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Deepak Kumar
Department of Agronomy, University of RVSKVV Gwalior, M.P, India

Dr. RP Singh
ICAR-IISS, Nabi Bag Berasia road Bhopal, (M.P.), India

Dr. J Somasundaram
Department of Agronomy, University of RVSKVV Gwalior, M.P, India

Vidya Simaiya
Department of Agronomy, University of RVSKVV Gwalior, M.P, India

Shweta Jamra
Department of Agronomy, University of RVSKVV Gwalior, M.P, India

Correspondence
Deepak Kumar
Department of Agronomy, University of RVSKVV Gwalior, M.P, India

Effect of foliar application of nutrients on growth and development of blackgram (*Vigna mungo* (L.)Hepper) under rainfed Vertisols of Central India

Deepak Kumar, Dr. RP Singh, Dr. J Somasundaram, Vidya Simaiya and Shweta Jamra

Abstract
An experiment was conducted to study the Effect of foliar application of nutrients on growth and development of black gram (*Vigna mungo* (L.) Hepper) under rain fed condition during *kharif* season 2014 at the research farm of AICRP on MULLaRP, R.A.K. College of Agriculture, Sehore (M.P.). The experiment was laid out in Randomized Block Design with three replications having nine treatments namely T_1 [Control (water spray)], T_2 [Urea 2% spray at flowering], T_3 [DAP 2% spray at flowering and 15 days later], T_4 [Urea phosphate 2% spray at flowering], T_5 [MOP 2% spray at flowering], T_6 [TNAU pulse wonder @ 5 kg ha^{-1} at flowering (contains- N, P, K, Boron, Fe and auxin)], T_7 [Brassinolide 0.75 ppm at flowering], T_8 [Salicylic acid 100 ppm at flowering], T_9 [19:19:19 (NPK) 2% spray at flowering]. Growth attributing characters i.e. plant height, branches/plant, root length, number and dry weight of root nodules, were significantly influenced with the different treatments and recorded higher values with the foliar application of DAP 2% spray at flowering and 15 days later. Dry weight per plant was significantly influenced by different foliar nutrition and recorded higher value with application of DAP 2% spray at flowering and 15 days later. From this study it may be concluded that different treatments had positive effect on yield, and growth of black gram. Application of DAP 2% spray at flowering and 15 days later recorded maximum yield (916 kg/ha) and higher net return (23313 ₹/ha). Application of 19:19:19 (NPK) 2% spray at flowering stage (T_9) recorded yield (870 kg/ha) and net return (20108 ₹/ha), which was at par with treatment application of DAP 2% spray at flowering and 15 days later (T3). So, this experiment concluded that application of DAP 2% spray at flowering and 15 days later (T3) is more economic than application of 19:19:19 (NPK) 2% spray at flowering stage (T9).

Keywords: Black gram, Urea, MOP, DAP, salicylic acid, growth characters

1. Introduction
Pulses are wonderful gift of nature with unique ability of biological nitrogen fixation, deep root system, mobilization of insoluble soil nutrients and bringing qualitative changes in soil properties - which make them known as soil fertility restores. Blackgram [*Vigna mungo* (L.) Hepper] is one of the most important pulse crop of rainfed areas grown thought the country. This crop is grown in different cropping system as a mixed crop, catch crop, sequential crop in the country. Black gram seed contains 25-26% proteins, 60% carbohydrates, 1.5% fat, and minerals combination, amino acid, and essential vitamins etc. In India black gram 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 specially for milch cattle. It is also used as a green manuring crop. Black gram is native of India and originated from *Phaseolus sublobatus* a wild plant. Black gram also known as urd, mash in India. In India total Urdbean production was estimated 1.90 million tonnes from 3.11 million hectare area with productivity of 642 kg/ha. In Madhya Pradesh total black gram production was estimated 350.5 thousand tonnes from 390.1 thousand hectares area with productivity of 578 kg/ha. (Anonymous, 2012-13). 10 November 2015 – Under the slogan ‘nutritious seeds for a sustainable future,’ the United Nations, led by its Food and Agriculture Organization (FAO), today launched the 2016 International Year of Pulses to raise awareness about the protein power and health benefits of all kinds of dried beans and peas, boost their production and trade, and encourage new and smarter uses throughout the food chain. The IYP 2016 aims to

