

## Original Research Article

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## Effect of Micronutrient Application on Seed Quality Attributes of Blackgram (Var. Prasad)

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### ABSTRACT

The field experiment was conducted during *rabi* season of 2013-2014 at the research plot of Department of Seed Science & Technology, Central Research Station, OUAT, Bhubaneswar, Odisha. This field investigation was carried out with the objectives of improving the efficacy of inoculated *Rhizobium* on seed quality attributes in black gram cv. Prasad by application of micronutrients. The experiment was laid out in 3×2 m<sup>2</sup> plots in a randomized complete block design with 3 replications to assess the effect of different micronutrients both as single and in combinations. The soil application of mixture of zinc sulphate @ 25 Kg/ha and borax @ 10 Kg/ha recorded significantly higher emergence percentage (86.67%) as compared to soil application of zinc sulphate @ 25 Kg/ha and soil application of zinc chelate @ 500 gm/ha. Soil application of mixture of zinc sulphate @ 25 Kg/ha and borax @ 10Kg/ha exhibited highest values of vigour index-I (3647.05) which was found at par with soil application of zinc chelate @ 500 gm/ha, seed treatment mixture and soil application of zinc sulphate @ 10 Kg/ha. Vigour index-II was found highest (2876.33) in seed treatment with mixture of ammonium molybdate @ 5 gm/ha and cobalt nitrate @ 1 gm/ha which was at par with other treatments except soil application of ZnSo<sub>4</sub>@ 25 Kg/ha alone, Borax @ 5 Kg/ha, and seed treatment with cobalt nitrate alone.

#### Keywords

Micronutrient, Seed Quality, Attributes, Blackgram

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### Introduction

Pulses are the second important Indian diet after cereals. Pulses are rich in proteins and found to be main source of protein to vegetarian people of India. India grows such a variety of grain legumes which none of the country in the World grows. In India, more than a dozen of pulses crop namely chickpea, pigeon pea, black gram, green gram, lentil,

cowpea, lathyrus, common bean, mothbean, horse gram, rice bean are cultivated under varying agro-ecological conditions. Micronutrients are essential for the normal growth of plants. Indian soils have become deficient not only in major plant nutrients like nitrogen, phosphorus and in some cases, potash but also in secondary nutrients, like sulphur, calcium, and magnesium. Micronutrients such as zinc, boron and to a limited extent iron, manganese, copper and

molybdenum have also been reported to be deficient. This has become a major constraint to production and productivity of rice, wheat and pulses. In Odisha low yield level is due to the fact that the crops are generally grown under poor management condition without application of nutrients, irrigation and plant protection measures, where these factors are reported to greatly affect seed quality in different crops (Agarwal, 2010). The Odisha farmers need awareness, proper knowledge and skills in seed production technology as they have better perception of the use of micronutrients in crop production is gaining importance now a day in almost all crop particularly in seed production. Basing on the above facts and realizing the low yield of pulses due to improper nutrient management by the farmer the present experiment has been conducted with the following objectives.

### **Materials and Methods**

In all the treatments seeds were first treated with *Rhizobium* culture @ 20gm/kg of seed. Two micronutrients viz. Mo and Co are applied as seed treatment and other two micronutrients viz. Zn and B were applied at the time of sowing on 27<sup>th</sup> Nov, 2013 as soil application.

The vegetative and reproductive growth behaviour of black gram cv. Prasada in response to micronutrients application were recorded in the field, then seed quality attributes were evaluated and recorded in the laboratory experiments after harvest of the crop. The field experiment was taken in a medium land in the research plot, Department of seed science and technology, Orissa University of Agriculture and Technology, Bhubaneswar situated at 20<sup>o</sup> 15' N latitude and 85<sup>o</sup> 52' Elongitudes. Test crop – Black gram (*Vigna mungo* L.) The experiment was done on the variety 'Prasada' of black gram. The seed of the blackgram variety 'Prasada' were

brought from centre for pulse research, OUAT, Ratanpur, Berhampur of Ganjam district. The seed crop was grown in *rabi*, 2013-2014 using 'Prasada' variety of black gram in a plot size 3×2 m<sup>2</sup> with spacing 15×10 cm<sup>2</sup>. The experiment was laid down in randomized complete block design with 3 replications. All the required agronomic practices were adopted along with appropriate seed production technology. Fertilizer was applied @ 20kg N, 40kg P<sub>2</sub>O<sub>5</sub> and 20 kg K<sub>2</sub>O along with ten cartload of FYM per hectare before sowing of seeds.

