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Micro-nutrients Seed Priming and *rhizobium* Coating on Seed Vigour, Crop Growth and Seed Yield in Blackgram (*Vigna mungo* L.)

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ABSTRACT

Background: Black gram is the important pulses crop, grown throughout the country; gives low seed yield mainly due to poor management and low soil fertility. Development of suitable technology is essential to enhance productivity. Seed priming is one such effective technology which enhance rapid and uniform emergence to achieve high vigour, leading to better stand establishment and yield. The current research aimed to study micronutrient seed priming and *rhizobium* coating on seed germination, seedling vigour, crop growth and seed yield in black gram.

Methods: Blackgram seeds were primed with 10 different micronutrient solutions with different concentrations and evaluated for its quality parameters to find out suitable seed priming technique. Seeds from two best priming treatments were coated with *rhizobium* @ 30g/kg of seed and evaluated for its production potential and resultant seed quality under field condition.

Result: Seed priming with 0.5% $ZnSO_4$ at 1/3rd seed to solution ratio for 3 hours recorded higher germination (96%) and vigour index (3811) than control which recorded 84% seed germination and 2528 of vigour index under laboratory experiment. Field experiments revealed that, seeds primed with 0.5% $ZnSO_4$ and coated with *rhizobium* @ 30g per kg of seeds improved seed yield by 13.2% over control.

Key words: Blackgram, Coating, Priming, Seed quality, Yield.

INTRODUCTION

Pulses are an important commodity group of crops that provide high quality protein complementing cereal proteins for pre-dominantly substantial vegetarian population of the country. Black gram (*Vigna mungo* L.), is the important pulses crop, grown throughout the country. It is resistant to adverse climatic conditions and improve the soil fertility by fixing atmospheric nitrogen in the soil (Mohanty and Satyasai, 2015). Blackgram is the fourth important pulse crop in India covering an area of about 44.93 lakh ha with the production of 29.26 lakh tones and productivity of 651 kg / ha. In Tamil nadu, black gram is grown in an area of 4,44,580 hectares with the production of 3,14,620 MT and productivity of 707 kg / ha. Blackgram gives low seed yield mainly due to poor management and low soil fertility (Tiwari and Shivhare, 2016). Seed is one of the major inputs in agriculture and decides future of crops. The rationale for pre-plant seed treatment is to mobilize the seeds own resources and to augment them with external resources to maximum improvement in stand establishment and yield.

Seed priming is one of the pre-sowing management technique for pulses to overcome drought, poor soil fertility and stress. It entails the partial germination of seeds by soaking in water / nutrient solution for a specified time period and then redries before radicle emerges (Copeland and Mc Donald, 1995). Priming stimulates many of the metabolic processes involved with the early phases of germination. Nutri-priming is now recently focused by using macro or micronutrient enriched seeds in rice (Hafeez Ur Rehman *et al.,* 2015). Seed priming with KNO_3 and water improved grain yield of rapeseed through enhancing rate and percentage of seedling establishment (Ali *et al*., 2013). Seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high vigour, leading to better stand establishment and yield (Harris *et al*. 2007). Seed coating with bio-fertilizer increased the plant growth and yield in many crops. Gupta and Abraham (2003) reported that *Rhizobium* inoculation coupled with 30 kg S/ha increased the drymatter accumulation, nodulation and grain yield in soybean. Therefore, seed priming with micronutrients followed by coating with biofertilizer *rhizobium* is a beneficial technology to increase the seed germination, seedling vigour, crop growth and seed yield by improving the seed

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quality. Keeping these in view, an experiment was undertaken to develop suitable micronutrient seed priming and coating technology for enhancing the survival, establishment, growth and yield in black gram.

