Environment and Ecology 42 (3A) : 1170—1175, July—September 2024
Article DOI: https://doi.org/10.60151/envec/JUFP2529
ISSN 0970-0420

Standardization of Halo Priming Treatments to Enhance Seed Quality in Groundnut (*Arachis hypogaea*)

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Received 2 February 2024, Accepted 31 May 2024, Published on 5 August 2024

ABSTRACT

Groundnut is a significant grain legume and oil seed crop around the world. The ultimate yield and quality of crops are significantly influenced by the uniformity and proportion of seedling emergence. Weaker seedlings arise from delayed emergence. These days, seed priming is frequently used to improve seed performance, namely to increase germination rate and uniformity of establishment. Therefore, research on priming methods is necessary to raise seedling germination rates and quality. The experiments were carried out to standardize various seed priming treatments with chemicals to enhance seed quality in groundnut. Groundnut seeds were soaked for 4, 6 and 8 hrs with chemical priming agents viz., calcium chloride, ammonium molybdate and zinc sulphate at the concentration of 1, 2 and 3% along with hydropriming and control. The results revealed that the seed to solution ratio of 1:1 soaked for 6 hrs recorded the maximum seed quality characters. Irrespective of soaking duration, seeds primed with calcium chloride @ 1% recorded the maximum seed quality attributes followed by 2% calcium chloride outperformed other treatments by recording higher imbibition rate, germination percentage, longest seedling length, maximum dry matter production and vigour index of groundnut.

Keywords Standardization, Seed quality, Seed priming, Seed germination.

INTRODUCTION

Groundnuts, or peanuts (*Arachis hypogaea* L.), are among the most significant legume crops in the world. It is farmed in many different types of habitats as a cash crop, oilseed, and food crop. Eleven states in India grow groundnuts, which make about 27 % of all oilseed production. With a 4 % GDP contribution, oilseeds play a significant role in the Indian economy (GNP). At the current level of area, production and productivity, it covers roughly 6.09 mha, 10.21 mt, and 1.67 t/ha in India respectively (DAC 2021). Through root nodule bacteria, groundnuts may fix atmospheric nitrogen in soils at a rate of 150-206 kg/ha yearly (Cagasan and Cagasan 2022). As a result, it may aid in raising the fertility and efficiency of the

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soil. However, due to poor production per unit area and time, this crop production is insufficient to meet industry demand (Papong and Cagasan 2020). This crop's supply needs to be increased in order to meet the growing demand for its seeds, which include 40-50% oil, 20-30% proteins, vitamins, and mineral sources (Bhuva *et al.* 2017). The most essential and fundamental component of sustainable agriculture is seed. Crop yield is dependent on effective seed germination procedures.

Studies on methods to enhance crop species' growth and development has been ongoing for a long time. A useful technique for achieving high vigour and accelerating and uniform emergence, seed priming improves stand establishment and yield. A variety of priming techniques include applying osmotica, inorganic salts, or hormones to seeds. According to sources, these seed pre-treatments cause pre-germination alterations, which typically improve seed germination rate, germination velocity, reserve mobilization, and uniformity of seedling growth and development (Pal *et al.* 2017). According to Shrestha *et al.* (2019), seed priming improved maize plant establishment and growth, prompted flowering earlier, increased seed tolerance to unfavorable environmental conditions, and increased yield. It has been demonstrated that seed priming with specific chemicals increases seed germination in a variety of crops.

The greater penetration capacity of chemical agents through the seed coat improves the nutrient uptake and WUE (Marthandan *et al*. 2020). However, a better understanding of the metabolic events during the priming treatment is needed to use this technology in a more efficient way. Therefore, the study was carried out to standardize various halo seed priming treatments to enhance seed quality in groundnut.

MATERIALS AND METHODS

The groundnut (*Arachis hypogaea*) var VRI 10 seeds obtained from Regional Research Station, Tamil Nadu Agricultural University, Virudhachallam served as the base material for the study. The experiment was conducted at Seed Science and Technology Laboratory, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India (located at 11° 24'N latitude and 79°44'E longitude with an altitude of + 5.79 mts above mean sea level). The groundnut seeds were surface sterilized by soaking in 0.1 percent mercuric chloride solution for three minutes, then thoroughly washed with distilled water and then dried. These surface sterilized seeds were halo primed with following chemicals with three replications.

