The Foliar Application of Sea Lettuce (*Ulva lactuca*) Liquid Extract on Growth and Quality of Groundnut (*Arachis hypogaea* L.)

M.Sukanya[1], N.Narmhikaa[2] and N. Tharminath[3]

[1]*Department of Biosystems Technology, Faculty of Technological Studies, Uva Wellassa University, Sri Lanka.*

[2,3]*Department of Biosystems Technology, Faculty of Technology, Eastern University, Sri Lanka.*

[1] mskanya92@gmail.com, [2] narmhikaan@esn.ac.lk, [3] tharminath@gmail.com

Abstract

At present there is a significant demand for environmentally sustainable agriculture to produce high-quality, nutritious food for the growing global population. Research efforts are currently focused on sustainable crop production methods, utilizing organic fertilizers and botanical compounds derived from natural resources to enhance the yield of commercially valuable crops. A field study was conducted to investigate the effects of foliar application of seaweed (Ulva lactuca) liquid extracts (SLE) on the growth and yield of the 'Indi' cultivar. The foliar application of SLE was applied to the plant at one-week interval. As treatment, the seed extract was applied at different concentrations 10% SLE (T2), 20% SLE (T3), 50% SLE (T4), and 100% SLE (T5) (v/v). Control treatment consisted of foliar application of distilled water (T1). The results showed that there were significant differences(p<0.05) among the tested parameters of the 'Indi' cultivar.Foliar application of seaweed extract at concentrations of 20% (T3) increased the ground nut plant height (49.44 cm), number of nodules (144) and pods (27), air dry pod weight (36.38 g), air dry seed weight seed yield (24.28 g), biological yield (2898.12 kg/ha), and harvest index (41.96 %). Seaweed extract with 100% foliar application reduced the above-mentioned parameters significantly compared to the control. Therefore, it could be concluded that the seaweed extract at a 20% concentration level can be used to enhance the growth and yield of 'Indi' groundnut cultivar.

Keywords: Biostimulator, foliar application, Groundnut, Seaweed liquid extract

I. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an economically important crop in Sri Lankan region. It belongs to the Leguminosae family and requires applicable quantities of nutrients at appropriate times to achieve better yield and quality. There is a growing need to enhance the environmentally friendly cropping system and reduce the negative environmental impacts (Zuma *et al*.,2023). In Sri Lanka, growers use chemical fertilizers to meet the added demand for food and prefer to gain a quick return. Additionally, the inordinate operation of agrochemicals and synthetic fertilizers has led to numerous environmental problems. Due to the runoff of synthetic fertilizers from agrarian lands, nitrate and phosphate concentrations were set up to be significantly more advanced than the admissible limits of the World Health Organization norms (Divya and Balagali, 2012). Hence, the indispensable nutrient operation is essential for overcomes the constraints prevailing in the eastern part of Sri Lanka. Seaweed extracts contain a large proportion of growth hormones such as (IAA and IBA), cytokinin, trace elements (Fe, Cu, Zn, Co, Mo, Mn, and Ni), vitamins, and amino acids that promote the growth, yield, and productivity of numerous crops (Kumar and Sahoo, 2011). Seaweeds are biodegradable, non-toxic, non-polluting, and safe for humans, animals, and livestock (Dhargalkar and Pereira, 2005). Several regions of the world must be explored and exploited to understand the richness of marine plants and macroalgae. Algal resource use has not yet been optimized, and there is a great abundance of potentially important species, similar to sea lettuce. It is a macroalga belonging to the phylum Chlorophyta that can grow attached, sessile, or free-floating. Sea lettuce has proven to be a useful fertilizer because it not only provides macronutrients such as nitrogen, phosphorus, and potassium but also contains numerous micronutrients needed by crops (Eyras *et al.*, 1998). In Sri Lanka, the utilize of *Ulva lactuca* as a biofertilizer or bio stimulant has not yet been adequately investigated and has been reported as a beneficial application for the growth of plants (Metting *et al*., 1990). The specific objective of the current study was to estimate the effects of different concentrations of seaweed foliar spray on the growth and yield of groundnut.

