STANDARDIZATION OF PRE-SOWING SEED PRIMING ENHANCEMENT TECHNIQUE USING SEAWEED EXTRACT IN BHENDI CV. ARKA ANAMIKA (*ABELMOSCHUS ESCULENTUS*)

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Abstract

Seed priming is an efficient, environmentally friendly way to enhance seed germination and seedling vigour. An experiment was carried to standardize seed priming technique on seed quality parameters in bhendi using seaweed extract at Seed technology lab, Faculty of Agriculture and Annamalai University, Chidambaram, Tamil Nadu. The present experiment was designed as factorial completely randomized design with 4 replications. The mean data were collected and analysed for individual factor effect and their interactions. The result indicated that among the two different seaweed extracts, *Sargassam wightii* was significantly performed well at 2.5% concentration when the bhendi cv. Arka Anamika seeds were soaked at 24 hours for all the seed quality parameters *viz*., germination percentage (86%), shoot length (21.69 cm), root length (15.39 cm), seedling fresh weight (5.32 g plant^{-1}), dry matter production (0.357 g plant^{-1}), seedling vigour index I (3174), and seedling vigour index II (31). From the present study, the result revealed that bhendi seed primed with seaweed extract could be a better alternative over chemical priming.

Keywords: Bhendi, seaweed extract, seed priming, germination percentage, seedling vigour

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Introduction

Bhendi commonly known as lady's finger or okra and scientifically known as *Abelmoschus esculentus*, is a flowering plant belonging to the Malvaceae family. Bhendi crop is a warm-season vegetable widely cultivated in tropical and subtropical regions for its edible green pods. Bhendi crop is primarily grown in India's various agro-ecological zones for its immature fruits, which are consumed as cooked vegetables (Nagegowda *et al.*, 2020). Bhendi crop originated in South-East Asia and now widely cultivated in tropical and subtropical regions, but is particularly popular in India, West Africa and Brazil.

India is the largest producer of bhendi globally, with a contribution of more than 72% and cultivated in an area of 0.52 million hectares with a production of 6.41 million MT in 2021-2022. In Tamil Nadu bhendi was cultivated in an area of 23,330 hectares with a production of 2,08,250 MT in 2021-2022 (MoAF, 2022). Bhendi plants are generally propagated through seeds. Majority of farmers collect seeds from a heterogeneous landrace or from their own native cultivar. Leaving the pods until seed is needed and is the cheapest method for conserving bhendi seeds. One of the crucial stage in the life cycle of crop plants is seed germination. Bhendi seeds are viable, although they germinate irregularly and slowly. A significant issue in the cultivation of okra is reduced, delayed, and unpredictable emergence, which is brought on by seed hardness, that hinders germination (Lamichhane *et al.*, 2021). The hard seed coat restricts the water imbibition and uniform growth and development of the embryo and as a result interferes with seed germination (Mereddy, 2015). The problem of low germination due to the hard seed coat in okra can be overcome by seed priming. Seed priming is the process of controlled hydration of seeds which is potentially able to promote rapid and more uniform seed germination and plant growth (Sharma *et al.*, 2014).

Seaweed extract contains plant essential macro- and micronutrients, several plant growth regulators such as IAA, gibberellin, cytokinin, choline chloride and glycine betaine that are responsible for many physiological responses in plants which favourably affect yield and quality of several crops (Layek *et al.*, 2018). The advantages of using seaweeds in agriculture are vast and varied, including the promotion of seed germination and the improvement of plant health and growth (Nabti *et al.*, 2017). Despite the extensive studies on the okra seed priming, less information is currently available on the utilization of seaweeds *viz*., *Kappaphycus alvarezii* and *Sargassam wightii* for seed priming the bhendi seeds. With this objective, the present study was carried out to standardize the seed priming of okra seeds using two seaweed extract for enhancing the seed quality.

Materials and Methods

Experiment location and seed material

The present experiment entitled "Standardization of pre-sowing seed priming enhancement technique using seaweed extract in Bhendi cv. Arka Anamika" was conducted at Seed Science and Technology laboratory, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University during the year 2021-22. Seeds utilized for the present study was cultivar Arka Anamika obtained from Indian Institute of Horticulture Research, Bengaluru which is Resistant to yellow vein mosaic virus (YVMV) with 130-135 days duration.