heighten public awareness of the nutritional benefits of pulses as part of sustainable food production aimed towards food security and nutrition. The Year will create a unique opportunity to encourage connections throughout the food chain that would better utilize pulse-based proteins, further global production of pulses, better utilize crop rotations and address the challenges in the trade of pulses. Diet is an important contributor to health, and to disease. Most countries face nutritional problems, from under nutrition and micronutrient deficiencies to obesity and diet-related diseases (such as type II diabetes and certain types of cancer), or a mix of these. Pulses are a nutrient-rich food that as part of a healthy diet can help fight malnutrition in both developed and developing countries. Infect, Potential of black gram is very low because the fact that the crop is mainly grown in rainfed condition with poor management practices and also due to various physiological, biochemical as well as inherent factors associated with the crop. Apart from the genetic makeup, the physiological factor viz., insufficient portioning assimilates, poor pod setting due to the flower abscission and lack of nutrients during critical stage of crop growth, coupled with a number of disease and pest (Mahala *et al.*, 2011) constitute the major constraints for the poor yield. The productivity of black gram in our country is very low. Hence, there is need for enhancement of the productivity of black gram by proper Agronomic practices. One among them is foliar application of organic and inorganic sources of nutrients for exploiting genetic potential of the crop. This is considered to be an efficient and economic method of supplementing part of nutrients requirements at critical stages. Foliar application is credited with the advantage of quick and efficient utilization of nutrients, elimination of losses through leaching, fixation and regulating the uptake of nutrients by plant (Manonmani and Srimathi, 2009). Since foliar nutrients usually penetrate the leaf cuticle or stomata and enters the cells facilitating easy and rapid utilization of nutrients. Foliar application of N at particular stage may solve the slow growth, nodule senescence and low seed yield of pulse without involving root absorption at critical stage (Latha and Nadanassababady, (2003) [12]. Manivannan *et al*. (2003) found that *Rhizobium* seed treatment and foliar application of microsol (NPK and Chelated micronutrients) recorded markedly higher leaf area index, dry matter production and crop growth rate Application of nutrients through foliar spray at appropriate stages of growth becomes important for their utilization and better performance of the crop (Anandhakrishnaveni *et al*.,2004) [2]. Foliar application of nutrient and growth regulator at pre flowering and flowering stage was seen on reduction in flower drop percentage in black gram gram (Ganapathy *et al.* 2008) [6]. Foliar spray of nutrients mixture with salicylic acid 100 ppm at 20, 30 and 40 DAS proved to be the best treatment to improve Leaf area index, Leaf area duration, specific leaf weight, total dry matter accumulation and seed yield of black gram (Amutha *et al.*, 2012) [1]. Foliar spray of N, P and K significantly increased number of pods / plant, number of seeds / pod, biomass and grain yield. Since the information on foliar nutrition in blackgram grown in black soils under M.P. condition is require. Rahman *et al.* (2014) [16] conducted a trial and the result showed that foliar spray of N, P and K significantly increased number of pods/plant, number of seeds / pod, biomass and grain yield. It may be concluded that foliar spray of N, P and K is the suitable application for the maximum yield of black gram. Field experiment was conducted to investigate the effect of foliar spray of nutrients and plant growth regulator on morpho-physiological traits, biochemical parameters and yield of black gram. The treatments viz., foliar spray of 2% DAP, 100 ppm salicylic acid + 2% DAP + 0.2% Boric acid + 0.5% FeSO4 + 0.5% ZnSO4 + 0.05% Na2MoO4, 2% urea, humic acid 20 kg soil application + 0.1% humic acid foliar spray, 1% KCl + humic acid 20 kg/ha as soil application + 0.1% humic acid foliar spray, 1% KCl + humic acid 20 kg/ha as soil application, brassinosteroid 0.1 ppm and control were imposed at 25 days after sowing and 15 days after first spray. Among the treatments, foliar spray of 2% urea had the profound effect in improving the growth attributes, chlorophyll content, soluble protein and nitrate reductase activity. Further foliar spray of 2% urea recorded the highest yield of 900 kg/ha with a yield increment of 20% over control. The yield enhancement might be due to the improved morpho-physiological traits and yield attributes.

