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

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ABSTRACT

India's most significant crop for food and oilseeds is groundnut. A final crop yield requires high-quality seeds with uniform field emergence that happens quickly. One of the key methods for improving the quality of seeds and promoting early crop seedling establishment is seed priming. Treatments for seed priming may aid in healthy crop establishment and prevent yield loss. To improve groundnut seed quality, experiments were conducted to standardize several seed priming treatments using botanicals. Groundnut seeds were soaked for 4, 6, and 8 hours with botanical priming agents viz., custard apple leaf extract, basil leaf extract, and chicory leaf extract 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 hours recorded the maximum seed quality characters. Irrespective of soaking duration, seeds primed with holy basil leaf extract @ 2% recorded the maximum seed quality attributes followed by 1% chicory leaf extract outperformed other treatments by recording higher imbibition rate, germination percentage, longest seedling length, maximum dry matter production, and vigor index of groundnut.

Keywords Standardization, Seed quality, Seed enhancement, Seed priming, Botanicals.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an economically important oilseed crop also called as peanut or monkey nut. It is referred to as the "King of Oilseeds" since it is a significant source of both vegetable protein and edible oil. Groundnuts are an amazing plant-based source of vegetable oil (47–53%) and protein (25–36%) (Jeyaraman 2017). It is also a rich source of dietary fiber, minerals and vitamins such as biotin, copper, niacin, folate, manganese, vitamin E, thiamine, phosphorus and magnesium (Bonku and Yu 2020). The primary use for it is as vegetable cooking oil; it is also utiliSed in the manufacturing of soap, lubricants, cosmetics, olein, and their salts.

Generally, 28.3% of the country's cultivated land is used for groundnut cultivation, which accounts for 31.7% of all oilseed production. The state's groundnut production is restricted to a few areas, and it is insufficient to fulfil the demand for seeds. As a result, farmers typically utilise their own conserved seed because the government or the public sector seldom supplies CS or TLS, or supplies them infrequently.

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In comparison, the quality of seeds preserved by farmers is lower than that of seeds bought from the market. The crop's performance is further impacted by unfavorable weather during the planting and/or crop-growing season because of the usage of inferior seeds. The low productivity of this crop in the state is mostly caused by the combination of all these variables.

Seed viability and seedling vigour are crucial factors for the successful growth of peanut (Prasad *et al.* 2020). Strong rapid development, uniform emergence, quick germination, and sturdy seedlings all indicates a good chance of crop stand establishment and cropping system performance (Damalas *et al.* 2019). Improving stand establishment is a vital prerequisite for high growth and productivity (Sagvand *et al.* 2022). Despite the fact that food production is now self-sufficient, a significant amount of vegetable oil is still imported. Enhancing seed viability through seed treatments is a practical and effective way to improve seedling vigor, which is essential to improving farmers' economic standing (El-Sanatawy *et al.* 2021).

Priming is one method for enhancing the performance of seeds. A controlled hydration method known as "seed priming" involves immersing seeds in water or a solution with a low osmotic potential to the extent that germination-related metabolic processes start in the seeds but radicle emergence does not take place. Without actual germination, priming enables some of the metabolic processes required for germination to occur. A useful technique for achieving high vigor and accelerating and uniform emergence, seed priming improves stand establishment and yield. Rehman *et al.* (2011). Farmers may readily implement this low-cost and straightforward hydration technique to enhance the performance of their seedlings. Numerous studies have demonstrated that seed priming improves seedling performance, crop establishment, and eventually yield in a number of crops, including groundnut. It is a simple, inexpensive, low-risk, and efficient method of increasing plant resistance to harsh conditions (Ashraf and Foolad 2005). The benefits of priming include an increase in germination rate, consistent seedling emergence under a broad range of environments and improved seedling vigor and growth. Some studies have reported positive effects of priming on deteriorated seeds of different species (Jisha *et al.* 2013). Therefore, the study was carried out to standardize various botanicals 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, TNAU, Virudhachallam served as the base material for the study. The experiment was carried out at the Seed Science and Technology Laboratory, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India. It is Located at 11´24'N latitude and 79°44'E longitude, with an altitude of + 5.79 meters above mean sea level. After soaking in a solution containing 0.1% mercuric chloride for three minutes, the groundnut seeds were surface sterilized. They were then completely cleaned with distilled water and allowed to dry. The following botanicals were used to biopriming these surface-sterilized seeds, with three replications.

