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Standardization of Concentration and Duration of Seed Priming with Zinc Sulphate for Enhancing Germination and Seedling Growth of Blackgram

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ABSTRACT

To standardize the concentration and duration of seed priming with zinc sulphate in blackgram variety, Tulasi (LBG-787), a laboratory experiment was conducted in Factorial Completely Randomized Design (FCRD) with four replications using various concentrations (0, 0.01, 0.05, 0.1 and 0.5 %) as first factor and different durations (0, 2, 4, 6, and 8 h) of priming as second factor. Primed as well as unprimed seed were tested for germination and seedling growth. Analysis of variance of results revealed that concentration of micronutrient, duration of priming and their interaction exhibited highly significant effect on germination (%), seedling length (cm) and seedling vigour index. Among all the concentrations, 0.05 % zinc sulphate has recorded the highest mean germination (88.60 %), seedling length (27.60 cm) and seedling vigour index (2457). Irrespective of concentration, 6 h duration of priming has effectively improved germination and seedling parameters. Seed priming with 0.05 % zinc sulphate for 6 hours caused maximum improvement in germination and early seedling growth of blackgram.

Keywords: *Blackgram, Germination, Nutripriming, Seedling length, Seedling vigour index and Zinc sulphate.*

Blackgram, a short duration pulse crop with high protein content (25-28 %), became one of the farmers' first choices which can fit into any cropping pattern. Blackgram is mostly cultivated in heavier soils such as black cotton soils which retain moisture better in kharif and in paddy fallows during post rainy season. Availability of nutrients at appropriate time is indispensable for perfect growth and development of plants. Approximately 60 % of agricultural lands across the world are deficient in micronutrients (Ambica *et al.,* 2014). Besides low nutrient use efficiency, soil or foliar application of nutrients is expensive. Nutripriming not only mitigates these problems, but also offers solution to enhance the germination, seedling establishment and ultimately the productivity.

In seed priming, seeds are partially hydrated to allow metabolic events to occur without actual germination and then re-dried close to their original weight to permit routine handling (Bradford, 1986). In case of seed priming with micronutrients, seeds were soaked in optimum concentration of micronutrient for definite duration. In this way crucial nutrients can be supplied and the primed seeds exhibit a faster germination and more synchronized growth of young seedlings which are often more vigorous and resistant to abiotic stress.

Zinc is required for maintaining membrane integrity and it is an important component of various plant enzymes such as alcohol dehydrogenase, carbonic anhydrase, Cu-Zn-superoxide dismutase (SOD), alkaline phosphatase, phospholipase, carboxypeptidase and RNA polymerase (Soetan *et al,.* 2010). During the seed germination, production of Reactive Oxygen Species (ROS) is a well known phenomenon and zinc plays an important role in scavanging ROS in plant cells (Cakmak, 2000). Moreover, higher zinc content in seeds may resist invasion of soil borne pathogens during germination (Marschner, 1995). Zinc is required in lesser quantities and higher concentrations of zinc may result in poor germination (Farooq *et al.,* 2005). Hence, the present investigation was executed to determine the optimum concentration and duration of nutripriming with zinc sulphate for improving germination and early seedling growth of blackgram.

MATERIAL AND METHODS

The present laboratory experiment was conducted in the Department of Seed Science and Technology, Advanced Post Graduate Centre, Lam, Guntur, Andhra Pradesh, India during 2019-20. The experiment was laid out in Factorial Completely Randomized Design (FCRD) with four replications. The seed of blackgram variety, Tulasi (LBG-787), were soaked in either water (hydropriming - without zinc sulphate) or various concentrations (0.01, 0.05, 0.1 and 0.5 %) of zinc sulphate solution for different durations (2, 4, 6 and 8 h) by maintaining the seed to solution ratio of 1:2 (w/v). After priming, seeds were washed thoroughly with distilled water and dried to safe moisture content (9 %) under shade. Seeds with initial germination of 82.75 %, seedling length of 21.38 cm and seedling vigour index of 1770 served as control. Four replicates of 100 seeds from each treatment were kept for germination test by between paper method.

