ISSN: 0974 - 0376

The Ecoscan : Special issue, Vol. VII: 325-329: 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.in

INFLUENCE OF SULPHUR AND FOLIAR SPRAY OF NUTRIENTS ON YIELD OF BLACK GRAM

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KEYWORDS

Blackgram
Sulphur
Ffoliar application
DAP

Proceedings of National Conference on Harmony with Nature in Context of Bioresources and Environmental Health
(HORMONY - 2015)
November 23 - 25, 2015, Aurangabad,
organized by
Department of Zoology,
Dr. Babasaheb Ambedkar Marathwada University
Aurangabad (Maharashtra) 431 004
in association with
National Environmentalists Association, India
www.neaindia.org

The Ecoscan
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ABSTRACT

A field experiment was carried to assess the effect of sulphur and foliar spray of nutrients on seed yield of black gram during *kharif* 2011 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. The experiment was laid out in split plot design with three replications. The results of the research revealed that, application of 20 Kg S/ ha recorded significantly higher seed yield (1088 kg/ha) compared to without sulphur (824 kg/ha). The increasein seed yield was to the magnitude of 32% compared to without sulphur application. Among the foliar sprays, spray comprised of 2% DAP + 40 ppm NAA at 45 and 55 DAS recorded significantly higher seed yield (1202 kg/ha) compared other treatment. However, significantly lower seed yield (820 kg/ha) was recorded with water spray.The interaction between sulphur and foliar sprays revealed that, application of 20 kg S/ha + RDF in combination with foliar sprays of 2% DAP + 40 ppm NAA at 45 and 55 days after sowing recorded significantly higher seed yield (1415 kg/ha).

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INTRODUCTION

Among the various pulses, blackgram or urdbean (*Vigna mungo*[L.]Hepper) is an important grain legume with easily digestible protein. It belongs to the family fabaceace with 2n=22. India is the world's largest producer as well as consumer of blackgram. It produces about 1.5 to 1.9 million tonnes of blackgram annually from about 3.5 million hectares of area, with an average productivity of 0.5 tonnes per hectare (Agropedia, 2013).

Blackgram grain contains about 25 per cent protein, 56 per cent carbohydrate, 2 per cent fat, 4 per cent minerals and 0.4 per cent vitamins. It forms one of the important constituents in the dietary practices of the population depending on vegetarian diet. Slow pulse production growth has substantially reduced the per capita consumption of pulses, especially in predominantly vegetarian countries (from 63.0 g/day in 1961 to 27.3 g in 2010 in India (Swati Das *et al.*, 2014). Imbalanced use of nutrients is one of the major factors responsible for reduced yield levels. Hence, there is need to enhance its productivity through agronomic means.

Now a day it is being released that apart from major nutrients, the role of secondary nutrients in general and sulphur is particular in increasing in pulse production is well established. In recent years, sulphur deficiency has become an increasing problem in agriculture, which limits the crop production (Wells and Darts, 1986). The role of sulphur in plant nutrition as one of the essential plant nutrients is well documented (Marschner, 1995). Sulphur is recognized as fourth major nutrient after nitrogen, phosphorus, and potassium. It is essential for the growth and development of plant, besides stimulating seed formation. It not only influences yield but also improves grain quality owing to its influence on protein metabolism and oil sysnthesis. It improves crop management through its favorable effect on environmental stress, resistance against pest and disease (Kruse *et al.*, 2007). Sulphur application is beneficial for enhancing the productivity of blackgramas well as quality of grains.

Foliar application of nutrients for increasing and exploiting genetic potential of the crop is considered as an efficient and economic method of supplementing the nutrient requirement. Application of inorganic nutrient spray will also enhance the nutrient availability, quick absorption and in turn increases the productivity. Nutrients applied through foliage play a pivotal role in increasing the seed yield in pulses (Chandrasekhar and Bangarusamy, 2003).

So far meagre work has been carried out in this direction and there is need to study the response of sulphur and foliar nutrition in blackgram. Further, there is a growing interest in the use of secondary nutrients, sulphur in particular. Keeping these facts

in view, the present experiment was planned to enhance the productivity of blackgram through sulphur application to soil and foliar sprays of nutrients and growth regulators.

