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Utilization of Seaweed *Sargassum liebmannii* Extract as a Stimulant of Germination of *Pachyrhizus erosus*

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Abstract: Seaweeds are an integral part of the coastal ecosystem and they are known to aid and stimulate growth of vegetables, fruits and other crops. They contain all major and minor plant nutrients including bio-control properties; they also contain organic compounds such as auxins, gibberellins and precursors of ethylene and betaine that impact plant growth. A crude extract was prepared with 30 g dry weight of *S. liebmannii*. The solution was considered as 100% concentration and three different concentrations (2%, 5% and 10%) were prepared by dilution with distilled water. Four treatments were used (0%, 2%, 5% and 10%), with three replicates for treatment, and one hundred seeds for each replicate. Prior to germination, seeds were soaked in seaweed extract at treatment concentration for 24 h at room temperature (24 ± 2 °C), and then placed on Petri dishes with filter paper. Seaweed extract had a significant effect on germination of *Pachyrhizus erosus* seeds ($p<0.05$). All concentrations promoted a higher germination percentage when compared to control treatment. Seeds exposed to the 2% concentration exhibited a 25% increase in seed germination in comparison with control treatment. There was a significant effect of *S. liebmannii* extract on germination time ($p=0.0013$). The results presented in this study clearly show the efficacy of *Sargassum liebmannii* extract promoting jicama seed germination percentage.

Key words: seaweed, extract, *Sargassum liebmannii*, germination

INTRODUCTION

Seaweeds are an integral part of coastal ecosystems and are known to aid and stimulate vegetables, fruits and other crops growth[1]. Seaweeds are also considered important marine renewable resources. They are used as food, fodder, fertilizer, to obtain agar, alginate, carrageenan and as a source of various fine chemicals[2]. In recent years, the use of natural seaweeds as fertilizer has allowed the gradual substitution of conventional synthetic fertilizers[3]. Seaweed extracts are marketed as liquid fertilizers and bio-stimulants since they contain multiple growth regulators such as cytokinins[4], auxins[5], gibberellins[6,] betaines[7,] as well as micronutrients such as Ca, K, P, and micronutrients like Fe, Cu, Zn, B, Mn, Co and Mo, necessary for plant growth and development[3]. Seaweed extracts also enhance soil properties through the improvement of moisture holding capacity[2] and promoting the growth of beneficial soil microorganisms[3]. Application of seaweed extract as organic bio-stimulant is quickly becoming an accepted practice in horticulture[8]. Abetz[9] and Ferreira & Lourens[10] reported that seaweed extract is an effective fertilizer for many crops including trees, flowering plants and grain crops. Many physiological responses to seaweed extracts exhibited by crop plants are attributed to cytokinins[5, 11, 12].

In this work we assessed the effect of *Sargassum liebmannii* extract concentration on jicama germination (*Pachyrhizus erosus* (L.) Urban).

METHODS

Sargassum liebmannii was collected from the coastal area of Majahua, Guerrero (17° 48’ 08’’ N, 101° 44’ 55’’ W) during May 2013. The samples were washed thoroughly with seawater to remove all unwanted impurities, adhering sand particles and epiphytes. Then samples were washed thoroughly using distilled water to remove surface salt and spread on blotting paper to remove excess water.

A crude extract was prepared with 30 g dry weight of *S. liebmannii*. Dry material was cut into small pieces using a blender and mortar pestle, and 100 ml ethanol were added afterwards. The mixture was allowed to stand 24 hours under refrigeration, filtered with gauze and centrifuged at 3500 rpm for 20 minutes. The solution was considered as 100% concentration and three different concentrations (2%, 5% and 10%) were prepared by dilution with distilled water.

Jicama seeds were purchased from a seed supplier ("El semillero") in Mexico City. Seeds were washed 3-5 times with distilled water, then soaked in 30 ml of 5% sodium hypochlorite solution (NaClO) for 3 min, stirred vigorously, the solution was immediately decanted into a 125 ml beaker and washed three times with distilled water for 1 minute.

Seeds uniform in shape, size, color, and weight were selected for the experiment. Four treatments were used (0%, 2%, 5% and 10%), with three replicates for each treatment, and one hundred seeds for each replicate. Prior to germination, seeds were soaked in seaweed extract at treatment concentration for 24 h at room temperature (24 ± 2 °C), and then placed on Petri dishes with filter paper. Petri dishes were placed in the dark. Filter paper was kept moist by regular addition of distilled water or seaweed extract according to treatment. Seed germination was counted every day, until day 14.