### **Application of micronutrients**

Four different micronutrients zinc, boron, molybdenum and cobalt were applied in different concentrations both singly and in combinations of 10 treatments along with a control. The detail procedures of application of micronutrients are provided in the table 1.

Seed quality attributes were evaluated in the laboratory. The quality was assessed in term of moisture content, germination, field emergence, vigour and storability of seeds. The detailed procedure of various laboratory experiments of seed quality is given below.

The moisture content of freshly harvested seeds of each treatment of the variety and replication was estimated by air oven method (ISTA, 1985). Seed germination test was conducted by B.P. method (ISTA, 1985).

Moisture content (%) = (loss of moisture/weight of sample) × 100

The damaged seedlings, deformed seedlings and diseased seedlings or delayed seedlings were taken into observation on the day of final count and percentage of abnormal seedlings was computed.

From each paper towel number of hard seeds

was counted on the day of final count and average percentage of hard seeds was computed. After final germination count, ten normal seedlings were kept separately for length measurement. Shoot and root length of the seedlings were measured by using a scale and expressed in cm. The shoot and root portion of all normal seedlings after length measurement were dried in an oven at  $85\pm 1^{\circ}\text{C}$  temperature for 48 hours and again  $103\pm 1^{\circ}\text{C}$  temperature for 24 hours. Then dry weight was determined by an electronic balance and was expressed in grams. Vigour index of seeds of all the treatments were calculated as per formula developed by Abdul Baki and Anderson (1973).

Seed vigour index-I = Mean seedling length (cm)  $\times$  germination (%)

Seed vigour index-II = Mean seedling dry weight (g)  $\times$  germination (%)

## Results and Discussion

Seed quality itself has a profound effect on the development and yield of a crop. Simple techniques for the measurement of seed quality, related to aspects such as moisture content, germination percentage and plant vigor, are taken for consideration when assessing the quality of seeds.

From the observation presented in Table 2 on seed moisture content, it was revealed that there was no significant variation among the treatments. All micronutrient treatments showed lower seed moisture content compared to control. However minimum seed moisture content (4.08%) was recorded with the soil application of mixture of Zn and B and maximum value (4.74%) were recorded in control. The seed moisture in the present experiment, it was found that micronutrient application had no influence on regulating moisture content of the seed as remarkable

value was not produced.

## Seed germination percentage

Significant difference was observed in respect of seed germination percentage among various treatment combinations of micronutrients as revealed from the data presented in the Table 2. All the treatments of micronutrients showed enhancing effect on germination. However highest germination percentage (93.33%) was with the soil application of mixture of zinc sulphate @ 25 Kg/ha and borax @ 10 Kg/ha which was found at par with seed treatment of mixture of ammonium molybdate @ 5 gm/Kg seed and cobalt nitrate @ 1 gm/Kg seed and soil application of zinc sulphate @ 25 Kg/ha alone. Lowest value (79%) was registered in control. Germination and vigour represents physiological quality of the seed. The germination percentage is an indicator of the ability of the seed to emerge from the soil to produce a plant in the field under normal conditions. Higher germination percentage (93.3%) was obtained with soil application of mixture of zinc sulphate and borax followed by seed treatment mixture of ammonium molybdate and cobalt nitrate which are 18.13% and 16.87% more than the control respectively.

This may be due to synergistic action of micronutrient mixture which activate the enzymes involved in germination. Similar result was also reported by Manonmani *et al.*, in lucerne by application of Zn + B @ 0.3%, Ullagaddi *et al.*, (2002) in tomato by application Zn+B+GA<sub>3</sub> and John *et al.*, in maize by seed film coating with micronutrient mixture. Further Rahman *et al.*, (1996) reported positive influence on germination percentage in tomato due to application of boron. Padma and Jagadewsari (1998) also reported same result in sunflower by application of S, B and Zn.

