PERFORMANCE OF SEED PRIMING USING SEAWEED EXTRACTS ON SEED GERMINATION INDICES IN BHENDI

S. Srimathi[1]* and A. Kamaraj[2]

Abstract

Background: Seaweed extracts are rich in various active compounds, including polysaccharides, polyphenols, and phytohormones which helps in nutrient uptake and enhance the growth of crops, both in challenging and normal favourable conditions. In this study, seaweed extracts of *Kappaphycus alvarezii* and *Sargassam wightii* have been explored for their ability to improve seed germination of Bhendi.

Method: Bhendi seeds were primed with two seaweed extracts viz., *Kappaphycus alvarezii* and *Sargassam wightii* at three soaking durations viz., 8, 16, and 24 hours with five different concentrations viz., 0.5, 1.0, 1.5, 2.0 and 2.5%. The experiment was designed as factorial completely randomized design with 4 replications. Observations were recorded on various germination related traits. The mean data were collected and analysed for individual factor effect and their interactions.

Results: The present study revealed that the bhendi seeds primed with *Sargassam wightii* at 2.5% for 24 hours has the highest germination ability and showed superior performance than other treatments for all the seed germination traits *viz.,* first count (36%), days to 50% emergence (4.97 days), days to maximum emergence (9.31 days), speed of germination (4.42), co-efficient of variation of germination time (33.38), germination index (4.58 days), mean daily germination (8.56), peak value of germination (10.29) and germination value (88.06).

Conclusion: Among all the treatments, bhendi seeds soaked in *Sargassam wightii* at 2.5% for 24 hours had positively and significantly influenced all the seed germination traits when compared to all the other treatments.

Keywords: Seaweed extracts, co-efficient of variation of germination time, germination index, mean daily germination, peak value of germination, germination value.

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Introduction

The pivotal phases in the plant life cycle are germination and seedling emergence, which significantly impact crop production. The main challenges affecting the cultivation of crops are inadequate seedling emergence and uneven stand establishment. Indeed, it is widely acknowledged that priming offers significant benefits to the germination process, including shortened seedling emergence time and improved stand establishment. Priming, which involves the physiological enhancement of the seed lot, serves as an effective method to enhance both the rate and uniformity of germination. The primary objective of seed priming is to partially hydrate the seed to a level where germination processes can commence and dehydrate before radicle emergence (Singh *et al.*, 2015).

Seed priming is a beneficial technique that involves controlled hydration of seeds to improve germination, seedling vigour, and overall plant performance (Barupal *et al.*, 2022). Several chemicals are commonly used in seed priming to achieve better results. Polyethylene glycol (PEG) is a widely used osmo-protectant that improves seed hydration and germination under water stress conditions (Lamichhane *et al.*, 2021). Potassium nitrate (KNO_3) is employed to stimulate enzyme activity during germination and enhance the rate of seed imbibition and metabolism. Gibberellic acid (GA_3) serves as a plant growth regulator, promoting seed germination and breaking dormancy in certain seeds (Sheferie *et al.*, 2023). Salicylic acid is used to improve seed tolerance to abiotic stresses and enhance germination rates (Rhaman *et al.*, 2021).

In today's global context, addressing the needs of a growing world population necessitates the use of chemicals and synthetic fertilizers to enhance agricultural output. However, the utilization of these harmful substances presents a significant risk to human health, animals, plants, and the entire ecosystem (Shukla *et al.*, 2019).

To minimize the agricultural chemical footprint, seaweed extracts of *Kappaphycus alvarezii* and *Sargassam wightii* have been explored for their ability to improve seed germination of bhendi.

Okra is a tropical crop belonging to the Malvaceae family, known for its robust nature, dietary fibres, and balanced seed protein containing lysine and tryptophan amino acids (Barupal *et al.*, 2022). Seaweed extracts have demonstrated their ability to boost nutrient uptake and enhance the growth of crops, both in challenging and normal environmental conditions. These extracts are rich in various active compounds, including polysaccharides, polyphenols, and phytohormones. While some of these compounds have been found to promote plant growth, the precise molecular mechanisms through which seaweed extracts exert their effects are not yet fully understood and require further investigation (Deolu-Ajayi *et al.*, 2022). With the above facts, the present study was carried out to assess the performance of seed priming using seaweed extracts on seed germination indices in bhendi.

