

Exogenous application of liquid Seaweed extract through the root dipping technique in transplanted Finger millet (*Eleusine coracana* (L.))

¹S. Seemansethupathi and *A. Kamaraj

¹Department of Genetics and Plant Breeding,
Faculty of Agriculture, Annamalai University-608002 (India)

*Corresponding author E mail:

*Department of Genetics and Plant Breeding,
Faculty of Agriculture, Annamalai University-608002 (India)
ORCID ID: <https://orcid.org/0000-0003-2706-113X>

Abstract

Root dipping of seedlings with sea weed extract is a simple and effective way to enhance the crop growth and seed yield. The current experiment was conducted on finger millet 'CO15' in a factorial randomized block design with three replication during season of 2021 at Srivilliputhur block, Tamil Nadu. Sea weed extract of *Sargassum wightii* was used in liquid formulation for root dipping. Treatments include two factors of which, Factor I consisted of different duration of root dipping of finger millet seedlings before transplanting (30 min, 45min and 60 min) and factor II comprised various levels of concentration of liquid seaweed (5%, 10%, 15% and 20%) along with control. The study was aimed to explore the concentration of seaweed extract and duration of root dipping that could potentially increase the seed yield and quality. The plant growth characters namely plant height, number of tillers/hill, leaf area index, dry matter production and yield attributes such as number of ear heads/hill, number of fingers/ear head, finger length, test weight, seed yield and straw yield were assessed. From the study, we have identified the interaction effect of seaweed extract @ 5% concentration and 60 minutes duration of root dipping showed yield increase of 17.7% over the control. Therefore, our study showed that T₃ (root dipping of finger millet seedlings in 5% seaweed extract for 60 minutes) offered the scope of better performance in term of crop growth and seed yield over untreated control.

Key words : Finger millet, bio-stimulants, root dipping, plant growth and seed yield.

The globe over, millets are widely grown as drought-tolerant crops, in many parts of the world, including Africa and Asia. Finger millet is one of the important millet crops grown in India next to sorghum and pearl millet⁵ and has a pride place in having higher productivity among millets. It contains vitamins and less gluten, makes them excellent for the control of diabetes, atherosclerosis, and celiac disease¹⁴. Despite its immense nutrient composition, high level of anti-nutrients such as tannins, phenols, phytates, saponins, and trypsin inhibitors present in the seed³. In India, finger millet constitutes an area of 891000 ha with an annual production of 1239 million tones and productivity of 1390 kg/ha. In Tamil Nadu, finger millet occupies 79000 ha with 256 million tones production and 3257 kg/ha productivity¹².

For improving crop production, growth-promoting bio-stimulants such as seaweed may be a preferable option. Seaweeds are photo-autotrophic, macroscopic sea algae that are utilised widely as food, feed, medicine, phycocolloids, and fertilizers⁹. Nearly 200 species of seaweeds have been identified in India's southern coastal region, and the majority of them are employed as manure or compost in coastal agricultural communities¹³. Liquid extracts of these seaweeds are found to have higher concentrations of phyto hormones such as gibberellins, auxins, cytokinins, and abscisic acid, macronutrients (P, N, and K), micronutrients (Fe, Cu, Ca, Mg, Mn, Zn, and Ni), carbohydrates, vitamins, fatty acids, protein, fiber, lipid, and minerals^{1,2,17}.

Liquid seaweed extracts (LSEs) are organic bio-stimulants that effectively

encourage plant growth and enhance productivity because they contain high nutritional components. Therefore, in sustainable organic farming, the LSEs have been administered as a foliar spray and soil drench for increased agricultural yield¹⁹. In green technologies, LSEs has a wide range of uses, including seed priming, root growth, leaf quality, increasing yield, and enhancing resilience to various biotic and abiotic stressors¹⁰. In this case, it was revealed that applying seaweed extract at early stage of plant's growth had better stimulatory effects than applying it later. The goal of the study was to identify the concentration of seaweed extract and duration of seedling root dipping before transplanting that could improve the crop growth and seed yield.

