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# Effect of foliar nutrient and seed hardening in black gram under irrigated conditions (*Vigna mungo* L.)

**Balaji V, Ravinder Kaur and Utkarsh Singh**

### Abstract

Field experiment was conducted at the college field of BFIT Group of Institutions, Dehradun district, Uttarakhand to evaluate seed hardening and foliar nutrition in black gram under irrigated condition during 2020-2021. Ten treatments were included in a randomized block design and replicated three times. The treatments consisted of seed hardening chemicals KCl,  $\text{KH}_2\text{PO}_4$ ,  $\text{CaCl}_2$ , foliar application of DAP, chelated micronutrient and control. The results revealed that seed hardening of KCl,  $\text{KH}_2\text{PO}_4$ ,  $\text{CaCl}_2$  and foliar nutrition of DAP and chelated micronutrient mixture registered the maximum values for growth and yield parameters of black gram. Seed hardening with 1%  $\text{KH}_2\text{PO}_4$  + DAP foliar spray @ 2% and Seed hardening with 1%  $\text{KH}_2\text{PO}_4$  + Chelated micronutrient foliar spray @ 0.5% was recommended to get profitably higher yield under irrigated black gram. Higher net income, benefit-cost ratio, eco-friendly and biologically active system were also associated with the seed hardening of 1%  $\text{KH}_2\text{PO}_4$  + DAP foliar spray @ 2% that can be supported to the farmers.

**Keywords:** seed hardening, foliar nutrition, economics, yield, black gram

### Introduction

Pulses, an important group of crops occupy a unique position in Indian Agriculture for providing protein rich food, feed & Fodder and their well-recognized role in restoring soil fertility and its physical condition. The availability of pulses declined from 69 g/day in 1961 to 29.7 g/day/capita at present day as against the minimum requirement of 80 g/day/capita as nutritional standard established by WHO and FAO. In India pulse is cultivated under area of 29.03 million ha with a production of 23.40 million tonnes and a productivity of 806 kg ha<sup>-1</sup> (GOI, 2019) [1]. In Tamil Nadu, black gram is cultivated under area of 1.79 lakh ha with a production of 1.44 lakh tonnes (<http://dpd.gov.in>). Several strategies have been initiated to boost the productivity of black gram. A few among them is seed hardening and foliar application of nutrients for exploiting genetic potential of the crop.

Seed hardening is a common practice followed to enhance seed performance with respect to rate and uniformity of germination (De Lespinay *et al.*, 2010) [2]. Foliar application of essential nutrients also plays a vital role in pulse production by stimulating root development, nodulation, energy transformation, various metabolic processes, translocation activity in plant and increasing pod setting and thereby increasing the yield. The application of DAP and micro nutrient as a foliar spray significantly improved the yield attributing characters by reducing flower shedding and resulted in increased number of pods plant<sup>-1</sup> and number of grains pod<sup>-1</sup> (Ravisankar *et al.*, 2003) [3]. On the other hand, if deficient, crop growth and quality will be affected. As far as black gram concerned, a detailed research on seed hardening chemicals along with foliar nutrients on productivity of black gram is still not well documented. In this context, present study was carried out to evaluate seed hardening and foliar nutrition in black gram under irrigated condition.

### Materials and methods

The field experiment was conducted at the college field of BFIT Group of Institutions, Dehradun district to evaluate seed hardening and foliar nutrition in black gram under irrigated condition during 2020- 2021. A total ten treatments were evaluated in a randomized block design and replicated three times. The treatments consisted of (T<sub>1</sub>) - Seed hardening with 1% KCL + Chelated micronutrient foliar spray @ 0.5%, (T<sub>2</sub>)- Seed hardening with 1%  $\text{KH}_2\text{PO}_4$  + Chelated micronutrient foliar spray @ 0.5%, (T<sub>3</sub>) – Seed hardening with 1%  $\text{CaCl}_2$  + Chelated