## Abnormal seedling percentage

Abnormal seedling percentage differed significantly among various treatments of micronutrients. The mean values of abnormal seedling percentage varied from 2 to 3.67 % with an overall mean of 5.17% (Table 2). It was found lowest (2%) in the soil application of mixture of zinc sulphate @ 25 Kg/ha and borax @ 10 Kg/ha and maximum value (13.67%) was recorded with the application of zinc sulphate @ 10 Kg/ha followed by seed treatment with cobalt nitrate @ 1 gm/Kg seed. Abnormal seedling percentage and hard seed percentage also differed significantly with the application of micronutrients. Maximum reduction in abnormal seedling % was recorded in soil application of mixture of zinc sulphate and borax followed by soil application of zinc sulphate @ 25 Kg/ha. But surprisingly hard seed percent was less in case of soil application of zinc sulphate @ 10 Kg/ha followed by seed treatment with mixture of ammonium molybdate and cobalt nitrate surpassing the soil application of mixture of zinc sulphate and borax.

### **Hard seed percentage**

The analyzed data relating to the hard seed percentage in black gram have been presented in the Table 2. Hard seed percentage as recorded and presented in the table indicated that significant difference was found between the treatments. Control recorded maximum hard seed percentage (16.33%) and lowest value (2.67%) was recorded in soil application of zinc sulphate @ 10 Kg/ha followed by seed treatment mixture (4%).

### **Root and shoot length of seedling**

The analyzed data relating to the root and shoot length in black gram have been presented in the Table 3. Effect of various micronutrients application showed significant difference with respect to root and shoot

length of seedling. Soil application of mixture of zinc sulphate @ 25 Kg/ha and borax @ 10 Kg/ha recorded higher shoot length (29.90 cm) followed by soil application of zinc chelate @ 500 gm/ha and soil application of zinc sulphate @ 25 Kg/ha. Similar results were recorded with the soil application of zinc sulphate @ 10 Kg/ha alone and borax @ 5 Kg/ha alone.

Lowest value (21.93 cm) was recorded in control. Maximum root length (11.03 cm) was obtained from seed treatment mixture of ammonium molybdate @ 5 gm/Kg and cobalt nitrate @ 1 gm/Kg which was at par with the soil application of mixture of zinc sulphate @ 25 Kg/ha and borax @ 10Kg/ha, soil application of zinc chelate and zinc sulphate @ 10 Kg/ha. Control recorded the lowest root length (8.10 cm). Shoot length is an important parameter which reflects early seedling growth during germination of crop seeds.

Measurement of root length is a part of the procedure to assess early seedling growth of germinated seeds. Enhanced seedling growth was recorded in all the treatments of micronutrients either soil application or seed treatment. The maximum shoot length was recorded in soil application mixture of zinc and boron followed by soil application of zinc chelate @ 500 gm/ha and soil application of zinc sulphate @ 25 Kg/ha alone. Maximum root length was found in seed treatment mixture of Mo and Co followed by soil application of mixture of Zn and B and soil application of zinc chelate. No significant influence of micronutrients was noted for seedling dry weight. As boron increases the rate of respiration, more food material are degraded resulting in supply of energy during germination. Further Zn behave as plant growth regulator for which there is increase in shoot length indicating possible result of both Zn and B application.

**Table.1** Details of micronutrients application

Sl No	Treatment symbol	micronutrients	Name of the salt	Dose of application	Mode of application
1	T1	Control	—	—	—
2	T2	Zinc(Zn)	Zinc sulphate	10kg/ha	Soil
3	T3	Zinc(Zn)	Zinc sulphate	25kg/ha	Soil
4	T4	Boron(B)	Borax	5kg/ha	Soil
5	T5	Boron(B)	Borax	10kg/ha	Soil
6	T6	Molybdenum (Mo)	Ammonium molybdate	5gm/kg seed	Seed
7	T7	Cobalt(Co)	Cobalt nitrate	1gm/kgseed	Seed
8	T8	Mixture (Mo + Co)	Ammonium Molybdate + Cobalt nitrate	5g/kg + 1gm/kg seed	Seed
9	T9	Zinc(Zn)	Zinc chelate	500g/ha	Soil
10	T10	Mixture (Zn+B)	Zinc sulphate + Borax	25kg/ha +10kg/ha	Soil

