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Utilization of Seaweeds to Enhance Growth and Nutritive Status of *Amaranthus Caudatus* L

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Abstract: *Modern agriculture is looking for new biotechnological advances that would allow a reduction in the use of chemical inputs without affecting crop yield or the farmer's income. Seaweeds, marine organic resource was formulated into organic aqueous extract and was applied to Amaranthus caudatus L. Seaweed liquid fertilizer (SLF) of Padina pavonia enhanced the shoot length, root length and leaf area by 83%, 131% and 79% respectively under the soil application in comparison with control. Application of SLF of Padina tetrastromatica also increased number of leaves (56.8%), above ground biomass (145%), flavonoid (91.8%), total carbohydrate (61.6%), free radical scavenging activity (67.8%) and superoxide radical scavenging activity (175%) when compared to control. Application of SLF of Stoechospermum marginatum enhanced the total cholorophyll, total phenolic content, vitamin C, carotenoid, total soluble protein and free amino acid in relation to control. The study revealed that SLF of Padina pavonia was found to be highly effective in enhancing only the growth and leaf area. Application SLF of Padina tetrastromatica also enhancing number of leaves and above ground biomass. Even though, SLF of Stoechospermum marginatum did not promote any of these growth parameters, but stimulated the production of photosynthetic pigments, phytochemical and biochemical constituents. The results of the present study showed that SLF of three seaweeds maintained well the plant growth to increase yield of consumable product.*

Keywords: *Seaweed liquid fertilizer (SLF), Stoechospermum marginatum (Ag) Kulz, Padina pavonia (L.) J.V. Lamouroux, Padina tetrastromatica Hanck and Amaranthus caudatus L.*

1. INTRODUCTION

Application of synthetic growth promoters in agriculture farming has been in practice for many decades. However, continuous use of inorganic fertilizers in traditional farming has been losing its popularity because of its adverse effect in altering the chemistry of the soil, making it less congenial for plant growth. Moreover, the harmful effects of inorganic fertilizers have serious impact on human health [1]. Seaweeds constitute one of the important biotic components of the ocean and might serve as an alternative to inorganic fertilizers [2]. The use of seaweed manure in conjunction with the inorganic fertilizers has been found to be better than the other organic input for the growth and development of plant [3]. Seaweed liquid fertilizers will be useful for achieving higher agricultural production, because the extract contains growth promoting hormones (IAA and IBA), cytokinins, gibbrellins, trace elements, vitamins, amino acids, antibiotics and micronutrients [4]. The higher amount of water soluble potash, other minerals and trace elements present in seaweeds are readily absorbed by plants and they control deficiency diseases [5]. The carbohydrates and other organic matter present in seaweeds alter the nature of soil and improve its moisture retaining capacity [5]. Liquid seaweed extract when applied to seed, soil or sprayed on crops increased seed germination percentage, nutrient uptake, growth [6] and yield of crops [7]. The diluted liquid seaweed extract also enhanced the plant's defence against diseases and increases salt [8] and biotic and abiotic stress [9, 10 and 11]. Considering the importance of seaweed extract for agricultural applications, an attempt has been to evaluate the growth enhancing properties of extracts prepared from three species of brown seaweeds namely: *Padina pavonia, Padina tetrastromatica* Hanck and *Stoechospermum marginatum* (Ag) Kulz on a green leafy vegetable plant (*Amaranthus caudatus* L.)

2. MATERIALS AND METHODS

2.1. Collection of Seaweeds

Padina pavonia, Padina tetrastromatica and Stoechospermum marginatum were collected during low tide, at Hare Island, Thoothukudi from November 2012 to February 2013. The samples were washed thoroughly with seawater followed by fresh water to remove the sand particles and macroscopic epiphytes. After draining, the seaweeds were shade – dried, powered, sieved and used for the preparation of seaweed concentrate.