micronutrient foliar spray @ 0.5%, (T<sub>4</sub>)- Seed hardening with 1% KCl + DAP foliar spray @ 2%, (T<sub>5</sub>) - Seed hardening with 1% KH<sub>2</sub>PO<sub>4</sub>+ DAP foliar spray @2%, (T<sub>6</sub>) - Seed hardening with 1% CaCl<sub>2</sub> +DAP foliar spray @ 2%, (T<sub>7</sub>) - Seed hardening with 1% KCl, (T<sub>8</sub>) - Seed hardening with 1% KH<sub>2</sub>PO<sub>4</sub>, (T<sub>9</sub>) - Seed hardening with 1% CaCl<sub>2</sub> and (T<sub>10</sub>) - Control. The soil of the experimental field was clay loamy with a pH of 7.5 and having NPK status of low, medium and medium respectively. Good and viable seeds of ADT 5 black gram variety was treated with 1% KCl, 1% KH<sub>2</sub>PO<sub>4</sub> and 1% CaCl<sub>2</sub>. To get 1% solution 10 gram of KCl, KH<sub>2</sub>PO<sub>4</sub> and CaCl<sub>2</sub> salts were dissolved in 1000 ml of water, respectively and 1 kg of seeds soaked in 650 ml of solution for 10 hours and dried back to original moisture by shade drying. The black gram variety ADT 5 were used during 2020- 2021, respectively with a spacing of 30 x 10 cm. The foliar spraying of 2% DAP, 0.5% chelated micronutrient was done as per treatment schedule on 25 and 45 DAS using knapsack sprayer. The growth attributes, yield and yield parameters and economics was also worked.

## Result and Discussion

### Growth attributes

#### Plant height

The plant height was significantly influenced by various treatments at harvest stage (Table 1). Among the various treatments, seed hardening with 1% KH<sub>2</sub>PO<sub>4</sub> +DAP foliar spray @ 2% (T<sub>5</sub>) recorded the higher plant height of 29.88 cm. This was on par with 1% KH<sub>2</sub>PO<sub>4</sub> + chelated micronutrient foliar spray @ 0.5% (T<sub>2</sub>). It recorded the plant height of 29.88 cm at harvest stage. The least plant height of 21.12 cm was observed in Control (T<sub>10</sub>). This might be due to seed hardening and foliar application of DAP which enhanced the availability of micro and macro nutrients throughout the crop growth period which might have helped in increasing translocation into the plants without any loss that contributed for better photosynthetic activity and ultimately reflected on significant increase in plant height (Elankavi *et al.*, 2019). Similar findings was reported by Uma Maheshwari *et al.* (2017) [5] and Deepak kumar *et al.*, (2018) [6].

**Table 1:** Effect of seed hardening and foliar nutrition on plant height (cm) of blackgram

Treatments		At harvest (cm)	LAI	DMP
T1	Seed hardening with 1% KCl + chelated micronutrient mixture foliar spray @ 0.5%	28.38	4.21	2937
T2	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> + chelated micronutrient mixture foliar spray @ 0.5%	29.78	4.62	3155
T3	Seed hardening with 1% CaCl <sub>2</sub> + chelated micronutrient mixture foliar spray @ 0.5%	26.78	3.77	2750
T4	Seed hardening with 1%KCl + DAP foliar spray @ 2%	28.58	4.28	3001
T5	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> + DAP foliar spray @ 2%.	29.88	4.98	3219
T6	Seed hardening with 1% CaCl <sub>2</sub> +DAP foliar spray @ 2%.	26.88	3.83	2795
T7	Seed hardening with 1% KCl	24.28	3.06	2473
T8	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> .	25.58	3.41	2614
T9	Seed hardening with 1% CaCl <sub>2</sub>	22.78	2.72	2338
T10	Control	21.14	2.30	2094
SEm±		0.38	0.06	41.35
CD (p=0.05)		1.01	0.16	127.90

#### Leaf area index

Among the various treatments, seed hardening with 1% KH<sub>2</sub>PO<sub>4</sub> + DAP foliar spray @ 2% (T<sub>5</sub>) registered higher Leaf Area Index of 4.68 at flowering stage. This was on par with 1% KH<sub>2</sub>PO<sub>4</sub> + chelated micronutrient foliar spray @ 0.5% (T<sub>2</sub>) and recorded the leaf area index of 4.62 (Table 1). This was followed by T<sub>4</sub> (Seed hardening with 1% KCl + DAP foliar spray @ 2%). The least leaf area index was recorded in T<sub>10</sub> (control). This might be due to seed hardening with KH<sub>2</sub>PO<sub>4</sub> and foliar application of DAP at critical stages of the crop growth. This enhances photosynthetic activity, cell division and cell enlargement in plants. The present results were in agreement with earlier findings of Shashikumar *et al.* (2013) [7] and Ramesh *et al.* (2016) [8].

