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Effect of Foliar Application of Nutrients on Growth and Yield Attributes of Blackgram (*Vigna mungo* L.) under Rainfed Condition of Southern Rajasthan

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ABSTARCT

A field experiment was conducted at Dryland Farming Research Station, Arjia, Bhilwara, MPUAT, Udaipur during *kharif*, 2022 to assess the effect of foliar application of nutrients on growth and yield attributes of black gram (*Vigna mungo* L.) under rainfed condition of southern Rajasthan. The experiment consisted of eight treatments and replicated thrice in Randomized Block Design (RBD). The foliar spray of nutrients was done at flower and pod initiation stage. The experiment results revealed that maximum plant height (cm) (63.18), dry matter accumulation plant^{-1} (9.15), number of nodules plant^{-1} (48.02) and weight of nodules plant^{-1} were registered with treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%). Significantly higher number of pod plant^{-1} (37.15), pod length (5.10 cm), number of seed pod^{-1} (7.42), test weight (43.94 g), grain yield (950 kg ha^{-1}) and straw yield (1808.33 kg ha^{-1}) were also reported in the same treatment of RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5% (T_8) and it was at par with treatment T_7 (RDF + Foliar spray of DAP @ 2% + $ZnSO_4$ @ 0.5%).

***Key word**: Foliar spray, Blackgram, RDF, NPK, DAP, $ZnSO_4$*

Introduction

In our country, pulses are commonly referred as food legumes and secondary to cereals in consumption and production. Being the cheapest source of protein, they provide nutritional security in our nation and also play an essential function in maintaining the soil's nutrient status through biological nitrogen fixation, working as a mini factory to enhance soil health (Pooniya *et al*., 2015). India is the world's largest producer and consumer of pulses, accounting for around 29% of the world's area and 19% of the world's production. In India, pulses are cultivated in 31.24 million hectare area with production 27.75 million tonnes and productivity of 888 kg ha^{-1} (Anonymous, 2021-22). The major legumes grown in

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India are chickpea, pigeon pea, greengram, blackgram, cowpea, lentil and field pea. Among these grain legumes, the most important pulse crop grown in India is blackgram (*Vigna mungo* L.), belonging to the Fabaceae family. In rainfed area of India, blackgram is a significant pulse crop. In *kharif* and *summer* seasons, blackgram is cultivated as a sole crop, mixed crop, or crop under rainfed or semi-irrigated conditions. Nutritionally, blackgram contains 59.6% carbohydrates, 24% protein, 1.4% fat, 0.9% fiber and 4.5-5.5% ash on dry weight basis. Due to high values of lysine and phosphoric acid, blackgram is an essential aspect of balanced human nutrition. In India, blackgram is cultivated in the area of 4.64 million hectares with the production of 2.76 million tonnes and productivity of 1681 kg ha^{-1} (Anonymous 2021-22).

Major blackgram producing states are Rajasthan, Maharashtra and Madhya Pradesh. The area, production and average productivity of blackgram in Rajasthan is 5.02 lakh ha, 1.23 lakh tonnes and 246 kg ha^{-1}, respectively (Anonymous, 2020). The productivity of pulses for ever growing population in our country including blackgram is not sufficient enough to meet the demand. Hence, there is a considerably scope for improving blackgram's production through proper agronomic practises. Blackgram has poor yield potential due to a number of factors, including improper management practices, various factors related to the crop that are physiological, biochemical, and inherent. Poor yield is primarily caused by inadequate assimilate partitioning, flower drop, and poor pod setting, which occur at critical stages of crop growth resulted in poor yield (Ramesh *et al.,* 2020). To increase productivity of blackgram, several strategies were introduced. One of them is the use of foliar spray of nutrients to enhance the genetic potential of the crop (Khusboo *et al.,* 2023).

Foliar application of nutrients is essential to avoid or lessen the severity of such a disease, and it is the quickest technique to accelerate crop growth since the plants have access to nutrients both at the initial stages and at critical stages (Sruthi *et al.,* 2020).

Zinc is one of the crucial micronutrients needed by plants in small amount for its healthy growth. The application of Zinc promotes chlorophyll formation, starch sugar conversion, auxin metabolism and stem elongation. Zinc deficiency might result in significant reduction in crop yield and quality.

