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RESEARCH ARTICLE

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Enhancement of Seed Germination and Seedling Vigour through Different Seed Priming Treatments in Blackgram (*Vigna mungo* L.)

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ABSTRACT

Background: Blackgram (*Vignam ungo* L.) is one of the most important legume crops, grown all around the world. It is used as a vegetable, feed, food and fodder purpose. Blackgram has lower germination and production because of its hard outer covering. To improve germination and seedling vigour, priming alters the physiological state of the seed. This change may improve germination uniformity, increasing seed vigour or physiology. Primed seeds generate seedlings that germinate faster and more uniformed than unprimed seeds and these early seedlings are frequently more robust and resistant to biotic and abiotic stresses. This is a time-saving and low-cost strategy that farmers may employ to improve crop stand and productivity while reducing cost.

Methods: The experiment was carried out in 2016-2017 at Department of Genetics and Plant Breeding, SHUATS, Prayagraj. Blackgram (var. PU-31) seeds were primed with Hydro, Halo, Osmo and Organic priming at 12 hours. Then, four replications of the Complete Randomized Block Design were used to test seeds for germination and vigour.

Result: The experimental results indicated that seed primed with PEG_{6000}@ 20% had the highest germination, seedling length and vigour indices, followed by $CaCl_2$@ 1%, when compared to control and other treatments.

Key words: Black-gram, $CaCl_2$, Curi leaf-extract, Germination, NaCl, PEG_{6000}, Seedling characteristics, Tulsi leaf-extract.

INTRODUCTION

India is the largest producer and consumer of pulses in the world. Pulse crops are an important part of Indian agriculture and have almost three times as much high-quality protein per gram as cereals (Upadhayay *et al.,* 2006). Blackgram (*Vigna mungo* L.), one of the world's most nutrient-dense pulse crops, is grown in India and is a member of the *leguminoseae* family with chromosome number 2n = 2 × = 22 (Malik, 1994). About 70% of the world's Blackgram still originates in India, despite the fact that Indian immigrants introduced it to other tropical areas (Dahanayake *et al.,* 2014). Blackgram is India's third-largest pulse crop, accounting for 16 per cent of the country's total pulse area and 9 percent of total pulse production and contributes significantly to sustainable agriculture by enriching the soil via biological nitrogen fixation. It is mostly grown during the rainy season in Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, Rajasthan and Gujarat and during the winter (*rabi*) season in Andhra Pradesh and West Bengal (Ram *et al.,* 2010). Due to its short duration, photosensitivity and dense crop canopy, it plays a critical role in crop intensification, diversity, conservation of natural resources and system sustainability (Katiyar and Dixit, 2010). This crop has poor germination and establishment because it is grown in rain-fed marginal lands with insufficient nutrients. Low-fertility soils make it hard to get good germination, which is important for getting a good crop yield (Joshi *et al.,* 2013). High and stable production requires quality seed. Seed quality is the basis of efficient crop production and farmers need such seeds for optimum yield production. Therefore, various procedures are applied in seed production technology that aims to improve not only the germination of seeds but also the speed of its germination (Miladinov *et al.,* 2021). Seed priming is administered as a pre-sowing treatment to help plants endure these issues and the unfavorable weather circumstances.

Pre-sowing treatment known as priming involves partially hydrating seeds such that germination begins but no visible radical emergence is seen (Giri and Schillinger, 2003). Using primed seeds has been shown to increase germination rate, germination uniformity, rapid growth, early blooming and yield. As reported, seed priming is a crucial development for speeding up and uniformly emerging of seeds, as well as enhancing resistance for adverse environment conditions in seeds (Heydecker *et al.,* 1973; Harris *et al.,* 1999). Singh *et al.,* (2015) found that organic solutes such proline accumulation in primed seeds increased tolerance to salinity by increasing K^+ and Ca^{2+}

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accumulation while decreasing Na+ accumulation. There are numerous priming techniques available to improve seed germination. Osmotic priming agents include sugar, polyethylene glycol (PEG), glycerol, mannitol, sorbitol and specialty vermiculite compounds (Pawar and Laware, 2018). Osmo-priming strengthens the antioxidant system and increases seed germination potential, resulting in an increased stress tolerance in germinating seeds (Tiwari and Agarwal, 2021). After drying, organic priming plant extracts such as neem leaf extract, curi leaf extract, tulsi leaf extract and neem seed kernel powder for maize may be used. Priming of seeds with different concentrations of organic treatments are being adapted for improving the physiological stamina of the seed, achieving uniform crop stand and further improving quality of seed by minimizing the variation of seed quality within the seed lots (Sajjan *et al.,* 2017). Over an extended period of time, it was discovered that a larger concentration of this powder was advantageous (Sharma, 1995).

