Impact of foliar application of nutrients on economicsof Black gram (*Vigna mungo* L.)

ABSTRACT

The present experiment was laid out at research farm of R.A.K. College of Agriculture, Sehore (M.P.) during Kharif season of 2022. The experiment was laid out in a randomized complete block design with 8 treatments and each treatment replicated three times.The Blackgram (cv. Pratap -1) was sowing with a seed rate of 15 kg $ha^{-1}$and with a spacing of 30 cm x 10 cm . The recommended dose of chemical fertilizer viz. 20:40:20 kg ha^{-1}N: P_2O_5: K_2O, respectively was applied to the crop. Results revealed that foliar spray application of nutrient shows significant effect on yield economics. Treatment T_7 **(**2% Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage) found higher for yield and yield attributes *i.e.*grain yield (0.836 kg/plot and 7.86 q/ha respectively), straw yield (17.30q/ha), biological yield (25.16 q/ha), harvest index (31.21 %), gross return (₹ 62550 ha^{-1}), net return ((₹ 36491 ha^{-1}) and B:C ratio (2.40). While, minimum values found with T_1 (Water spray at pre-flowering stage and pod initiation stage).

Keywords: B:C ratio, black gram, economics, foliar spray, yield.

Introduction:

Black gram scientifically known as *Vigna mungo*L., is an essential pulse crop within the legume family that plays a pivotal role in the diets and economies of many countries in South Asia. It is a vital source of protein and other essential nutrients and holds cultural and economic significance for the region (Suneja *et al*., 2011).

The United Nations declared the year 2016 as "International Year of Pulses" to increase the public awareness regarding the nutritional benefits of pulses aimed to improve food security and nutrition as part of sustainable food production (Mohanty and Satyasai, 2015). The World Health Organization (WHO) recommends 80 g pulse per day per person and the Indian Council of Medical Research (ICMR) recommends 47g pulse per day per person. Blackgram consists 22.3% of protein, 48.0% of carbohydrates, 154 mg of calcium, 300 mg phosphorus, 9.1 mg of iron, 1.4 g of 3.37 g of riboflavin, 0.42 g of thiamin and 2 mg niacin per 100 g of black gram (Asaduzzaman *et al*., 2010). Though pulses are rich in protein they are still being cultivated 95 per cent under rainfed condition and more than 78 per cent under energy starved condition. The main reasons for low productivity of blackgram is poor nutrient management practices and cultivation under moisture stress condition (Suhathiya and Ravichandran, 2018). Hence there is a need to increase the production potentaial of pulses.

The growth phase of blackgram is often obstructed by the slow translocation of assimilates, poor pod setting due to flower abscission and lack of nutrient during critical stages of crop growth (Mahala *et al*., 2001).

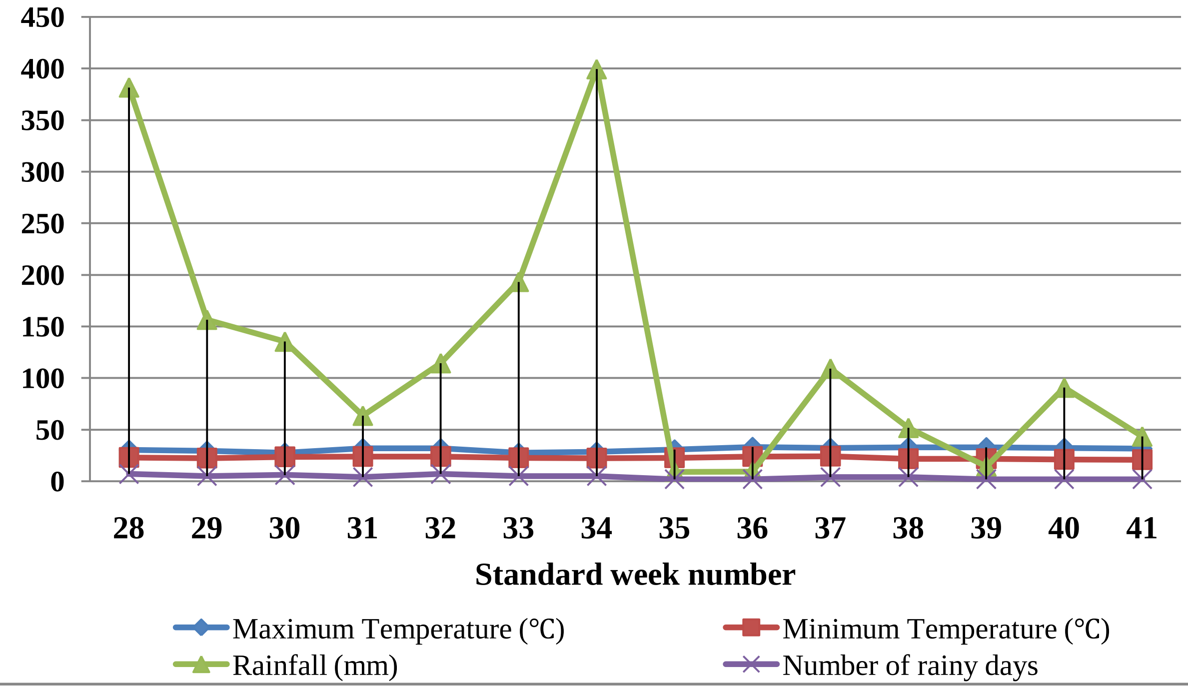
About 70% of world's black gram production comes from India. In India, its total area, production and productivity is 4.63 million ha, 2.70 million tones and 570.27 kg/ha respectively (Agristats, 2022). In India blackgram is very popularly grown in Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, U.P., West Bengal, Punjab, Haryana, and Karnataka .It is used as nutritive fodder especially for milch cattle. In Madhya Pradesh its total area, production and productivity is 130.7 lakh ha, 43.937 lakh tonnes and 341 kg/ha respectively (Anonymous 2022).