Materials and Methods

A field experiment was conducted at Dryland Farming Research Station, Arjia, Bhilwara, Maharana Pratap University of Agriculture and Technology, Udaipur. The investigation was done to study the effect of foliar application of nutrients on growth and yield attributes of blackgram (*Vigna mungo* L.) under rainfed condition of southern Rajasthan. The experiment consisted eight treatments *i.e.*, T_1 (RDF + Control (Water Spray), T_2 (RDF + Foliar spray of urea @ 2%), T_3 (RDF + Foliar spray of DAP @ 2%), T_4 (RDF + Foliar spray of NPK (18:18:18) @ 2%), T_5 (RDF + Foliar spray of $ZnSO_4$ @ 0.5%), T_6 (RDF + Foliar spray of Urea @ 2% + $ZnSO_4$ @ 0.5%), T_7 (RDF + Foliar spray of DAP @ 2% + $ZnSO_4$ @ 0.5%) and T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%) which were replicated thrice in Randomized Block Design (RBD). The recommended dose of 20 kg N and 40 kg P_2O_5 ha^{-1} was applied as basal dose through urea and DAP fertilizers as a source of nitrogen and phosphorus, respectively. Foliar spray of nutrients was applied as per treatments. Mukundra Urd-2:-It is a variety of black gram having yield potential upto 10-11 q ha^{-1}, released by the Agriculture University, Kota in 2018 and it matures in 75-80 days. Its suitable *kharif* and *summer* season and resistance to MYMV and can be grown in rainfed conditions. The sowing was done on 7th July, 2022 in line, keeping row to row distance and plant to plant distance by 30 cm × 10 cm, respectively at a depth of 5 cm with recommended seed rate of 15 kg ha^{-1}.

Results and Discussion

Effect on growth parameters

The data about various growth parameters *viz.,* plant height (cm), dry matter accumulation $plant^{-1}$, number of effective nodulesandweight of effective nodule $plant^{-1}$ of blackgram crop was recorded at 30, 45 DAS and at harvest, respectively were influence by foliar application of nutrients along with recommended dose of fertilizers.

The maximum plant height, dry matter accumulation, number of effective nodulesandweight of effective nodule $plant^{-1}$ at 30, 45 DAS and at harvest, respectively and number of branches $plant^{-1}$ at harvest were recorded in treatment T_8 (RDF +Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%).

The maximum plant height at 30, 45 DAS and at harvest was recorded under treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%). At 30 DAS, foliar application of nutrients to blackgram crop failed to bring any significant effect on Plant height. The maximum plant height at 45 DAS and at harvest (53.52 and 63.18 cm, respectively) was found under treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%). The least plant height was recorded under treatment T_1 (40.78), (49.08) at 45 DAS and at harvest, respectively. However, treatment T_7 (RDF + Foliar spray of DAP @ 2% + $ZnSO_4$ @ 0.5%), T_6 (RDF + Foliar spray of Urea @ 2% + $ZnSO_4$ @ 0.5%) and T_4 (RDF + Foliar spray of NPK (18:18:18) @ 2%) were statistically at par with treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%). The maximum plant height was recorded with application of RDF as basal Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5% (T_8) might be due to the internodes elongation and the vigorous shoot growth which is responsible for the significant increase in plant height of blackgram crop. The more availability of nitrogen, P_2O_5 and K_2O may also be responsible, which play a crucial role in cell division and helps in enhance of several metabolic process *viz.* photosynthesis, energy transfer and symbiotic biological N-fixation. These finding are well supported by the work of Vaibhav *et al*. (2019), Godase *et al*. (2014) and Shashikumar *et al*. (2013).

