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Research Article

Influence of Plant Growth Regulators and Micronutrients on Seed Quality of Black Gram (*Vigna mungo* L.) cv. LBG-625 (Rashmi)

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ABSTRACT

The pulses are an important source of nutritional security with cereals to mitigate malnutrition in undeveloped and under-developing countries. An experiment was conducted to study the effect of foliar application of six growth regulators viz., Indole acetic acid (600 ppm), Ethrel (250 ppm), Gibberellic acid (30 ppm), Thiourea (500 ppm), Salicylic acid (100 ppm) and Naphthalene acetic acid (40 ppm) and two micronutrients viz., Boron (0.5%) and Ferrous sulphate (0.5%) at two growth stages (30 and 45 DAS) in black gram cv. LBG-625 on seed quality. The results revealed that foliar application of gibberellic acid recorded significantly higher test weight (59.03 g), germination (88.10 %), seedling vigour index I & II (2,531 and 514), total dehydrogenase activity (0.440 OD at A_{480} nm), protein (24.96%), field emergence (85%), electrical conductivity (275.48 dSm^{-1}), mean seedling length (28.72 cm), seedling dry weight (5.84 mg) and seed mycoflora (16.00%) in comparison to control. Foliar application is ultra-efficient when roots are incapable of absorbing the required amount of nutrients from the soil.

Key words: *Black gram, Growth regulators, Micronutrients, Seed quality, Seedling vigor index.*

INTRODUCTION

Black gram (*Vigna mungo* L.), also known as black matpe bean, urid, urd, urd bean, udad dal or urad and; is cultivated in Southern Asia. It is widely grown grain legume and belongs to the family Fabaceae and; assumes considerable importance from the point of food, energy and nutritional security (24% protein, 60% carbohydrate, 1.3% fat, 3.2% minerals, 0.9% fiber, 154 mg calcium, 385 mg phosphorus, 9.1 mg iron and small amount of vitamin B-complex) with cereals in the undeveloped and under-developed countries of the world. It is favorable short duration (80-85 days) pulse crop as it thrives better in all seasons either as sole, inter, mixed or fallow crop.

In India, black gram was cultivated in an area, production and productivity of 4.49 m ha, 2.92 m tons and 651 kg/ ha, respectively (Directorate of Economics and Statistics, 2016-17).

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Important states producing black gram are Madhya Pradesh (24.11%), Maharashtra (9.68%), Rajasthan (7.42%), Karnataka (2.62%) and Bihar (0.42%). In Karnataka, black gram occupies 71 thousand ha with a production of 20 thousand tons and productivity is 282 kg ha^{-1}. Country productivity is higher than state productivity[2].

The productivity of black gram is not adequate to meet the domestic demand of the growing Indian population. Consequently, there is an urgent need for enhancement of productivity by proper agronomic practices. Various approaches have been initiated to boost productivity, one among them is the foliar application of organic and inorganic sources of nutrients for exploiting the genetic potential of the crop. This is considered to be an efficient and economically feasible method of supplementing nutrient requirement during critical growth stages. Diversion of food from the sink to source and arresting of vegetative growth in black gram is an essential criterion to obtain higher seed yield and quality[6].

Growth regulating substances/growth regulators are known to influence a wide array of physiological parameters *viz*., alteration of plant architecture, assimilate partitioning, promotion of photosynthesis, uptake of nutrients (mineral ions), enhancing nitrogen metabolism, promotion of flowering, uniform pod formation, increased mobilization of assimilates to defined sinks, induction of synchrony in flowering and delayed senescence of leaves and improved seed quality[14].

The micronutrient plays a significant role in determining the yield potential in pulses. Foliar application is ascribed with the advantage of swift and coherent utilization of nutrients, elimination of losses through leaching and fixation; and least regulation in the uptake of nutrient by plants[11].

MATERIAL AND METHODS

Plant material and Experimental design:

Single cultivar (LBG-625) of black gram was used to study the effect of plant growth regulators and micronutrients on seed quality. Traditionally, LBG-625 grows up to a height of 100 cm, crop duration of 80-85 days with potential production up to15,00 kg ha^{-1}. The field experiment was conducted during rabi season of 2015-16 at I block, ZARS (11°30' N, 76° 05' E; 695 m above mean sea level), VC Farm, Mandya, University of agricultural sciences, Bengaluru, India. The soil of the experiment site was sandy loam with pH 5.30, organic carbon 0.51(%) and available N, P_2O_5, K_2O_5 was 226, 33, 156 kg/ha, respectively. Experimental detail is given below (**Table 1).**

The experiment was laid out in a randomized complete block design (RCBD) with three replications and sown with a spacing of 30 X 10 cm as per the recommended package of practices[1]. The resultant seeds obtained from each treatment of field experiment were collected manually, cleaned, graded and their seed quality parameters were assessed as prescribed by International Seed Testing Association (ISTA)[1] and the laboratory work was conducted in Department of Seed Science and Technology, UAS, GKVK, Bangalore.