Experimental site :

A field experiment was conducted during 2021 at a farmer's field in Srivilliputhur block, Tamil Nadu, India (137.2 meters MSL). The experimental soil at 0 – 30 cm depth was assessed and field's soil is a sandy clay loam in nature. The soil texture is 54.23% sand, 23.53% silt and 26.24%clay . The pH of soil 7.1 and electrical conductivity of soil 0.42 ds m⁻¹. The maximum temperature during the cropping period ranges from 30.4°C to 35.7 °C with a mean temperature of 32.8 °C and the minimum temperature fluctuates between 20.7°C to 25.5°C with a mean temperature of 22.7 °C. The relative humidity ranged from 61.0% to 76.0% with an average of 67.9%. During the crop period, 435.7 mm of rainfall was recorded.

Treatments, agronomic practices and experimental design :

The seed of finger millet 'CO 15' was

sown in first fortnight of July in well prepared nursery beds of 1.5 m width, 3m length and provide 30 cm space between plots for irrigation. The field experiment was laid out in a factorial randomized complete block design with fifteen treatments and replicated thrice. The fifteen treatments were combinations of different durations with various levels of concentrations.

Factor I: Seedling dipping durations (D):

- a) 30 minutes (D₁)
- b) 45 minutes (D₂)
- c) 60 minutes (D₃)

Factor II: Treatments (T):

- a) Control (T₀)
- b) Seaweed extracts (*Sargassum wightii*) @ 5 % (T₁)
- c) Seaweed extracts (*Sargassum wightii*)

- d) Seaweed extracts (*Sargassum wightii*) @ 10 % (T₂)
- e) Seaweed extracts (*Sargassum wightii*) @ 15 % (T₃)
- f) Seaweed extracts (*Sargassum wightii*) @ 20 % (T₄)

The twenty days old seedlings were, dipped in different concentration of *Sargassum wightii* for different duration as mentioned above treatments and transplanted to the main field in second fortnight of July. Net plot size was 4.4×3.8 m planted at a spacing of 30 cm×10cm. The recommended package of practices was followed. The crop was harvested in second week of November, 2021. From the plot of each treatment replication wise, randomly selected five plants were tagged for recording the vegetative traits and yield traits. Treatment details given in the table.

Table-1. Treatment its combination and details of liquid seaweed extract in the present experiment

Treatment	Treatment combination	Treatment Details
T ₀	D ₁ T ₀	Control
T ₁	D ₁ T ₁	30 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 5 %
T ₂	D ₁ T ₂	30 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 10 %
T ₃	D ₁ T ₃	30 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 15 %
T ₄	D ₁ T ₄	30 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 20 %
T ₀	D ₂ T ₀	Control
T ₅	D ₂ T ₁	45 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 5 %
T ₆	D ₂ T ₂	45 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 10 %
T ₇	D ₂ T ₃	45 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 15 %
T ₈	D ₂ T ₄	45 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 20 %
T ₀	D ₃ T ₀	Control
T ₉	D ₃ T ₁	60 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 5 %
T ₁₀	D ₃ T ₂	60 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 10 %
T ₁₁	D ₃ T ₃	60 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 15 %
T ₁₂	D ₃ T ₄	60 Minutes + Seaweed extracts (<i>Sargassum wightii</i>) @ 20 %

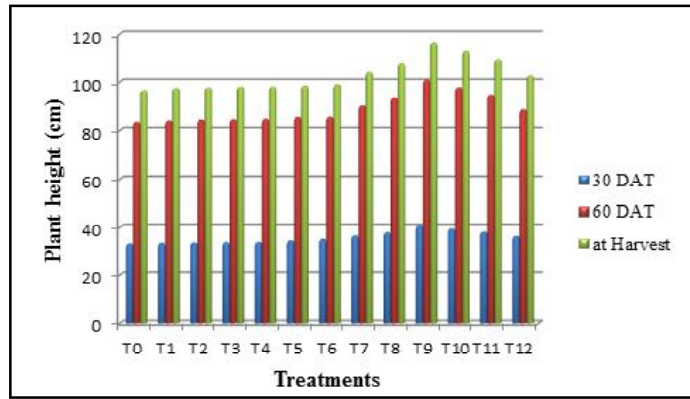


Fig. 1. Effect of root dipping on plant height at different growth stages (DAT – Days after transplanting)