T_0 - Control (Unprimed seed)
T_1 – Hydropriming
T_2 – Custard Apple Leaf Extract @ 1%
T_3 - Custard Apple Leaf Extract @ 2%
T_4 - Custard Apple Leaf Extract @ 3%
T_5 – Holy Basil Leaf Extract @ 1%
T_6 – Holy Basil Leaf Extract @ 2%
T_7 – Holy Basil Leaf Extract @ 3%
T_8 - Chicory Leaf Extract @ 1%
T_9 - Chicory Leaf Extract @ 2%
T_{10} - Chicory Leaf Extract @ 3%

The three different soaking durations i.e., 4, 6 and 8 hours 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 vigor. The data were analyzed statistically adopting the procedure described by Panse and Sukhatme (1954).

RESULTS AND DISCUSSION

The fundamental component of agriculture is seed, which is an embryo—a living thing encased in its supporting tissue. A high-quality seed will react to additional inputs. Along with agronomic and environmental conditions, the quality of the seed used for sowing has a significant impact on the productivity and quality of the seed produced for any given crop. The quality of the seed determines several factors, including yield and productivity, plant population per unit area, and germination percentage.

The establishment of seed priming as a crucial method to improve seed response against oxidative stress (Ashraf and Foolad 2005). An approach used for increasing production in several crops is seed priming. Water or other chemical or organic substances can be used for this priming, which will improve the quality and germination of the seed. In mechanized agriculture, synchronous germination and a high germination percentage are two desirable characteristics (Basu 1990). Hence a study was formulated to standardize various seed priming treatments with botanicals to enhance seed quality in groundnut.

The imbibition ability of the seed, which is primarily determined by the chemical composition and structure of the seed, may be the cause of the effect of seed to solution ratios in the expression of seed and seedling characteristics (Bewley and Black 1982). According to the current study's findings on seed quality characteristics, groundnut responded favorably to a 1:1 seed-to-solution ratio for standardization.

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 50% and germination of 86% followed by 4 h of imbibition rate 48% and germination percentage of 84%. Irrespective of duration of soaking, higher imbibition rate of 61% and germination of 93% was recorded by seeds primed with holy basil leaf extract @ 2% followed by seeds primed with chicory leaf extract @ 1% recorded 59% of imbibition rate and 91% of germination, whereas the lower germination percentage of was noticed in non-primed seeds (72%) (Table 1) (Fig. 1) Priming influences the lag phase and results in quicker embryo development, more ATP availability, early DNA replication, and enhanced RNA and protein synthesis. Priming permits some of the metabolic processes necessary for germination to take place in the absence of germination (Yari *et al.* 2010). Bioactive substances found in herbal plants, including phytohormones, growth regulators, and phenolic acid, may have been important in controlling the metabolism related to seed germination and seedling establishment. Holy

Table 1. Effect of various seed priming treatments with botanicals 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	53	55	52	53	51	53	48	51
T_2	56	56	55	56	49	53	48	50
T_3	50	53	49	51	45	49	42	45
T_4	48	50	46	48	40	44	40	41
T_5	57	59	57	58	52	53	50	52
T_6	60	63	60	61	55	58	53	55
T_7	45	48	45	46	38	41	37	39
T_8	59	60	57	59	52	56	50	53
T_9	54	55	51	53	46	50	46	47
T_{10}	49	51	46	49	42	46	41	43
Mean	48	50	47	48	43	46	41	43
Level of significance	T	D	T × D		T	D	T × D	
SEd	2.635	1.376	4.564		2.378	1.242	4.119	
CD (p= 0.05)	5.262	2.748	9.113		4.748	2.480	8.225	