MATERIALS AND METHODS

The experiment was done in the postgraduate Seed Testing Laboratory, Department of GPB, SHUATS, Prayagraj (Uttar Pradesh). Priming treatments were applied at varying concentrations with Blackgram (var. PU-31), *viz;*- T_0-Un-primed (Control), T_1- DH_2O, T_2- PEG_{6000}@ 20%, T_3- NaCl@ 1%, T_4- $CaCl_2$@ 1%, T_5- Tulsi Leaf Extract@ 5% and T_6-Curi Leaf Extract@ 5%. Afterwards, the seeds were placed in their respective priming solutions and allowed too steep for twelve hours. Before being used for planting, the seeds were air dried in the shade at 20°C for 24 hours to restore their natural moisture content.

Preparation of solutions

The solution was obtained by putting one gram of each ingredient. These chemicals were added to 1000 ml distilled water, continually stirring. When the solution volume reaches one litter, it should be a 1000 parts per million stock solutions of each component. To avoid contamination, the chemical flasks were covered with muslin cloth. The PEG_{6000} solution 20% was made by taking 200 (g.) of PEG and diluting it with distilled water to a volume of 1000 ml. finally, NaCl (1%) solution 10 (g.), $CaCl_2$ (1%) solution 10 (g.), Tulsi leaf extract (5%) solution 50 (g.) and Curi leaf extract (5%) solution 50 (g.) were also taken in the same way.

Preparation of plant leaf extract

Drying the tulsi and curi leaves in the shade was the first step in preparing the plant leaf extract. A mortar and pestle were used to grind the shade-dried leaves into a fine powder. Afterwards, weigh 50 grams of leaf powder and dissolve it in 1000 ml of pure water that has been calibrated in the beakerto generate a 5 percent leaf extract. The leaf extract was filtered through muslin cloth in order to remove any unwanted particles or leaf debris.

Moisture content after priming

Treatments	Moisture content (after priming)
Control	9%
DH_2O	11.5%
PEG_{6000}@ 20%	11%
NaCl @ 1%	10.6%
$CaCl_2$ @ 1%	10.9%
Tulsi leaf extract @ 5%	10%
Curi leaf extract @ 5%	10.4%

The following characteristics were observed: germination percentage (ISTA, 2004), root length (cm), shoot length (cm), seedling length (cm) (ISTA, 2004), seedling fresh weight (g), seedling dry weight (g) (ISTA, 2004), seedling vigour index-I and seedling vigour index-II (Baki and Anderson, 1973). The collected experimental data were analyzed statistically to determine the analysis of variance, range, mean, critical difference and coefficient of variation (Fisher, 1936).

RESULTS AND DISCUSSION

The results indicate that the treatments had an impact on all of the characteristics tested, with a significant difference between the control (unprimed seeds) and the primed seed (Table 1 and Fig 1 to Fig 6).

All seedling characteristics, including the percentage of seedlings that germinate, Root length (cm), shoot length (cm), seedling length (cm), seedling fresh weight (g.), seedling dry weight (g.), Seedling Vigour index-I and Seedling Vigour index-II were profoundly influenced by PEG_{6000}@ 20%.

Significantly highest germination percentage (86.25%) recorded in seed treatment with T_2-PEG_{6000}@20% followed by T_4- $CaCl_2$@ 1% (82.75%), which was *at par* with T_6-Curi leaf extract@ 5% (82.75%) and found to be lowest in T_0-Control (78.75%). Fig 1 depicts the germination percentage data and similar findings are reported by Heydecker *et al.,* (1973); Arif *et al.,* (2014); Arun *et al.,* (2017) and Nawaz *et al.,* (2013). The increase in germination % under primed seed might be a result of water and certain substances

Table 1: Analysis of variance for 8 seed germination and vigour attributes of blackgram.

Characters	Mean sum of squares	
	Treatments (df=6)	Error (df=21)
Germination percentage	28.39*	4.21
Root length	19.09*	3.16
Shoot length	30.91*	3.05
Seedling length	97.73*	8.05
Seedling fresh weight	3.39*	0.15
Seedling dry weight	0.019*	0.001
Seedling vigour index-I	957575.82*	54131.88
Seedling vigour index-II	180.54*	10.47

*Data that is even at the 5% p-value significance level.

accelerating metabolic activities, resulting in fast cell division and multiplication. Numerous osmotic agents, such as PEG, have been found to improve germination capacity (Toklu *et al.,* 2015), which is essential for the seed embryo's growth and development.