Seaweed liquid fertilizer

The sea weeds *Kappaphycus alvarezii* and *Sargassam wightii* were collected from coastal regions of Tuticorin district of Tamil Nadu. The seaweed was washed with tap water to remove salts and it was finally washed with distilled water. Then seaweed was shade dried followed by oven drying at 60°C for 5 hours. The dried sample was grounded with blender to get fine powder and was stored for future use. In the present study, seaweed extract was prepared by boiling method (Erulan *et al.*, 2009). Seaweed powder of 10 g was mixed with 100 ml of distilled water and it was heated for 1 hour at 100ºC. Then the contents were filtered through the filter paper. The collected filtrate was stored in refrigerator (0-20ºC) and thus obtained filtrate had 100% concentration.

Treatment details and experiment details

The present study had three factors *viz*., two seaweed species, three different seed soaking hours and five various concentration of extract (Table 1). Individual factor effect was observed and analysed along with their interactions. The experiment was organized in a Factorial completely randomized design with 4 replications. The above treated seeds were evaluated for their seed quality parameters (i.e) germination percentage (ISTA, 2013), shoot length (ISTA, 2013), root length (ISTA, 2013), seedling fresh weight (Gupta *et al*., 1993), dry matter production (Sankar and Mani, 2015), electrical conductivity (Presley, 1958), seedling vigour index I and seedling vigour index II (Abdul-Baki and Anderson, 1973).

Statistical analysis

Among the treatments, the individual factor effect and their interactions were tested for significance using analysis of variance (ANOVA) (Panse ahd Sukhatme, 1985) and the means were compared by Duncan multiple range test. Pearson's correlation coefficient was used to correlate the parameters. For statistical analysis SAS statistical software package version 9.4 was used.

Result and discussion

Influence of seaweed species

The ANOVA results (table 2.) of the seed quality parameters have showed significance. The results of seed quality parameters as influenced by individual factors and their interactions are shown as follows, germination percentage (table 3.), shoot length (table 3.), root length (fig.1), seedling fresh weight (fig.1), dry matter production (fig.2), EC (fig.3), seedling vigour index I (fig.4) and seedling vigour index II (fig.5). from the result, it was observed that among the two sea weeds compared, *Sargassam wighti* showed significant dominance over *Kappaphycus alvarezii* for all the seed quality parameters. This might be attributed by the nature of the seaweed species. Khan *et al.* (2022) in his experiment on bhendi concluded that Sargassum aqueous extract (SAE) was rich in growth-promoting metabolites, antioxidant, and hormones which has enhanced the seed quality characters by influencing germination and accumulation of dry matter (Rexliene and Sridhar, 2018).

Influence of soaking hours

Comparing the three different hours of soaking the seeds in the extract 24 hours of soaking showed significantly high results for all the above mentioned seed quality parameters. The reason might be due to that, 24 hours had more and enough time for imbibition which paved the way for softening the seed coat that has influenced the germination and seed quality characters. The similar results were reported earlier by Ali *et al.* (2016) for okra seed priming at various soaking hours. The similar results were earlier reported by Sharma *et al.* (2014) found that 24 hours of soaking significantly increased the seed germination, seedling vigour and mean germination time. Additionally, Benaseer (2016) in blackgram and suggested that the process of pre-sowing soaking may have played a significant role in facilitating the absorption of an adequate amount of water by the seeds. This soaking method might have also contributed to the provision of a suitable concentration of nutrients, thus enabling a prompt initiation of the germination process.

Influence of seaweed extract concentrations

While comparing various concentrations of extracts 2% and 2.5% of the extract stood significantly higher than other concentration levels for the seed quality parameters. The higher level of seaweed extract concentration has influenced the seed quality traits. As far as interaction were concerned electrical conductivity showed no significant difference among the treatment, rest of the characters showed significance and their results are as follows. Interaction between sea weed extract and soaking hours *i.e.,* (AxB) showed non significance for all the parameters. In the interaction between the seaweed extract and the extract concentration, the *Sargassam wighti* and 2.5% of extract concentration (A1C5) was observed for significantly higher performance in all the above mentioned parameters when compared with other treatments. This might be due to the reason of sea weeds effect and the higher concentration might contributed for the better performance. The similar results were observed earlier by (Khan *et al.*, 2022).