After 7 days of test period, observations were recorded on the following parameters as per the details mentioned below:

Germination (%)

The normal seedlings were counted and expressed as germination (%) as per the following formula:

Germination (%) =

$$\frac{\text{Number of normal seedlings}}{\text{Total number of seed sown}} \times 100$$

Seedling Length (cm)

The total distance from the tip of primary leaf to root tip of ten randomly selected seedlings from each replication of each treatment was measured with a scale and their mean was expressed as seedling length in centimeters.

Seedling Vigor Index

It was computed by adopting the following formula as suggested by Abdul-Baki and Anderson (1973) and was expressed in whole number.

Seedling Vigor I ndex (SV I) =

Germination (%) × (Mean Root Length + Mean Shoot Length)

The data were analyzed using SPSS (version 16.0) software after subjecting the obtained data to appropriate transformations. The differences among the means of concentrations of micronutrient and duration of priming were compared by using Duncan's multiple range test at 5% level of probability.

RESULTS AND DISCUSSION

Analysis of variance (Table.1) of results revealed that nutripriming with zinc sulphate at different concentrations, for various durations and their interaction has exerted highly significant impact on germination and seedling growth. Hydropriming also improved germination and seedling growth of blackgram variety, Tulasi (LBG-787), but the impact was lesser than that noticed with nutripriming with zinc sulphate.

Nutripriming with zinc sulphate significantly improved the mean germination with increase in concentration from 0 % (83.90 %) to 0.05 % (88.60 %) and thereafter declined with increase in the concentration up to 0.5% (84.65 %) (Table.2). Highest (7.07 %) per cent increase in mean germination was recorded upon seed priming with 0.05 % zinc sulphate over control (Fig.1). Duration of priming had significant effect on germination in blackgram variety, Tulasi (LBG-787). Priming for 6 h was effective in recording the highest mean germination (88.50 %), while unprimed seed showed lowest mean germination (82.80 %). Further increase in duration of seed priming up to 8 h (85.50 %) caused a significant decline in mean germination (Table.2). The increment in mean germination after seed priming for 6 h over control was 6.95 % (Fig.2). Significant variation in germination ranging from 82.75 % in control (unprimed) seed to 93.00 % upon seed priming with 0.05 % zinc sulphate for 6 h was noticed with an overall mean germination of 85.46 % (Table.2). Raj *et al.* (2019) obtained an increase in germination in cowpea after priming for 4 h with either 0.025 % or 0.05 % zinc sulphate. Rehman *et al.* (2015) noticed an improvement in germination with increase in concentration of zinc sulphate up to 0.5 M and duration for 12 h in wheat. Similar results were reported in cluster bean (Manivasagaperumal *et al.,* 2011).

Nutripriming with zinc sulphate improved the mean seedling length from 24.07 cm (0 %) to 27.60 cm (0.05 %) (Table.2). The per cent improvement in mean seedling length after priming with 0.05 % concentration of zinc sulphate compared to control was 29.09 % (Fig.1). Duration of priming up to 6 h significantly enhanced the mean seedling length. Nutripriming with zinc sulphate showed an improvement in mean seedling length from 21.73 cm (0 h) to 28.73 cm (6 h) (Table.2). Maximum (34.38

Table 1. Mean squares for germination and seedling growth in blackgram variety Tulasi, as affected by seed priming with different concentrations of zinc sulphate for various durations

Source	d.f.	Germination (%)	Seedling length (cm)	Seedling vigor index
Concentration	4	52.46**	33.32**	523062.40**
Duration	4	61.59**	137.80**	1535963.08**
Duration × Concentration	16	5.19**	3.07**	47410.26**
Error	75	0.86	1.11	8048.57

** Significant difference at 1% probability level

Table.2. Influence of seed priming with different concentrations of zinc sulphate for various durations on germination and seedling growth of blackgram variety, Tulasi