MATERIALS AND METHODS

Laboratory and field experiments were conducted in the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu during 2018 - 2019 and 2019 - 2020 to study the influence of seed priming with micro-nutrients followed by *rhizobium* coating on seed vigour, crop growth and seed yield in blackgram cv. Vamban 6. The seeds were first Pre-conditioned by keeping the seeds in between two layers of moist gunny bags for one hour. Then, the preconditioned seeds were soaked in different micronutrient solutions at 1/3rd seed to solution ratio for 3 hours and air dried in shade to bring its original moisture content and evaluated for its quality parameters *viz.,* germination percentage, seedling growth, dry matter production and vigour index under laboratory condition to find out the best micronutrients seed priming treatment by adopting Factorial Completely Randomized Design in three replications.

Experiment I: Treatment details

Seed treatments

	Concentration		
	C_1	C_2	C_3
T_1 - Control	-	-	-
T_2 - Water	-	-	-
T_3 - Zinc sulphate	100 ppm		
T_4 - Ferrous sulphate	0.5%	0.75%	1.0%
T_5 - Zinc sulphate	0.5%	0.75%	1.0%
T_6 - Borax	0.5%	0.75%	1.0%
T_7 - Ammonium molybdate	0.5%	0.75%	1.0%
T_8 - Manganese sulphate	0.5%	0.75%	1.0%
T_9 - Magnesium sulphate	0.5%	0.75%	1.0%
T_{10} - Potassium chloride	0.5%	0.75%	1.0%
T_{11} - Potassium dihydrogen phosphate	0.5%	0.75%	1.0%
T_{12} - Ammonium chloride	0.5%	0.75%	1.0%
T_{13} - Ammonium sulphate	0.5%	0.75%	1.0%

From the results and findings obtained, the best performing two priming treatments (priming with 0.5% $ZnSO_4$ and 0.5% $MnSO_4$) were selected and forwarded to field trials along with control and combination of *Rhizobium* seed coating @ 30g per kg of seeds using 10% maida solution (adhesive) in such a way to have uniform coating for evaluating their effect on crop growth and yield. The treatment details were as follows.

Experiment II: Treatments details

T_1 - Control
T_2 - Seed priming with 0.5% $ZnSO_4$
T_3 - Seed priming with 0.5% $MnSO_4$
T_4 - T_1 + *Rhizobium* coating @ 30 g / kg of seeds
T_5 - T_2 + *Rhizobium* coating @ 30 g / kg of seeds
T_6 - T_3 + *Rhizobium* coating @ 30 g / kg of seeds

The field experiments were conducted by adopting randomized block design with three replications and evaluated for crop growth, seed yield and resultant seed quality parameters. The results were subjected to analysis of variance and tested for significance according to Panse and Sukhatme (1999). Percentage values were transformed into arcsine values prior to analysis.

RESULTS AND DISCUSSION

Seed germination and seedling vigour

In the present study, standardization of seed priming with different micro-nutrients revealed that seed priming with 0.5% $ZnSO_4$ recorded higher germination (96%) and vigour index (3811) than control which recorded 84% germination and 2528 of vigour index. Seed priming with 0.5% $MnSO_4$ was the next best treatment. It recorded higher germination of 11.9% and vigour index of 4.6% over control (Fig 1). The probable reason for higher germination in 0.5% $ZnSO_4$ primed seeds could be due to greater hydration of colloids, higher viscosity and elasticity of protoplasm, increase in bound water content, lower water deficit, more efficient root system and increased metabolic activity. The increased seedling growth and vigour index observed in this treatment might be due to greater early vigour and higher percentage of germination of the seeds that had reached autotropic stage well in advance than others. $ZnSO_4$, as a constituent of dehydrogenase enzyme, activator of other enzymes and a constituent for biosynthesis of IAA and amino acid that favored the synthesis of protein. Sulphur in $ZnSO_4$ also increased the levels of vitamins, biotins and thiamin's and its coenzymes in seeds and enhanced growth rate of seedlings. These observations were similar to previously reported findings in germination of soybean cultivar LS678 and TGx1835-10E which were influenced by hydropriming and Benzyladenine priming (Mangena**,** 2020). Seed priming found effective for reducing emergence time, accomplishing uniform emergence, better allometric attributes and requisite stand in blackgram (Raja *et al.* 2019). In general, priming results in metabolic repair of damage during treatment (Bradford *et al*., 1990) and better genetic repair like earlier and faster synthesis of DNA, RNA and proteins, which may be the basis for enhanced growth. Seed priming with water and KNO_3 accelerates seed germination and seedling establishment in rapeseed (Alishavandhi *et al.,* 2014) under both normal and stressful environments.