2. Materials and Methods

An experiment was conducted to study the Effect of foliar application of nutrients on growth and development of blackgram (*Vigna mungo* (L.) Hepper) under rain fed condition during *kharif* season 2014 at the research farm of AICRP on MULLaRP, R.A.K. College of Agriculture, Sehore (M.P.). The experiment was laid out in Randomized Block Design with three replications having nine treatments namely T_1 [Control (water spray)], T_2 [Urea 2% spray at flowering], T_3 [DAP 2% spray at flowering and 15 days later], T_4 [Urea phosphate 2% spray at flowering], T_5 [MOP 2% spray at flowering], T_6 [TNAU pulse wonder @ 5 kg ha^{-1} at flowering (contains- N, P, K, Boron, Fe and auxin)], T_7 [Brassinolide 0.75 ppm at flowering], T_8 [Salicylic acid 100 ppm at flowering], T_9 [19:19:19 (NPK) 2% spray at flowering]. The plot size was 5m x 3m with a spacing of 30 cm x 10 cm. The data on plant height, number of branches, root length, number of root nodules and nodule dry weight, CGR and RGR were taken from 30 DAS to at maturity and yield and yield components were recorded at harvest.

2.1 Climate and weather condition

Sehore is situated in the eastern part of Vindhyan Plateau in sub- tropical zone at the latitude of 23^0 12' North and longitude of 77^0 05' East at an latitude of 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 ^{0}C and 18.5 ^{0}C, respectively. The summer months are hot and May is the hottest month having a maximum temperature up to 45.60 ^{0}C. Winter month experienced mild cold with an average temperature from 16.56 ^{0}C to 8.74 ^{0}C, December is the coldest month as temperature reaches up to 5 ^{0}C.

The weekly meteorological data viz., rainfall, temperature, relative humidity and number of rainy days during crop season were recorded in meteorological observatory of R.A.K. College of Agriculture, Sehore. The data indicates that during the crop season total rainfall was 669.5 mm concentrated in 49 rainy days with maximum and minimum rainfall, ranged from 143.0 mm to 0.5 mm was observed in 35th and 37th and 38th meteorological standard week, respectively. The maximum temperature ranged from 42.38 ^{0}C to 28.14 ^{0}C was observed in 23th and 37th meteorological standard week, respectively, and the minimum temperature ranged from 17.28 ^{0}C to 29.82 ^{0}C was observed in 43th and 23rd meteorological standard week, respectively, while, the maximum relative humidity of 88.85 per cent was observed in

24rd meteorological week and the minimum relative humidity of 64.85 per cent was recorded in 30th meteorological week.

2.2 Soil

The soil of the experiment field was medium black clay loam in texture fairly deep having a slight slope from west to east, which provides good drainage. Soil sample were collected randomly from different places of the field at 0-30 cm depth to access the initial fertility status of the soil of experimental field with the help of a screw type soil auger. After this a composite sample was prepared for the analysis of organic carbon, available nitrogen, phosphorus, potassium, pH and electric conductivity. The analytical values soil physical and chemical propertiy was found that respectively Organic carbon low (0.36%), available nitrogen low (155.3 kg/ha), available Phasphoras low (22 kg/ha), available Potasium medium (320 kg/ha), soil ph normal (7.4), electrical conductivity normal (0.6 dS/m at 25 ^{0}C).

3. Results and Discussion

3.1 Plant population

The plant population is an important parameter from the point of determination of yield. The population of black gram was counted at 30 DAS and at harvest stage in various treatments. The data revealed that the effect of foliar application of nutrients on plant population was found non-significant at both the stages of crop growth. However, the plant population ranged from 27.56 to 31.45 and 28.83 to 31.83 at 30 DAS and at maturity respectively. The plant height increases from 30 DAS to 60 DAS but the rate of increase was declined from 60 DAS irrespective of the treatments. Significant differences were not observed among the treatments at 30 DAS as foliar application was effected from 30 DAS. From 45 to 60 DAS there was an exponential increase in the plant height and the treatments also differed significantly from each other.

3.2 Plant height (cm)

Foliar application of nutrients influenced plant height of blackgram significantly over control. It was observed that the rate of growth in height was faster in the beginning up to 60 DAS, thereafter, it was slowed down**.** Nitrogen has been widely accepted as dominant growth promoter. The significant increase of plant height was due to the internodes elongation and the vigorous root growth. The maximum height of the plant (58.33cm) was obtained from foliar application of DAP 2% at flowering and 15 days later (T3). It was closely followed by application of 19:19:19 (NPK) 2% spray at flowering (T9). Significant increase in plant height with foliar application can be attributed to the fact that micronutrients enhance plant vigour and strengthen the stalk (Das, 1999). During this study we examined that these results also resemble the findings of Barik *et al*. (1994) who reported increase in plant height with foliar application of nutrients.