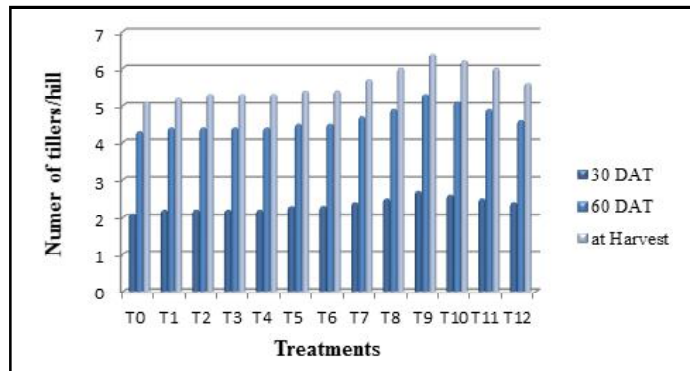


Fig. 2. Effect of root dipping on the number of tillers/hill at different growth stages (DAT – Days after transplanting)

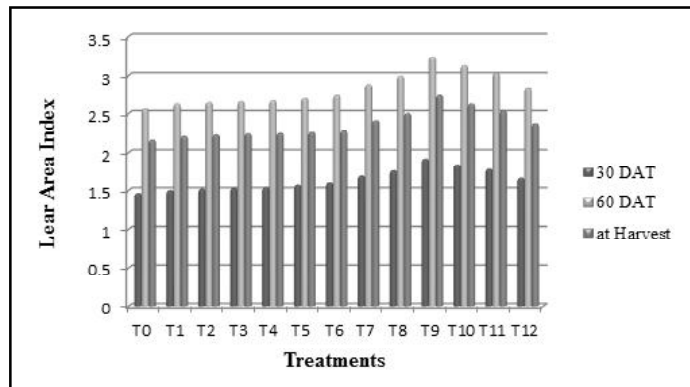


Fig. 3. Effect of root dipping on leaf area index at different growth stages (DAT – Days after transplanting)

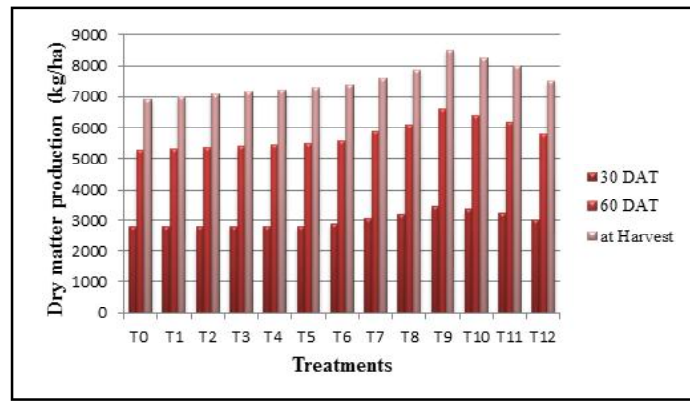


Fig. 4. Effect of root dipping on the dry matter production at different growth stages (DAT – Days after transplanting)