Experimental approach:

For test weight, mensuration thousand seeds were counted manually from the sample drawn randomly from each treatment in four replications and weighed as per prescribed by ISTA[1]. The mean weight of the sample was recorded as a thousand seed weight and expressed in grams. The germination test was conducted by using between paper method as per ISTA[1]. Four hundred seeds in four replications were placed on germination paper and rolled towels were incubated in germination chamber maintained at 25 ± 1°C and 95 percent relative humidity. The germinated seedlings were assessed on the fourth and eighth day as first and final count, respectively and percentage germination was revealed based on normal seedlings.

The seedling vigour index was calculated as per the formula is given by Abdul Baki and Anderson[4].

SVI (I) = Germination (%) × Mean seedling length (cm).
SVI (II) = Germination (%) × Mean seedling dry weight (mg).

For measurement of mean seedling length, ten seedlings taken at random from each treatment and replication were separated carefully from the paper towel of laboratory germination test and the total length of seedlings after removing the cotyledons was measured using a metric scale on the germination table. The mean length of ten seedlings in each treatment and replications was calculated and expressed in centimeters. Mean seedling dry weight can be calculated by taking ten seedlings from each treatment and replication were used for measuring the mean seedling length was kept in the hot air oven at 80±1°C for 24 hours. The dry weight was measured and expressed as mean dry weight (mg seedling^{-1}). The total dehydrogenase activity was determined by the method described by Perl *et al.*[12] with necessary modifications. The seeds selected for estimating the electrical conductivity value were used to determine the total dehydrogenase activity. The seed coat of these imbibed seeds was carefully removed and soaked in a 0.5 percent tetrazolium solution at 30 ± 1ºC for a period of 24 hours in dark. Subsequently, they were washed thoroughly with distilled water. The red color (Formazan) was eluted from the stained embryos by soaking in 5 ml of 2-methoxy-ethanol (methyl cellosolve) for 24 hours in airtight screw-capped vials. The extract was decanted and the color intensity was measured with the help of spectrophotometer (Model-Systronics UV-VIS spectrophotometer 1l7) at 480 nm. The dehydrogenase activity was expressed in terms of optical density at 480 nm. Four hundred seeds with hundred seeds in each replication selected in random from each treatment were used for the field emergence studies. The seeds were sown in well-prepared soil bed, at 2.50 to 3.00 cm depth and covered with soil. Field emergence count was taken on the 8th day after sowing and the emergence percentage was calculated based on the number of seedlings emerged three centimeters above the soil surface.

$$\text{Field emergence (\%)} = \frac{\text{Number of seedling emergence at } 8^{th} \text{ day}}{\text{Total number of seeds sown}} \text{ x100}$$

The total soluble protein was estimated as per the method prescribed by Lowery *et al.*[10].

For measurement of electrical conductivity of seed leachate twenty-five seeds of two replications were taken randomly from each treatment in a beaker. Then the seeds were soaked in 25 ml of distilled water for 24 h incubated at 25±10°C. The steeped water from soaked seeds was collected and the electrical conductivity (EC) of seed leachate was measured in digital conductivity meter (Model: Systronics conductivity meter 306). After subtracting the EC of the distilled water from the value obtained from the seed leachate, the actual EC due to electrolytes was expressed in dSm^{-1}.

Detection and identification of seed mycoflora were done by blotter paper method (TP) as per ISTA procedures[3]. Twenty-five seeds each from each replication were placed equidistantly in sterile glass Petri dishes of 15 cm diameter containing 2 moist blotter paper (Whatman No. 1). Then, the Petri dishes were incubated at 20^0 C for seven days with 12 hours' light and 12 hours' dark cycles. After incubation, seeds were examined under the stereo-binocular microscope for the presence of infection. The infected seeds are identified and expressed as a percentage of total infection.