#### Dry Matter Production (DMP)

All the treatments exerted significant influence on dry matter production (Table 1). At harvesting stages seed hardening with 1% KH<sub>2</sub>PO<sub>4</sub> +DAP foliar spray @ 2% (T<sub>5</sub>) recorded the

higher dry matter production of 3219 kg ha<sup>-1</sup>. This was on par with 1% KH<sub>2</sub>PO<sub>4</sub> + chelated micronutrient foliar spray @ 0.5% (T<sub>2</sub>). It recorded the dry matter production of 3155 kg ha<sup>-1</sup> harvesting stages respectively. The least dry matter production of 2094 kg ha<sup>-1</sup> was resulted in T<sub>10</sub>. This might have resulted into better interception, absorption and utilization of radiant energy, leading to higher photosynthetic rate and finally more accumulation of dry matter by the plants (Elankavi *et al.*, 2019).

#### Yield attributes

##### Number of pods plant-1

All the treatments significantly influenced the number of pods plant<sup>-1</sup> (Table 2). Among the different treatments, seed hardening with 1% KH<sub>2</sub>PO<sub>4</sub> + DAP foliar spray @ 2% (T<sub>5</sub>) recorded the highest number of pods plant<sup>-1</sup> of 16.5 and it was on par with 1% KH<sub>2</sub>PO<sub>4</sub> + chelated micronutrient foliar spray @ 0.5% (T<sub>2</sub>). The least number of pods plant<sup>-1</sup> was recorded in Control-T<sub>10</sub> (4.08).

**Table 2:** Effect of seed hardening and foliar nutrition on number of pods plant-1 and seeds pod-1 of blackgram

Treatments		Number of pods plant <sup>-1</sup>	Number of seeds pod <sup>-1</sup>
T1	Seed hardening with 1% KCl+ chelated micronutrient mixture foliar spray @ 0.5%	13.88	6.10
T2	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> + chelated micronutrient mixture foliar spray @ 0.5%	16.10	6.74
T3	Seed hardening with 1% CaCl <sub>2</sub> + chelated micronutrient mixture foliar spray @ 0.5%	11.58	5.56
T4	Seed hardening with 1%KCl + DAP foliar spray @ 2%	14.30	6.14
T5	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> + DAP foliar spray @ 2%.	16.3	6.77
T6	Seed hardening with 1% CaCl <sub>2</sub> +DAP foliar spray @ 2%.	11.98	5.59

T7	Seed hardening with 1% KCl	8.08	4.67
T8	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> .	9.78	5.15
T9	Seed hardening with 1% CaCl <sub>2</sub>	6.38	4.27
T10	Control	4.08	3.74
	SEm±	0.34	0.08
	CD (p=0.05)	1.03	0.26

### Number of seeds pod<sup>-1</sup>

There was significant difference between treatments with regard to number of seeds pod<sup>-1</sup> (Table 2). Among the different treatments, seed hardening with 1% KH<sub>2</sub>PO<sub>4</sub> + DAP foliar spray @ 2% (T5) recorded the highest number of seeds pod<sup>-1</sup> of 6.79. This was on par with 1% KH<sub>2</sub>PO<sub>4</sub> + chelated micronutrient foliar spray @ 0.5% (T2). The least number of seeds pod<sup>-1</sup> was recorded in Control-T10 (3.74). Foliar application of nutrients enhanced the number of floral buds, prevented the floral shedding by maintaining optimum bio-physiological conditions in plants. The present finding is in line with the reports of Uma Maheswari *et al.* (2017)<sup>[5]</sup>.

### Yield

#### Seed yield

All the treatments significantly influence the black gram seed yield (Table 3). Among the different treatments, seed hardening with 1% KH<sub>2</sub>PO<sub>4</sub> + DAP foliar spray @ 2% (T5) recorded the higher seed yield of 1360 kg ha<sup>-1</sup>. This was on par with 1% KH<sub>2</sub>PO<sub>4</sub> + chelated micronutrient foliar spray @ 0.5% (T2) which recorded 1320 kg ha<sup>-1</sup>. This was followed by treatment T4 (Seed hardening with 1% KCl + DAP foliar spray @ 2%) and it is on par with T1 (Seed hardening with 1% KCl + Chelated micronutrient foliar spray @ 0.5%). The least seed yield was recorded in Control-T10 (856 kg ha<sup>-1</sup>).