3.3 Number of Branches per plant

Branching is an important character of crop, which bears the pods/ plant and ultimately enhanced the yield of crop. The data revealed that application of DAP 2% spray at flowering and 15 days later (T3) at maturity recorded maximum number of branches/plant (6.80), which was significantly superior than rest of the treatments except T6. The minimum number of branches/ plant (5.53) was recorded in control treatment (T1).The increase in branches per plant due to the twice application of DAP, which helped in acceleration of various metabolic process viz. photosynthesis, energy transfer reaction and symbiotic biological N- fixation process. More number of branches and plant height might be due to the more availability of nitrogen and phosphorus (DAP), which plays a vital role in cell division.

3.4 Root length per plant (cm)

The effect of foliar application of nutrients on root length per plant was found non-significant. However, the maximum root length (18.50 cm) was observed in application of 19:19:19 (NPK) 2% spray at flowering at 60 DAS.

3.5 Dry Biomass per plant (g)

Dry matter production in above ground parts is contributed by stem, branches, leaves, pods and grains inside the pods. Various growth factors such as height of the plants which indicate stem length, number of branches have been described in relation to foliar nutrition. Growth parameters clearly indicated maximum growth in plants treated with DAP 2% spray at flowering and 15 days later. At 60 DAS The application of DAP 2% spray at flowering and 15 days later (T3) was recorded maximum dry matter production per plant (14), which were significantly better than remaining treatments and at par with treatments 19:19:19 (NPK) 2% spray at flowering (T9), TNAU pulse wonder @ of 5 kg/ha at flowering (T_6) and Brassinolide 0.75 ppm at flowering (T7). The lowest dry matter production per plant (9.33) was recorded in control treatment (T_1) at all the staged of crop growth viz. 30, 45 and 60 DAS. The significant increase of dry weight/plant was due to the fact that nitrogen helps in maintaining higher auxin level which might have resulted in better plant height, leaf area and presumably chlorophyll content of the leaves. This might have resulted into better interception, absorption and utilization of radian energy, leading to higher photosynthetic rate and finally more accumulation of dry matter by the plants. Geetha and Velayutham (2009) results revealed that all the growth parameters, NPK uptake and yield were significantly influenced when foliar spray of 2% DAP+1% Kcl was given at flowering and pod filling stages of crop growth.

3.6 Number and Dry weight of root nodules (mg)

The data in table 2 revealed that application of Urea 2% spray at flowering (T2) gave maximum number of root nodules/plant (14.33) at 30 DAS. At 45 DAS the application of DAP 2% spray at flowering and 15 days later (T3) recorded maximum number of root nodules/plant (15.60),which was found significantly superior than rest of treatments except application of 19:19:19 (NPK) 2% spray at flowering (T9).The minimum number of root nodules/ plant was recorded of 11.67 in control treatment (T1). The treatment application of DAP 2% spray at flowering and 15 days later (T3) recorded maximum dry weight of root nodules/plant (18.50) at 45 DAS, which was significantly superior than rest of treatments except application of Urea phosphate 2% spray at flowering (T4). The minimum dry weight of the per plant was recorded of 7.22 mg in control treatment (T1). Maximum number of root nodules were recorded by the application of DAP 2% spray at flowering and 15 days later (T3), which might be because of nitrogen and phosphorus influenced the better root development of the plant and it might profuse nodulation on account of increase in the rhizobial activity in the rhizosphere under the influence of foliar nutrition of 2% DAP, which in turn resulted in the formation of active and more number of nodules. These

results are in close agreement with the findings of Geetha and Velayutham (2009).

3.7 Physiological parameters

3.7.1 Crop growth rate (g/m^2/day)

The average daily increment of crop growth under the influence of various factors as affected by metabolic efficiency of the crop, It is indicated by crop growth rate. It was observed that the rate of growth in CGR was faster in the 45-60 days interval. Application of 19:19:19 (NPK) 2% spray at flowering stage produced maximum CGR (35.42 g/m^2/day) followed by application of DAP 2% spray at flowering stage and 15 days later (35.28 g/m^2/day) at 45 -60 days interval.

3.7.2 Relative growth rate (g/g/day)

It was observed that the RGR during 30-45 days interval was found non- significant and 45-60 days interval was found significant**.** Application of 19:19:19 (NPK) 2% spray at flowering stages produced maximum RGR (0.066 g/g/day) followed by foliar application of DAP 2% spray at flowering stage and 15 days later (0.062 g/g/day) at 45 -60 days interval.