Maximum root length, shoot length and seedling length were measured in seed treatment with T_2-PEG_{6000}@ 20% (17.10 cm, 21.40 cm and 38.50 cm), followed by T_4- $CaCl_2$@ 1% (15.45 cm, 19.65 cm and 35.10 cm), which was *at par* with T_6-Curi leaf extract@ 5% (14.25 cm, 18.87 cm and 33.12 cm) and found to be minimum in T_0-Control (10.55 cm, 13.20 cm and 23.75 cm), respectively. Fig 2 depicts the length of root shoot and seedling data and similar findings are reported by Bray *et al.,* (1989); Saha *et al.,* (1990); Heydecker *et al.,*(1973); Afzal *et al.,* (2008); Ananthi *et al.,* (2015) and Babu and Rosaiah,(2017). The increased seedling length seen with PEG and halo-priming is a result of the cumulative positive effect of H_2O and PEG on root and shoot growth (Demir and Oztokar, 2003). According to some research, seed hydration equivalent to, but not higher than, the lag phase of priming enables early DNA replication, enhanced RNA and protein synthesis, increased ATP

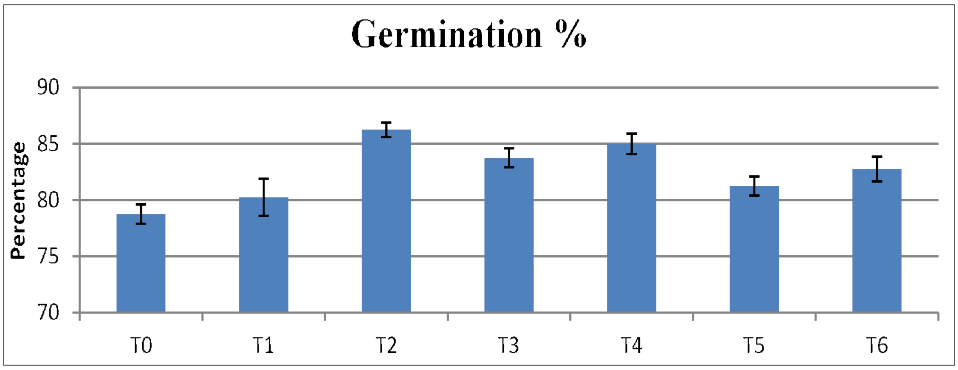

Fig 1: Histogram depicting germination percentage due to influence of different priming treatments.

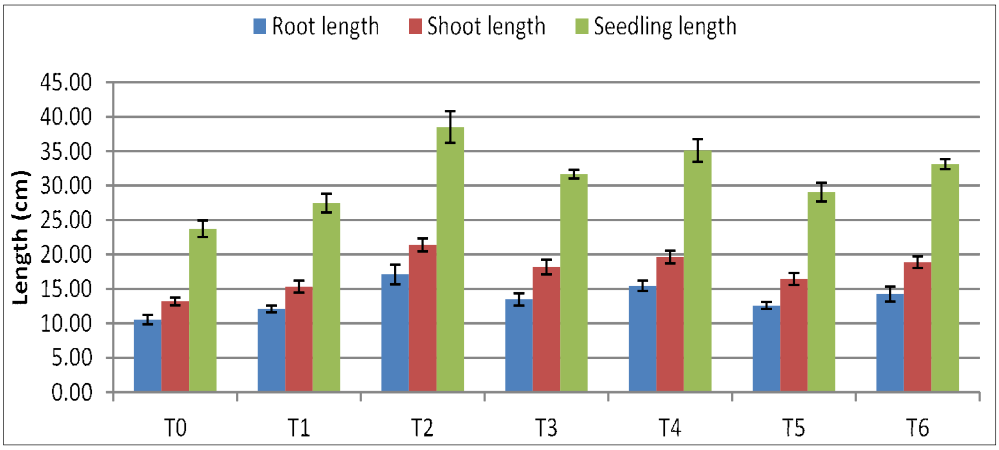

Fig 2: Histogram depicting root, shoot and seedling length due to influence of different priming treatments.