II. MATERIALS AND METHOD

A. Experimental site.

The experiment was conducted at the agronomy farm of Eastern University of Sri Lanka. The soil of the experimental area is sandy regosol. The latitude is 43' and the longitude is 81° 42'. During the growing periods, the average temperatures ranged between 26-35°C. The minimum and maximum rainfalls during the experimental season were 7 mm and 60 mm respectively. Certified seeds 'Indi' was obtained from the seed sales Centre of Karadiyanaru, Batticaloa, Sri Lanka. The experiment was laid out in randomized complete block design (RCBD) with four replications. Polythene bags were used to establish the plants. The diameter and height of polythene bags were 42 cm and of 36 cm respectively. The foliar spraying was done five times during the experimental period at one-week intervals from three weeks after planting. The recommended plant management practices (watering, fertilizer applications) were carried out based on the guideline of the Department of Agriculture, Sri Lanka.

B. Seaweed collection and seed weed extract preparation.

Seaweed was collected by the hands along the coastal waters of Passikudaha, Batticaloa and the sediment, epiphytes, and organic matter on the surfaces of seaweed were cleaned immediately with seawater. The seaweed was packed in polythene bags and transported to the horticulture laboratory.Inorder to remove excess dirt and salt, the seaweed was once again cleaned with tap water in the laboratory. The seaweed was air dried in a dark room for three days. After drying, it was cut to a size of 0.5 cm to 1 cm. The samples were weighed (1 kg) and boiled in 1 litter distilled water for an hour. The mixture was allowed to cool to room temperature and was filtered through muslin cloth. The seaweed extract was treated at a 100% concentration and diluted with distilled water at a rate of 1:5 (Bhosle *et al.*, 1975). During each application, 10 ml of extract was applied to each plant. The treatment structures are as follows,

Table 01. Details of treatments for conducting groundnut cultivar trials using seaweed liquid extract

Treatments	**Seaweed liquid extract (SLE)Concentrations**
T1	Distilled water (Control)
T2	10 %
T3	20 %
T4	50 %
T5	100 %

C. Samples Collection for analysis

Five plants have been arbitrarily chosen from each replicate of treatments. The control plants too were selected for the measurement.

D. Plant height

The plants were pulled out, and their roots were rinsed with tap water. A measuring tape was used to record the heights of each plant from the base of the stem (at the soil surface) to top of the highest part of the plant by a measuring tape.

E. Number of pods and number of nodules

The plants were uprooted from each treatment and the roots were washed with tap water. The plant's pods and nodules were counted.

F. Air dry pod

The pods of each plant were removed and separated and sundried for five days and their dry weight was recorded using an electric balance.

G. Air dry seeds

Seeds were separated from the pods. Seeds were sundried for five days and their dry weight was recorded using an electric balance.

H. Seed yields

Seeds were collected from each pod and seed yield was calculated from each treatment

I. Biological yield

The biological yield was determined by weighing all pants harvested from each treatment.

J. *Harvest index*

The harvest index (HI) was calculated to determine the fraction of economically useful products of a plant in relation to its total productivity (grain-to-straw ratio) using the following formula:

$$HI = (EY/BY) \times 100$$

Where HI- Harvest index, EY- Economic yield, BY-Biological yield.

K. *Statistical analysis*

Data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS) software (SAS version 9.1, Institute INC., Cary, USA). Treatment means were compared according to Tukey's to find out the significance between the treatments at p<0.05.