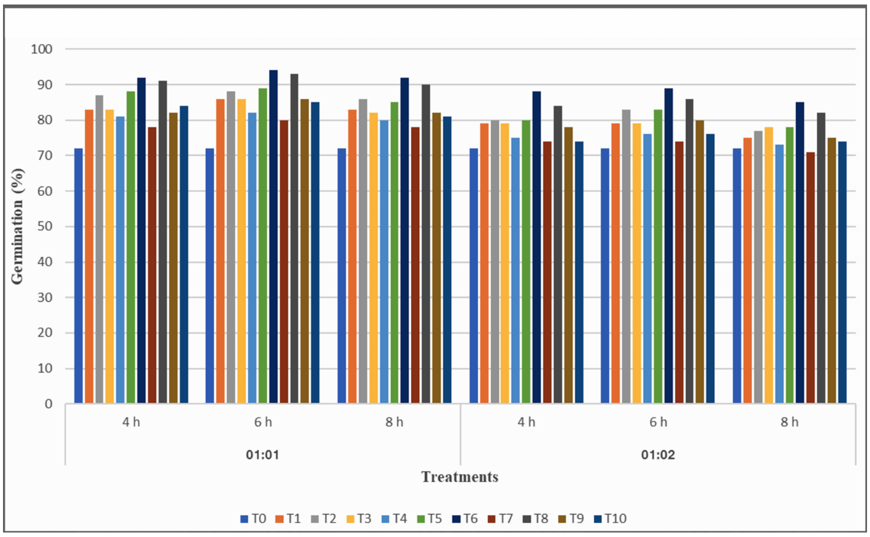

Fig. 1. Effect of various seed printing treatments with botanicals on germination (%) in groundnut.

basil leaves contain a range of compounds, such as saponins, flavonoids, triterpenoids, and tannins, that may have biological action (Pattanayak *et al.* 2010). This substance may be crucial to the physiological functions of the seed or plumule, maybe in relation to germination, maturation, or growth (Ruiz *et al.* 1996).

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 27.8 cm followed by 4 h recorded 27.2 cm. Irrespective of duration of soaking, higher seedling length of 30.7 cm was recorded by seeds primed with holy basil leaf extract @ 2% followed by chicory leaf extract @ 1% recorded 30.1 cm of seedling length. Whereas the lower seedling length was noticed in non-primed seeds (19.0 cm) (Fig. 2). Primed seeds may have longer roots than unprimed seeds due to the flexibility of the embryo's cell wall. Abraha and Yohannes (2013) state that in order to promote plant

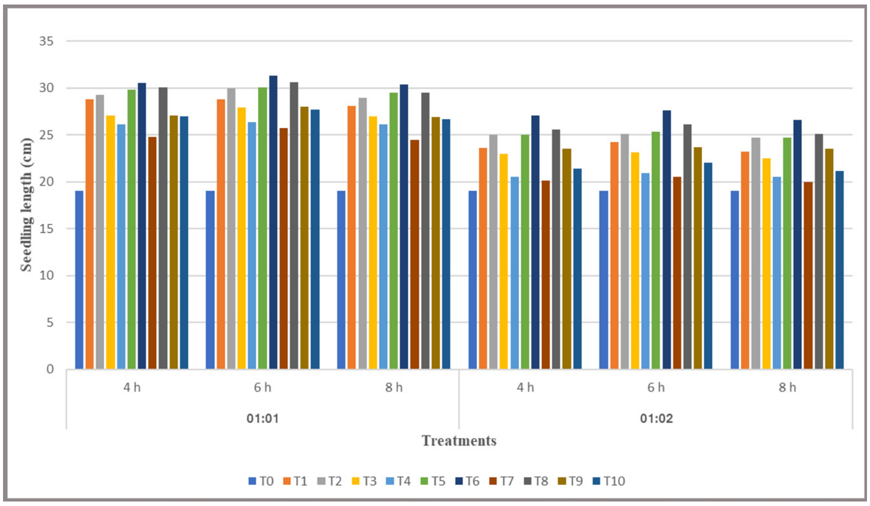

Fig. 2. Effect of various seed priming treatments with botanicals on seedling length (cm) in groundnut.

viability and vigor, seed priming increases the free radical scavenging enzymes peroxidase, catalase, and superoxide dismutase. *Ocimum sanctum* L. is rich in chlorophyll and other phytonutrients, as well as minerals including calcium, zinc, and iron. Calcium is required for cell elongation in both shoots and roots. Calcium ions are involved in regulating the activity of enzymes and proteins that are critical for cell division and elongation. These processes are fundamental for increasing the number of cells and extending their length, ultimately leading to the growth of seedlings (White and Broadley 2003). Zinc has a significant impact on the activities of carbonic anhydrase and hydrogenase, stabilizes ribosomal fractions, and influences cytochrome production in plants (Hafeez *et al.* 2013).