Influence of interactions

In the interaction between the soaking hours and concentration, 24 hours of soaking hours in 2.5% of extract concentration (B3C5) was observed for significantly higher performance for all the characters when compared with other treatments. This might be due the reason that optimum soaking hours and concentration routed for better performance, similar results were reported earlier by Murungu (2011). Among the interaction between the sea weed species, soaking hours and soaking concentration *Sargassam wighti* extract soaking in 2.5% of concentration for 24 hours performed better than other interaction combinations for all the seed parameters. The findings suggest that by treating seeds with extracts from seaweed, which contain beneficial nutrients, the availability of stored food reserves in the seeds may have been enhanced. Additionally, the treatment may have helped to preserve the structural integrity of the cells, resulting in heightened seed vigor and improved germination.

Sasikala *et al.* (2016) reported that *Sargassam* sp. seaweed extract performed well on seed germination of tomato. Thinh and Sundareswaran, (2019) in black gram concluded that the presence of antioxidants, growth regulators, vitamins, as well as macro and micronutrients in seaweed extracts potentially played a role in facilitating a repair mechanism within the cells. This mechanism could have aided in maintaining the cellular

integrity and function. As a result, the primed seeds exhibited increased dehydrogenase activity, which is an important indicator of metabolic activity and cellular health. As a result of these beneficial effects, various physiological parameters related to seed germination and growth may have been improved. Regarding the Pearson's correlation coefficient, the data showed a various degree of correlation between them (table 4.). Among the parameters a total of 28 significant relationship were found and 21 of them were positively correlated and 7 of them were negatively correlated.

Conclusion

Hence, the present study revealed that the bhendi seeds primed with *Sargassam wighti* at 2.5% for 24 hours has the highest ability to germinate early and faster than other treatments for all the seed quality characters *viz.,* germination percentage, shoot length, root length, seedling fresh weight, dry matter production, electrical conductivity, seedling vigour index I and seedling vigour index II.

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. Summary of analysis of variance (ANOVA table) for germination percentage (GP), shoot length (SHL), root length (RL), seedling fresh weight (SFW), dry matter content (DMP), electrical conductivity (EC), seedling vigour index – I & seedling vigour index II (SV-I & SV- II) and their interactions.

	F value							
Source	**GP**	**SHL**	**RL**	**SFW**	**DMP**	**EC**	**SV - I**	**SV – II**
Accesssion (A)	8.83*	19.60*	66.83*	6.32*	230.55*	66.95*	62.28*	684.84*
Soaking hour (B)	52.3*	51.73*	69.41*	52.30*	30.48*	17.85*	158.29*	251.94*
Concentration (C)	9.82*	11.84*	20.55*	9.82*	6.18*	3.59*	36.65*	50.51*
A x B	0.00^{NS}	0.0^{NS}	0.37^{NS}	0.00^{NS}	0.14^{NS}	0.03^{NS}	0.22^{NS}	1.16^{NS}
A x C	4.12*	9.80*	10.31*	4.12*	4.08*	2.35*	22.83*	29.61*
B x C	2.63*	5.91*	6.05*	2.63*	2.52*	1.48*	12.95*	18.37*
A x B x C	2.09*	7.29*	7.47*	2.09*	2.51*	1.47*	15.46*	17.19*

*, indicates significance $p<0.005$
^{NS}, indicates non significance $p>0.005$

Table 3. Influence of sea weed extracts, soaking hours, concentrations and their interactions on germination percentage and shoot length of bhendi seeds cv. Arka Anamika