III. RESULTS AND DISCUSSION

Foliar application of seaweeds affected the growth of groundnut plants and significantly (p<0.05) influenced plant height compared to the control treatment (Table2). The highest plant height was obtained from T3 (20% SLE) treatment, whereas the lowest average was observed in T5 (100 % SLE). The application of seaweed extracts may have contributed to the observed outcomes by tending to raise the total chlorophyll content of the leaves, which in turn affected the photosynthetic process's capacity and efficiency (Fan *et al.*, 2013) and enhancing nutrient availability and absorption (Mancuso *et al.,* 2006). These factors likely contributed positively to plant vegetative growth. This result is similar to the results of Sutharsan *et al.* (2017) who reported that a lower concentration of *Sargassum crassifolium* significantly increased the plant height of maize, while a higher concentration exhibited an inhibitory effect than control plants. Means followed by the same letter are not significantly different (P<0.05.) from each other according to Tukey's honestly significant difference test at 5% significant level. There was a noticeable difference (P<0.05) in the number of nodules between Seaweed Liquid Extract (SLE)-treated and untreated plants. The highest number of nodules (144.67) was recorded in 20% SLE (T3), which differed remarkably from T1, T2, T4, and T5. The lowest nodule number was observed at the highest SLE concentration (100 %). The results align with the findings of Sivashankari *et al.* (2006), who observed that higher concentrations of seaweed extracts hindered germination, while seeds of *V. sinensis* soaking in lower concentrations of the extracts showed higher rates of germination.. Additionally, they observed that certain growth-promoting compounds such IAA and IBA, Gibberellins, cytokinin, minerals (Fe, Cu, Zn, Co, Mo, Mn, and Ni), vitamins, and amino acids may be accountable for the higher germination percentage at low concentrations.

Table 02: Effect of foliar application of SLE on Plant height, pod and nodule numbers per groundnut cultivar.

Treatment	Plant height (cm)	Number of nodules/plants	Number of pods/ plants
T1	22.67± 0.12^{d}	99.53b±2.4 0^{d}	20.3±0.25 ^{d}
T2	36.65± 0.23^{b}	134.44±2.82 ^{b}	25.73 ± 0.88^{ab}
T3	49.44 ± 0.44^{a}	144.67± 0.43^{a}	27.00 ± 1.54^{a}
T4	31.97± 0.23b^{c}	131.54± 0.33^{bc}	22.27 ± 0.17^{ab}
T5	20.26± 0.15^{e}	91.14 ±2.73 ^{e}	14.34±0.38 ^{e}

Statistical analysis of data showed that application of a lower concentration (20%) of SLE (T3) significantly (P<0.05) increased the mean number of pods per plant (27) in treated plants compared to the control plants, whereas a higher concentration (100%) of SLE (T5) reduced the mean number of pods per plant (14). This could be because increased SLE concentrations have an inhibiting impact even if SLE contains higher concentrations of macro-and microelements. It was clearly indicated that foliar application of seaweed (*Sargassum crassifolium*) at lower concentrations favored tomato plant growth by increasing. photosynthesis through an increased leaf area, as reported by Rasheed *et al.* (2003). These results coincide with those of earlier studies on tomatoes, where the number of fruits of tomato remarkably increased at lower concentrations of *Kappaphycus alvarezii* sap of Zodape, since phytohormones, amino acids, and essential macro and micronutrients found in seaweed extracts enhance plant growth and development. Furthermore, he reported that fruit number per plant was significantly reduced at higher concentrations than in control plants. It was also in agreement with the findings of Vijayakumar *et al*. (2018) who stated that higher concentrations of seaweed liquid extracted from *Codium decorticatum* decreased chlorophyll content, which led to reduced plant growth as well as the number of pods in *Capsicum annum*. Means followed by the same letter are not significantly different (P<0.05.) from each other according to Tukey's honestly significant difference test at 5% significant level. The application of SLE treatments had a significant (P<0.05) effect on the air-dried weights of pods and seeds per plant compared to the control (Table 03). The highest air-dried pod weight (36.38 g) and seed weight (24.28 g) per plant were obtained in T3 (SLE 20 %), whereas 100% SLE exhibited an inhibitory effect on pods (13.12 g) and seeds (10.02 g) weight per plant.

Polyphenols, polysaccharides, alginates, polyamines, pigments, free amino acids, betaines, vitamins, micro- and macronutrients, and naturally occurring phytohormones are among the biologically active compounds found in seaweed extract. These different chemicals found in seaweed extract may have a stimulatory effect, potentially influencing the cellular metabolism processes of treated plants and producing the positive effects of seaweed extract that have been reported (Khan *et al*., 2009).Additionally, the high magnesium and mineral content found in seaweed extracts may have contributed to the observed increases in total leaf chlorophyll and carotenoid concentrations, which in turn may have improved photosynthetic efficiency, nutrient availability, and absorption, ultimately leading to increased carbohydrate production (El-Din, 2015).

