Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(1): 2373-2376
Received: 09-11-2018
Accepted: 13-12-2018

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Effect of foliar application of nutrients on yield and economics of blackgram (*Vigna mungo* {L.} Hepper) under rainfed Vertisols of Central India

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Abstract
An experiment was conducted to study the effect of foliar application of nutrients on yield and economics of blackgram under rain fed condition during *kharif* 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 Control, only water spray, Urea 2% spray at flowering**,** DAP 2 % spray at flowering and 15 days later**,** Urea phosphate 2 % spray at flowering**,** MOP 2 % spray at flowering**,** TNAU pulse wonder @ 5 kg ha^{-1} at flowering (contains- N, P, K, Boron, Fe and auxin), Brassinolide 0.75 ppm at flowering, Salicylic acid 100 ppm at flowering, 19:19:19 of NPK as 2 % spray at flowering. Application of 2 % DAP spray at flowering and 15 days later recorded highest yield and higher net return and being on par closely. Followed by application of 19:19:19 (NPK) as 2 % spray at flowering stage. It is concluded that application of 2 % DAP spray at flowering and 15 days later is more remunerative than application of 2 % 19:19:19 (NPK) spray at flowering stage. Further the different treatments had positive effect on yield, and economics of black gram.

Keywords: Black gram, B:C ratio, economics, grain yield, harvest index

Introduction
Black gram (*Phaseolus sublobatus*) also known as urdbean, URD and mash is a native of India. It is one of the most important pulse crops of rainfed areas grown throughout the country. Due to its wider adaptability it is grown in different cropping system as a mixed crop, catch crop, sequential crop in the country. In India black gram is grown in Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, U.P., West Bengal, Punjab, Haryana, and Karnataka. In India total production of black gram is estimated at 1.90 million tonnes from 3.11 million hectare area at a productivity of 642 kg/ha. In Madhya Pradesh black gram production is estimated at 350.5 thousand tonnes from 390.1 thousand hectares area with a productivity of 578 kg/ha. Potential of black gram is very low as this crop is mainly grown in rain fed condition with poor management practices. It is also due to various physiological, biochemical as well as inherent factors associated with the crop. Apart from the genetic make-up, 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 diseases and pests constitute the major constraints for the poor yield. Hence, there is an urgent 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 economical method of supplementing part of nutrients requirements at critical growth stages. 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. Foliar application of nutrient and growth regulator at pre-flowering and flowering stage was seen on reduction in flower drop percentage in blackgram gram (Ganapathy *et al.* 2008) [9]. 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 urdbean. (Amutha *et al.*, 2012) [1]. Significant increase was recorded in growth, and grain yield with foliar application of nutrients (Doss *et al* 2013) [5]. However, the information on foliar nutrition in black gram is scanty and hence this study was conducted to generate information on foliar application of nutrient on yield and economics in blackgram.

Materials and Methods

An experiment was conducted in black gram Hepper) under rain fed condition during *kharif* 2014 at the Research Farm of AICRP on MULLaRP, R.A.K. College of Agriculture, Sehore (M.P.). The sowing was done on 31 July 2014 and crop harvested on dated 16/10/2014. The seeds were drilled manually in the furrows using the recommended seed rate @ 20 kg/ha. The attack of Mung bean yellow mosaic virus (little bit due to resistant variety) and blue beetle at vegetative and flowering stages.

The variety was taken AKU 96-3. This variety is developed by cross with (PU 19) x (NP 21). It matures in 73 days. This variety is suitable for all the urd growing area of central zone of India for kharif season. It is resistant to yellow mosaic virus. The average grain yield is 10 q/ha.

The experimental site was situated in the eastern part of Vindhyan Plateau in sub- tropical zone at a latitude of 23^0 12' North and longitude of 77^0 05' East at an altitude of 498.77 m above mean sea level. A total rainfall 669.5 mm was received during the crop season in 49 rainy days.

