise in pod setting resulted in more No. of pods per plant. This is in line with the findings of Deepak kumar *et al.* (2019) [4] and Kushwah *et al.* (2023) [11] as foliar application of TNAU pulse wonder or 2% DAP or 2% Urea significantly increased the plant growth and yield of blackgram compared to control.

Organic fertilizers represent a source of nutrients for plants that is an alternative to synthetic fertilizers. In addition to their nutrient content, they contain bioactive molecules with generally beneficial effects on plant growth and productivity (Fahimi *et al.*, 2016; Souri, 2016) [7, 24]. In this study all the sources of organic fertilizers increased the growth and yield of the crop when compared to control. This might be due to favourable effect of organic solutions (FAA, EAA and panchagavya) increase the nutrients availability and promote the vegetative growth viz., number of branches per plant and reproductive growth. Panchagavya was an efficient bio-stimulant that enhances the physiological growth of the plant and promotes immense biological activity in soil and enhance availability of essential nutrients to crop (Nileema *et al.*, 2011) [15]. The above findings are in line with the observations of Jarecki *et al.* (2005) [9]; Devakumar *et al.* (2014) [6] and Verma *et al.* (2017) [28].

3.2 SPAD value

The SPAD values indicate the nutritional health of plants and the supplemental foliar application influenced the meter readings and it was ranged from 42.5 to 45.4, and 42.5 to 45.5 during 2022 and 2023, respectively (Table 2). The percentage increase

in SPAD value was ranged from 1.6 to 6.8 (2022) and 1.8 to 7.0 (2023) when compared to control. Among the different organic formulations, 3% panchagavya recorded higher SPAD values (43.6 during 2022 and 2023) followed by 5% FAA and 2% FAA spray. Among the different inorganic sources, 1% TNAU pulse wonder spray (45.4 and 45.5, respectively during 2022 and 2023) significantly produced greener plants than 1% of Urea spray but they are on par with 2% DAP spray treatment. TNAU pulse wonder performed better than 2% DAP and 1% Urea application for SPAD value where as 3% panchagavya spray performed better among the organic sources of nutrients followed by 5% FAA and 2% EAA spray. Among the difference sources of foliar nutrition, the effect of 1% TNAU pulse wonder spray (T₆) was found to be higher and significant when compared to T₇, T₃, and T₅, but comparable with T₂, T₄ and T₁. The pulse wonder contains essential nutrients and growth regulators in the form of powder and readily soluble in water. Application of TNAU pulse wonder leads to an increase in the number of pods and their growth, as well as more efficient photosynthate and photosynthetic activity transfer from source to sink relationships. The higher values of SPAD readings also indicated the better growth status of plant. This could be due to foliar spraying more nutrients into the foliage during the vegetative and flowering stages of the crop's growth. These findings are consistent with those of Devaraju and Senthivel. (2018) [5] and Sachin *et al.* (2018) [22]. The application of TNAU pulse wonder demonstrated better performance of blackgram due to increase in chlorophyll content, better stomatal conductivity and consequently in seed yield (Sachin *et al.* 2019 [22]; Deepak kumar *et al.* (2019) [4]. In present study also spray of 1% TNAU pulse wonder spray (T₆) out performed than the other sources of supplementation of foliar nutrition.

3.3 Economic analysis

Analysis of economic indicators (Table 3) revealed that higher gross income (Rs.53578 ha⁻¹ and 54550, respectively during 2022 and 2023), net income (Rs.16118 ha⁻¹ and 16835, respectively during 2022 and 2023) and BCR (1.43 and 1.44, respectively during 2022 and 2023) were recorded when plants supplied with 1% TNAU pulse wonder when compared to other treatments. Among organic sources, 3% spray of panchagavya recorded higher values for economic indicators than 2% FAA and 5% EAA spray. The lowest values for gross income, net income and BCR were recorded in control treatment. The higher net income obtained mainly because of additional yield of crop due to foliar application of 1% TNAU pulse wonder spray. Devaraju and Senthivel (2018) [5] also reported the higher net income by application of 1% TNAU pulse wonder.