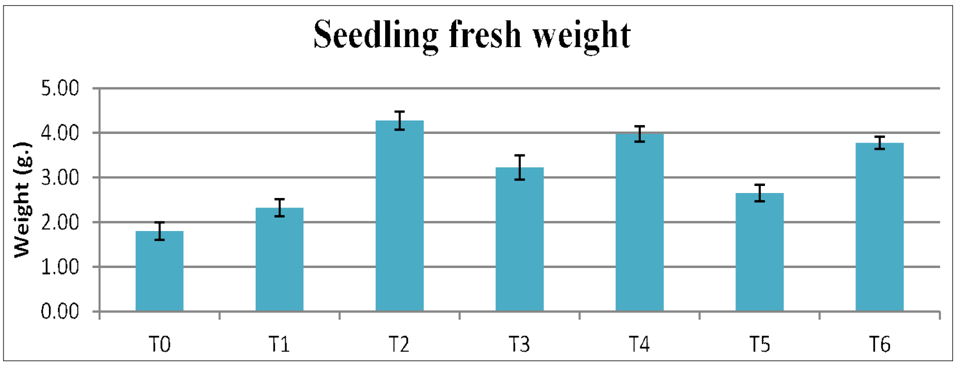

Fig 3: Histogram depicting seedling fresh weight due to influence of different priming treatments.

availability, quicker embryo development and repair of degraded seed components (Karssen *et al.,* 1989). All of these factors contributed to an increase in seed root and branch length, which resulted in an increase in overall seedling length.

Seedling fresh weight and dry weight recorded maximum in seed treatment with T_2-PEG_{6000}@ 20% (4.27 g. and 0.448 g.), followed by T_4- $CaCl_2$@ 1% (3.97 g. and 0.417 g.) which was *at par* with T_6-Curi leaf extract@ 5% (3.77 g. and 0.380 g.) and found to be minimum in T_0-Control (1.80 g. and 0.250 g.), respectively. Fig 3 and 4 depicts the seedling fresh and dry weight data and similar findings are reported by Bewley and Black, (1994); Koehler *et al.,* (1997); Sedghi *et al.,* (2010); Arif *et al.,* (2014) and Babu and Rosaiah, (2017). Ashrsaf and Rauf, (2001) also revealed that their findings on root and shoot fresh weights are consistent with those of who observed that the fresh and dry weights of seedlings from halo-primed seeds were significantly greater than those from other un-primed seeds. Jie *et al.,* (2002) demonstrated that PEG treatment activates numerous chemicals that enhance germination, resulting in increased root and shoot dry matter accumulation.

Seedling vigour index-I and II was recorded highest in seed treatment with T_2-PEG_{6000}@20% (3318.62 and 38.64), followed by T_4- $CaCl_2$@ 1% (2980.60 and 35.49), which was *at par* with T_6-Curi leaf extract@ 5% (2740.00 and 31.42) and found to be lowest in T_0-Control (1870.50 and 19.72), respectively. Fig 5 and 6 depicts the seedling vigour index-I and II data and similar findings are reported by Finch-Savage *et al.,* (2016); Sedghi *et al.,* (2010); Toklu *et al.,*

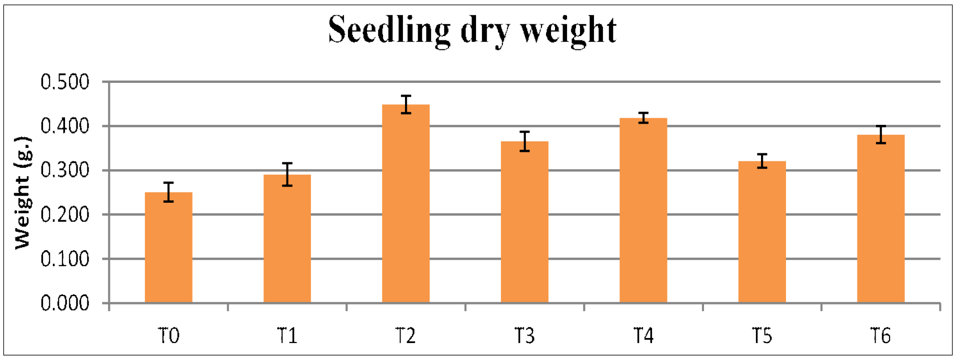

Fig 4: Histogram depicting seedling dry weight due to influence of different priming treatments.