RESULT AND DISCUSSION

Growth regulators and micronutrients are pre-requisite for plant growth and development. The present investigation in black gram cv. LBG-625 (Rashmi) revealed that foliar application of GA_3 30 ppm with a recommended dose of fertilizer (25:50:20 NPK Kg/ha) gave higher test weight by registering 59.03g while the control (only RDF) recorded 52.76g. **(Table 2).**

Germination percentage was higher on foliar application of GA_3 30 ppm by registering 88.10% as compared to control

recorded as 80.14%. This is in the conformity with the result of Chauhan *et al.* They observed that seeds treated with GA_3 (10 ppm) showed the highest germination percentage (96.25%) as compared to other treatments in black gram. The plausible rationale is due to the applications of gibberellic acid, the amino acid content in embryo increases and; responsible for the release of hydrolytic enzymes required for digestion of endospermic starch at the time of seed germination. Gibberellic acid was noticed more effective and amenable to the regulation of radicle and plumule elongation[5] **(Figure 1).**

Foliar application of GA_3 gave higher mean seedling length and mean seedling dry weight by registering 28.72 cm and 5.84 mg, respectively while control was recorded as 21.83 cm and 5.16 mg, respectively. GA_3 has been reported to increases cell division, cell elongation and to increases cell wall extensibility leading to elongation growth. GA_3 can suppress the activity of short internode, hence leads to elongation growth of shoot and increased seedling dry matter. These results are in agreement with the findings of Rahman *et al*.[13] in soybean.

Seedling vigour Index-I and II were revealed higher on foliar application of GA_3 30 ppm by registering 2,531 and 514, respectively while control was recorded as 1,749 and 413, respectively. Higher vigor index might be due to the efficient protein synthesis and better source to sink relationship which resulted in better development of seeds. Kumar *et al*.[9] were found a similar result in French bean **(Figure 2).**

Total dehydrogenase activity was recorded highest on foliar application of GA_3 by registering 0.440 OD at A_{480} nm as compared to control (0.346 OD at A_{480} nm). Dehydrogenase enzyme is essential for protein synthesis and energy production during germination. Definitely, total dehydrogenase activity is one of the effective parameters to assess the quality of seeds **(Figure 3).**

Significant differences were noticed in protein percent among the treatments. The highest protein percent was recorded on the foliar application of GA_3 by registering 24.96% as compared to control (22%). The appropriate reason might be due to the GA_3 amino acid content increases in seeds[7]. These amino acids are prerequisite for protein synthesis.

Maximum field emergence of the resultant seeds was noticed on the foliar application of GA_3 by registering 85% and 76.67% was recorded under control condition. Gibberellic acid releases hydrolytic enzymes required for digestion of endospermic starch at the time of seed germination[5].

Electrical conductivity was highest in the control condition by registering 814.33 dSm^{-1} and lowest was registered in the foliar application of GA_3 (275.48 dSm^{-1}). Electrical conductivity value indicates the membrane integrity and quality of seeds. Higher the EC, lower will be the membrane integrity and leading to decreases the quality. GA_3 increases membrane integrity via a close arrangement of lipid and protein. It also enhances bonding between cellulose fibers in the cell wall[8].

Seed infection (seed mycoflora) was recorded lower on the resultant seed of foliar application of GA_3 by registering 16.00 percent as compared to control (25.00%).

Table 1: Application of different level of treatments on black gram cultivar LBG-625 (Rashmi)

Treatments	Test weight (g)	Germination (%)	Mean seedling length (cm)	Seedling dry weight (mg)	SVI I	SVI II	TDH (OD at A480 nm)	Protein (%)	Field emergence (%)	EC (dSm^{-1})	Seed mycoflora (%)
T1	54.90	84.00	24.44	5.39	2,053	452	0.353	23.76	80.67	440.93	23.00
T2	56.81	86.30	25.24	5.63	2,177	485	0.378	24.22	83.67	286.00	21.00
T3	54.37	84.25	23.95	5.31	2,018	447	0.355	23.29	82.67	524.67	21.67
T4	59.03	88.10	28.72	5.84	2,531	514	0.440	24.96	85	275.48	16.00
T5	55.40	85.15	24.95	5.40	2,125	459	0.379	23.36	80.67	378.33	25.00
T6	54.18	82.80	23.67	5.38	1,959	445	0.362	23.55	79.67	620.07	22.00
T7	56.29	86.41	26.22	5.67	2,265	489	0.374	24.37	83.67	333.53	21.00
T8	54.60	83.50	23.40	5.38	1,953	449	0.353	23.62	80	646.00	23.00
T9	52.76	80.14	21.83	5.16	1,749	413	0.346	22	76.67	814.33	25.00
Mean	55.26	84.83	24.77	5.48	2,104	461	0.371	23.68	81.41	479.72	21.96
S.Em±	1.09	1.34	0.59	0.10	48	9	0.01	0.476	1.46	13.00	0.703
CD (P=0.05)	3.56	5.31	1.05	0.03	188	233	0.36	0.672	6.31	501.78	1.467
CV (%)	3.95	3.16	4.81	3.54	5	4	5.26	3.5	3.1	4.69	5.5