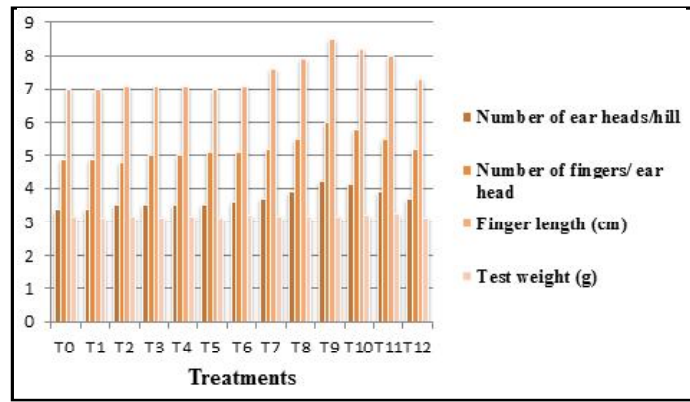


Fig. 5. Effect of root dipping on of yield attributes

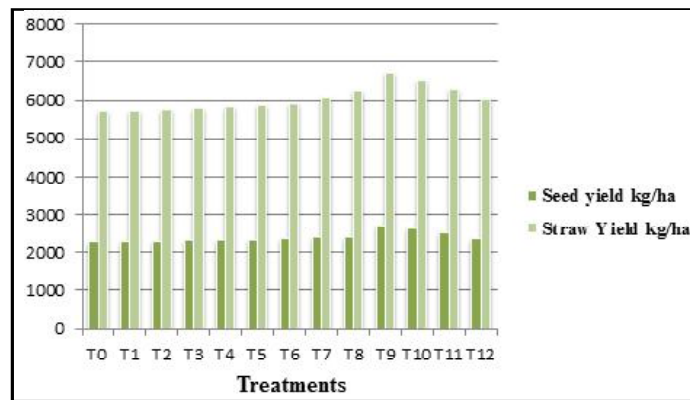


Fig. 6. Effect of root dipping on seed and straw yield

Data analysis :

Data were analyzed using OPSTAT for analysis of variance (ANOVA) as described by Gomez and Gomez (1984) and the treatment difference was calculated using the critical difference (CD) at a 5% level of probability.

Plant growth parameters :

Root dipping of finger millet seedlings dipped in 5% concentration of seaweed extract (*Sargassum wightii*) for 60 minutes before transplanting (D₃T₁) produced tallest plants with values of (40.8 cm, 100.8 cm and 116.4 cm at 30 DAT, 60 DAT and harvest stage respectively) accounting 20 % more than the control at harvest stage. Plant height was increased linearly by minimum level of seaweed extract with maximum level of dipping duration. Similarly the same trend was observed and result of number of tillers/hill, leaf area index, dry matter production was presented in Fig. 1, 2, 3 and 4. Significantly maximum LAI (1.9, 3.2 and 2.7 at 30 DAT, 60 DAT and harvest stage respectively), number of tillers/hill (2.7, 5.3 and 6.4 tillers at 30 DAT, 60 DAT and at harvest stage respectively) and dry matter production (3425, 6596 and 8514 kg/ha at 30 DAT, 60 DAT and harvest stage respectively) of finger millet were recorded under (D₃T₁) 5% concentration of seaweed extract (*Sargassum wightii*) for 60 minutes, accounting 26%, 25% and 22% greater than control. The treatment (D₃T₂) ranked second in the order of all the plant growth and yield attributes.

The dominant effect of (D₃T₁) over the control might be due to the presence of growth hormones, macro and micro nutrients

in the sea weed extract had influenced the physiological and biochemical process of the plant by reducing the transplantation shock during transplanting and enhances the natural root growth development. A number of metabolic and physiological processes induced by sea weed extract and sea weed extract had a potential role in enhancing the plant growth characters such as plant height, number of tillers/hill, leaf area index, dry matter production. The minimum values recorded by the control were due to the absence of plant growth regulators and nutrients have caused the stunted growth and vegetative traits. These outcomes were similar to the reports by Crouch and van Staden⁴; George *et al.*,⁶ Prasad *et al.*,¹⁶; Khan *et al.*,¹⁰ and Parthiban *et al.*,¹⁵.

Yield and yield attributes :

The yield attributes showed remarkable differences, such as number of ear heads/hill, number of fingers/ear head, finger length, and test weight accounting 23%, 22% and 21% and 1.0% higher than the control and above measured yield attributes were recorded significantly higher under the (D₃T₁), however test weight was failed to show the significant effect (Fig. 5 and 6). The maximum numbers of ear heads/ hill at harvest stage (4.2), number of fingers/ear head (6.0), and finger length was longer (8.5 cm) and test weight (3.2 g).

While, root dipping treatment was not showed a significant variation with respect to test weight of finger millet and sea weed extract 5% along with 60 minutes dipping duration increased the yield attributes over rest of the other treatments. Similar findings have been reported earlier by Gokul and Senthilkumar⁸ and Kumar *et al.*,¹¹.

Yield :

Total yield may be considered to be the mirror of all growth and yield features. As depicted Fig. 6, the treatment with (D₃T₁) recorded significantly highest seed yield (2692 kg/ha) and straw yield (6722 kg/ha) with an increase to the tune of 17.7% and 17.4% respectively. Followed by root dipping of Seaweed extracts (*Sargassum wightii*) @ 10% for 60 Minutes (D₃T₂). The lowest values were recorded in control (2286 kg/ha and 5725 kg/ha) respectively. Root dipping of seaweed extracts triggers to development of flowering and seed set in crop and its leads to robust plant yield^{18,20}.