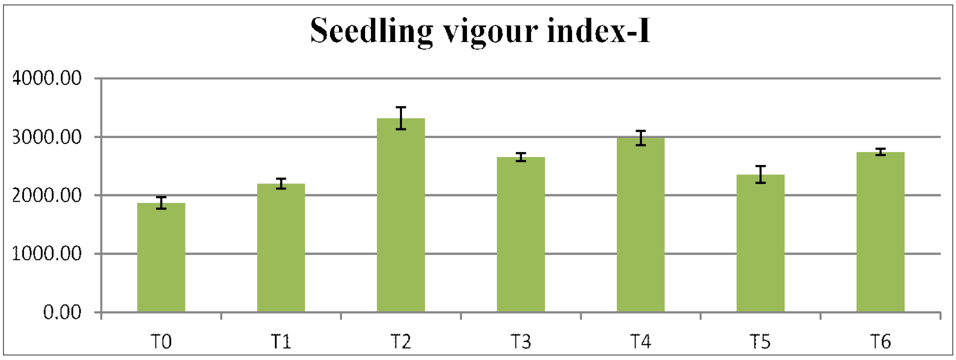

Fig 5: Histogram depicting seedling vigour index-I due to influence of different priming treatments.

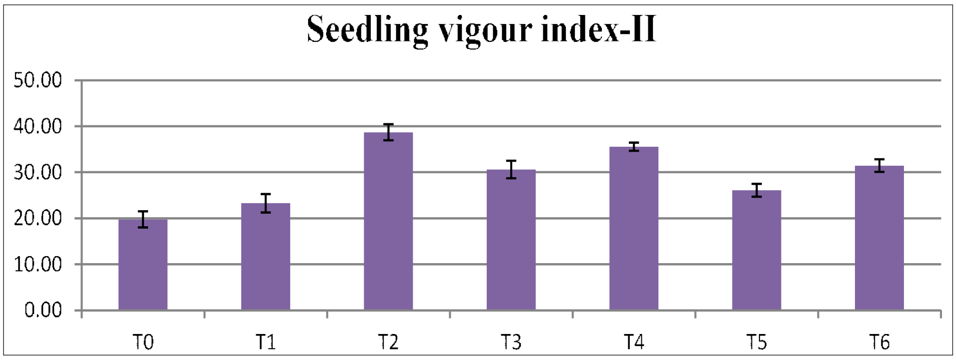

Fig 6: Histogram depicting seedling vigour index-II due to influence of different priming treatments.

(2015); Arif *et al.,* (2014); Saha *et al.,* (1990); Paparella *et al.,* (2015); Musa *et al.,* (1999) and Hussian *et al.,* (2014). The increased seed vigour index-I under PEG and CaCl2 treatment compared to control is attributable to their pro-germination and seedling length promoting actions. During osmotic priming, the normal/low-vigor seed's vigour may be boosted due to the mobilization of food reserves and the activation and re-synthesis of certain enzymes. It has been found that primed seeds exhibit a more favorable germination pattern and a greater degree of vigour than un-primed seeds (Ruan *et al.,* 2002).

Outlook

This research has helped us in the screening of priming strategies for seed germination and seedling characteristics at 12 hours. The outcomes of this study can be used to further research.

- The study focused on improving the quality of black-gram seeds by different priming treatments in terms of germination, seedling characteristics and vigour indices.
- The study looked at how different priming treatments could improve the quality of black-gram seeds, such as how quickly they sprouted, how well they grew and how strong they were.
- Seeds exhibited poor dormancy or may have exhibited late germination as a result of deterioration during harvesting, processing and storage. Seeds are treated with various priming methods (strategies) before to germination to reduce the degradation impact and improve seed quality.
- Seed treatment with T_2-PEG_{6000}@ 20% showed maximum germination percentage, seedling length (cm), weight of seedling (g.) and vigour indices among all the treatments, due to their positive effect and less phyto-toxics.
- The greater percentage emergence of seedlings and vigour indices that were observed with PEG in comparison to other treatments suggest that it should be used as a pre-sowing treatment to retain more elevated seed vigour.

CONCLUSION

Priming improves the germination and vigour of blackgram seeds. Osmo-priming (PEG) and Halo-priming ($CaCl_2$) greatly improved black-gram germination and seedling characteristics. Osmo-priming with PEG resulted in the greatest increase in viability and vigour, as well as the greatest rise in germination. Priming the black-gram seeds for 12 hours with PEG results in improved germination, vigour and seedling characteristics. These findings are the outcome of a six-month investigation; consequently, further research is required to make valid suggestions.

Conflict of interest: None.

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