	Germination %						**Shoot length (cm)**					
	Sargassam wighti			***Kappaphycus alvarezii***			***Sargassam wighti***			***Kappaphycus alvarezii***		
	8 hrs	**16 hrs**	**24 hrs**	**8 hrs**	**16 hrs**	**24 hrs**	**8 hrs**	**16 hrs**	**24 hrs**	**8 hrs**	**16 hrs**	**24 hrs**
0.50 %	74±1.6^{gh}	76±2.1^{fgh}	76±1.9^{fgh}	73±1.5^{h}	75±1.8^{fgh}	76±2.3^{fgh}	16.58±0.6^{def}	16.99±0.8^{def}	17.16±0.5^{def}	16.04±0.6^{f}	16.52±0.7^{def}	16.71±0.5^{def}
1.00 %	75±1.7^{fgh}	77±1.6^{efg}	78±1.6^{cde}	74±1.7^{gh}	76±2.1^{fgh}	77±1.6^{efg}	16.80±0.6^{def}	17.28±0.9^{def}	17.60±0.7^{bcd}	16.25±0.6^{ef}	16.80±0.8^{def}	17.01±0.7^{def}
1.50 %	75±1.8^{fgh}	77±2.3^{efg}	80±2.0^{b}	74±1.7^{fgh}	77±1.9^{fgh}	79±1.9^{cb}	16.84±0.5^{def}	17.38±0.8^{cde}	18.01±0.6b	16.39±0.5^{def}	16.93±0.7^{def}	17.42±0.6^{cde}
2.00 %	75±2.1^{fgh}	78±2.4^{def}	80±2.7^{b}	74±2.1^{gh}	77±1.5^{def}	84±2.8^{a}	16.95±0.6^{def}	17.52±0.9^{cde}	18.03±0.6b	16.29±0.6^{ef}	17.12±0.8^{def}	20.90±0.7a
2.50 %	76±1.8^{fgh}	78±2.3^{cbd}	86±2.6^{a}	75±1.8^{fgh}	75±2.3^{fgh}	78±2.4^{cbd}	17.09±0.9^{def}	17.72±0.7^{cb}	21.69±0.8^{a}	16.43±0.8^{def}	16.59±0.7^{def}	17.40±0.6^{cde}

Data are mean values with standard deviations (n = 4). Different letters in the same column indicate significant differences (p <0.05) by DMRT.

Fig. 1 & 2 Influence of seaweed extracts, soaking hours, concentrations and their interactions on root length (RL) and seedling fresh weight (SFW) of bhendi seeds cv. Arka Anamika