Table 03: Effect of foliar application of SLE on air-dried pod weight and air-dried seed weight of the groundnut cultivar.

Treatment	Air-dried pod weight per plant(g)	Air-dried seed weight per plant(g)
T1	16.24 ± 0.41^{d}	12.91 ± 0.35^{d}
T2	24.87 ± 0.47^{b}	17.38 ± 0.29^{b}
T3	36.38 ± 0.41^{a}	24.28 ± 0.55^{a}
T4	21.03 ± 1.14^{c}	15.72 ± 0.14^{c}
T5	13.12 ± 1.23^{e}	10.02 ± 0.45 ^{e}

Our results are in line with the findings of other researchers applying the SLE of *Sargassum crassifolium* with 20% concentration as the foliar application significantly increased the average polar diameter per fruit of tomato by 12.31% compared to control plants (Sutharsan *et al*., 2014).

Means followed by the same letter are not significantly different (P<0.05.) from each other according to Tukey's honestly significant difference test at 5% significant level. Pod and seed yields were significantly (P<0.05) affected by the application of SLE (Table 04). It was noted that the addition of 20% SLE (T3) had a significant effect on economic yield than the other treatments. Maximum seed yield was obtained in T3 (2898.12 kg/ha) followed by T2 (2727.58 kg/ha) and T4 (2227.76 kg/ha) respectively. The harvest index is a consequence of the grain yield

Table 04: Effect of foliar application of SLE on pod yield, seed yield and harvest index of the ground nut plant during the harvesting stage.

Treatment	Pod yields (kg/ha)	seed yields (kg/ha)	Harvest index (%)
T1	2576.41 ± 106.40^{d}	2134.97± 232.66^{d}	30.89± 01.35^{d}
T2	3452.98 ± 105.53^{b}	2727.58 ± 111.40^{b}	36.12± 01.61^{b}
T3	4135.57 ± 123.14^{a}	2898.12 ± 134.01^{a}	41.96± 02.33^{a}
T4	3176.98 ± 117.21^{bc}	2227.76 ± 201.42^{c}	32.44± 02.33^{c}
T5	1796.23 ± 122.41^{e}	1978.55 ± 102.01^{e}	17.01± 01.31^{e}

and biological yield. There was also a significant difference ($P < 0.05$) in the harvest index of the ground nut plants after the foliar application of SLE (Table 03). Maximum harvest index (41.96 %) was noticed under the foliar application of T3 (20% SLE) which was followed by the foliar applications of T2 (10 % SLE) and T4 (50% SLE), whereas T5 (100 %) had the lowest value of 17.01 % in the present study. The increase in harvest index percentage may be due to an increase in seed yield. Major and minor minerals, vitamins, cytokinins, auxins, and compounds that promote growth akin to abscisic acid are all found in seaweed extracts. Studies have shown that these nutrients can enhance plant growth and yield as well as help plants become more resilient to environmental stress (Khan *et al*., 2009; Zhang *et al*., 2003). An increase in yield with SLE application is associated with improved chlorophyll biosynthesis (higher SPAD index) (Yusuf *et al*., 2018)

IV.CONCLUSION

The present study determined that the foliar application of Seaweed liquid extract (*Ulva lactuca*) improved the growth and yield of 'Indi' groundnut cultivar. Among the four concentrations tested, 20% of SLE performed better in terms of groundnut plant growth and yield. Hence, foliar treatment with *Ulva lactuca* at 20% may thus be recommended for improving the characteristics of pods and nodules and yield and yield components of the groundnut.

REFERENCES

Bhosle, N. B., Dhargalkar, V. K. and Untawale, A. G. 1975. Effect of seaweed extract on the growth of *Phaseolus vulgaris* L. Indian J. Mar. Sc., 4 : 208-210.

Dhargalkar, V. K., and Pereira, N. (2005). Seaweed: promising plant of the millennium.

Divya, J., and Belagali, S. L. (2012). Impact of chemical fertilizers on water quality in selected agricultural areas of Mysore district, Karnataka, India. *International journal of environmental sciences*, 2(3), 1449-1458.