The soil of the experiment field was medium black clay loam in texture fairly deep having a slight slope from west to east, having good drainage. The was low in organic carbon low (0.36%), available nitrogen (155.3 kg/ha), available phasphoras (22 kg/ha), available potasium (320 kg/ha), with slightly alkaline soil ph (7.4). The experiment was laid out in Randomized Block Design with three replications having nine treatments namely Control only water spra, Urea 2% spray at flowering, DAP 2 % spray at flowering and 15 days later, Urea phosphate 2 % spray at flowering, MOP 2 % spray at flowering, TNAU pulse wonder @ 5 kg ha^{-1} at flowering (contains- N, P, K, Boron, Fe and auxin), Brassinolide 0.75 ppm at flowering, Salicylic acid 100 ppm at flowering, 19:19:19 (NPK) 2 % spray at flowering. The plot size was 5m x 3m with a spacing of 30 cm x 10 cm. Observations on grain yield, number of pods/plant, number of seed/pod, seed index, grain yield/plant, straw yield and economics were recorded at maturity.

Results and Discussion

3.1 Yield parameters

The effect of foliar spray treatments on number of pods/plant was found significant over control. The highest number of pods (18.50), were produced by application of 2% DAP at flowering stage and 15 days later which was statistically at par with treatments MOP 2 % spray at flowering**,** TNAU pulse wonder @ 5 kg ha^{-1} at flowering (contains- N, P, K, Boron, Fe and auxin)**,** Salicylic acid 100 ppm at flowering and 19:19:19 of NPK as 2 % spray at flowering and significantly superior than rest of the treatments. The minimum number of pods per plant (11.17) were produced in control treatment. 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) [9]. 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 $plant^{-1}$. Solaiappan *et al*. (2002) also reported similar finding in red gram in red gram are concomitant to the present finding. Number of seeds $pods^{-1}$ and seed index showed that the effect of foliar nutrients on number of seeds per pod was observed not significant. The maximum number of seeds per pod (6.50) was recorded in with the application of 19:19:19 (NPK) 2 % spray at flowering and application of DAP 2 % spray at flowering and 15 days later. The minimum number of seeds per pod was recorded in control treatment. (Table 1). The effect of foliar nutrients treatments on seed index was found significant. The higher seed index was obtained in treatment application of 19:19:19 (NPK) 2 % spray at flowering which was significantly superior to rest of the treatments. The minimum seed index was recorded in control treatment Foliar application of 2% DAP twice at flower initiation and pod formation stages of crop growth significantly influenced the number of seeds pod^{-1} and 100 seed weight. This might be due to better absorption of nutrients applied through foliage leading to better activity of functional root nodules resulting in more leaf area, dry matter production and uptake of nutrients. This could have led to more flower production and subsequently pod formation and other yield attributing characters. The increased 100 seed weight might be attributed to increased mobilization of metabolites to the reproductive sinks. Foliar spray of 2% DAP might have supplied nitrogen and phosphorus at the fag end of the crop and might have helped in effective translocation of the nutrients from one plant part to another. This result is in agreement with that of Solaiappan *et al*. (2002) in rainfed red gram.

Table 1: Yield attributing characters as influenced by different treatments

Treatments	Yield attributing characters			
	Number of Pods/plant	Number of Seeds/plant	Grain Yield/plant (g)	Seed Index (g)
T1: Control (water spray).	11.17	5.6	2.6	4.17
T2: Urea 2% spray at flowering.	15.67	6.23	3	4.9
T3: DAP 2% spray at flowering and 15 days later.	16.5	6.5	3.43	4.83
T4: Urea phosphate 2 % spray at flowering.	15.67	5.87	2.83	4.5
T5: MOP 2 % spray at flowering.	15.83	5.83	2.93	4.6
T6: TNAU pulse wonder @ 5kg/ha at flowering (contains-N,P,K, Boron, Fe and auxin).	15.83	6.17	3.2	4.93
T7: Brassinolide 0.75 ppm at flowering.	15.5	6.27	3.1	4.87
T8: Salicylic acid 100 ppm at flowering.	15.83	5.97	3.07	4.7
T9:19:19:19 (NPK) 2 % spray at flowering	15.9	6.5	3.33	5.23
SE m±	0.235	0.22	0.089	0.176
CD at P= 0.05%	0.7	NS	0.27	0.53

3.1.1 Seed yield (kg ha^1)

The foliar nutrients recorded significant response on seed yield over control treatments (Table 2). The maximum grain yield was recorded with the application of DAP 2% spray at flowering stage and 15 days later. It was found significantly superior than all the treatments except application of 19:19:19

(NPK) 2% spray at flowering. The minimum seed yield was recorded in control treatment. The increase in yield might be due to enhanced yield attributes like number of pods plant^{-1} and number of seeds pod$^{-1.}$ It may also be due to increased uptake of nutrients by black gram by effective translocation of nutrients from sink to reproductive area of crop. The positive effect of P in increasing the grain yield was also reported by Mathan *et al*. (1996) in black gram.