Table 1: Effect of foliar application of nutrients on growth and development of black gram (*Vigna mungo* {L.} Hepper) under rain fed Vertisols of Central India

Treatments	Plant height (cm)				Number of branches per plant				Root length per plant (cm)		
	30 DAS	45 DAS	60 DAS	At Maturity	30 DAS	45 DAS	60 DAS	At Maturity	30 DAS	45 DAS	60 DAS
T1:Control (water spray)	15.7	36.2	46.5	46.7	2.3	3.5	5.4	5.5	8.3	13.2	15.9
T2:Urea 2% spray at flowering	16.1	43.2	54.8	55.7	2.3	5.9	6.2	6.2	8.5	13.7	16.3
T3:DAP 2% spray at flowering and 15 days later	16.7	39.0	58.3	58.3	2.3	5.3	6.7	6.8	7.5	14.9	17.2
T4: Urea phosphate 2% spray at flowering.	16.7	38.8	54.2	56.2	2.2	5.2	6.1	6.1	8.2	14.0	17.7
T5: MOP 2% spray at flowering.	16.7	37.8	55.0	55.8	2.4	5.2	5.9	6.0	7.8	13.8	16.3
T6:TNAU pulse wonder @ 5kg/ha at flowering	16.3	41.2	57.0	57.2	2.1	5.3	6.4	6.6	8.1	13.8	17.1
T7:Brassinolide 0.75 ppm at flowering	15.0	39.7	55.2	56.2	2.2	5.4	6.3	6.4	7.3	13.8	17.9
T8:Salicylic acid 100 ppm at flowering	16.6	37.2	52.0	52.2	2.3	5.8	5.8	5.8	7.5	13.3	17.4
T9:19:19:19 (NPK) 2% spray at flowering	14.6	41.8	57.5	58.0	2.1	5.7	6.4	6.5	7.5	15.0	18.5
S. Em ±	1.8	0.6	0.8	0.7	0.1	0.2	0.1	0.1	0.3	0.4	1.1
C.D at P = o.o5%	NS	1.9	2.5	2.1	NS	0.7	0.2	0.3	NS	NS	NS

Table 2: Effect of foliar application of nutrients on growth and development of black gram (*Vigna mungo* {L.} Hepper) under rain fed Vertisols of Central India

Treatments	Number of root nodules per plant		Dry weight of root nodules (mg)		CGR (g/m^2/day)		RGR (g/g/day)	
	30 DAS	45 DAS	30 DAS	45 DAS	30-45 DAS	45-60 DAS	30-45 DAS	45-60 DAS
T1:Control (water spray)	11.5	11.7	3.3	7.22	2.94	19.14	0.011	0.045
T2:Urea 2% spray at flowering	14.3	14.5	4	12.11	5.56	19.86	0.016	0.039
T3:DAP 2% spray at flowering and 15 days later	13.1	15.6	3.45	18.5	5.56	35.28	0.018	0.062
T4:Urea phosphate 2% spray at flowering	13.5	13.5	2.78	17.87	3.47	25.69	0.012	0.053
T5:MOP 2% spray at flowering	13.5	13.6	3.22	11.78	4.03	26.39	0.014	0.053
T6:TNAU pulse wonder @ 5kg/ha at flowering	14	14.2	3	13	3.61	33.19	0.011	0.06
T7:Brassinolide 0.75 ppm at flowering	12.9	13.8	3.11	10.5	4.44	31.53	0.014	0.058
T8:Salicylic acid 100 ppm at flowering	13.8	13.8	2.78	10.45	3.75	25.14	0.013	0.052
T9:19:19:19 (NPK) 2% spray at flowering	13.9	15.1	3.11	11.56	3.33	35.42	0.012	0.066
S.Em ±	1.11	0.35	0.259	0.784	0.61	2.45	0.001	0.003
C.D at P = 0.05%	NS	1.05	NS	2.34	NS	7.35	NS	0.01

4. Conclusion

Based on the results of present investigation it can be concluded that the application of DAP 2% spray (T3) recorded significantly superior in the all growth attributing characters in all observation stages and it was at par with the application of 19:19:19 (NPK) 2% spray at flowering stage. In the physiological parameters, Treatment T9 was found superior than other treatment.

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