2.2. Preparation of Seaweed Liquid Fertilizer for Soil Application

About 20g dried seaweed powder with 200ml distilled water was added. It was heated to 60^0C and maintained at the temperature for 24h using a hot air oven. The extract was filtered and then centrifuged at 5000 – 10000 rpm to remove most of the suspended impurities. The filtrate was stored in air tight bottles at 4^oc (100% seaweed concentrate) [12]. Suitable dilution (1%) was used for soil application on leafy green vegetable crop, *Amaranthus caudatus L*.

2.3. Experimental Design

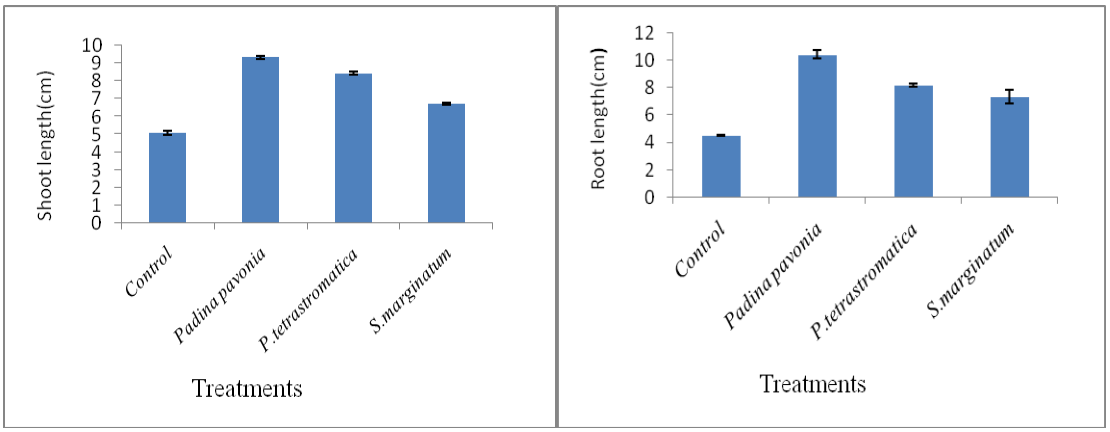
A pot culture experiment was conducted during February to April 2013 at Plant Research Centre, St. Mary's College Campus, Thoothukudi. The pots were filled with 3kg of garden soil. 50 seeds were sown in each pot. After the emergence of seedlings, they were thinned to ten plants per pot and allowed to grow for a period of 30 days. Weeding and watering were done at regular intervals throughout the experimental period. SLF was applied in soil (along with 100ml of distilled water in the ratio of 1: 10) after expansion of first leaf and was continued for twenty days.

2.4. Analyses

Chemicals of analytical grade were used for all the analyses. Plants from each treatment were randomly drawn to study the growth parameters, photosynthetic pigments, biochemicals and antioxidant activities. Growth contributing parameters such as shoot and root length, number of leaves/plant, leaf area and above ground biomass were measured. Root length and shoot length were measured using ruler and recorded in centimeter. Leaf area was measured by using graph paper method as described by [13]. Total chlorophyll and carotenoid [14], total soluble protein [15], carbohydrate [16], free amino acid [17], vitamin C [18], total phenolic content [19], flavonoids [20], DPPH scavenging activity [21], super oxide radical scavenging activity [22] and ferric ion reducing power assay [23] were also recorded. Leaves harvested from 30 days old plants were used for all analyses.

2.5. Statistical Analysis

Data collected in this study was analysed by using Microsoft Excel 2007. One way ANOVA was used to compare differences in the means of total chlorophyll, carotenoid, carbohydrate, free amino acid, soluble protein, vitamin C, total phenolic content, flavonoids, DPPH scavenging activity, superoxide radical scavenging activity and ferric ion reducing power assay of control and treated plants. A significant difference was considered at the level of $p<0.05$.