T_0 - Control (Unprimed seed)
T_1 - Hydropriming
T_2 - Calcium chloride @ 1%
T_3 - Calcium chloride @ 2%
T_4 - Calcium chloride @ 3%
T_5 - Ammonium Molybdate @ 1%
T_6 - Ammonium Molybdate @ 2%
T_7 - Ammonium Molybdate @ 3%
T_8 - Zinc sulphate @ 1%
T_9 - Zinc sulphate @ 2%
T_{10} - Zinc sulphate @ 3%

The three different soaking durations i.e., 4, 6 and 8 hrs and two seed to solution ratio of 1:1 and 1:2 (w/v) were followed with Factorial Completely Randomized Block Design. The treated seeds were evaluated for its seed quality characters i.e., Imbibition rate, germination, seedling length, dry matter production and seedling vigour. The datas were analyzed statistically adopting the procedure described by Panse and Sukhatme (1954).

RESULTS AND DISCUSSION

If growers want to produce enough groundnut at an attainable rate, they need a consistent stand of robust, healthy seedlings. The increasing usage of groundnut as a food crop as a result of the ongoing scarcity of pulses and the rising incidence of protein malnutrition among the starving population in emerging nations has made the quality of the seed of groundnuts more important. One important factor affecting the way priming works is the quality of the seed. A healthy seed is a necessary prerequisite for a successful priming outcome (Lutts *et al.* 2016). Hence a study was formulated to standardize various seed priming treatments with chemicals to enhance seed quality in groundnut.

According to the current study's findings on seed quality characteristics, groundnut responded favor-

Table 1. Effect of various seed priming treatments with chemicals on imbibition rate (%) in groundnut.

Treatments (T)	Imbibition rate (%) Seed to solution ratio 1:1				1:2			
	Duration of soaking (D)							
	4 h	6 h	8 h	Mean	4 h	6 h	8 h	Mean
T_0				0				
T_1	50	51	48	**50**	44	46	43	**44**
T_2	63	65	63	**64**	61	62	61	**61**
T_3	61	64	60	**62**	61	62	59	**61**
T_4	50	52	50	**51**	47	47	45	**46**
T_5	59	60	57	**59**	55	57	55	**56**
T_6	54	55	54	**54**	51	51	50	**51**
T_7	50	51	48	**50**	46	46	45	**46**
T_8	58	59	55	**57**	54	54	52	**53**
T_9	53	55	51	**53**	51	52	50	**51**
T_{10}	48	50	46	**48**	43	43	40	**42**
Mean	**50**	**51**	**48**	**50**	**47**	**47**	**45**	**46**
Level of significance	**T**	**D**	**T x D**		**T**	**D**	**T x D**	
SEd	1.010	0.528	1.750		0.950	0.496	1.645	
CD (p= 0.05)	2.017	1.053	3.494		1.896	0.990	3.283	

ably to a 1:1 seed-to-solution ratio for standardization. The crops' ability for intake was shown by the 1:1 ratio, which showed the strongest invigorating impact. The duration of the soaking period is another factor that affects the success of seed priming, with genetic influence on the seed's imbibition capacity being of greater significance. To obtain the most impact of any priming treatment, the soaking time should be kept within a safe range. If this limit is exceeded, permanent damage may result. Regardless of priming treatments, the current study found that soaking groundnut for six hours and then drying them back to their initial moisture content achieved the best physiological seed quality characteristics.

Higher imbibition rate and germination percentage was observed in seed to solution ratio of 1:1 than in seed to solution ratio of 1:2. Seeds soaked for 6 h recorded maximum imbibition rate of 51% and germination of 86% followed by 4 h of imbibition rate 50% and germination percentage of 83%. Irrespective of duration of soaking, higher imbibition rate of 63% and germination of 93% was recorded by seeds primed with calcium chloride @ 1% followed by seeds primed with calcium chloride @ 2% recorded 62% of imbibition rate and 90% of germination, whereas the lower germination percentage of was noticed in non-primed seeds (75%) (Tables 1-2). Seed priming has a beneficial impact on seed germination and subsequent effects, which accounts for the increase in germination percentage. According to Chen *et al.* (2022), they aid in the release of enzymes and quicken the metabolism and physiological processes of seeds. It's interesting to note that the concentration and duration of calcium chloride priming had different effects on germination parameters. The activation of metabolic mechanisms that get seeds ready for radical protrusion and seed germination is aided by calcium seed priming. Enhanced water imbibition by cell wall breaking via calcium chloride priming may facilitate germination. A previous study in rice found that applying calcium chloride to the seeds improved germination (Kata *et al.* 2014). According to Mulaudzi *et al.* (2020), there is a positive correlation between the content of calcium in seeds and germination. This suggests that calcium plays a crucial role in stabilizing membranes and serving as an enzyme co-factor.