Table 2: Effect of plant growth regulators and micronutrients on seed quality of black gram cultivar LBG-625 (Rashmi)

Treatments	Application
T1	RDF + foliar application of Boron (0.5%)
T2	RDF + foliar application of IAA @ 600 ppm
T3	RDF + foliar application of Ethrel @ 250 ppm
T4	RDF + foliar application of GA_3 @ 30 ppm
T5	RDF + foliar application of Thiourea @ 500 ppm
T6	RDF + foliar application of Salicylic acid @ 100 ppm
T7	RDF + foliar application of NAA @ 40 ppm
T8	RDF + foliar application of $FeSO_4$ (0.5%),
T9	RDF (Control)

RDF: Recommended dose of fertilizer (25:50:20 NPK kg/ha); **IAA**: Indole acetic acid; **NAA**: Naphthalene acetic acid; **GA_3**: Gibberellic acid and **$FeSO_4$**: Ferrous sulphate Foliar application once at 30 DAS and second at 45 DAS were given to all the treatments except T_9

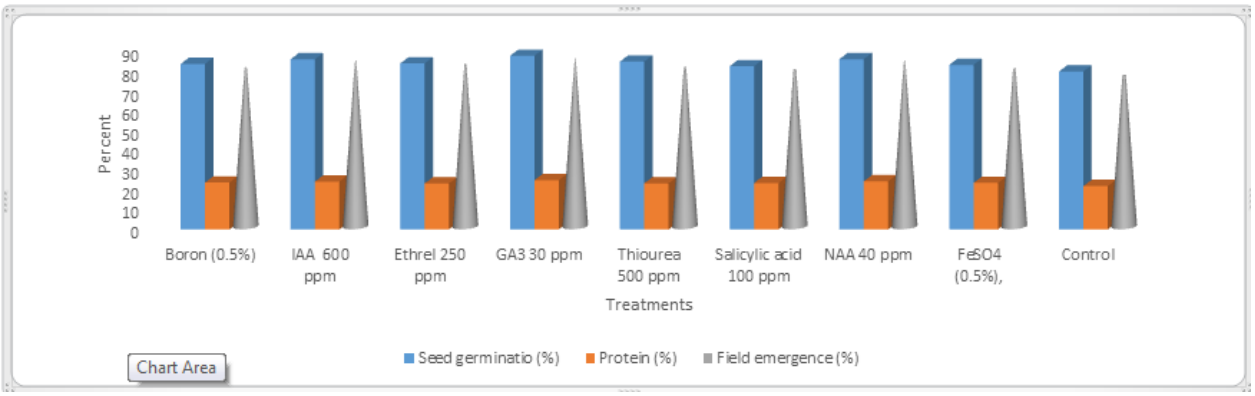

Fig. 1: Influence of plant growth regulators and micronutrients on seed germination (%), protein (%) and field emergence (%) in black gram cv. LBG-625 (Rashmi)