The present study suggests the dual treatment of T₉ (Seaweed extract (*Sargassum wightii*) @ 5% + 60 minutes dipping duration) gave the best results for plant growth and yield attributes. The interaction effects between seaweed extract and seedling dipping durations were significant for the maximum traits exhibited seed test weight, which meant that the effects of seaweed extract (*Sargassum wightii*) were consistent and offers the scope of increasing yield at 17.7% with low concentration (5%) of liquid seaweed extract.

References :

1. Battacharyya, D., M. Z. Babgohari, P. Rathor, and B. Prithiviraj (2015). *Scientia Horticulturae* 196: 39–48.
2. Basavaraja, P. K., N. D. Yogendra, S. T. Zodape, R. Prakash and A. Ghosh (2018). *Journal of Plant Nutrition* 41(14): 1851–61.
3. Chandra, D., Chandra, S., Pallavi and A.K. Sharma, (2016). *Food Science and Human Wellness* 5(3): 149–155.
4. Crouch, I. J, and Van Staden (1992). *Journal of Applied Phycology* 4: 291–296.
5. Dass, A., S. Sudhishri and N.K. Lenka. (2013). *Journal of Crop Improvement*, 27(5): 528-546.
6. George, E. F., M. A Hall, and G. J. De Klerk (2008). *Dordrecht* (pp. 205-226).
7. Gomez, K. A. and A. A. Gomez, (1984). *Statistical procedures for agricultural research*.
8. Gokul, G and N. Senthilkumar (2019). *Plant Archives* 19(2): 2889-2892.
9. Hernandez-Herrera, R. M., F. Santacruz-Ruvalcaba, M. A. Ruiz-Lopez, J. Norrie, and G. Hernandez-Carmona (2014). *Journal of Applied Phycology*, 26(1): 619–28.
10. Khan, W., U. P. Rayirath, Subramanian, S Jithesh, P Rayorath, D. M Hodges, A.T Critchley, J. S Craigie, J Norrie, and B. Prithiviraj (2009). *Journal of Plant Growth Regulation* 28(4): 386–99.
11. Kumar, A.P., P. Parasuraman, K. Sivagamy and B. Sivakumar, (2019). *Journal of Pharmacognosy and Phytochemistry*, 8(3): 660-663.
12. Ministry of Agriculture and Farmers Welfare, Govt. of India. (2019). *Selected State-wise area, production and productivity of finger millet*.
13. Nedumaran, T. and D. Arulbalachandran. (2015). *Seaweeds: A promising source for sustainable development. In Environmental sustainability*, 65–88. New Delhi: Springer.
14. Park, K.O., Y. Ito, T. Nagasawa, M.R. Choi and N. Nishizawa (2008). *Bioscience, Biotechnology, Biochemistry*. 72(11):

- 2918–2925.
15. Parthiban, C., C Saranya, A Hemalatha, B. Kavitha and Anantharaman. (2013). *International Journal of Recent Science & Research*, 4(9): 1418-142.
 16. Prasad, K.D., A.K. Das, M.D. Oza, H.A. Brahmabhatt, A.R. Siddhanta, K.E. Eswaran, M. R. Rrajyaguru and P. K. Ghosh (2010). *Journal of Agricultural Food Chemistry*, 58: 4594-4601.
 17. Roy, S. and P. Anantharaman (2017). *Journal of Marine Science: Research & Development* 07 (05): 240–2.
 18. Sujatha, K, R Anand, K.P Ragupathi and A. Sabir Ahamed (2016). *American international journal of research in formal, applied & natural sciences*, 16: 314.
 19. Vinoth, S., P Gurusaravanan, and N. Jayabalan (2012). *Journal of Applied Phycology* 24(5): 1329–37.
 20. Wajahatullah Khan, Usha P. Rayirath. Sowmyalakshmi Subramanian, Mundaya N. Jithesh, Prasanth Rayorath. D. Mark Hodges. Alan T. Critchley. James S. Craigie. Jeff Norrie and Balakrishan Prithiviraj. (2009). *Journal of Plant Growth Regulators*, 28: 386–399.