**Table.2** Effect of micronutrients application on seed characteristics in black gram cv. Prasada

SL. NO.	Treatment code	Treatment details	Seed moisture content (%)	Seed germination (%)	Abnormal seedling (%)	Hard seed (%)
1	T <sub>1</sub>	Control	4.74	79.00 (8.88)	4.67	16.33
2	T <sub>2</sub>	ZnSO <sub>4</sub> @ 10kg/ha (soil application)	4.71	83.67 (9.15)	13.67	2.67
3	T <sub>3</sub>	ZnSO <sub>4</sub> @ 25kg/ha (soil application)	4.72	89.00 (9.43)	3.33	7.67
4	T <sub>4</sub>	Borax @ 5kg/ha (soil application)	4.67	80.67 (8.98)	5.33	14.00
5	T <sub>5</sub>	Borax @ 10kg/ha (soil application)	4.73	83.00 (9.11)	4.00	13.00
6	T <sub>6</sub>	Ammonium molybdate @ 5gm/kg seed (seed treatment)	4.73	82.00 (9.05)	4.00	14.00
7	T <sub>7</sub>	Cobalt nitrate @ 1gm/kg seed (Seed treatment)	4.39	83.67 (9.15)	7.33	9.00
8	T <sub>8</sub>	Ammonium molybdate @ 5gm/kg seed + Cobalt nitrate @ 1gm/kg seed (seed treatment)	4.39	92.33 (9.60)	3.67	4.00
9	T <sub>9</sub>	Zinc chelate @ 500gm/ha (soil application)	4.70	82.33 (9.07)	3.67	14.00
10	T <sub>10</sub>	Zinc sulphate @ 25kg/ha+ Borax @ 10kg/ha (soil application)	4.08	93.33 (9.66)	2.00	4.67
	<b>MEAN</b>		<b>4.59</b>	<b>84.90</b>	<b>5.17</b>	<b>9.93</b>
	<b>CD (0.05)</b>		<b>NS</b>	<b>7.56</b>	<b>2.19</b>	<b>6.37</b>
	<b>CV (%)</b>		<b>9.11</b>	<b>5.19</b>	<b>24.73</b>	<b>37.48</b>

Figures in parentheses are transformed values

**Table.3** Effect of micronutrients application on seedling characteristics in Black gram cv. Prasada

SL. NO.	Treatment code	Treatment details	Shoot Length (cm)	Root length (cm)	Seedling dry weight (gm)
1	T <sub>1</sub>	Control	21.93	8.10	0.20
2	T <sub>2</sub>	ZnSO <sub>4</sub> @ 10 kg/ha (soil application)	28.03	9.24	0.30
3	T <sub>3</sub>	ZnSO <sub>4</sub> @ 25 kg/ha (soil application)	29.37	8.69	0.23
4	T <sub>4</sub>	Borax @ 5 kg/ha (soil application)	28.63	8.89	0.22
5	T <sub>5</sub>	Borax @ 10 kg/ha (soil application)	27.00	9.20	0.26
6	T <sub>6</sub>	Ammonium molybdate @ 5gm/kg seed (seed treatment)	25.60	9.23	0.22
7	T <sub>7</sub>	Cobalt nitrate @ 1gm/kg seed (Seed treatment)	28.93	9.97	0.24
8	T <sub>8</sub>	Ammonium molybdate @ 5gm/kg seed + Cobalt nitrate @ 1gm/kg seed (seed treatment)	27.47	11.03	0.31
9	T <sub>9</sub>	Zinc chelate @ 500 gm/ha (soil application)	29.37	10.27	0.26
10	T <sub>10</sub>	Zinc sulphate @ 25kg/ha+ Borax @ 10kg/ha (soil application)	29.90	10.27	0.30
	<b>MEAN</b>		<b>27.62</b>	<b>9.49</b>	<b>0.25</b>
	<b>CD (0.05)</b>		<b>2.38</b>	<b>0.99</b>	<b>NS</b>
	<b>CV (%)</b>		<b>5.03</b>	<b>6.09</b>	<b>24.18</b>