Growth parameters

Evaluation of production potential of the best performing micronutrient seed priming treatment in combination with *rhizobium* coating in blackgram revealed that seeds primed with 0.5% $ZnSO_4$ and coated with *rhizobium* @ 30g per kg of seeds (T_5) recorded higher field emergence (88%), root length (10.9cm), shoot length (21.4cm) and dry matter production (7.24g/plant) at vegetative stage than control which recorded lower field emergence (82%), root length (9.3cm), shoot length (16.9cm) and dry matter production (5.20 g/plant) (Table 1). In pulses, micronutrients play an important role in plant growth and yield. Moreover, the above said treatment contains Zn which is constituent of an enzyme essential for the synthesis of plant hormone indole acetic acid, which is presumed to be capable for stimulating emergence. The root growth was increased due to *Rhizobium* treatment. The microorganisms that are used as biofertilizers stimulate plant growth by providing necessary nutrients by their colonization at the rhizosphere/their symbiotic association. The association may also regulate the physiological processes in the ecosystems by involving in the decomposition of organic matter, fixation of atmospheric nitrogen, secretion of growth promoting substances, increasing the availability of mineral nutrients and protecting the plants from pathogen. Seed priming with chemicals play a major role in increasing leaf and stem dry matter and redistribution of dry matter in reproductive parts compared to hydro–priming and control (Arun *et al.*, 2020). Vazirimehr *et al.* (2014) reported that seed priming with 1% KNO_3 shorten the time from seed emergence to harvest, improved crop stand and dry matter partitioning to grain in maize. In the present study, the same treatment (T_5) recorded

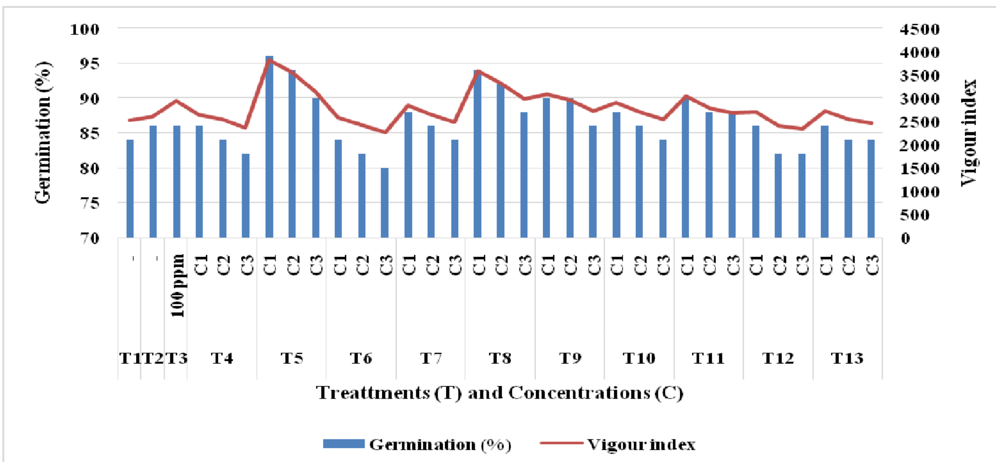

Fig 1: Effect of seed priming with micro-nutrients on seed germination (%) and vigour index in blackgram under laboratory condition.
T_1 – Control; T_2 - Water; T_3 - Zinc sulphate; T_4 - Ferrous sulphate; T_5 - Zinc sulphate; T_6 - Borax;
T_7 - Ammonium molybdate; T_8 - Manganese sulphate; T_9 - Magnesium sulphate; T_{10} - Potassium chloride; T_{11} - Potassium dihydrogen phosphate; T_{12} - Ammonium chloride;T_{13} - Ammonium sulphate
C_1 - 0.50%; C_2 - 0.75%; C_3 – 1.0%.