When plant nutrients are applied straight to the foliage of plant, smaller quantities of the fertilizer material are required than when applying to the soil.The loss of fixation and/or leaching is also reduced when nutrients are applied to the foliage of the plant. The application of the fertilizer at the same time as an insecticide, fungicide, etc., reduces labor costs and machinery costs, thereby reducing the cost of crop production.(Patil and Chetan 2018).Foliar application of nutrients in crops offers advantages such as faster nutrient absorption, targeted delivery to specific plant tissues, and efficient utilization during critical growth stages(Vighnesh*et al.* 2022). It allows for rapid correction of nutrient deficiencies and is particularly effective when soil conditions limit nutrient availability. Due to which the growth of the crop is good, resulting in higher yield and the reduction of cost of cultivation(Shashikumar *et al.* 2013).However, soil application provides a more sustained supply of nutrients over time, contributing to overall plant health and long-term growth. The choice between foliar and soil application depends on specific crop needs, soil conditions, and management goals.

Materials and Methods:

The present experiment was laid out at research farm of R.A.K. College of Agriculture, Sehore (M.P.) during Kharif season of 2022. Sehore is situated in the eastern part of Vindhyan Plateau in subtropical zone at the latitude of 23.1876° North and longitude of 77.0646° East at 498.77 m above mean sea level in Madhya Pradesh. The average rainfall varies from 1000 to1200 mm concentrated mostly from June to September. The mean annual maximum and minimum temperature are 31.16℃ and 18.50℃, respectively. The summer months are hot and May is the hottest month having a maximum temperature up to 45.60℃. Winter month experienced mild cold with an average temperature from 16.56℃ to 8.74℃, December is the coldest month as temperature reaches up to 5℃.The experiment was laid out in a randomized complete block design with 8 treatments and each treatment replicated three times. The Blackgram (cv. Pratap -1) was sowing with a seed rate of 15 kg ha^{-1}and with a spacing of 30 cm x 10 cm . The recommended dose of chemical fertilizer viz. 20:40:20 kg ha^{-1}N: P_2O_5: K_2O, respectively was applied to the crop. The experimental area having fairly uniform topography, normal fertility status and soil homogeneity.

Fig. 1: Weekly meteorological data recorded at Sehore (M.P.) during crop season (From 9th July to 14 October 2022)



Treatment details T_1:- Water spray at pre-flowering stage and pod initiation stage, T_2:- 2% Spray of Urea at pre-flowering stage and pod initiation stage, T_3:- 2% Spray of DAP at pre-flowering stage and pod initiation stage, T_4:- 2% Spray of NPK (18:18:18) at pre-flowering stage and pod initiation stage, T_5:- 0.5% Spray of $ZnSO_4$ at pre-flowering stage and pod initiation stage, T_6:- 2% Spray of Urea + 0.5% Spray of $ZnSO_4$ at pre-flowering stage and pod initiation stage, T_7:- 2% Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage, T_8:- 2% Spray of NPK (18:18:18) + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage.