Materials and Methods

Experimental location and design

The present experiment was carried out with seeds of bhendi cv. Arka Anamika at Seed Science and Technology, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University during the year 2021-22. The seaweeds *Kappaphycus alvarezii* and *Sargassam wightii* were collected from coastal regions of Tuticorin district of Tamil Nadu and the extract was prepared by following the method demonstrated by Erulan *et al.*, 2009. In this study, three factors were considered namely two different seaweed species, three seed soaking durations and five various concentrations of the extract (Table 1). The effect of each individual factor, as well as their interactions were carefully observed and analyzed. To conduct the experiment, a Factorial completely randomized design was employed with four replications for each treatment combination. The treated bhendi seeds and unprimed seeds were evaluated for their seed germination parameters (i.e) First count (%) (Anonymous, 2008), days to 50% germination (days) **(**Coolbear *et al.*,1984), co-efficient of velocity of germination (Jones and Sanders, 1987), germination index (days) (AOSA and SCST 1993), mean daily germination percentage and peak value of germination (Adams and Farrish, 1992) and germination value (Czabator, 1962).

Statistical analysis

Mean data were tested for significance by ANOVA (Panse and Sukhatme, 1985) and their means were compared by least significant difference LSD at 95% confidential level. For statistical analysis, R studio was used.

Result and discussion

The F-value for the seed germination characters has shown significance for all the characters at $p<0.005$ were given in table 2.

Influence of Sargassum seaweed extract

Among all the treatments, bhendi seed soaked in seaweed extract *Sargassam wightii* for 24 hours at 2.5% concentration had positively and

significantly influenced all the characters when compared to all the other treatments (Table2., Fig,1 and Fig 2). From the current study, seaweed extract has shown promising results as a seed priming agent for enhancing the performance of bhendi seeds during germination and germination related traits. The speed of germination is widely regarded as a reliable indicator to assess seed vigour. In case of bhendi seeds primed with *Sargassum wightii* extract @ 2.5% concentration for a 24-hour duration exhibited superior performance in terms of the first count (36%), days to 50% emergence (4.97 days), days to maximum emergence (9.31 days), speed of germination (4.42), co-efficient of variation of germination time (33.38), germination index (4.58 days) mean daily germination (8.56), peak value of germination (10.29) and germination value (88.06) when compared to all other treatments, which was recorded in our present study.

The findings also suggested that, the application of seaweed extracts during seed priming, contains valuable nutrients, may have enhanced the accessibility of seed reserves and preserved cellular integrity, resulting in heightened germination which was confirmed by the reports of Thinh (2021) in blackgram and Guragain *et al.* (2023) in radish. This study concluded that the pre-sowing soaking of seeds with seaweed extracts facilitated sufficient water absorption and optimal nutrient uptake, leading to prompt initiation of the germination process and improved physiological parameters.

The process of priming involves subjecting seeds to controlled hydration and dehydration cycles, which can trigger membrane restructuring and repair mechanisms. This leads to improved membrane integrity and reduced solute leakage during imbibition. By minimizing solute leakage, primed seeds can better retain essential nutrients and protect their cellular structure, ultimately resulting in enhanced germination performance. The reorganization of membranes and the subsequent decrease in solute leakage through priming treatments contribute to improved seed quality and germination success. The improvement in seed germination observed in primed seeds can be attributed to a reduction in solute leakage through membrane reorganization. When seeds imbibe water, high solute leakage indicates damage or leakage in the cell membranes (Espanany *et al.*, 2016).