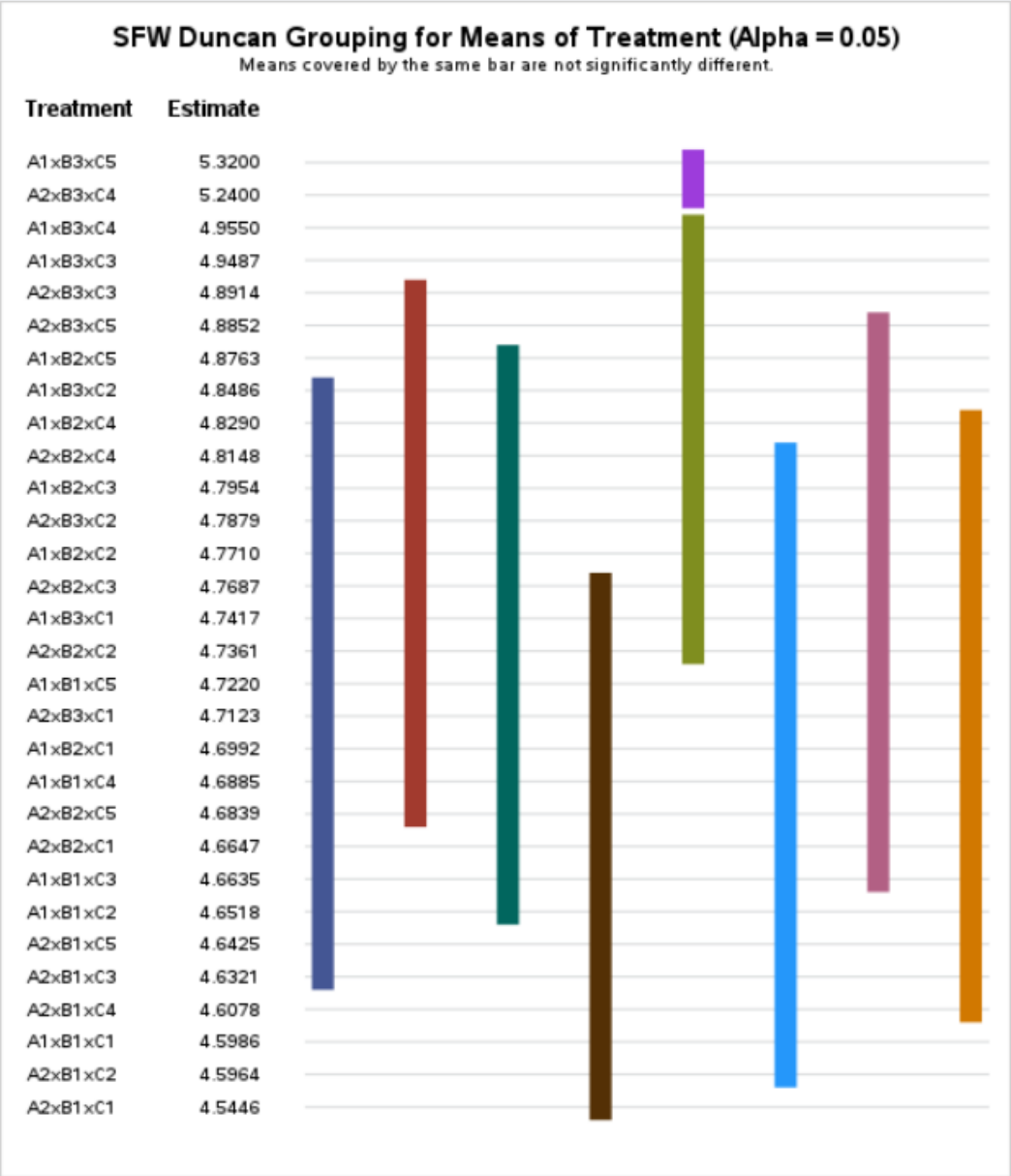
SFW Duncan Grouping for Means of Treatment (Alpha = 0.05)
Means covered by the same bar are not significantly different.
Treatment Estimate
A1xB3xC5 5.3200
A2xB3xC4 5.2400
A1xB3xC4 4.9550
A1xB3xC3 4.9487
A2xB3xC3 4.8914
A2xB3xC5 4.8852
A1xB2xC5 4.8763
A1xB3xC2 4.8486
A1xB2xC4 4.8290
A2xB2xC4 4.8148
A1xB2xC3 4.7954
A2xB3xC2 4.7879
A1xB2xC2 4.7710
A2xB2xC3 4.7687
A1xB3xC1 4.7417
A2xB2xC2 4.7361
A1xB1xC5 4.7220
A2xB3xC1 4.7123
A1xB2xC1 4.6992
A1xB1xC4 4.6885
A2xB2xC5 4.6839
A2xB2xC1 4.6647
A1xB1xC3 4.6635
A1xB1xC2 4.6518
A2xB1xC5 4.6425
A2xB1xC3 4.6321
A2xB1xC4 4.6078
A1xB1xC1 4.5986
A2xB1xC2 4.5964
A2xB1xC1 4.5446

Fig. 3 Influence of seaweed extracts, soaking hours, concentrations and their interactions on dry matter production (DMP) of bhendi seeds cv. Arka Anamika