Duration	Germination (%)						Seedling length (cm)						Seedling vigour index					
	Concentration of zinc sulphate (%)						Concentration of zinc sulphate (%)						Concentration of zinc sulphate (%)					
	0#	0.01	0.05	0.1	0.5	Mean	0#	0.01	0.05	0.1	0.5	Mean	0#	0.01	0.05	0.1	0.5	Mean
0 hours	82.75	82.75	82.75	83	82.75	82.80^{A}	21.38	21.79	21.87	21.72	21.87	21.73^{A}	1770	1803	1810	1803	1810	1799^{A}
	(65.44)	(65.44)	(65.44)	(65.62)	(65.44)	(65.47)*												
2 hours	83.75	83.25	88	84.25	83.75	84.60^{B}	23.6	23.98	26.03	24.11	24.87	24.52^{B}	1976	1996	2290	2032	2082	2075^{B}
	(66.21)	(65.83)	(69.71)	(66.60)	(66.21)	(66.91)												
4 hours	84	85.25	90.75	84.5	85	85.90^{C}	24.58	25.38	28.97	26.68	26.31	26.38^{C}	2065	2163	2629	2254	2237	2269^{C}
	(66.40)	(67.39)	(72.28)	(66.80)	(67.19)	(68.01)												
6 hours	85.75	87.75	93	88.5	87.5	88.50^{D}	25.93	27.56	32.47	29.04	28.65	28.73^{D}	2223	2417	3019	2570	2507	2547^{D}
	(67.80)	(69.50)	(74.65)	(70.17)	(69.29)	(70.28)												
8 hours	83.25	84.5	88.5	87	84.25	85.50^{C}	24.07	26.47	28.65	26.65	26.37	26.59^{C}	2068	2236	2535	2318	2218	2275^{C}
	(65.82)	(66.79)	(70.17)	(68.86)	(66.66)	(67.66)												
Mean	83.90^{a}	84.70^{b}	88.60^{d}	85.45^{c}	84.65^{b}	85.46	24.07^{a}	25.03^{b}	27.60^{c}	25.64^{b}	25.61^{b}	25.59	2020^{a}	2123^{b}	2457^{d}	2195^{c}	2171^{bc}	2193
	(66.33)	(66.99)	(70.45)	(67.61)	(66.96)	(67.67)												
	D		C			D × C	D			C		D × C	D			C		D × C
S Em ±	0.21		0.21			0.46	0.24			0.24		0.53	20.06			20.06		44.86
CD (5%)	0.59		0.59			1.31	0.66			0.66		1.49	56.63			56.63		126.63
CV (%)	1.37						4.11						4.09					

#Hydropriming

*Values in the parenthesis indicate arc-sine transformed values

The values in the same column with the same alphabet are not significantly different as per DMRT ($P < 0.01$).

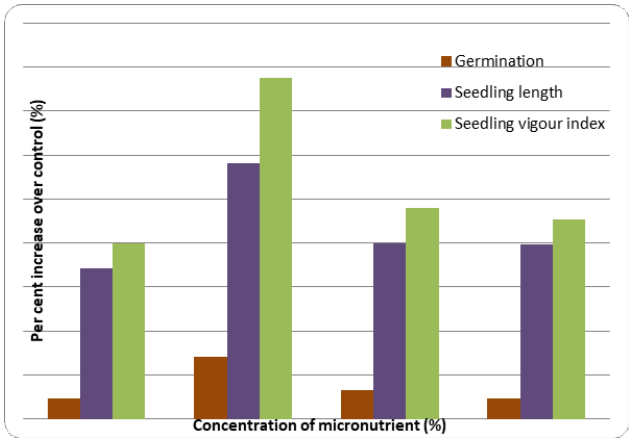

Figure 1. Per cent increase in mean germination and seedling growth after seed priming with various concentrations of zinc sulphate over control