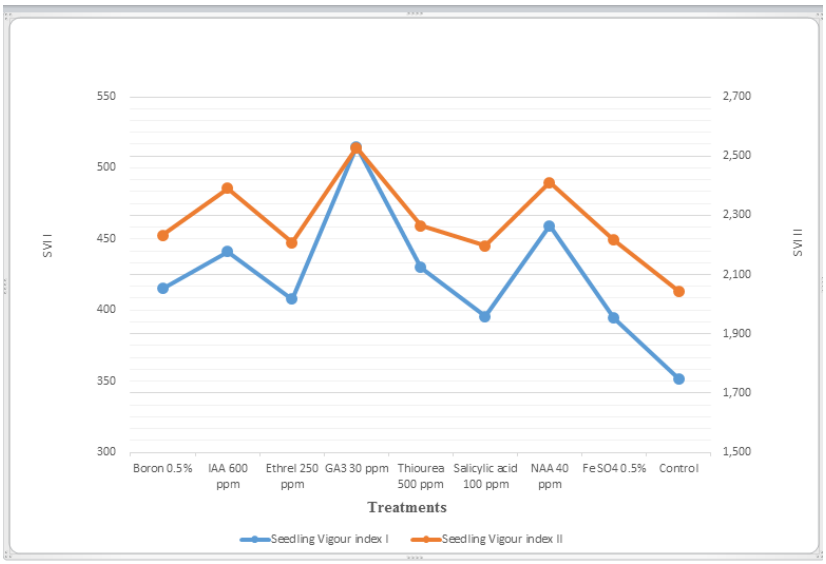

Fig. 2: Influence of plant growth regulators and micronutrients on seedling vigour index I and seedling vigour index II in black gram cv. LBG-625 (Rashmi)

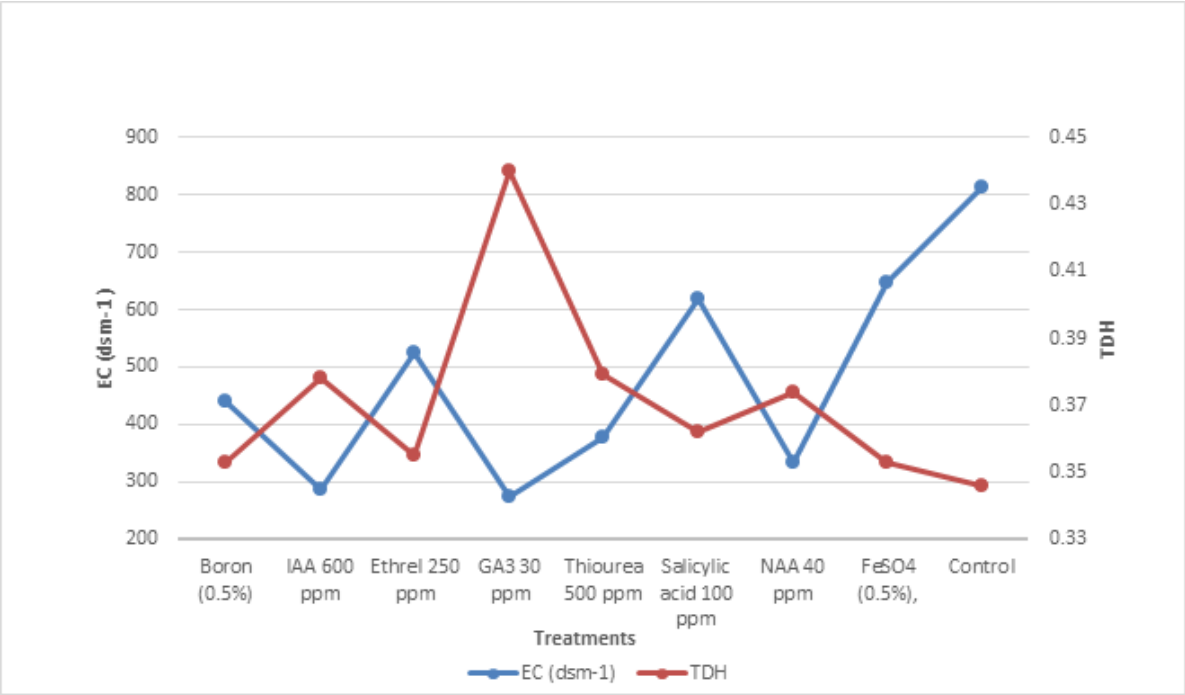

Fig. 3: Influence of plant growth regulators and micronutrients on EC (dsm^{-1}) and TDH (OD A_{480} nm) in black gram cv. LBG-625 (Rashmi)

CONCLUSION

The present study clearly showed that foliar application of GA_3 30 ppm at different crop growth stages gave positive result as compare to control. Foliar application of other growth regulators and micronutrients also gave significant result as compare to control. Foliar application is ultra-efficient when roots are incapable of absorbing the required amount of nutrients from the soil due to lack of soil moisture, the high degree of nutrient fixation, losses through leaching and low soil temperature. It would be more useful and efficient in early maturing short duration crops. Thus, foliar application of nutrients using water-soluble fertilizer is one of the possible ways to enhance seed yield and quality of black gram.

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