El-Din, S. M. M. (2015). Utilization of seaweed extracts as bio-fertilizers to stimulate the growth of wheat seedlings. *The Egyptian Journal of Experimental Biology* (Botany), 11(1), 31-31.

Eyras, M. C., Rostagno, C. M., and Defossé, G. E. (1998). Biological evaluation of seaweed composting. Compost Science & Utilization, 6(4), 74-81.

Fan, D., Hodges, D. M., Zhang, J., Kirby, C. W., Ji, X., Locke, S. J., Critchley,A.T. and Prithiviraj, B. (2011). Commercial extract of the brown seaweed Ascophyllum nodosum enhances phenolic antioxidant content of spinach (*Spinacia oleracea* L.) which protects Caenorhabditis elegans against oxidative and thermal stress. *Food Chemistry*, 124(1), 195-202.

Khan, W., Rayirath, U. P., Subramanian, S., Jithesh, M. N., Rayorath, P., Hodges, D. M., and Prithiviraj, B. (2009). Seaweed extracts as biostimulants of plant growth and development. *Journal of plant growth regulation*, 28, 386-399.

Kumar, G., and Sahoo, D. (2011). Effect of seaweed liquid extract on growth and yield of *Triticum aestivum* var. Pusa Gold. *Journal of applied phycology*, 23, 251-255.

Mancuso, S., Azzarello, E., Mugnai, S., and Briand, X. (2006). Marine bioactive substances (IPA extract) improve foliar ion uptake and water stress tolerance in potted Vitis vinifera plants. *Advances in Horticultural Science*, *20*(2), 156-161.

Metting B, WJ Zimmerman, IJ Crouch and J van Staden. (1990). Agronomic uses of seaweed and microalgae. In: Akatsuka I (Ed). Introduction to Applied Phycology SPB Academic Publishing, The Hague, Netherlands. pp. 589-627.

Muhammad Rasheed, M.R., Abid Hussain, A.H. and Tariq Mahmood, T.M.(2003). Growth analysis of hybrid maize as influenced by planting techniques and nutrient management.

Sivasankari, S., V. Venkatesalu, M. Anantharaj and M. Chandrasekaran (2006). Effects of seaweeds extracts on the growth and biochemical constituents of *Vigna sinensis*, *Bioresource Technology*, 97: 1745-1751

Sutharsan, S., Nishanthi, S., and Srikrishnah, S. (2014). Effects of foliar application of seaweed (*Sargassum crassifolium*) liquid extract on the performance of *Lycopersicon esculentum* Mill. in sandy regosol of Batticaloa District Sri Lanka. sandy regosol of batticaloa district sri lanka. *American-Eurasian Journal of Agriculatural & Environmental Sciences*, 14(12), 1386-1396.

Sutharsan, S., Nishanthi, S., and Srikrishnah, S. (2017) .Effects of seaweed (*Sargassum crassifolium* extract foliar application on seedling performance of *Zea mays* L. *Research Journal of Agriculture and forestry sciences.* Vol. 5(4), 1-5

Vijayakumar, S., Durgadevi, S., Arulmozhi, P., Rajalakshmi, S., Gopalakrishnan, T., and Parameswari, N. (2018). Effect of seaweed liquid fertilizer on yield and quality of *Capsicum annum* L. *Acta Ecol*. Sin. , 39, 406–410.

Yusuf, S., Arsyad, M., and Nuddin, A. (2018). Prospect of seaweed developement in South Sulawesi through a mapping study approach. In IOP Conference Series: *Earth and Environmental Science* (Vol. 157, No. 1, p. 012041). IOP Publishing.

Zhang, X., Ervin, E. H., and Schmidt, R. E. (2003). Physiological effects of liquid applications of a seaweed extract and a humic acid on creeping bentgrass. *Journal of the American Society for Horticultural Science*, 128(4), 492-496.

Zuma, M., Arthur, G., Coopoosamy, R. and Naidoo, K.(2023). Incorporating cropping systems with eco-friendly strategies and solutions to mitigate the effects of climate change on crop production. *Journal of Agriculture and Food Research*, p.100722.

ABBREVIATIONS

SLE – Sea weed liquid extract