Observations Recorded

Five Blackgram plants were randomly selected from the inner rows of each plot. The sampled plants were carefully dugged up, put in labeled envelop bags and yield parameters viz. number of pods/plant, number of seed/pod, seed index, seed yield/plant, straw yield and economics were recorded at maturity.

Statistical analysis

The data obtained on various parameters were tabulated and subjected to statistical analysis by the method suggested by Fisher (1921).

Results and Discussion

Effect of foliar application of nutrients on yield

Results displayed in the table 1. that the treatment T_7 (2% Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage) recorded significantly higher grain yield (0.836 kg plot^{-1} and 7.86 q ha^{-1} respectively) which was statistically similar with treatment T_8 (2% Spray of NPK (18:18:18) + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation) (0.804 kg plot^{-1} and 7.56 q ha^{-1} respectively) The lowest grain yield was recorded by treatment T_1 (Water spray at pre-flowering stage and pod initiation stage) i.e. 0.619 kg plot^{-1} and 5.81 q ha^{-1} respectively. It might be due to constant supply of nutrients due to foliar spray at reproductive stage of the crop and enhanced the yield components like number of pods/plant, number of seeds/pod, pod length and 100-seed weight, which had direct influence on the grain yield. It also might be due to increased uptake of nutrients by black gram by effective translocation of nutrients from source to reproductive area of crop. The findings are in agreement with earlier findings of Shashikumar *et al*., (2013) and Ramesh *et al*. (2016).

The foliar application of nutrients through 2% DAP at flower initiation and pod formation stage might have reduced flower drop. This might have significantly increased the number of pods plant^{-1} as reported by Ganapathy *et al*. (2008). Higher supply of all nutrients at flower initiation and pod formation stages of crop growth might have caused efficient translocation of photosynthates from source to sink. Decreased flower drop due to prolonged assimilatory activity of leaves might be another possible reason for higher number of pods plant^{-1}. Further, the foliage applied nitrogen and phosphorus at the initial stages might have been effectively absorbed and translocated to the pods resulting in more number of pods plant^{-1}in Black gram reported byMeena*et al*. (2017). It might be due to the fact that DAP application contributed towards overall biomass production under rainfed condition and it also might be due to the enhancement in growth and yield parameter as well as uptake of nutrients by crop. Obviously, cumulative effects of these parameters might have contributed to increased grain yield potential of the black gram. This confirms the finding of Mondal *et al*. (2011), Sritharan *et al*. (2007), Sritharan *et al*. (2005), Bhowmick *et al*. (2014), Venkatesh *et al*., (2012), Mondal *et al*., (2012), Rajavel and Vincent (2009), Jeyakumar *et al*. (2008) and Malay and Bhowmick (2008). The similar results are also reported by Anu Lavanya (2011) in green gram, Sengupta *et al*. (2011) in soybean and Tahir *et al*. (2014) in mash bean.

Straw yield

Data on straw yield of black gram is affected by different foliar treatments. Straw yield is directly related with increase in vegetative growth of the plant. It was observed from the data that the treatment T_7 recorded significantly higher straw yield (17.30 q/ha). The treatment T_8 (17.18 q/ha) and T_6 (16.54 q/ha) were found at par with treatment T_7 and rest of treatments found significantly lower straw yield. However, the lowest straw yield was recorded with treatment T_1 (14.45 q/ha) which was significantly inferior to the rest of the treatments. The increase in straw yield is directly related mainly to increase in the vegetative growth of the plant. It might be due to continuous supply of nutrients as basal and as nutrient spray which in turn increased the leaf area and dry matter accumulation resulting in higher straw yield. This is also attributed to higher nutrient uptake throughout the crop growth period. Similar finding is confirmed with the report of Mondal *et al*. (2011), Sritharan *et al*. (2007), Sritharan *et al*. (2005), Mondal *et al*., (2012), Rajavel and Vincent (2009) and Malay and Bhowmick (2008).

Biological yield

The biological yield of black gram was significantly affected due to different foliar nutrition treatments. The foliar nutrition with of treatment T_7 recorded significantly higher biological yield (25.16 q/ha) which was statistically at par with the treatment T_8 (24.74 q/ha) and T_6 (23.67 q/ha) and rest of treatments found significantly lower biological yield. However, the lowest straw yield was recorded with treatment T_1 (20.26 q/ha) which was significantly inferior to the rest of the treatments. The increased haulm yield might be due to continuous supply of nutrients which could have increased the leaf area and dry matter resulting in higher haulm yield (Kuttimani and Velayutham, 2011).