Table 1: Effect of supplemental foliar nutrition on growth and yield parameter of blackgram

Treatments	2022			2023		
	Plant height (cm) at harvest	DMP (kg ha ⁻¹) at harvest	No. of pods per plant	Plant height (cm) at harvest	DMP (kg ha ⁻¹) at harvest	No. of pods per plant
T ₁ -FA of 1% urea at flower initiation and 15 days later	39.6	2765	15	39.8	2882	16
T ₂ -FA of 2% DAP at flowering and 15 days later	40.8	2950	17	41.1	3068	17
T ₃ -FA of 2% egg amino acid at flowering and 15 days later	36.1	2640	15	36.4	2735	16
T ₄ -FA of 3% panchagavya at 30 and 45 DAS	37.6	2835	16	37.7	2920	16
T ₅ -FA of 5% fish amino acid at flowering and 15 days later	36.8	2725	15	37.0	2835	16
T ₆ -FA of 1% TNAU pulse wonder at flowering and 15 days later	41.5	3055	18	41.8	3175	19
T ₇ -control (No spray)	34.5	2515	14	34.7	2610	15
S.Ed	0.6	45	0.2	0.7	46	0.3
CD (P=0.05)	1.8	138	0.7	1.8	140	0.8

Table 2: Effect of supplemental foliar nutrition on SPAD value and yield of blackgram

Treatments	2022			2023		
	SPAD value	Seed yield	Haulm yield	SPAD value	Seed yield	Haulm yield
T ₁ -FA of 1% urea at flower initiation and 15 days later	44.8	835	3025	44.9	850	3135
T ₂ -FA of 2% DAP at flowering and 15 days later	45.1	858	3115	45.1	880	3240
T ₃ -FA of 2% egg amino acid at flowering and 15 days later	43.2	810	2920	43.3	835	3005
T ₄ -FA of 3% panchagavya at 30 and 45 DAS	43.6	852	3080	43.6	875	3185
T ₅ -FA of 5% fish amino acid at flowering and 15 days later	43.5	822	3010	43.6	846	3105
T ₆ -FA of 1% TNAU pulse wonder at flowering and 15 days later	45.4	875	3215	45.5	905	3360
T ₇ -control (No spray)	42.5	735	2830	42.5	752	2915
S.Ed	0.6	13	54	0.6	14	56
CD (P=0.05)	2.0	41	151	2.0	43	154

Table 3: Effect of supplemental foliar nutrition on economic analysis of blackgram

Treatments	2022				2023			
	Cost of cultivation	Gross return	Net return	BCR	Cost of cultivation	Gross return	Net return	BCR
T ₁ -FA of 1% urea at flower initiation and 15 days later	39132	51105	11973	1.30	39387	52110	12723	1.32
T ₂ -FA of 2% DAP at flowering and 15 days later	39764	52148	12384	1.31	40020	53150	13130	1.33
T ₃ -FA of 2% egg amino acid at flowering and 15 days later	38560	49555	10995	1.29	38815	50560	11745	1.30
T ₄ -FA of 3% panchagavya at 30 and 45 DAS	39212	52469	13257	1.34	39467	53510	14043	1.35
T ₅ -FA of 5% fish amino acid at flowering and 15 days later	38756	50248	11492	1.30	39010	51270	12260	1.31
T ₆ -FA of 1% TNAU pulse wonder at flowering and 15 days later	37460	53578	16118	1.43	37715	54550	16835	1.45
T ₇ -control (No spray)	35652	45020	9368	1.26	35907	46040	10133	1.28

4. Conclusion

The supplementation of essential nutrients through soil application is a common agronomic practice in blackgram to meet nutrient demand. Foliar application is also one of the economic agronomic strategies to improve the crop yield in blackgram. Foliar applied nutrients are generally absorbed more rapidly than when applied to the soil. Supplying nutrients in small amounts through foliage improved the growth and quality of produce. Application of inorganic and organic sources of nutrients improved the performance of blackgram by their own ways and contributed in yield increment compared to without supplement of nutrients through foliar application. It could be concluded that foliar application of pulse wonder developed by TNAU recorded higher seed yield than the other sources of nutrient. Among inorganic chemical supplementation, TNAU pulse wonder performed better than 2% DAP and 1% Urea application in terms of seed yield, net income and BCR where as 3% panchagavya spray performed better among the other organic sources of nutrients viz, 5% FAA and 2% EAA spray.

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