**Table 3:** Effect of seed hardening and foliar nutrition on seed and haulm yield (kg ha<sup>-1</sup>) of blackgram.

Treatments		Seed yield (kg ha <sup>-1</sup> )	Halum yield (kg ha <sup>-1</sup> )
T1	Seed hardening with 1% KCl+ chelated micronutrient mixture foliar spray @ 0.5%	1225	1695
T2	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> + chelated micronutrient mixture foliar spray @ 0.5%	1320	1800
T3	Seed hardening with 1% CaCl <sub>2</sub> + chelated micronutrient mixture foliar spray @ 0.5%	1140	1595
T4	Seed hardening with 1% KCl + DAP foliar spray @ 2%	1255	1721
T5	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> + DAP foliar spray @ 2%.	1350	1828
T6	Seed hardening with 1% CaCl <sub>2</sub> + DAP foliar spray @ 2%.	1165	1630
T7	Seed hardening with 1% KCl	968	1497
T8	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> .	1038	1532
T9	Seed hardening with 1% CaCl <sub>2</sub>	910	1424
T10	Control	856	1352
	SEm±	15.09	24.51
	CD (p=0.05)	45.58	4.05

### Haulm yield

Haulm yield was significantly influenced by various treatments (Table 3). Among the different treatments, seed hardening with 1% KH<sub>2</sub>PO<sub>4</sub> + DAP foliar spray @ 2% (T5) recorded the highest haulm yield of 1830 kg ha<sup>-1</sup> and it was on par with 1% KH<sub>2</sub>PO<sub>4</sub> + chelated micronutrient foliar spray @ 0.5% (T2). This was followed by treatment T4 (Seed hardening with 1% KCl + DAP foliar spray @ 2%) and it is on par with T1 (Seed hardening with 1% KCl + Chelated micronutrient foliar spray @ 0.5%). The least haulm yield was recorded in Control-T10 (1352 kg ha<sup>-1</sup>). This might be due to adequate supply of nutrients at different growth stages of the crop which helped in better absorption and translocation into the plant system more efficiently contributing to developing pods and proper filling up of seeds thereby resulting in higher grain yield (Thanunathan *et al.*, 2018)<sup>[9]</sup>.

### Economics

The economics of different treatments as indicated by cost of cultivation, gross income, net return and return rupee<sup>-1</sup> invested were calculated (Table 4). Among the treatment

combinations, seed hardening with 1% KH<sub>2</sub>PO<sub>4</sub> + DAP foliar spray @ 2% (T5) recorded the highest gross income (Rs.102000), net income (Rs. 58640) and rupee return (Rs. 2.35) and it was on par with 1% KH<sub>2</sub>PO<sub>4</sub> + chelated micronutrient foliar spray @ 0.5% (T2). This was followed by treatment T4 (Seed hardening with 1% KCl + DAP foliar spray @ 2%) and it is on par with T1 (Seed hardening with 1% KCl + Chelated micronutrient foliar spray @ 0.5%). The least gross income (Rs. 64200), net income (Rs. 24115) and return rupee (Rs. 1.60) was observed in T10 (Control).

This might be due to higher grain yield and haulm yield recorded in this treatment. Despite the additional input cost involved, the substantial yield increment obtained with this treatment might have resulted in increased net income and return rupee<sup>-1</sup>. The least return rupee<sup>-1</sup> invested was observed under control. This might be due to reduced grain yield resulting in least gross income and net return. The present results are in agreement with earlier findings of Pradeep Mohan Dixit and Elamathi (2007)<sup>[10]</sup>, Shashikumar *et al.* (2013)<sup>[7]</sup>, Marimuthu and Surendran (2015)<sup>[11]</sup>, Ramesh *et al.* (2016)<sup>[8]</sup> and Pradeepa and Ganajaximath (2017)<sup>[12]</sup>.

**Table 4:** Effect of seed hardening and foliar nutrition on economics of blackgram.

Treatments		Cost of cultivation (Rs. ha <sup>-1</sup> )	Gross Income (Rs. ha <sup>-1</sup> )	Net Income (Rs. ha <sup>-1</sup> )	BCR
T1	Seed hardening with 1% KCl+ chelated micronutrient mixture foliar spray @ 0.5%	43470	91875	47405	2.11
T2	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> + chelated micronutrient mixture foliar spray @ 0.5%	43490	99000	55510	2.27
T3	Seed hardening with 1% CaCl <sub>2</sub> + chelated micronutrient mixture foliar spray @	43400	85500	42100	1.97

	0.5%				
T4	Seed hardening with 1% KCl + DAP foliar spray @ 2%	43340	94125	50785	2.17
T5	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> + DAP foliar spray @ 2%.	43360	102000	58640	2.35
T6	Seed hardening with 1% CaCl <sub>2</sub> + DAP foliar spray @ 2%.	43300	87375	44075	2.01
T7	Seed hardening with 1% KCl	40316	72600	32284	1.80
T8	Seed hardening with 1% KH <sub>2</sub> PO <sub>4</sub> .	40336	77850	37514	1.93
T9	Seed hardening with 1% CaCl <sub>2</sub>	40276	68250	27974	1.69
T10	Control	40085	64200	24115	1.60

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