The presence of biological chemicals and nutrients in seaweed extract, which are involved in the priming process, could have potentially stimulated early germination in the primed seeds. This observation aligns with the findings of Takoliya *et al.* (2018) in green leafy vegetables seeds using *Sargassum wightii* and *Sargassum johnstonii* seaweed extract.

Influence of Kappaphycus seaweed extract

In the present study, the performance of *Kappaphycus alvarezii* extract was found to be superior to the control group, but not as impressive as the performance exhibited by *Sargassum* extract (Table2., Fig 1 and Fig 2). However, it is essential to further discuss and analyze the specific outcomes and effects of *Kappaphycus* extract to gain a deeper understanding of its potential benefits and limitations. In the case, bhendi seeds primed with *Kappaphycus alvarezii* extract @ 2.0% for a 24-hour duration showed the best results for all seed germination parameters like first count (32%), days to 50% emergence (5.35 days), days to maximum emergence (9.32 days), speed of germination (4.36), co-efficient of variation of germination time (33.40), germination index (4.52 days), mean daily germination (8.41), peak value of germination (10.00) and germination value (84.13) when compared to control.

Kappaphycus seaweed extract has demonstrated the potential to enhance seed priming in bhendi by improving several seed traits. The bioactive compounds present in *Kappaphycus* extract may play a crucial role in stimulating physiological processes and providing essential nutrients, ultimately contributing to improved seed priming outcomes in bhendi. Similar kind of results was found by various investigators in different crops Rathore *et al.* (2009) in soybean and Spinelli *et al.* (2010) in strawberry. This might be due to seaweed extract exhibited remarkable potential in enhancing seed germination, which can be attributed to various bioactive compounds present in their extracts. Moreover, seaweed extracts contain essential nutrients like carbohydrates, phenyl acetic acid, macro- and microelements, vitamins, cytokinins, and gibberellins, all of which play crucial roles in seed metabolism and growth. These compounds contribute to overall seed vigour and stimulate key physiological processes that enhance germination and seedling development.

Additionally, seaweed extracts may contain leakage inhibitors, such as abscisic acid, which helps in preventing water loss and maintaining seed dormancy under unfavourable conditions. By regulating seed hydration levels, abscisic acid can positively impact the germination process once the seeds are exposed to suitable conditions (Speer and Tupper, 1975). The presence of above-mentioned mineral nutrients and plant growth regulators in the extract of *K. alvarezii* might have positively influenced the mean germination time, vigour

index and seedling weight. Similar results were observed by previous researchers reported by Dutta *et al.* (2019) in chilli, Patel *et al.* (2018) in cabbage and onion.

Conclusion

Bhendi seeds soaked in *Sargassam wightii* at 2.5% for 24 hours had highest positively and significantly influenced all the seed germination traits than all the treatments and followed by *Kappaphycus alvarezii* at 2.0% for 24 hours showed the best results when compared to control. The difference in effect of seaweed extract seems to be species related as the multitude and composition of ingredients are different. The positive effects of seaweed extracts of *Sargassum wightii and Kappaphycus alvarezii* emphasize its potential as an environmentally friendly alternative to synthetic antioxidants for seed priming in seed industry.

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Table 1. Treatment details for the present experiment

Seaweed extracts		**Soaking hours**		**Soaking concentrations**	
A1	*Sargassum wightii*	**B1**	8 hrs	**C1**	0.50%
A2	*Kappaphyccus alvarezii*	**B2**	16 hrs	**C2**	1.00%
		B3	24 hrs	**C3**	1.50%
				C4	2.00%
				C5	2.50%

Table 2. Performance of seed priming using seaweed extracts on seed germination indices in Bhendi.