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 2.73 g $seedlings^{-10}$ followed by 4 h recorded 2.67 $seedlings^{-10}$. Irrespective of duration of soaking, higher dry matter production of 3.07 g $seedlings^{-10}$ was recorded by seeds primed with holy basil leaf extract @ 2% which was on par with chicory leaf extract @ 1% recorded 3.03 g $seedlings^{-10}$. Whereas the lower dry matter production was noticed in non-primed seeds (1.74 g $seedlings^{-10}$) (Table 2). The increased germination rate of the priming treatments was positively correlated with the standard root volume of the seedlings along with the fresh and dry weights of both roots and shoots. The quicker growth and development of seedlings and the rise in vigor index may be the cause of the dry weight increase following botanical seed priming treatment.

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 2394 followed by 4 h recorded vigor index of 2297. Irrespective of duration of soaking, vigor index of 2848 was recorded by seeds primed with holy basil leaf extract @ 2% followed by chicory leaf extract @ 1% recorded vigor index of 2747. Whereas the lower vigor index of 1368 was noticed in non-primed seeds (Table 2). Early emergence promoted seedling vigor leading to better plant development, which might explain improved seedling growth in early or optimal planting for root, shoot lengths, and seedling fresh and dry weights. The presence of micronutrients, growth-regulating substances, antioxidants, and secondary metabolites in herbal powders may also

Table 2. Effect of various seed priming treatments with botanicals on dry matter production (g/10 seedlings) and vigour index in groundnut.

Treatments (T)	Dry matter production (g/10 seedlings)								Vigor index							
	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				1.74								1368				
T_1	2.77	2.85	2.77	2.80	2.6	2.61	2.49	2.57	2390	2477	2332	2400	1864	1912	1740	1839
T_2	2.85	2.89	2.82	2.85	2.64	2.67	2.62	2.64	2549	2640	2494	2561	2000	2083	1902	1995
T_3	2.62	2.7	2.6	2.64	2.22	2.25	2.19	2.22	2249	2399	2214	2288	1817	1825	1755	1799
T_4	2.55	2.61	2.49	2.55	1.9	1.94	1.82	1.89	2114	2165	2088	2122	1538	1588	1497	1541
T_5	2.91	3.03	2.83	2.92	2.65	2.72	2.6	2.66	2622	2679	2508	2603	2000	2100	1927	2009
T_6	3.05	3.15	3.01	3.07	2.75	2.77	2.7	2.74	2806	2942	2797	2848	2385	2456	2261	2367
T_7	2.51	2.61	2.49	2.54	1.74	1.74	1.68	1.72	1934	2056	1911	1967	1487	1517	1420	1475
T_8	3.03	3.11	2.96	3.03	2.69	2.73	2.68	2.70	2739	2846	2655	2747	2150	2245	2058	2151
T_9	2.7	2.74	2.63	2.69	2.36	2.43	2.35	2.38	2222	2408	2206	2279	1833	1896	1763	1831
T_{10}	2.61	2.63	2.54	2.59	2.01	2.18	2	2.06	2268	2355	2163	2262	1584	1672	1569	1608
Mean	2.67	2.73	2.63	2.68	2.30	2.34	2.26	2.30	2297	2394	2249	2313	1821	1878	1751	1817
Level of significance	T	D	T x D		T	D	T x D		T	D	T x D		T	D	T x D	
SEd	0.134	0.070	0.233		0.121	0.063	0.210		131.05	68.44	226.98		96.04	50.15	166.33	
CD (p=0.05)	0.269	0.140	0.465		0.242	0.126	0.419		261.65	136.64	453.19		191.74	100.13	332.11	

contribute to their beneficial effects. It was found that this enhancing approach encouraged enzymatic activity, which set off the seeds for early emergence and improved expression of seedling vigor. Similar results were reported by Arunkumar and Sathiya Narayanan (2022) and Anbarasan and Srimathi (2015).

CONCLUSION

Hence, the study revealed that the seed to solution ratio of 1:1 soaked for 6 hours recorded the maximum seed quality characters. Irrespective of soaking duration, seeds primed with holy basil leaf extract @ 2% recorded the maximum seed quality attributes followed by 1% chicory leaf extract. For future directions, to find possible substitutes or enhancements for holy basil and chicory leaf extracts, look into the impact of other herbal and medical plant extracts on seed quality.

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