The maximum dry matter accumulation at 30, 45 DAS and at harvest was recorded in treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%). The dry matter accumulation at 30 DAS was found not significant due to foliar spray of nutrients along with RDF. The highest dry matter accumulation was found at 45 DAS and at harvest (5 and 9.15 g $plant^{-1}$, respectively) was found under treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%). The lowest dry matter accumulation was recorded under treatment T_1 (2.77), (4.81) at 45 DAS and at harvest, respectively. However, treatment T_7 (RDF + Foliar spray of DAP @ 2% + $ZnSO_4$ @ 0.5%), T_6 (RDF + Foliar spray of Urea @ 2% + $ZnSO_4$ @ 0.5%) and T_4 (RDF + Foliar spray of NPK (18:18:18) @ 2%) were statistically at par with treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%). The significant increase of dry matter production was recorded with application of RDF as basal Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5% (T_8) might be due to the fact that nitrogen helps to sustain greater auxin levels, which may have led to better plant height, leaf area andchlorophyll content of the leaves. This may have led to improved radiant energy interception, absorption and utilization, resulting in a faster photosynthetic rate and finally more dry matter accumulation by the plants. The maximum dry matter accumulation in blackgram crop due to foliar spray of nutrients has also been observed by Manonmani and Srimathi (2009). The findings are well supported by Vaibhav *et al*.,(2019) and Godase *et al*., (2014).

The maximum number of effective nodule $plant^{-1}$ at 30, 45 DAS and at harvest was recorded in treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%. At 30 DAS, number of effective nodule $plant^{-1}$ was not significantly influenced due to foliar spray of nutrients. The significantly maximum number of effective nodule $plant^{-1}$ at 45 DAS and at harvest (45.77 and 48.02 $plant^{-1}$) was recorded under treatment T_8 (RDF + Foliar spray of NPK

Table 1. Effect of foliar spray of nutrients on growth parameters of blackgram

Treatment	Plant height(cm)			Dry matter accumulation (g $plant^{-1}$)			Number of root nodules$plant^{-1}$		
	30 DAS	45 DAS	At harvest	30 DAS	45 DAS	At harvest	30 DAS	45 DAS	At harvest
T1	12.08	40.78	49.08	2.43	2.77	4.81	20.30	30.60	31.67
T2	12.78	45.65	55.60	2.55	3.42	6.64	22.80	37.52	40.37
T3	12.75	46.57	56.12	2.59	3.90	7.57	23.61	39.97	42.00
T4	13.55	48.58	57.17	2.69	4.48	8.20	24.39	40.83	44.21
T5	12.58	44.18	54.34	2.50	3.23	6.15	22.15	34.00	36.51
T6	13.57	50.73	61.44	2.60	4.63	8.30	23.12	42.71	46.47
T7	14.59	52.91	62.65	2.65	4.87	8.83	24.07	44.83	47.00
T8	14.74	53.52	63.18	2.71	5.00	9.15	25.22	45.77	48.02
SEm ±	0.59	1.77	2.31	0.10	0.19	0.34	1.05	1.70	1.87
CD at 5%	NS	5.36	7.01	NS	0.57	1.02	NS	5.15	5.67
CV	7.65	6.39	6.68	6.43	8.13	7.83	7.87	7.51	5.09

(18:18:18) @ 2% + $ZnSO_4$ @ 0.5%. The least number of effective nodule plant^{-1} was recorded under treatment T_1 (30.60), (31.67) at 45 DAS and at harvest, respectively. However, treatment T_7 (RDF + Foliar spray of DAP @ 2% + $ZnSO_4$ @ 0.5%), T_6 (RDF + Foliar spray of Urea @ 2% + $ZnSO_4$ @ 0.5%) and T_4 (RDF + Foliar spray of NPK (18:18:18) @ 2%) were statistically at par with treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%). It might be due to the feeding of nitrogen and phosphorus affected the plant's better root elongation and development as a result of foliar nutrition of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%, which in turn resulted in the formation of more number of nodules. The significantly maximum number of effective root nodules plant^{-1} with the foliar application of 2%urea has been also observed by Chaudhary and Yadav (2011) in cowpea.

Effect on yield attributes and yield

The data about various yield attributing characters *viz.*, number of pod plant^{-1}, pod length (cm), number of seed pod^{-1}, test weight of blackgram and yield (Table 2 and 3) were significantly influenced by foliar spray of nutrients along with recommended dose of fertilizers. The yield attributes, yields and harvest index were depicted in Fig. 1 and 2.