Statistical analysis. One-way analysis of variance was performed to assess the effect of seaweed extract concentration on germination percentage. A Tukey test was used for the post-hoc multiple comparison of means. A Kruskal-Wallis test was performed to assess the effect on germination time. All statistical analysis were performed with PAST ® 2.17c.

RESULTS

Seaweed extract had a significant effect on germination of *Pachyrhizus erosus* seeds ($p<0.05$). All concentrations promoted a higher germination percentage when compared to control treatment. Seeds exposed to the 2% concentration exhibited a 25% increase in seed germination in comparison with control treatment **(Figure 1).**

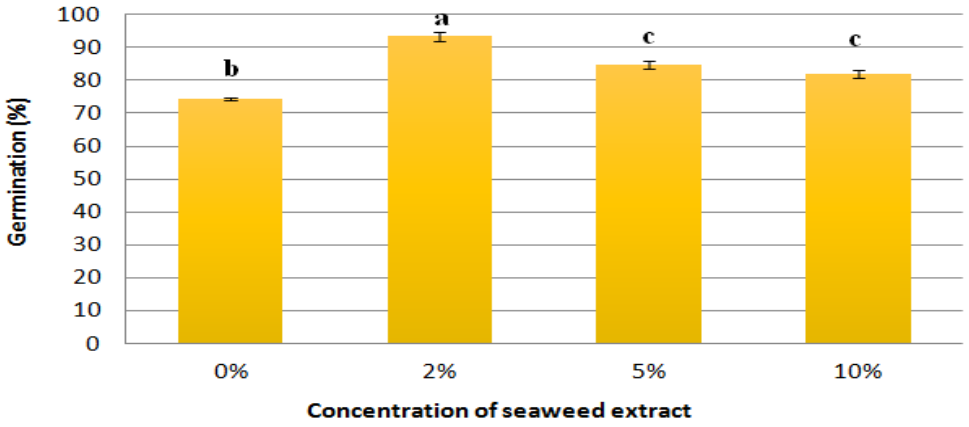

Figure 1: Effect of *Sargassum liebmannii* extract concentration on *Pachyrhizus erosus* germination percentage (mean +/- std.dev.).

Seeds treated with 2% seaweed extract concentration also exhibited a higher germination rate than 5 and 10% concentration as shown in **Figure 2.**

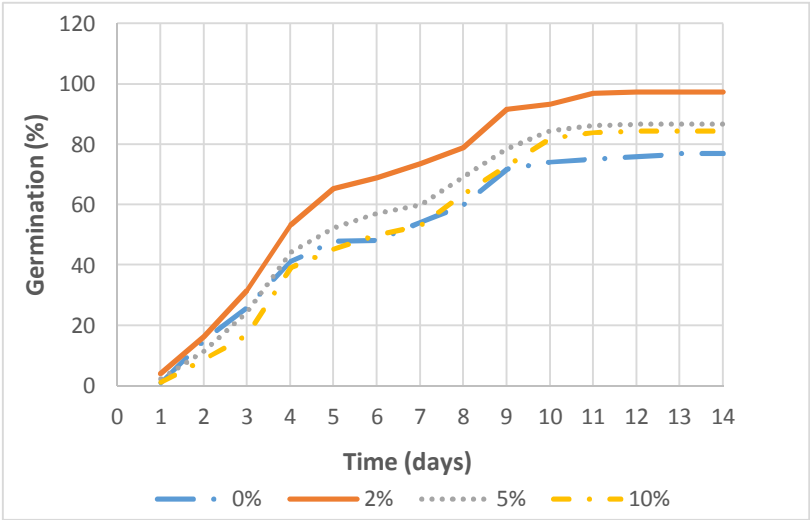

Figure 2: Daily germination of *Pachyrhizus erosus* seeds exposed to different concentrations of *Sargassum liebmannii* extract.

There was a significant effect of *S. liebmannii* extract on germination time (Kruskal-Wallis test, H=15.67, p=0.0013). A nonparametric multiple comparison test showed that there was no difference between seeds

exposed to a 2%, 5% concentration and control group. Nevertheless seeds exposed to a 10% concentration of the extract, germinated almost one day later than seeds exposed to a 2% concentration ($p<0.005$) **(Table 1 and Figure 3).**

Table 1: Germination time for *Pachyrhizus erosus seeds* exposed to different concentrations of *Sargassum liebmannii* extract (Mean ± std error, and 95% confidence interval)

Treatment	Mean germination time ± std. error	95% Confidence interval	n
0% (control)	5.07± 0.17	(4.73, 5.41)	223
2%	4.81 ± 0.16	(4.51, 5.12)	280
5%	5.27 ± 0.16	(4.95, 5.90)	254
10%	5.71 ± 0.17	(5.38, 6.03)	246