Table 1:- Effect of foliar application of nutrients on grain yield, haulm yield, biological yield and harvest index

Treatment	Seed yield (Kg plot^{-1})	Seed yield (Kg/ha)	Straw yield (Kg/ha)	Biological yield (Kg/ha)	Harvest Index (%)
T_1	0.619	581	1445	2026	28.77
T_2	0.721	677	1581	2258	30.04
T_3	0.749	702	1592	2294	30.68
T_4	0.681	640	1440	2080	30.77
T_5	0.705	662	1543	2204	30.04
T_6	0.761	712	1654	2367	30.10
T_7	0.836	786	1730	2516	31.21
T_8	0.804	756	1718	2474	30.54
S.Em (±)	**0.0200**	**18.89**	**36.96**	**53.59**	**0.356**
CD (5%)	**0.0607**	**57.29**	**112.10**	**162.54**	**1.079**

Harvest index (%)

It is revealed from the data (table-1) that significant variation was observed in harvest index due to different foliar nutrition. Harvest index varied from 28.77 % to 31.21 %. The higher harvest index (31.21 %) was observed in treatment T_7 -2% Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage which was followed by T_4 -2% Spray of NPK at 18:18:18) at pre-flowering stage and pod initiation stage (30.77 %), T_3- 2% Spray of DAP at pre-flowering stage and pod initiation stage i.e. 30.68 % and T_8- 2% Spray of NPK (18:18:18) + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation i.e. 30.54 %. While the lowest harvest index (28.77 %) was obtained within control plot (Water spray at pre-flowering stage and pod initiation stage). This might be because nitrogen and phosphorous are responsible in influencing the yield attributing characters like pods per plant and seeds per pod, which ultimately influenced the grain yield and straw yield.The findings are in agreement with earlier findings of Bhowmick *et al*. (2014), Venkatesh *et al*., (2012), Mondal *et al*., (2012),

Effect of foliar application of nutrients on economics

Cost of Cultivation (₹ . ha^{-1})

Data embodied in Table -2, revealed that other treatment of fertilizers gave more income over water spray. The highest total cost of cultivation (₹ . 30459 ha^{-1}) was incurred under treatment 2% spray of NPK (18:18:18) + 0.5 % spray of ZnSO4 at pre-flowering and pod initiation stage (T_8) which was higher as compared to all the fertilizer treatments. Minimum cost of cultivation found in Control treatment (Water spray at pre-flowering stage and pod initiation stage) i.e. ₹ 24599 ha^{-1}.

Gross Return (₹ ha^{-1})

It can be interpreted from the data presented in table 2. That gross returns highest response was obtained with 2% Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage i.e. ₹. 62550 ha^{-1} followed by 2% Spray of NPK (18:18:18) + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage (T_8) (₹. 60307 ha^{-1}). Gross return from water spray at pre-flowering stage and pod initiation stage was ₹ 46759 ha^{-1} was lower as compared to all the fertilizer spray. These were recorded highest due to treatment provided better nutritional environment resulted in higher productivity of grain as well as straw yield.Similar results were reported in cowpea by Martin Stanley (2013); Rajeshkumaret*et al*. (2017) and Kumar and Simaiya, (2019).

Net Return (₹ ha^{-1})

The data on net return of black gram as influenced by foliar application of different nutrients has been presented in Table-2.Net return varied significantly due to foliar application of different nutrients. Net return (₹. 36491 ha^{-1}) recorded under % Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage (T_7) was found significantly superior than all other treatments and followed by 2% Spray of Urea + 0.5% Spray of $ZnSO_4$ at pre-flowering stage and pod initiation stage (₹. 31753 ha^{-1}). While the lowest net return (₹. 22160 ha^{-1}) was obtained in control (water spray at flower initiation-T_1. This was due to higher gross return of treatment other than control. These finding are well supported by the work of Gupta *et al*., (2011), Deshmukh *et al*. (2008) and Thakare *et al*. (2006). Similar observations were also recorded by Yakadri and Ramesh (2002), Chandrasekhar and Bangarusamy (2003), Shashikumar *et al*. (2013), Maheswari and Karthik (2017).