Table 1: Influence of micronutrients seed priming and *rhizobium* coating on field emergence and crop growth at vegetative stage in black gram under field experiment.

Treatments	Blackgram			
		Vegetative stage		
	Field emergence (%)	Root length (cm)	Shoot length (cm)	Drymatter production (g/plant)
T_1	82.0 (64.89)	9.3	16.9	5.20
T_2	86.0 (68.03)	10.0	20.7	6.02
T_3	85.0 (67.22)	9.8	19.8	5.95
T_4	84.0 (66.42)	9.6	18.5	5.80
T_5	88.0 (69.73)	10.9	21.4	7.24
T_6	87.0 (68.87)	10.1	20.9	6.33
Mean	85.0 (67.22)	9.95	19.7	6.09
SEd	0.12	0.45	0.66	0.19
CD (P=0.05)	NS	0.91**	1.31**	0.39**

(Figs in parentheses are arc sine transformed values).
T_1 – Control; T_2 - Seed priming with 0.5 %$ZnSO_4$; T_3 - Seed priming with 0.5% $MnSO_4$; T_4 - T_1 + *Rhizobium* coating @ 30g / kg of seeds; T_5 - T_2 + *Rhizobium* coating @ 30g / kg of seeds , T_6 - T_3+ *Rhizobium* coating @ 30g / kg of seeds; *Significant at P = 0.05; NS - Non Significant.

Table 2: Influence of micronutrients seed priming and *rhizobium* coating on seed yield, yield attributing parameters and resultant seed quality in black gram under field experiment.

Treatments	Harvesting stage								Resultant seed	
	Plant height (cm)	No. of nodules /plant	No. of pods /plant	No. of seeds /pod	Pod yield /plant	Seed yield /plant	Pod yield (kg/ha)	Seed yield (kg/ha)	100 seed weight (g)	Germination (%)
T_1	47.2	29.0	24.3	6.0	4.92	3.87	958.20	769.14	4.24	90.0 (72.56)
T_2	53.1	33.2	26.7	6.3	5.94	4.99	1001.15	822.40	4.62	92.0 (74.94)
T_3	51.1	30.4	26.3	6.1	5.56	4.57	978.52	820.45	4.57	92.0 (73.59)
T_4	50.6	34.4	24.7	6.1	5.43	4.15	975.30	808.17	4.34	90.0 (71.58)
T_5	56.3	38.6	30.1	6.5	6.06	5.18	1098.64	870.39	4.77	94.0 (75.53)
T_6	55.0	36.4	28.7	6.3	5.98	5.12	1029.20	837.04	4.68	93.0 (74.30)
Mean	52.22	33.67	26.80	6.22	5.65	4.65	1006.84	821.27	4.54	92.0 (74.94)
SEd	0.49	0.61	0.43	0.008	0.06	0.36	6.11	7.98	0.07	0.11
CD (P=0.05)	0.98	1.21**	0.86**	0.016**	0.12**	0.73**	12.22**	15.96**	0.15**	NS

(Figs in parentheses are arc sine transformed values).