The maximum number of pod plant^{-1} (37.15) was recorded in treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%) which was statistically at par with treatment T_7, T_6 and T_4. The minimum number of pods plant^{-1} (28.37) was recorded with treatment T_1 (RDF + Control (Water Spray). During the flower initiation stage of crop growth, higher nutrient availability might have facilitated efficient photosynthates transfer from source to sink. As number of pod plant^{-1} is one of the crucial yield components of blackgram crop, foliar nutrition of nitrogen through source of urea was able to increase the number of pods plant-$^{-1}$. Similar results were also reported by Venkatesh and Basu (2011) for number of pods plant^{-1} of chickpea. Similar results were found by Khusboo *et al.*, (2023), Marimuthu and Surrendran (2015) and Gupta *et al.*, (2011).

Among all the treatments, application of RDF as basal + NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%) (T_8) was resulted insignificantly increased length of pod (5.10 cm) followed by application of treatment T_7 (application of RDF as basal + Foliar spray of DAP @ 2% + $ZnSO_4$ @ 0.5% at flower and pod initiation stage) (5.06 cm) while minimum pod length (3.65 cm) was observed under treatment T_1 (RDF + Control (Water Spray). It might be as a result of the ap-

Table 2. Effect of foliar application of nutrients on yield attributes

Treatment	No. of pod per plant	No. of seed per pod	Pod length (cm)	Test weight (g)
T1	28.37	5.05	3.65	39.03
T2	32.80	6.12	4.34	41.47
T3	32.87	6.23	4.37	41.50
T4	34.32	6.49	4.47	43.48
T5	32.54	5.99	4.30	41.45
T6	36.12	6.95	5.02	43.65
T7	36.83	7.07	5.06	43.86
T8	37.15	7.42	5.10	43.94
SEm ±	1.35	0.32	0.21	0.00
CD at 5%	4.11	0.98	0.64	2.41
CV	6.92	8.76	8.07	3.25

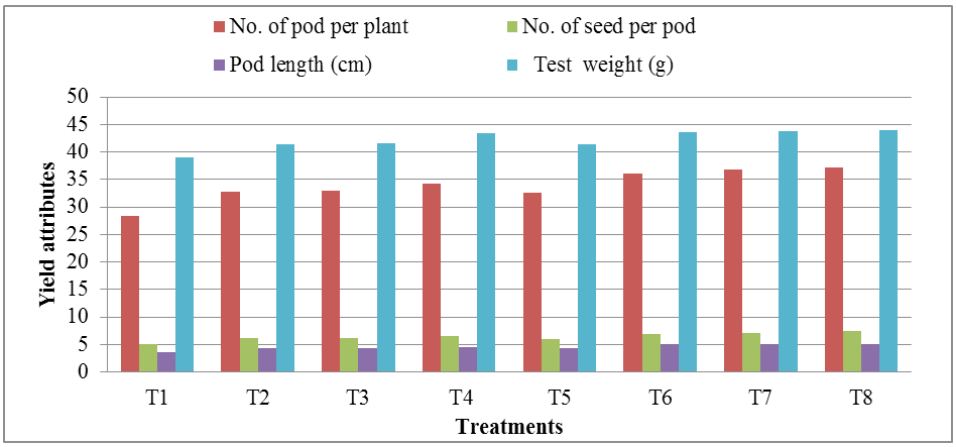

Fig. 1. Effect of foliar application of nutrients on yield attributes

plication of nutrients during the reproductive stage, which resulted in greater photosynthate translocation from source to the developing pods, which enhanced the length of the pod (5.10 cm). Similar result was found by Thakur *et al*., (2017).

Maximum number of effective root nodules plant^{-1} has been observed in treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%) followed by application of treatment T_7 (application of RDF as basal + Foliar spray of DAP @ 2% + $ZnSO_4$ @ 0.5% while the lowest number of effective nodules plant^{-1}recordedunder treatment T_1 (RDF + Control (Water Spray). It might be due to enhanced biological nitrogen fixation and continuous nitrogen supply through basal application during initial stage and through foliar application of nutrients at later stage of crop growth period. The beneficial effect of foliar application of nutrients with urea @ 2% at the reproductive stage in most of the pulse crops (Ali and Kumar 2006).