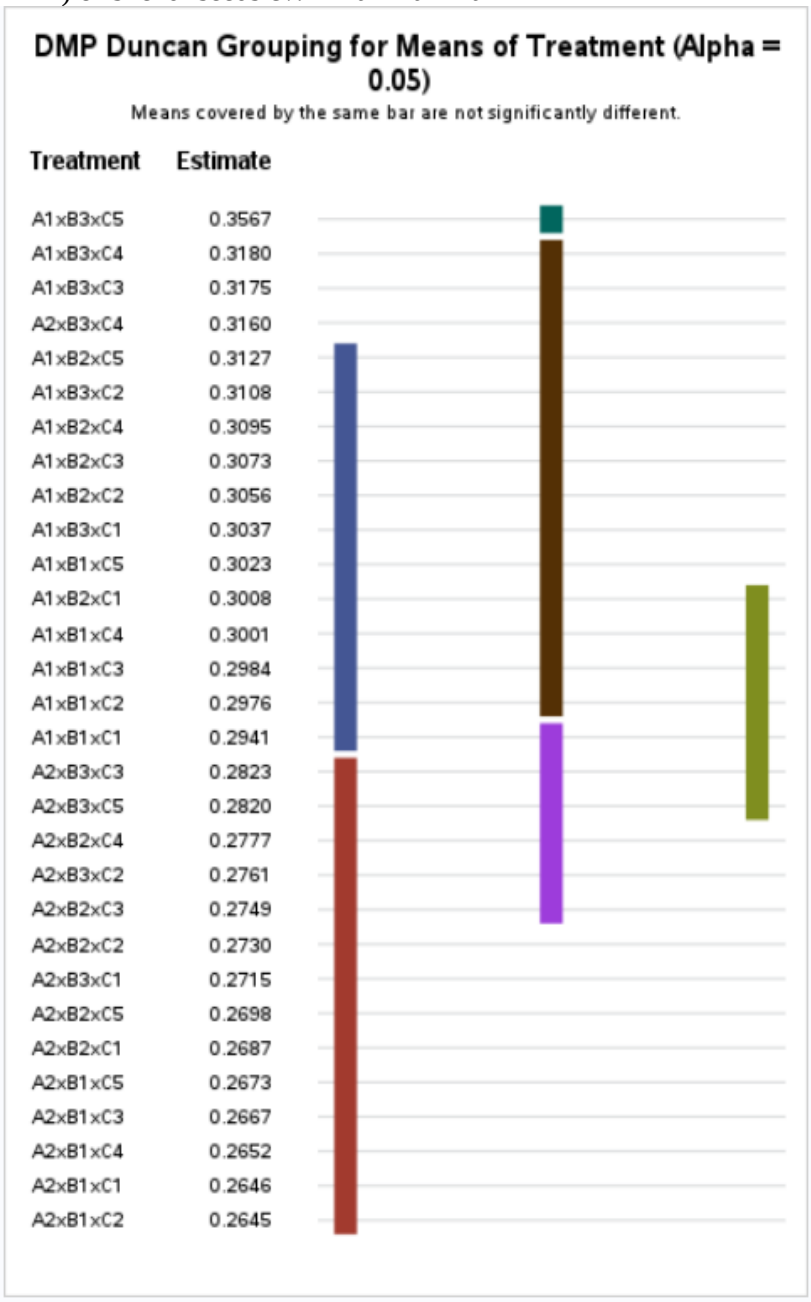

Fig. 4. Influence of seaweed extracts, soaking hours, concentrations and their interactions on electrical conductivity (EC) of bhendi seeds cv. Arka Anamika

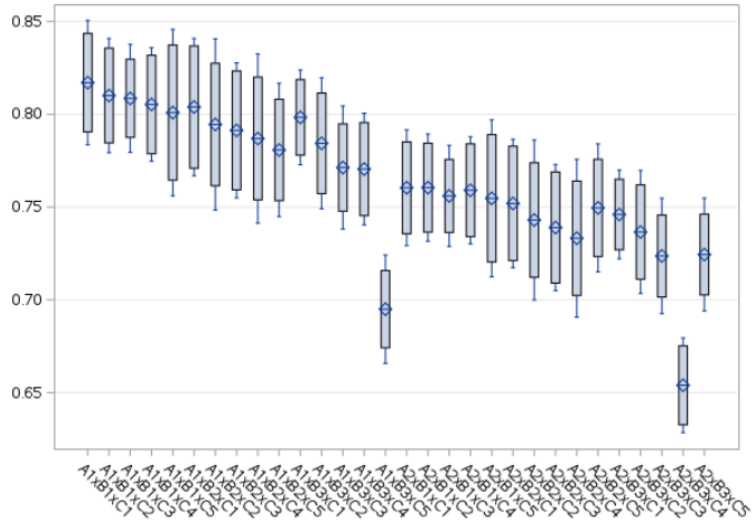

Fig. 5. Influence of seaweed extracts, soaking hours, concentrations and their interactions on Seedling vigour index I of bhendi seeds cv. Arka Anamika