T_1 – Control; T_2 - Seed priming with 0.5% $ZnSO_4$; T_3 - Seed priming with 0.5% $MnSO_4$; T_4 - T_1 + *Rhizobium* coating @ 30g / kg of seeds; T_5 - T_2 + *Rhizobium* coating @ 30g / kg of seeds , T_6 - T_3+ *Rhizobium* coating @ 30g / kg of seeds; **Significant at P = 0.05; NS - Non Significant.

higher plant height (56.3cm) and a greater number of nodules / plant (38.6) followed by seeds primed with 0.5 % $MnSO_4$ and coated with *rhizobium* (T_6) whereas plant height is 55.0cm and number of nodules / plants is 36.4. Control (T_1) recorded lower plant height of 47.2cm and lesser number of nodules / plant (29.0) (Table 2). Inoculation of seeds with *Rhizobium* recorded a greater number of nodules per plant. The increase in plant height and drymatter production might be due to increased supply of nitrogen due to more nodulation by the *Rhizobium* inoculation. Seed priming with 100ppm GA3 for 24 hours increased plant height, number of pods per plant, number of seeds per pod, 1000 seed weight and grain yield in cowpea (Arun *et al.,* 2020).

Yield and yield attributes

Seed priming techniques exerted a significant effect on seed yield and resultant seed quality. Seeds primed with 0.5% $ZnSO_4$ and pelleted with *rhizobium* culture (T_5) recorded more number of pods/plant (30.1), number of seeds/pod (6.5), pod yield/plant (6.06 g), seed yield/plant (5.18 g), pod yield/ha (1098.64 kg) and seed yield/ha (870.39 kg) followed by T_6 which registered 28.7 number of pods/plant, 6.3 number of seeds/pod, 5.98g pod yield/plant, 5.12 g seed yield/plant, 1029.20 kg pod yield/ha and 837.04kg seed yield/ha. The same treatment (T_5) recorded higher 100 seed weight (4.77g) and germination (94%) in the resultant seeds where as it were 4.68g and 93%, respectively in T_6 (Table 2). The increased pod yields due to unaborted reproductive structures could have resulted due to higher photosynthetic activity and adequate vegetative structure to produce more number of reproductive sinks. Poor translocation of metabolites to the reproductive stage may be one of the reasons for lower yield in control. Similar results were also reported in wheat (Kalpana *et al*., 2015). In line with the findings in this study, soybean seeds primed with benzyladenine increased number of pods/plant, number of seeds/pod and seed weight compared to hydro-primed seeds (Mangena, 2020). Seed priming with 5 ppm gibberellic acid enhanced seed quality thereby enhancing crop stand and yield in greengram (Krishna Devi *et al*., 2020). Similar effects were also highlighted in bittergourd (Debbarma *et al*., 2018). The seeds primed with 0.5% $ZnSO_4$ and coated with *rhizobium* in the present study enabled quick emergence and established well in the field with higher population that accounted for higher yield per unit area. Ebrahim Abbasi Seyahjani *et al.* (2020) reported that combined inoculation of bean with *Rhizobium*, pseudomonas and mycorrhizal fungi increases the yield might be due to enhancing the biological activity in the soil, soil characters' improvements, better root development, improved transport of nutritional elements, enhanced chlorophyll content synthesis and photosynthesis, solubilization of nutrients resulting in higher nutrients uptake (Menbari *et al*., 2017). Khandelwal *et al.*, (2012) reported that the inoculation of *Rhizobium* increased cowpea grain yield by 13.80% compared to control. Similar results were also reported in soybean (Lingaraju *et al*., 2016).

CONCLUSION

Thus, based on the findings, seed priming with 0.5% $ZnSO_4$ at $1/3^{rd}$ seed to solution ratio for 3 hours increased seed germination and seedling vigour under laboratory experiment. Seed priming with 0.5% $ZnSO_4$ and coated with *rhizobium* @ 30 g per kg of seeds improved crop growth, seed yield and resultant seed quality in blackgram under filed experiment. The present study proved that blackgram seeds can be primed with 0.5% $ZnSO_4$ and coated with *rhizobium* @ 30 g per kg of seeds to enhance the seed germination, seedling vigour, crop growth, seed yield and resultant seed quality.

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