Table 2: Grain yield (kg ha^{1}), straw yield (kg ha^{1}), harvest index (%) and economics as influenced by different treatments

S. No	Treatments	Grain Yield (kg ha^{1})	Straw Yield (kg ^{1}ha)	Gross Return (₹/ha)	Cost of Cultivation (₹/ha)	Net profit (₹/ha)	B:C Ratio (Per ₹ invested)	Harvest index (%)
1	T1: Control (water spray).	444	777	20091	17308	2783	1:1.16	36.36
2	T2: Urea 2% spray at flowering.	592	1064	26872	17374	9498	1:1.54	35.74
3	T3: DAP 2 % spray at flowering and 15 days later.	916	1527	41221	17908	23313	1:2.30	37.49
4	T4: Urea phosphate 2 % spray at flowering.	583	1046	26458	17512	8946	1:1.51	35.72
5	T5: MOP 2 % spray at flowering.	546	981	24783	17522	7261	1:1.41	35.75
6	T6: TNAU pulse wonder @ 5kg/ha at flowering (contains-N, P, K, Boron, Fe and auxin).	620	1055	27965	17808	10157	1:1.57	37
7	T7: Brassinolide 0.75 ppm at flowering.	592	990	26650	17870	8780	1:1.49	37.4
8	T8: Salicylic acid 100 ppm at flowering.	537	999	24477	18508	5969	1:1.32	34.96
9	T9:19:19:19 (NPK) 2 % spray at flowering	870	1472	39216	19108	20108	1:2.05	37.14
	SEm±	26	55					0.224
	CD at P= 0.05%	83	166					NS

3.1.2 Straw yield (kg ha^{1})

The effect of foliar treatments on straw yield was found significant compared to control. The maximum straw yield was observed due to application of DAP 2% spray at flowering and 15 days later. This treatment was found significantly superior than remaining treatments except 19:19:19 (NPK) 2% spray at flowering. The increase in straw yield is directly related to increase in the vegetative growth of the plant. Application of 2% DAP twice at flower initiation and pod formation produced highest straw yield, which was at par with application of 19:19:19 (NPK) 2% spray at flowering and significantly higher than remaining treatments. It turn was mainly due to the maximum plant height and CGR.

3.1.3 Harvest index (%)

The foliar application of nutrients on harvest index was found non-significant and it ranged from 34.96 to 37.49 per cent. The maximum harvest index was recorded with the application of DAP 2 % spray at flowering and 15 days later. This may be attributed to nitrogen and phosphorus influencing the yield attributing characters like pods per plant and seeds per pod, which ultimately influenced the grain yield and hence increased harvest index.

Economics

Foliar spray of 2% DAP twice at flower initiation and pod formation stages of crop growth recorded higher gross returns and net returns followed by foliar spray of 19:19:19 NPK 2% at flowering stage. Water spray treatment (control) recorded the least gross returns and net returns. Similarly, foliar application of 2% DAP twice at flower initiation and pod formation stages of crop growth registered higher B:C ratio followed by foliar spray of 19:19:19 NPK 2% spray at flowering stages of crop growth and the lowest B:C ratio was recorded under the water spray treatment. Similar result of improvement in the grain yield and net income with higher B: C ratio due to foliar applications of 2% DAP has been reported earlier by Chandrasekhar and Bangarusamy (2003) [3]. Yakadri and Ramesh (2002) reported that foliar application of 2% DAP in black gram recorded the highest B:C ratio of 3.78 compared to control.

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 the maximum yield and higher net return. Application of 19:19:19 (NPK) 2 % spray at flowering stage recorded grain yield and net return at par with application of DAP 2 % spray at flowering and 15 days later. In addition application of DAP 2 % spray at flowering and 15 days later was more remunerative than application of 19:19:19 (NPK) 2 % spray at flowering stage.

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