Significantly the maximum 1000-seed weight (43.94 g) has been recorded in treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%) followed by application of treatment T_7 (application of RDF as basal + Foliar spray of DAP @ 2% + $ZnSO_4$ @ 0.5%) (43.86 g) while the lowest 1000-seed weight (39.03 g) was recorded under treatment T_1 (RDF + Control (Water Spray). The enhanced mobilization of metabolites to the reproductive sinks may be the reason of the increased in test weight of blackgram crop. These finding are well supported by Khusboo *et al*. (2023) and (Dixit and Elamathi, 2007).

Blackgram crop fertilized with treatment T_8 (RDF + Foliar spray of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5%) produced maximum seed and straw yield (950 and 1808.33 kg ha^{-1}) followed by application of treatment T_7 (RDF + Foliar spray of DAP @ 2% + $ZnSO_4$ @ 0.5%) (916.33 and 1740 kg ha^{-1}, respectively) while minimum seed and straw yield (650 and 1027.67 kg ha^{-1}) were recorded with treatment T_1(RDF + Control (Water Spray). It might be because of the constant supply of nutrients through foliar spray during the reproductive stage of the crop, which increased yield components including number of pod plant^{-1}, number of seed pod^{-1}, pod length (cm) and test weight, which had a significant impact on seed yield. As a result, it reduced flower drop, which improved pod setting and resulted in better seed yield. Similar result was also found by Khusboo *et al*., (2023), Shashikumar *et al*., (2013) and Debata *et al*., (2019). Foliar application of nutrient

Table 3. Effect of foliar application of nutrients on seed, straw yield and harvest index

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
T1	650.00	1027.67	39.48
T2	760.00	1378.00	36.00
T3	811.00	1442.67	35.97
T4	838.00	1614.33	34.09
T5	796.33	1347.00	37.09
T6	885.00	1692.67	34.33
T7	916.33	1740.00	34.52
T8	950.00	1808.33	34.43
SEm ±	43.87	89.55	1.68
CD at 5%	133.08	271.61	NS
CV	9.20	10.30	8.14

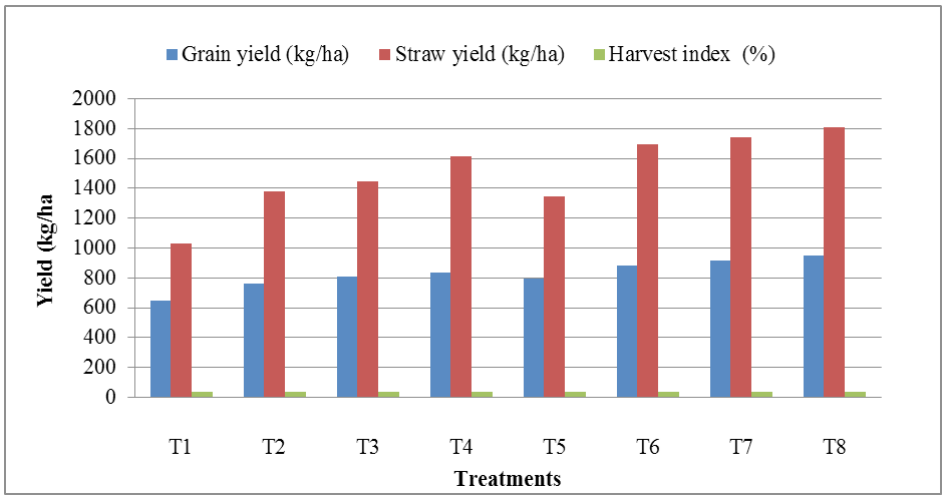

Fig. 2. Effect of foliar application of nutrients on seed, straw yield and harvest index

did not significantly influence the harvest index of black gram crop. The maximum harvest index was recorded with application of RDF as basal + Control (Water Spray) (T_1) (39.48%). This might be as a result of the fact that nitrogen and phosphorus are assigned to affecting the yield attributing characters like as pod plant^{-1}, seed pod^{-1}, which in turn affected the seed and straw yield.

Conclusion

On the basis of results of the experimentation it can be concluded that under rainfed condition, the foliar application of NPK (18:18:18) @ 2% + $ZnSO_4$ @ 0.5% along with RDF at flower and pod initiation stage of blackgram crop proved most suitable practice as it gave maximum seed (950 kg ha^{-1}), straw (1808.33 kg ha^{-1}) yield with highest net return and B C ratio.

Conflict of Interest: None

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