Seedling length of groundnut was higher in seed to solution ratio of 1:1 than in seed to solution ratio of 1:2. Seeds soaked for 6 h recorded maximum seedling length of 30.5 cm followed by 4 h recorded 29.8 cm. Irrespective of duration of soaking, higher seedling length of 33.6 cm was recorded by seeds primed

Table 2. Effect of various seed priming treatments with chemicals on germination (%) and seedling length (cm) in groundnut.

Treatments (T)	Germination (%)								Seedling length (cm)							
	Seed to solution ratio															
	1:1				1:2				1:1				1:2			
	Duration of soaking (D)															
	4 h	6 h	8 h	Mean	4 h	6 h	8 h	Mean	4 h	6 h	8 h	Mean	4 h	6 h	8 h	Mean
T_0				75								24.1				
T_1	80	81	79	**80**	78	80	76	**78**	28.4	29.0	27.7	**28.4**	26.3	26.7	25.7	**26.2**
T_2	92	95	91	**93**	87	91	84	**87**	33.3	34.5	33.0	**33.6**	31.5	32.6	31.1	**31.7**
T_3	89	93	88	**90**	86	87	83	**85**	33.1	33.6	32.3	**33.0**	31.2	31.7	30.6	**31.2**
T_4	81	84	81	**82**	79	81	79	**80**	29.7	30.2	28.9	**29.6**	28.0	28.7	27.7	**28.1**
T_5	85	90	83	**86**	81	85	78	**81**	31.2	32.4	30.6	**31.4**	30.4	30.9	29.4	**30.2**
T_6	86	90	83	**86**	83	84	80	**82**	31	31.2	30.2	**30.8**	29.6	30.4	29.3	**29.8**
T_7	82	82	81	**82**	80	81	79	**80**	28.3	29.5	27.8	**28.5**	27.4	27.7	26.3	**27.1**
T_8	83	88	82	**84**	84	84	82	**83**	31.3	31.6	30.2	**31.0**	30	30.6	29.9	**30.2**
T_9	83	85	80	**83**	82	83	80	**82**	29.7	30.8	29.5	**30.0**	29.5	29.8	29.2	**29.5**
T_{10}	79	80	79	**79**	78	78	77	**78**	27.6	28.3	27.2	**27.7**	25.7	26.4	25.5	**25.9**
Mean	**83**	**86**	**82**	**84**	**81**	**83**	**79**	**81**	**29.8**	**30.5**	**29.2**	**29.8**	**28.5**	**29.1**	**28.1**	**29**
Level of significance	**T**	**D**	**T x D**		**T**	**D**	**T x D**		**T**	**D**	**T x D**		**T**	**D**	**T x D**	
SEd	1.623	0.847	2.810		1.571	0.821	2.722		0.579	0.302	1.003		0.554	0.289	0.960	
CD (p= 0.05)	3.240	1.692	5.611		3.138	1.639	5.434		1.156	0.604	2.002		1.106	0.578	1.916	

with calcium chloride @ 1% followed by calcium chloride @ 2% recorded 33.0 cm of seedling length. Whereas the lower seedling length was noticed in non-primed seeds (24.1 cm) (Table 2). The activation of the cotyledon reserve may be the cause of calcium chloride's beneficial effect on seedling growth (Franco *et al.* 1999). In addition to improving cell hydration status, Ca^{2+} cofactors are involved in the actions of several different enzymes that are active during reserve mobilization and radical protrusion (Kaczmarek *et al.* 2017). Calcium chloride promotes root development, which facilitates improved food and water absorption. Priming, which increases the extensibility and metabolic activity of the cell wall. Vajanti *et al.* (2013) also observed that priming had a good influence on root and shoot lengths.

Dry matter production of groundnut was higher in seed to solution ratio of 1:1 than in seed to solution ratio of 1:2. Seeds soaked for 6 h recorded maximum dry matter production 2.95 g $seedlings^{-10}$ followed by 4 h recorded 2.88 $seedlings^{-10}$. Irrespective of duration of soaking, higher dry matter production of 3.50 g $seedlings^{-10}$ was recorded by seeds primed with calcium chloride @ 1% followed by calcium chloride @ 2% recorded 3.41 g $seedlings^{-10}$. Whereas the lower dry matter production was noticed in non-primed seeds (1.55 g $seedlings^{-10}$) (Table 3). This could be the result of a repair mechanism that simultaneously induces quicker germination, allowing seedlings to enter the autotrophic state far in advance and produce more photo assimilate from the source to sink, increasing the production of dry matter. This was consistent with Kumar *et al.* (2019).