MATERIALS AND METHODS

A field experiment was carried at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka) during the *kharif* 2011 blackgram crop was grown in the experimental area. The experiment was laid out in spilt plot design with two main plots (0 and 20 kg S/ha) and nine sub plots of foliar application (2% DAP, urea, ureaphos and 19:19:19 with and without NAA and water spray). Sulphur was applied in the form of gypsum to the soil. Nutrients and combinations of nutrients and growth regulators were applied to foliage through sprays. Blackgram variety DU-1 was used. DU–1 is a medium short duration variety, it grows to a height of 40 - 60cm with erect growing habit having more number of clusters and pods per plant and seeds are bold, moderately resistant to powdery mildew and it comes to harvest at 85-90 days after sowing. The fertilizers were applied to all the treatments at the rate of 25 kg N and 50 kg P_2O_5/ha in the form of urea and Diammonium phosphate, respectively. Sulphur @ 20 kg/ha was applied to nine treatments of each replication in the form of gypsum. Full dose of fertilizers was applied at the time of sowing. Two foliar sprays of nutrients and growth regulators, treatment wise were applied at 45 and 55 days after sowing which coincides with flowering and pod filling stage. Statastical data were analysed using Duncan's Multiple Range Test (DMRT). The mean values of treatments and interactions were separately subjected to Duncan's Multiple Range Test (DMRT) using the corresponding error mean sum of squares and degrees of freedom values at five per cent probability.

RESULTS

Yield attributes

Number of pods per plant

Number of pod per plant is an impotant yield component in blackgram. At 60 DAS, the higher number of pods per plant was recorded with application of sulphur at 20 kg/ha (28.04) over no sulphur (21.68). Among the foliar applications, 2% DAP + 40 ppm NAA recorded significantly higher number of pods per plant (28.47), but it was on par with 2% DAP(27.34) and 2% Ureaphos + 40 ppm NAA (26.74) [Table 1]. At harvest,the higher number of pods per plant was recorded with application of sulphur at 20 kg/ha (29.05) over RDF (19.85) alone. Among the foliar applications, 2% DAP + 40 ppm NAA recorded significantly higher number of pods per plant (31.35) over others (20.08-27.78) and significantly lower number of pods per plant was recorded with water spray (20.08).The interaction of sulphur and foliar sprays revealed that, sulphur at 20 kg/ha with 2% DAP and 40 ppm NAA recorded significantly higher number of pods per plant (41.23) over other treatment combinations. Significantly lower number of pods per plant was recorded in RDF with water spray (18.47).

Pod weight at harvest

Pod weight of blackgram was significantly influenced by application of sulphur and foliar application of nutrients during flowering and pod filling stage. Higher pod weight (g) was recorded with application of sulphur at 20 kg/ha (20.85g) over no sulphur (14.83g). Among the foliar sprays, 2% DAP + 40 ppm NAA recorded significantly higher pod weight compared to water spray (21.06). But it was on par with 2% DAP (20.17), 2% Ureaphos (19.70g), 2% Ureaphos + 40ppm NAA (20.00g) and 2% 19:19:19 + 40ppm NAA (19.43g) and significantly lower pod weight (13.54g) was recorded with water spray. The interaction of sulphur and foliar sprays revealed that, sulphur at 20 kg/ha with 2% DAP and 40 ppm NAA recorded significantly higher pod weight (23.00g), than RDF with water spray (17.59g). And significantly lower pod weight was recorded with RDF with water spray (17.59g)[Table 2].

Thousand seed weight (g)

There was a positive influence on test weight by the sulphur application and foliar spray of nutrients on blackgram (Table 2). Higher thousand seed weight (g) was recorded with application of sulphur at 20 kg/ha (51.24g) over no sulphur (41.23g). Among the foliar sprays, 2% DAP + 40 ppm NAA

Table 1: Number of pods per plant of black gram as influenced by sulphur and foliar application of nutrients and growth regulators at different growth stages

Treatment	60 DAS			At harvest		
	With sulphur	Without sulphur	Mean	With sulphur	Without sulphur	Mean
DAP (2%) spray	32.17	22.52	27.34	34.43	21.13	27.78
Urea (2%) spray	24.47	20.77	22.62	22.53	18.80	20.67
Ureaphos (2%) spray	30.60	22.00	26.30	30.33	20.00	25.17
19: 19: 19 (2%) spray	25.67	21.18	23.42	25.67	19.40	22.53
DAP (2%) + NAA (40 ppm) spray	33.47	23.47	28.47	41.23	21.47	31.35
Urea (2%) + NAA (40 ppm) spray	25.07	21.07	23.07	24.27	18.87	21.57
Ureaphos (2%) + NAA (40 ppm) spray	31.23	22.25	26.74	33.40	20.57	26.98
19: 19: 19 (2%) + NAA (40 ppm) spray	26.20	21.56	23.88	27.90	19.93	23.92
Water spray	23.50	20.27	21.88	21.70	18.47	20.08
Mean	28.04	21.68		29.05	19.85	
For comparing	SEm ±	CD at 5%		SEm ±	CD at 5%	
Main plot	0.40	2.42		0.18	1.09	
Sub plot	0.73	2.11		0.17	0.48	
Interaction	1.06	3.52		0.28	1.18	