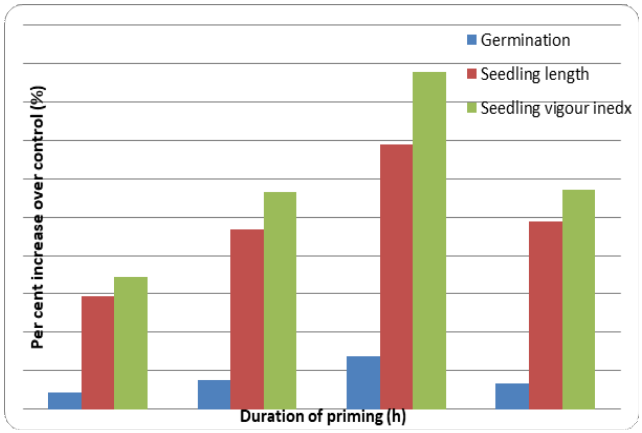

Figure 2. Per cent increase in mean germination and seedling growth after seed priming with zinc sulphate for different durations over control

%) per cent increase in mean seedling length over control was recorded with 6 h of priming (Fig.2). The maximum (32.47 cm) and minimum (21.38 cm) seedling lengths among various concentrations for different durations were obtained for seed priming with 0.05 % zinc sulphate for 6 h and unprimed seed, respectively. The grand mean seedling length was 25.59 cm (Table.2). Ullah *et al.* (2019) observed that 0.001 M zinc sulphate priming for 8 h showed highest shoot and root length of seedlings in chickpea. Concentration greater than 0.01M zinc was proven to be toxic. Rehman *et al.* (2015) observed that shoot and root lengths increased upon seed priming up to 0.5 M of zinc sulphate for 12 h and later declined with further increase in concentration in wheat. Similar results were obtained in cluster bean (Manivasagaperumal *et al.*, 2011).

Seedling vigor index followed similar trend of deviation noticed for germination and seedling length. Mean seedling vigour index was improved with increase in concentration of zinc sulphate from 0 % (2020) to 0.05% (2457). Later it decreased with further increase in concentration up to 0.5 % (2171) (Table.2). The per cent increase in mean seedling vigour index with 0.05 % zinc sulphate over control was 38.81 % (Fig.1). Duration of priming with zinc sulphate showed progressive increase in mean seedling vigour index from 1799 (0 h) to 2547 (6 h) (Table.2). The per cent increase in mean seedling vigour index with 6 h of seed priming over control was 43.90 % (Fig.2). Maximum seedling vigour index (3019) was recorded upon nutripriming with 0.05 % zinc sulphate for 6 h whereas minimum seedling vigour index (1770) was observed with unprimed seed. The overall mean seedling vigour index was 2193 (Table.2). Raj *et al.* (2019) recorded maximum seedling vigour index after seed priming for 4 h with either 0.025 % or 0.05 % zinc sulphate in cowpea. Munawar *et al.* (2013) noticed maximum seedling vigour index in carrot when seeds were primed with 1.5 % zinc sulphate for 24 h. Similar findings were documented in cowpea (Ganesh and Selvaraju, 2015).

Priming enhanced the germination characteristics probably by activating enzymes like á-amylase which is responsible for the disintegration of food reserves (Kaur *et al.,* 2002 and Farooq *et al.,* 2006). The improvement in germination, seedling growth and vigour index brought about by zinc as a priming agent at optimum concentration might be due to its action during early stages of seedling development (Ozturk *et al.,* 2006). But higher concentration of zinc has detrimental effects as it suppresses cell division in meristematic cells (Prasad *et al.,* 1999). According to Atici *et al.* (2005) zinc applied at higher dosage (10 mM) decreased the germination in chickpea. Over priming of seeds for extended duration leaches out certain chemicals from the seed into the priming solution that may inhibit germination (Samad *et al.,* 2014). From the present study it was noticed that increase in concentration of zinc sulphate beyond 0.05 % and priming for more than 6 h showed negative effect on seed quality parameters.

CONCLUSION

Nutripriming with zinc sulphate for various durations exhibited significant improvement in germination and seedling growth of blackgram variety, Tulasi (LBG-787). Nutripriming with 0.05 % zinc sulphate for 6 hours was most effective in enhancing the germination and seedling growth of balckgram.

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