Treatments	**FC (%)**	**DFE (Days)**	**DME (Days)**	**SG**	**CVGT**	**GI (Days)**	**MDG**
Seaweed extracts							
A1	9	7.51	11.76	2.90	43.25	3.10	7.74
A2	9	6.91	11.76	2.88	55.31	2.29	7.62
F-value	**115.95***	**4.11***	**-0.01***	**5.06***	**4072.61***	**5071.49***	**14.41***
LSD 5%	**0.148**	**0.07**	**0.12**	**0.02**	**0.37**	**0.02**	**0.06**
Soaking hours							
B1	0	8.5	12.69	2.36	59.15	2.15	7.45
B2	7	7.62	11.91	2.76	46.93	2.65	7.66
B3	20	6.31	10.69	3.55	41.76	3.28	7.93
F-value	**23743.01***	**1185.28***	**403.39***	**3580.31***	**2977.62***	**3340.05***	**86.84***
LSD 5%	**0.181**	**0.09**	**0.14**	**0.03**	**0.46**	**0.03**	**0.07**
Soaking concentrations							
C1	1	8.52	12.68	2.43	58.51	2.21	7.49
C2	8	7.73	12.26	2.74	50.38	2.54	7.61
C3	11	7.13	11.39	3.05	47.32	2.69	7.70
C4	13	6.8	11.17	3.13	44.22	3.07	7.80
C5	11	7.21	11.33	3.11	45.98	2.97	7.80
F-value	**3046.78***	**264.67***	**105.55***	**535.39***	**708.71***	**743.03***	**16.13***
LSD 5%	**0.233**	**0.13**	**0.18**	**0.04**	**0.59**	**0.04**	**0.09**
Interactions							
T0-Control	0	10.60	15.43	2.18	83.39	1.67	6.80
T1-A1B1C1	0	8.61	13.31	2.31	74.88	1.82	7.40
T2-A1B1C2	0	9.20	13.33	2.26	51.34	2.37	7.49
T3-A1B1C3	0	8.62	12.31	2.39	50.57	2.38	7.50
T4-A1B1C4	0	8.12	12.29	2.47	47.10	2.60	7.54
T5-A1B1C5	0	8.12	12.24	2.56	43.80	2.77	7.60
T6-A1B2C1	0	9.22	12.30	2.42	46.67	2.76	7.56

T7-A1B2C2	8	7.75	12.23	2.69	38.97	2.94	7.68
T8-A1B2C3	8	7.76	12.21	2.78	37.64	3.11	7.72
T9-A1B2C4	12	6.73	11.39	2.94	37.56	3.13	7.77
T10-A1B2C5	8	7.27	11.40	3.03	36.71	3.76	7.85
T11-A1B3C1	0	7.78	12.42	2.50	39.67	2.81	7.63
T12-A1B3C2	12	7.25	11.24	3.23	37.39	3.70	7.80
T13-A1B3C3	24	6.10	10.15	3.80	36.60	3.80	7.96
T14-A1B3C4	20	5.22	10.35	3.76	36.48	3.91	7.97
T15-A1B3C5	36	4.97	9.31	4.42	33.38	4.58	8.56
T16-A2B1C1	0	9.23	13.31	2.18	77.79	1.67	7.30
T17-A2B1C2	0	8.21	13.33	2.24	69.08	1.82	7.38
T18-A2B1C3	0	8.11	12.31	2.45	59.01	2.05	7.44
T19-A2B1C4	0	8.12	12.29	2.33	59.18	1.95	7.40
T20-A2B1C5	0	8.65	12.24	2.40	58.78	2.07	7.45
T21-A2B2C1	0	8.15	12.30	2.51	58.19	2.07	7.49
T22-A2B2C2	12	7.24	12.23	2.84	53.65	2.14	7.60
T23-A2B2C3	12	6.74	11.19	2.96	52.64	2.24	7.70
T24-A2B2C4	12	7.24	11.39	2.90	51.61	2.28	7.70
T25-A2B2C5	0	8.11	12.43	2.55	55.70	2.11	7.52
T26-A2B3C1	8	8.12	12.42	2.63	53.83	2.12	7.57
T27-A2B3C2	16	6.74	11.24	3.20	51.83	2.25	7.69
T28-A2B3C3	24	5.45	10.15	3.91	47.47	2.57	7.85
T29-A2B3C4	32	5.35	9.32	4.36	33.40	4.52	8.41
T30-A2B3C5	24	6.15	10.34	3.70	47.53	2.52	7.84
F-value	**325.91***	**12.36***	**5.25***	**31.68***	**52.65***	**160.58***	**3.59***
LSD 5%	**0.572**	**0.28**	**0.44**	**0.09**	**1.45**	**0.08**	**0.23**