DAS – Days after sowing ; NS – Non-significant

Table 2: Pod weight per plant, 1000 seed weight and seed yield per plant of black gram as influenced by sulphur and foliar application of nutrients and growth regulators at different growth stages

Treatment	Pod weight per plant (g)			1000 seed weight (g)			Seed yield per plant (g)		
	With sulphur	Without sulphur	Mean	With sulphur	Without sulphur	Mean	With sulphur	Without sulphur	Mean
DAP (2%) spray	21.67	18.67	20.17	61.59	42.67	52.13	6.05	5.89	5.97
Urea (2%) spray	19.67	7.78	13.73	44.51	40.33	42.42	4.93	4.87	4.90
Ureaphos (2%) spray	21.00	18.41	19.70	51.60	41.67	46.63	5.65	5.50	5.57
19: 19: 19 (2%) spray	20.33	17.33	18.83	46.41	41.51	43.96	5.26	5.13	5.20
DAP (2%) + NAA (40 ppm) spray	23.00	19.12	21.06	65.34	43.00	54.17	7.55	6.51	7.03
Urea (2%) + NAA (40 ppm) spray	20.00	8.23	14.12	45.99	40.67	43.33	5.09	4.91	5.00
Ureaphos (2%) + NAA (40 ppm) spray	21.48	18.51	20.00	54.99	42.00	48.49	5.87	5.50	5.68
19: 19: 19 (2%) + NAA (40 ppm) spray	21.00	17.86	19.43	47.41	41.67	44.54	5.37	5.37	5.37
Water spray	19.48	7.59	13.54	43.33	36.67	40.00	4.85	4.78	4.81
Mean	20.85	14.83		51.24	41.13		5.62	5.38	
For comparing	SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%	
Main plot	0.03	0.21		0.47	2.84		0.02	0.15	
Sub plot	1.36	3.91		0.73	2.11		0.05	0.15	
Interaction	1.81	5.22		1.08	3.76		0.07	0.24	

DAS – Days after sowing; NS – Non-significant

Table 3: Seed yield of black gram as influenced by sulphur and foliar application of nutrients and growth regulators at different growth stages

Treatment	Seed yield (kg/ha)		
	With sulphur	Without sulphur	Mean
DAP (2%) spray	1319	957	1138
Urea (2%) spray	944	751	848
Ureaphos (2%) spray	1050	778	914
19: 19: 19 (2%) spray	984	763	874
DAP (2%) + NAA (40 ppm) spray	1415	988	1202
Urea (2%) + NAA (40 ppm) spray	981	754	868
Ureaphos (2%) + NAA (40 ppm) spray	1166	948	1057
19: 19: 19 (2%) + NAA (40 ppm) spray	1007	765	886
Water spray	932	708	820
Mean	1089	824	
For comparing	SEm±	CD at 5%	
Main plot	2	15	
Sub plot	26	74	
Interaction	34	99	

DAS – Days after sowing; NS – Non-significant

recorded significantly higher thousand seed weight (54.17g) over other sprays except 2% DAP (52.13g). Significantly lower thousand seed weight was recorded with water spray (40.00g). Interaction of sulphur and foliar sprays revealed that, sulphur at 20 kg/ha with 2% DAP and 40 ppm NAA recorded significantly higher thousand weight (65.34g) over other treatment combinations except sulphur at 20 kg/ha with 2% DAP (61.59g).

Seed yield per plant (g)

The higher seed yield per plant (g) was recorded with application of sulphur at 20 kg/ha (5.62g) over RDF (5.38 g) alone (Table 2). Among the foliar sprays, of 2% DAP + 40 ppm NAA spray recorded significantly higher seed yield per plant (7.03g) over other sprays (4.81 - 5.97g). The interaction of sulphur and foliar sprays revealed that, sulphur at 20 kg/ha with 2% DAP and 40 ppm NAA recorded significantly higher thousand weight (7.55g) over other treatment combinations (4.78 - 6.05g).