**Table.4** Effect of micronutrients application on vigour parameters in black gram cv. Prasada

SL. NO.	Treatment code	Treatment details	Vigour index-I	Vigour index-II
1	T <sub>1</sub>	Control	2365.47	1607.67
2	T <sub>2</sub>	ZnSO <sub>4</sub> @ 10 kg/ha (soil application)	3390.71	2695.33
3	T <sub>3</sub>	ZnSO <sub>4</sub> @ 25 kg/ha (soil application)	3016.49	1855.33
4	T <sub>4</sub>	Borax @ 5 kg/ha (soil application)	3023.49	1798.67
5	T <sub>5</sub>	Borax @ 10 kg/ha (soil application)	3160.25	2241.67
6	T <sub>6</sub>	Ammonium molybdate@ 5gm/kg seed (seed treatment)	2855.25	1801.00
7	T <sub>7</sub>	Cobalt nitrate @ 1gm/kg seed (Seed treatment)	3244.18	2039.67
8	T <sub>8</sub>	Ammonium molybdate @ 5gm/kg seed + Cobalt nitrate @ 1gm/kg seed (seed treatment)	3426.97	2876.33
9	T <sub>9</sub>	Zinc chelate @ 500 gm/ha (soil application)	3538.75	2332.67
10	T <sub>10</sub>	Zinc sulphate @ 25kg/ha+ Borax @ 10kg/ha (soil application)	3647.05	2798.67
	<b>MEAN</b>		<b>3166.86</b>	<b>2204.7</b>
	<b>CD (0.05)</b>		<b>295.47</b>	<b>965.73</b>
	<b>CV (%)</b>		<b>5.44</b>	<b>25.53</b>

**Table.5** Effect of micronutrients application on Seedling emergence (%) and storability in black gram cv. Prasada

SL. NO.	Treatment code	Treatment details	Seedling emergence (%)	Germination % of AA seeds
1	T <sub>1</sub>	Control	73.33 (8.56)	65.00 (8.06)
2	T <sub>2</sub>	ZnSO <sub>4</sub> @ 10kg/ha (soil application)	76.33 (8.73)	74.67 (8.64)
3	T <sub>3</sub>	ZnSO <sub>4</sub> @ 25kg/ha (soil application)	83.00 (9.11)	81.67 (9.03)
4	T <sub>4</sub>	Borax @ 5kg/ha (soil application)	75.33 (8.68)	76.67 (8.75)
5	T <sub>5</sub>	Borax @ 10kg/ha (soil application)	81.00 (9)	79.33 (8.90)
6	T <sub>6</sub>	Ammonium molybdate @ 5gm/kg seed (seed treatment)	77.67 (8.81)	80.67 (8.98)
7	T <sub>7</sub>	Cobalt nitrate @ 1gm/kg seed (Seed treatment)	78.67 (8.87)	70.67 (8.40)
8	T <sub>8</sub>	Ammonium molybdate @ 5gm/kg seed + Cobalt nitrate @ 1gm/kg seed (seed treatment)	83.67 (9.14)	85.67 (9.25)
9	T <sub>9</sub>	Zinc chelate @ 500gm/ha (soil application)	81.67 (9.03)	79.00 (8.88)
10	T <sub>10</sub>	Zinc sulphate @ 25kg/ha+ Borax @ 10kg/ha (soil application)	86.67 (9.30)	89.00 (9.43)
	MEAN		79.73	78.23
	CD (0.05)		7.100	6.950
	CV (%)		5.192	5.180

Figures in parentheses are transformed values

The research result of Ullagaddi *et al.*, 2002 confirm the present findings on shoot length and root length in tomato with application of zinc sulphate + B + GA<sub>3</sub>. Further John *et al.*, (2005) reported similar findings in root length and shoot length in seed treatment of seeds or soil application of micronutrient mixture in maize.

### Seedling dry weight

The analyzed data relating to the seedling dry weight in black gram have been presented in the

table 3. The effect of micronutrients application on seedling dry weight was statistically non-significant. However maximum dry weight (0.31 gm) was recorded with seed treatment mixture followed by soil application of zinc sulphate @ 10 Kg/ha and soil application of mixture of Zn and B.

### Seed vigour

*Vigorous* seedlings are essential if plants are to establish quickly and along with root system to trap available water resources and obtain the



maximum amount of sunlight for growth. The common parameters used to represent seed vigour is seed vigour index (SVI) which is measured by integrating two other physiological parameters, germination percentage and seedling length (SVI-I) and dry weight (SVI-II). In the present experiment seed vigour was estimated using both the parameters. Effect of micronutrients application on parameter like vigour exhibited significantly different values (Table 4).