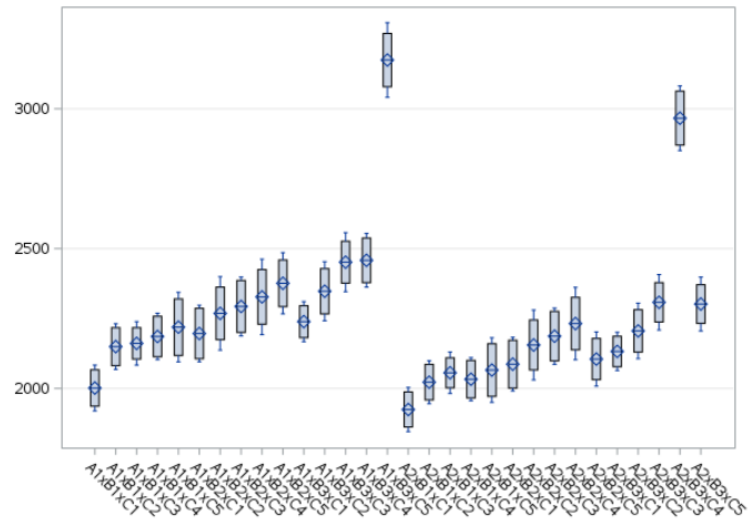

Fig. 6. Influence of seaweed extracts, soaking hours, concentrations and their interactions on Seedling vigour index II of bhendi seeds cv. Arka Anamika

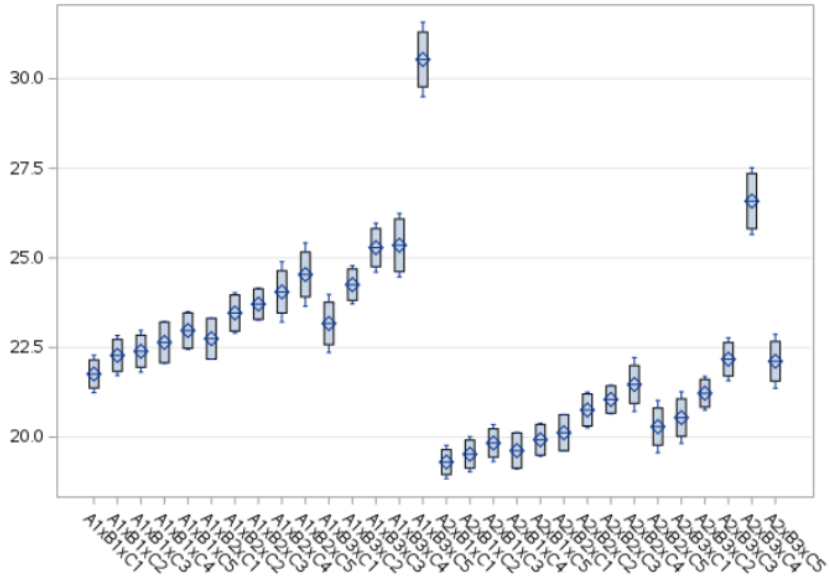

Table 4. Pearson's correlation coefficient

Pearson Correlation Coefficients, N = 30 Prob > |r| under H0: Rho=0								
	GP	**SHL**	**RL**	**SFW**	**DMP**	**EC**	**SVI**	**SVII**
GP	1	0.9616 <.0001	0.93751 <.0001	0.9995 <.0001	0.75657 <.0001	-0.9709 <.0001	0.97938 <.0001	0.85889 <.0001
SHL		1	0.95229 <.0001	0.96002 <.0001	0.78772 <.0001	-0.9474 <.0001	0.993 <.0001	0.85729 <.0001
RL			1	0.93174 <.0001	0.85349 <.0001	-0.9588 <.0001	0.97499 <.0001	0.91182 <.0001
SFW				1	0.73644 <.0001	-0.9631 <.0001	0.97719 <.0001	0.84272 <.0001
DMP					1	-0.8879 <.0001	0.8045 <.0001	0.98206 <.0001
EC						1	-0.9684 <.0001	-0.9546 <.0001
SVI							1	0.8814 <.0001
SVII								1

Germination percentage (GP), shoot length (SHL), root length (RL), seedling fresh weight (SFW), dry matter content (DMP), electrical conductivity (EC), seedling vigour index – I & seedling vigour index II (SV-I & SV-II)