Vigor index of groundnut was higher in seed to solution ratio of 1:1 than in seed to solution ratio of 1:2. Seeds soaked for 6 h recorded maximum vigor index of 2627 followed by 4 h recorded vigor index of 2485. Irrespective of duration of soaking, vigor index of 3061 was recorded by seeds primed with calcium chloride @ 1% followed by calcium chloride @ 2% recorded vigor index of 2971. Whereas the lower vigor index of 1808 was noticed in non-primed seeds (Table 3). According to Rao *et al.* (2012), seed priming results in an increase in α-amylase activity, which hydrolyzes large starch molecules into smaller, simpler sugars that are easily absorbed by sprouting seeds, resulting in increased vigor. According to Renganayaki and Ramamoorthy (2015), the activation of growth-promoting chemicals and the transfer of secondary metabolites to the developing seedling may be the cause of the increase in the seedling vigour index. It could be the result of both genetic potential

Table 3. Effect of various seed priming treatments with chemicals on dry matter production (g/10 seedlings) and vigour index in groundnut.

Treatments (T)	Dry matter production (g/10 seedlings)								Vigour index							
	Seed to solution ratio															
	1 : 1				1 ; 2				1 : 1				1 : 2			
	Duration of soaking (D)															
	4h	6h	8h	Mean	4h	6h	8h	Mean	4h	6h	8h	Mean	4h	6h	8h	Mean
T_0				1.55								1808				
T_1	2.65	2.66	2.53	**2.61**	1.90	2.03	1.86	**1.93**	2272	2349	2188	**2270**	2051	2136	1953	**2047**
T_2	3.44	3.66	3.41	**3.50**	2.93	3.09	2.90	**2.97**	3021	3268	2895	**3061**	2741	2967	2612	**2773**
T_3	3.40	3.45	3.38	**3.41**	2.89	3.00	2.86	**2.92**	2946	3125	2842	**2971**	2683	2758	2540	**2660**
T_4	2.96	3.01	2.95	**2.97**	2.45	2.45	2.37	**2.42**	2406	2537	2341	**2428**	2212	2325	2188	**2242**
T_5	3.25	3.28	3.24	**3.26**	2.85	2.88	2.84	**2.86**	2652	2916	2540	**2703**	2462	2627	2293	**2461**
T_6	3.12	3.13	3.07	**3.11**	2.70	2.71	2.59	**2.67**	2666	2808	2507	**2660**	2457	2554	2344	**2451**
T_7	2.80	2.86	2.79	**2.82**	2.01	2.10	1.99	**2.03**	2321	2419	2252	**2330**	2192	2244	2078	**2171**
T_8	3.08	3.14	3.05	**3.09**	2.60	2.79	2.55	**2.65**	2598	2781	2476	**2618**	2520	2570	2452	**2514**
T_9	3.01	3.10	3.00	**3.04**	2.65	2.79	2.63	**2.69**	2465	2618	2360	**2481**	2419	2473	2336	**2409**
T_{10}	2.43	2.60	2.31	**2.45**	1.90	1.93	1.82	**1.88**	2180	2264	2149	**2198**	2005	2059	1964	**2009**
Mean	**2.88**	**2.95**	**2.84**	**2.89**	**2.40**	**2.48**	**2.36**	**2.42**	**2485**	**2627**	**2396**	**2503**	**2323**	**2411**	**2233**	**2322**
Level of significance	**T**	**D**	**T x D**		**T**	**D**	**T x D**		**T**	**D**	**T x D**		**T**	**D**	**T x D**	
SEd	0.057	0.030	0.098		0.048	0.025	0.083		49.065	25.624	84.983		45.355	23.686	78.558	
CD (p= 0.05)	0.113	0.059	0.196		0.095	0.050	0.165		97.963	51.159	169.68		90.556	47.291	156.85	

for strong seedling vigour and quick, uniform germination. Due to a number of factors, including its role in the structure of the cell wall and membrane, calcium has the effect of enhancing growth characteristics. As a result, calcium maintains the balance and stability of membranes by interacting with different types of protein and lipids on their surface (Guimaraes *et al.* 2011).

CONCLUSION

Hence, the study revealed that the seed to solution ratio of 1:1 soaked for 6 hrs recorded the maximum seed quality characters. Irrespective of soaking duration, seeds primed with calcium chloride @ 1% recorded the maximum seed quality attributes followed by 2% calcium chloride.

ACKNOWLEDGMENT

The authors would like to thank Professor and Head, Department of Genetics and Plant Breeding, Annamalai University for their support during the research work.

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