*- $p<0.005$, FC-first count, DFE-days to 50%emergence, DME-days to maximum emergence, SG-Speed of germination, CVGT-Coefficient variation of germination time, GI-germination index, MDG-mean daily germination percent

Fig. 1. Performance of seed priming using seaweed extracts on seed germination indices in Bhendi.

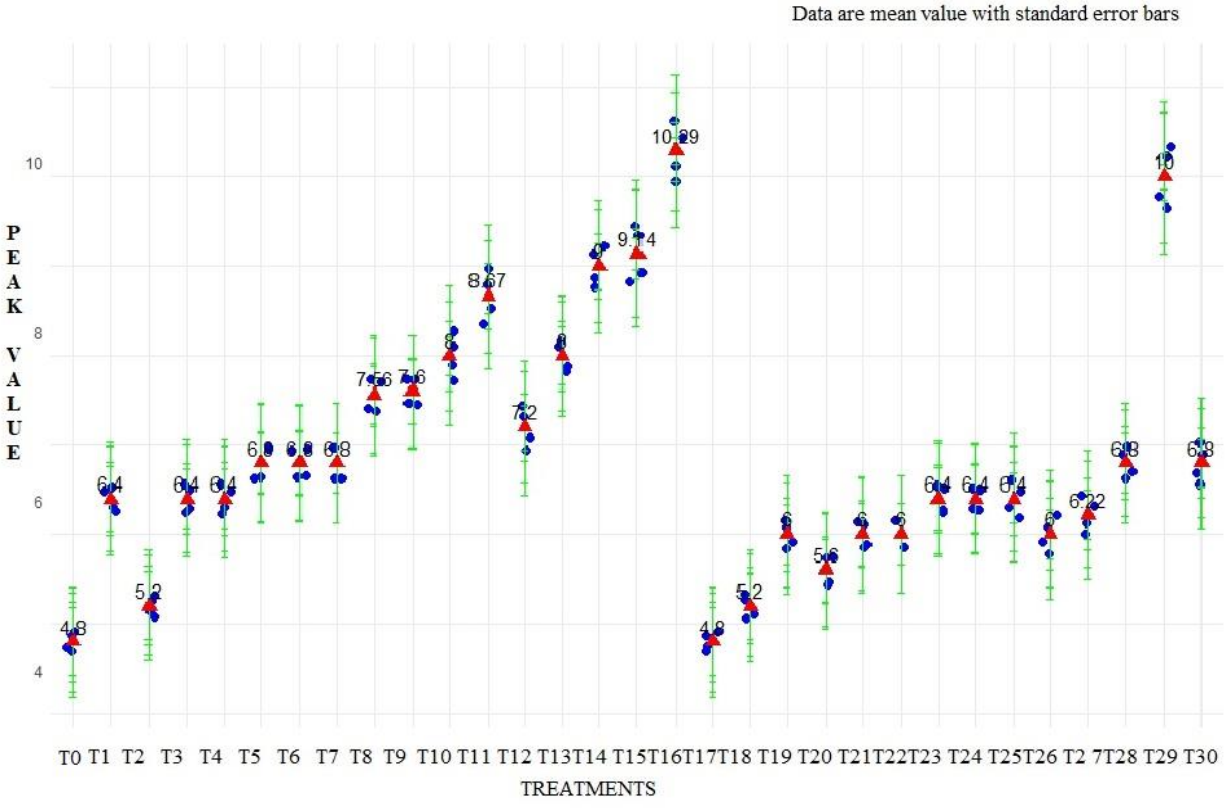

Fig 2: Performance of seed priming using seaweed extracts on seed germination indices in Bhendi.