Reference

1. Abdul-Baki, A.A., Anderson, J.D., 1973. Vigour determination in soybean seed by multiple criteria. *Crop Sci*. 13, 630–633
2. Ali, S., Adnan, M., Ibrahim, M., Saleem, N., & Khan, I. A. (2016). Effect of seed priming on growth parameters of Okra (*Abelmoschus esculentus* L.). *Pure and Applied Biology*, *5*(1), 165.
3. Benaseer S. Studies on seed priming and foliar treatments on enhancement of seed vigour, productivity and seed storability in blackgram. MSc. (Ag.) Thesis Tamil Nadu Agricultural University, Coimbatore, 2016.
4. Erulan, V., Soundarapandian, P., Thirumaran, G., & Ananthan, G. (2009). Studies on the effect of Sargassum polycystum (C. Agardh, 1824) extract on the growth and biochemical composition of Cajanus cajan (L.) Mill sp. *American-Eurasian Journal of Agricultural and Environmental Science*, *6*(4), 392-399.
5. MoAF, G. (2022). State of Indian Agriculture 2021-22. *Published by the Ministry of Agriculture & farmers welfare, Department of Agriculture & farmers welfare, Directorate of Economics and Statistics, New Delhi. https://agricoop.nic.in/en/Annual*.
6. ISTA., 1985. International rules for seed testing. *Seed Sci. Technol*. 13, 42–46.
7. ISTA., 2013. International rules for seed testing. *Seed Sci. Technol*. 27: 25-30.
8. Khan, Z., Gul, H., Rauf, M., Arif, M., Hamayun, M., Ud-Din, A., . . . Tabassum, A. (2022). Sargassum wightii Aqueous Extract Improved Salt Stress Tolerance in Abelmoschus esculentus by Mediating Metabolic and Ionic Rebalance. Front. *Mar. Sci*, *9*(853272), 10.3389.
9. Lamichhane, A., Mamata, K., & Shrestha, M. (2021). Effect of seed priming on germination of okra (Abelmoschus esculentus var. Arka Anamika). *Malaysian Journal of Sustainable Agriculture (MJSA)*, *5*(2), 111-114.
10. Layek, J., Das, A., Idapuganti, R. G., Sarkar, D., Ghosh, A., Zodape, S. T., . . . Ngachan, S. (2018). Seaweed extract as organic bio-stimulant improves productivity and quality of rice in eastern Himalayas. *Journal of Applied Phycology*, *30*, 547-558.
11. Mereddy, R. (2015). *Solid matrix priming improves seedling vigor of okra seeds.* Paper presented at the Proceedings of the Oklahoma Academy of Science.
12. Murungu, F. (2011). Effects of seed priming and water potential on seed germination and emergence of wheat (Triticum aestivum L.) varieties in laboratory assays and in the field. *African Journal of Biotechnology*, *10*(21), 4365-4371.
13. Nabti, E., Jha, B., & Hartmann, A. (2017). Impact of seaweeds on agricultural crop production as biofertilizer. *International Journal of Environmental Science and Technology*, *14*(5), 1119-1134. doi:10.1007/s13762-016-1202-1

14. Nagegowda, N., Hebbar, S. S., & Shilpashree, V. (2020). Performance of mulching and fertigation on nutrient uptake and nutrient use efficiency in okra (Abelmoschus Esculentus L. Moench) for seed production. *Current Agriculture Research Journal*, *8*(1).
15. Panse, V. G. and Sukhatme, P. V. (1985). In: Statistical methods for Agricultural workers. ICAR Publication, New Delhi, 327-340.
16. Presley, J.T. 1958. Relation of protoplast permeability on cotton seed viability and its pre-deposition to seedling diseases. *Plant Disease Report.*, 42: 852.
17. Rexliene, J. and Sridhar, J. (2018). Sargassum – A resource of necessity. *Shanlax International Journal of Arts, Science and Humanities, 5(4),* 163-171.
18. Sasikala, M., Indumathi, E., Radhika, S., & Sasireka, R. (2016). Effect of seaweed extract (Sargassum tenerrimum) on seed germination and growth of tomato plant. *International Journal of ChemTech Research, 9*(09), 285-293.
19. Sharma, A. D., Rathore, S. V. S., Srinivasan, K., & Tyagi, R. K. (2014). Comparison of various seed priming methods for seed germination, seedling vigour and fruit yield in okra (Abelmoschus esculentus L. Moench). *Scientia Horticulturae, 165*, 75-81. doi: https://doi.org/10.1016/j.scienta.2013.10.044.
20. Thinh, N & Sundareswaran, S. (2019). Effect of seed priming with seaweed extracts on Seed quality parameters in Blackgram (Vigna mungo L.) Cv. CO 6. *International Journal of Chemical Studies*, 7(3): 813-817.