4.4.4 Benefit : Cost

A close analysis of data indicated that Benefit : Cost ratio varied significantly among foliar application of different nutrients. Highest Benefit : Cost ratio of 2.40 was found out under 2% Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage (T_7) than all other treatments, followed by 2% Spray of Urea + 0.5% Spray of $ZnSO_4$ at pre-flowering stage and pod initiation stage (T_6), 2% Spray of DAP at pre-flowering stage and pod initiation stage and 2% Spray of Urea at pre-flowering stage and pod initiation stage.

Lowest Benefit: Cost ratio of 1.90 was found in control plot (water spray at flower initiation-T_1).This was due to higher gross return as compare to cost of cultivation. These finding are well supported by the work of Gupta *et al*., (2011), Deshmukh *et al*. (2008) and Thakare *et al*. (2006). Similar observations were also recorded by Yakadri and Ramesh (2002), Chandrasekhar and Bangarusamy (2003), Shashikumar *et al*. (2013), Maheswari and Karthik (2017).

Table 2:- Effect of foliar application of nutrients on economics of black gram

Treatment	Cost of Cultivation (₹ ha^{-1})	Gross Return (₹ ha^{-1})	Net Return (₹ ha^{-1})	B:C Ratio
T_1	24599	46759	22160	1.90
T_2	24835	54197	29362	2.18
T_3	25679	56024	30345	2.18
T_4	30079	51040	20961	1.70
T_5	24979	52927	27948	2.12
T_6	25215	56968	31753	2.26
T_7	26059	62550	36491	2.40
T_8	30459	60307	29847	1.98

Conclusion

From this investigation it can be concluded that, It was from the results that the treatment T_7 (2% Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage) recorded significantly higher grain yield, Straw yield and biological yield (7.86 q ha^{-1}, 17.30 q ha^{-1}and25.16 q ha^{-1} respectively) which was statistically similar with treatment T_8 (2% Spray of NPK (18:18:18) + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation) grain yield, Straw yield and Biological yield (7.56 kg ha^{-1}, 17.18 ha^{-1}, and24.74q ha^{-1}respectively) The lowest grain yield , Straw yield and biological yield (5.81 q ha^{-1},14.45 q ha^{-1}, and 20.26 q ha^{-1}respectively) were recorded by treatment T_1 (Water spray at pre-flowering stage and pod initiation stage). Similarly higher harvest index (31.21 %) was observed in treatment T_7 - 2% Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage which was followed by T_4 -2% Spray of NPK at 18:18:18) at pre-flowering stage and pod initiation stage (30.77 %), While the lowest harvest index (28.77 %) was obtained within control plot (Water spray at pre-flowering stage and pod initiation stage). This might be because nitrogen and phosphorous are responsible in influencing the yield attributing characters like pods per plant and seeds per pod, which ultimately influenced the grain yield and straw yield. The findings are in agreement with earlier findings of Bhowmick *et al*. (2014), Venkatesh *et al*., (2012), Mondal *et al*., (2012).

The highest total cost of cultivation (₹ . 30459 ha^{-1}) was incurred under treatment 2% spray of NPK (18:18:18) + 0.5 % spray of ZnSO4 at pre-flowering and pod initiation stage (T_8) which was higher as compared to all the fertilizer treatments. Minimum cost of cultivation found in Control treatment (Water spray at pre-flowering stage and pod initiation stage) i.e. ₹ 24599 ha^{-1}.The highest gross returns and net returns (₹ . 62550 ha^{-1}, and ₹ .36491 ha^{-1} respectively) were obtained with 2% Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage followed by T_8 (2% Spray of NPK (18:18:18) + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage)(₹ . 60307 $ha^{-1}$and ₹ . 31753 ha^{-1} respectively). Minimum Gross and net returns(₹ 46759 ha^{-1} and ₹ . 22160 ha^{-1} respectively) found in water spray at pre-flowering stage and pod initiation stage. Highest benefit : Cost of 2.40 was found out under 2% Spray of DAP + 0.5% Spray of $ZnSO_4$ at pre-flowering and pod initiation stage (T_7) than all other treatments. While, lowest Benefit: Cost ratio of 1.90 was found in control plot (water spray at flower initiation-T_1). This was due to higher gross return as compare to cost of cultivation. Similar finding reported in moongbean by Chandrasekhar and Bangarusamy (2003).

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