Soil application of mixture of zinc sulphate @ 25 Kg/ha and borax @ 10Kg/ha exhibited highest values of vigour index-I (3647.05) which was found at par with soil application of zinc chelate @ 500 gm/ha, seed treatment mixture and soil application of zinc sulphate @ 10 Kg/ha. Vigour index-II was found highest (2876.33) in seed treatment with mixture of ammonium molybdate @ 5 gm/ha and cobalt nitrate @ 1 gm/ha which was at par with other treatments except soil application of ZnSO<sub>4</sub>@ 25 Kg/ha alone, Borax @ 5 Kg/ha, and seed treatment with cobalt nitrate alone. Seed vigour is the capacity of seed to emerge from the soil and survive under potentially stressful field conditions and to grow rapidly under favorable condition. In the present experiment seed vigour was estimated using both the procedure viz. VI-I & VI-II.

Significantly higher value of 3647.05 of VI-I was found was with soil application of mixture of zinc sulphate and borax. In contrast maximum value of 2876.33 was obtained in VI-II with seed treatment mixture. The present findings also confirm the findings of Deosarkar *et al.*, (2002) in vigour index in soybean by application of zinc and boron. Increase in vigour index was also reported by Manonmani *et al.*, in lucerne by application of Zn + B @ 0.3% and Ullagaddi *et al.*, (2002) in tomato, Pathak and Pandey (2010) in green gram and Swain *et al.*, (2013) in rice. Further Sundra *et al.*, (2004) found significant increase in seedling vigour index by application of zinc sulphate @ 20 Kg/ha and by ammonium molybdate (1 Kg/ha).

### **Field emergence percentage**

The analyzed data relating to the field emergence percentage in black gram have been presented in the Table 5. Differences in the field emergence of seed lots with high germination per cent in laboratory after storage are referred to as seed vigour (Dornbos, 1995; TeKrony, 2003), a concept that comprises various aspects of quality and indicates the stage of seed deterioration. Field emergence represents the vigour potential of the crop. The soil application of mixture of zinc sulphate @ 25 Kg/ha and borax @ 10 Kg/ha recorded significantly higher emergence percentage (86.67%) as compared to soil application of zinc sulphate @ 25 Kg/ha and soil application of zinc chelate @ 500 gm/ha. Seed treatment with mixture of ammonium molybdate @ 5 gm/Kg and cobalt nitrate @ 1 gm/Kg seed was found at par with soil application of mixture of Zn and B.

But lowest emergence (73.33%) was recorded in control. Enhancing effect of all the treatment combination of micronutrients singly or in combination on field ensure that maximum enhancement was recorded with soil application of mixture Zn and B followed by seed treatment mixture of Mo and Co. This result indicated that seeds fed with mixture of zinc and boron have better stand establishment compared to other treatments. Similar enhancing effects have been recorded in tomato by Hamsaveni *et al.*, (2002) Singh (2011) in green gram and Swain *et al.*, (2013) in rice.

### **Storability of seed**

The data on mean germination percentage of accelerated aged seeds (Table 5) indicated that significant variation was there among various micronutrients treatments in black gram. Seeds of the plants receiving mixture soil application of zinc sulphate @ 25 Kg/ha and borax @ 10Kg/ha maintained higher germinability (89%) after accelerated ageing as compared to the other treatments. Seed treatment with ammonium molybdate @ 5 gm/Kg seed and cobalt nitrate 1 gm/Kg seed also maintained

good germination potential (85.67%) after ageing treatment. Mean germination percentage varied from 65 to 89%.

The mean germination percentage was recorded below standard (75%) in soil application of zinc sulphate @ 10 Kg/ha as well as in control after accelerated ageing of seeds.

Data recorded on mean germination % of accelerated aged seeds indicated that seeds fed with mixture of zinc and boron maintained good germination potential even after exposing to the ageing environment followed by seed treatment mixture.

The enhancement of the seed quality parameter may be due to participation of micronutrients (Zn, B) in catalytic activity and breakdown of complex substances into simpler forms. These in turn were helpful to repair of cellular damages resulting in increased storability. The result of the study is in agreement with the findings of Swain *et al.*, (2013) in rice and Singh (2011) in green gram.

It was concluded that most of the seed quality parameters viz. germination percent, seedling growth, field emergence, seed vigour and storability were enhanced by soil application of micronutrient mixture of zinc sulphate @ 25 Kg/ha and borax @ 10 Kg/ha. From this, it may be concluded that *Rhizobium* inoculated seed with recommended dose of inorganic fertilizer and FYM with soil application of micronutrient mixture of zinc sulphate @ 25 Kg/ha and borax @ 10 Kg/ha can enhance the quality seed production in black gram cv. Prasada.

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