Seed yield (kg/ha)

Sulphur and foliar application of nutrients had significant variation in the seed yield of blackgram.The higher seed yield (kg) was recorded with application of sulphur at 20 kg/ha (1088kg/ha) over RDF (824kg/ha) alone. Among the foliar sprays, 2% DAP + 40 ppm NAA recorded significantly higher seed yield (1202 kg/ha) over other sprays except 2% DAP (1138kg/ha) and significantly lower seed yield was recorded with water sprays (820 kg/ha). The interaction of sulphur and foliar sprays revealed that, sulphur at 20 kg/ ha with 2% DAP and 40 ppm NAA recorded significantly higher seed yield (1415 kg/ha) over other treatment combinations except sulphur at 20 kg/ha with 2% DAP (1319kg/ha) and significantly lower seed yield was recorded by RDF with water spray (708 kg/ha) [Table 3].

DISCUSSION

The present study, application of 20 kg S per ha recorded significantly higher seed yield (1088 kg/ha) compared to no sulphur (824 kg/ha) . The increase was 32% higher than RDF alone. The reason behind increased seed yield owing to sulphur application might be due to increased metabolic and enzymatic processes including photosynthesis and legume-rhizobium symbiotic nitrogen fixation. Successive increase in

sulphur level upto 20 kg S/ ha significantly increased seed yield of blackgram (Khatkar *et al.*, 2007, Mishra and Tiwari., 2002 and Singh *et al.*,2005). Seed yield is the manifestation of yield attributing characters. Significant increase in seed yield of blackgram can be traced back to the significant increase in yield components. Application of sulphur at 20 kg/ha might have promoted the higher uptake and translocation of food assimilates from source to sink effectively, resulting in higher yield attributes *viz.*, number of pods per plant (29.05), pod weight per plant (20.85g), thousand seed weight (51.24g) and seed yield per plant (5.62g) which lead to higher seed yield.Similar results were found by Singh *et al.* (1993) when sulphur was applied at 40 kg/ha.

Among the foliar sprays, spray comprised 2% DAP + 40 ppm NAA at 45 and 55 DAS recorded significantly higher seed yield (1202 kg/ha) and was on par with foliar application of 2% DAP (1138 kg/ha). The increased seed yield with 2% DAP + 40 ppm NAA was mainly due to the cumulative effect of DAP and NAA. Spraying of DAP helps in quick absorption of nitrogen and phosphorous, which enhanced the growth of root and shoot effectively which resulted in higher uptake of nutrients. While spraying of growth regulator NAA mainly reduced the flower drop and ultimately enhanced the pod setting and resulted in higher seed yield. The results are in with the findings of Revathy *et al.* (1997), Dixit and Elamathi (2007).

Significantly higher values for yield components *viz.*, number of pods per plant (31.35), pod weight per plant (21.06 g), thousand seed weight (54.17 g) and seed yield per plant (7.03 g) at harvest was associated with foliar spray consisting of 2% DAP + 40 ppm NAA at 45 and 55 DAS compared to rest of foliar spray. Similar findings were reported by Behera and Elamathi (2007) and it was on par with foliar spray of 2% DAP with respect to all the yield components except number of pods per plant. Combined spraying of 2% DAP + 40 ppm NAA at 45 and 55 DAS might have enhanced the root and shoot development effectively which resulted in higher uptake of nutrients. While NAA reduced flower dropping, resulting in higher uptake and translocation of food assimilates from source to sink effectively which resulted in higher yield attributes. Application of 20 kg S/ha along with foliar spray of 2% DAP + 40 ppm NAA at 45 and 55 days after sowing recorded higher seed yield (1415 kg/ha) and was on par with application of sulphur at 20 kg/ha in combination with 2% DAP foliar spray (1319 kg/ha). This clearly shows that sulphur increases the availability and uptake of other nutrients due to synergetic interaction, while foliar spray of DAP helps in root and shoot development. Foliar spray of 40 ppm NAA reduced the flower drop effectively and helped in enhancing the pod setting. All these cumulative effects resulted in higher seed yield.

The improvement in yield could be attributed to substantial increase in yield components like, number of pods per plant, pod weight per plant, thousand seed weight and seed yield per plant (Table 1 and 2). In present investigation, the application of 20 kg S/ha in combination with foliar sprays of 2% DAP +40 ppm NAA at 45 and 55 DAS recorded significantly higher number of pods per plant (41.23), pod weight per plant (23.00g), thousand seed weight (65.34g) and seed yield per plant (7.55g) compared to other treatment combinations. The increase in these yield attributes may be associated with increased yield attributes.

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