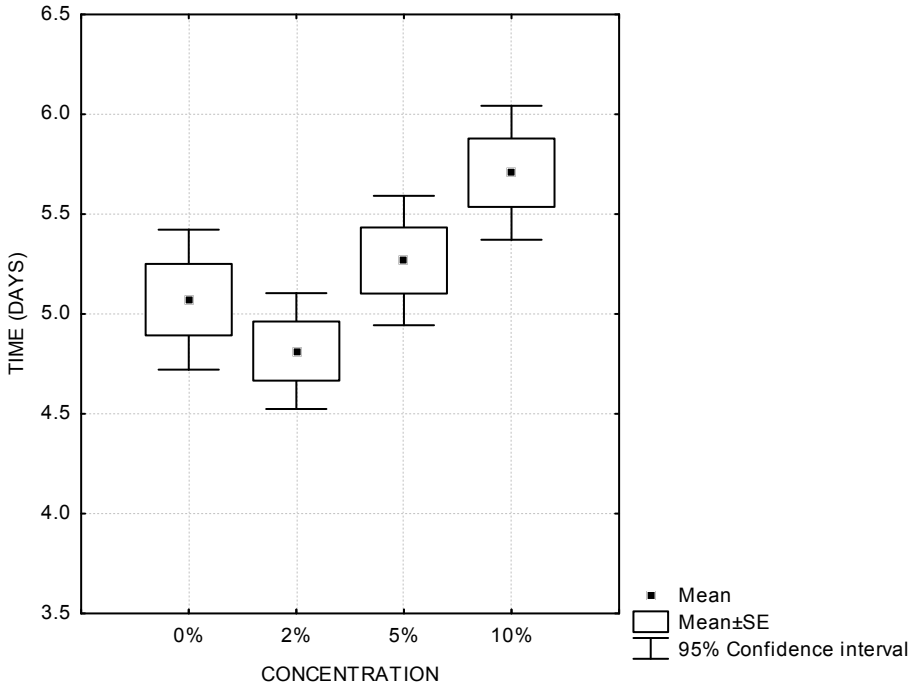

Figure 3: Germination time for *Pachyrhizus erosus seeds* exposed to different concentrations of *Sargassum liebmannii* extract (mean ± std error, and 95% confidence interval)

Seaweed extracts are known to enhance the growth of vegetables, fruits, and other crops as they are reported to contain growth regulators such as auxins (IAA and IBA), gibberellins, cytokinins, betaines, and major macro- and micronutrients[1].

The results presented in this study clearly show the efficacy of *Sargassum liebmannii* extract promoting jicama seed germination percentage ANOVA ($F = 38.39$ and $p = 0.042$). Seed treatment with 2% seaweed extract

gave the highest percentage of seed germination while 0% of concentration gave the lowest. The control treatment (0%) was statistically different from other treatments ($p<0.05$) as well as treatment 2% which had the highest germination percentage of seeds, while there was no significant difference between 5 and 10 % treatments, according to Tukey multiple comparison test **(Figure 1)**.The increased germination percentage at low concentrations may be due to the presence of some growth regulators, micro- and macronutrients[13].
Our results coincide with those of earlier studies. Kalaivanan and Venkatesalu[14] proved that seeds soaked with low concentrations of *Sargassum myriocystum* seaweed extracts showed higher rates of germination, while increasing concentrations of the extract inhibited the germination. Hong *et al.* [3] reported that the percentage of germination in various crop such as vegetables and fruits were increased by using seaweeds as bio-fertilizer. Xavier and Jesudass[15] also reported that 100% seed germination was found in lower concentrations of *Caulerpa racemosa* extract. Pise and Sabale[16] found that higher concentrations of *Sargassum ilicifolium* and *Ulva fasciata* showed a decreasing effect on the seed germination. Numerous studies have revealed a wide range of beneficial effects of seaweed extract applications on plants, such as early seed germination and establishment, improved crop performance and yield, elevated resistance to biotic and abiotic stress, and enhanced postharvest shelf-life of perishable products[17].

CONCLUSIONS

The present study revealed that *Sargassum liebmannii* is a potential germination promoter for *Pachyrhizus erosus* seeds. These results support the application of seaweeds as natural fertilizers. This study is an important step towards the use of *S. liebmannii* in Mexico and supports that the seaweed extract is an effective and low cost fertilizer that may be promoted as an eco-friendly bio-fertilizer across Mexico.

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