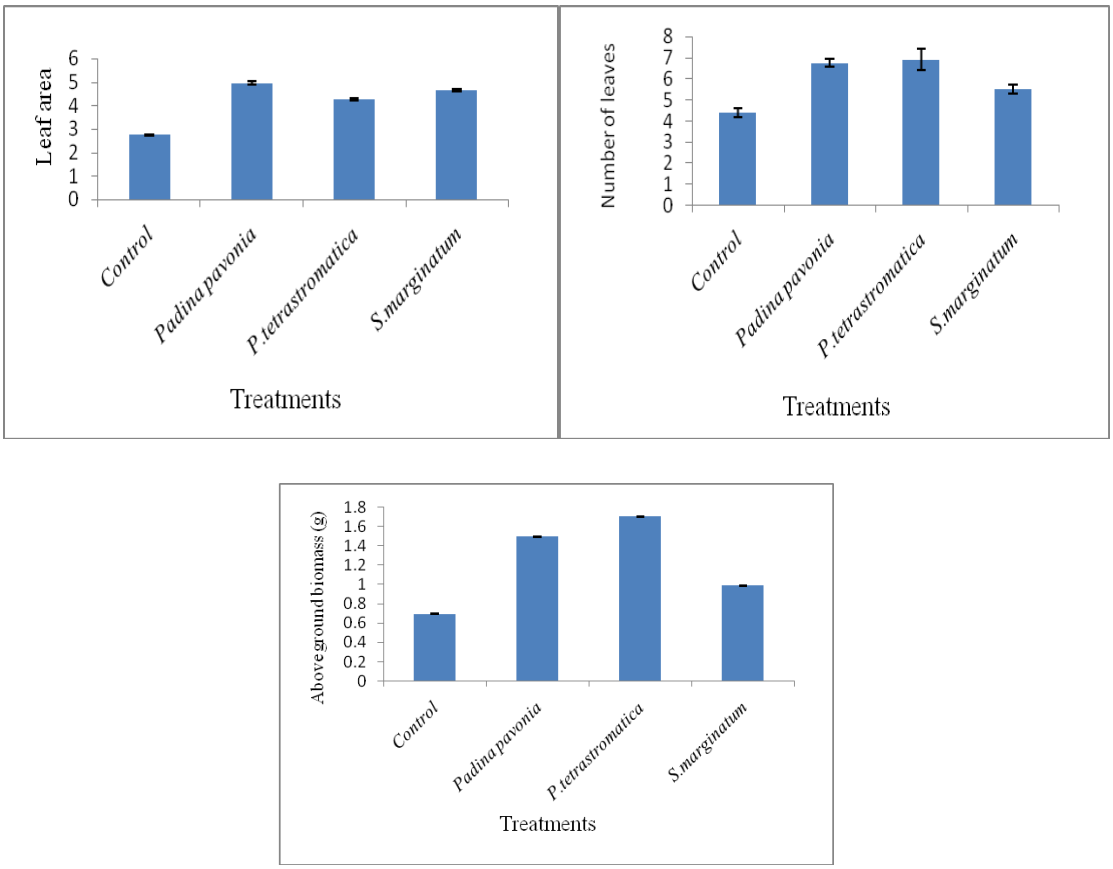


Fig1. *SLF (1%) was applied for 30 days. Each value represent the mean of 10 replicates ± SD.*

Table1. *Effect of soil application of SLF on photosynthetic pigments, phytochemical and biochemical constituents of Amaranthus caudatus L.*

Soil application				
Parameters	Control	*Padina pavonia*	*Padina tetrastromatica*	*Stoechospermum marginatum*
Carotenoids (mg/g FW)	41.71±0.6	60.73±0.4*	54.24±0.7*	66.96±0.5*
Total phenolic content (mg GAEs/g FW)	2.18±0.04	3.03±0.02*	3.10±0.004*	3.31±0.06*
Flavonoid (mg QEs/g FW)	35.56±1.3	60.47±1.3*	68.22±1.5*	57.98±0.8*
Vitamin C(mg AAEs/g FW)	3.84±0.10	5.11±0.08*	5.36±0.1*	5.54±0.9*
Total soluble protein (mg/g FW)	1.9±0.05	2.3±0.02*	2.8±0.03*	3.1±0.007*
Total carbohydrates (mg/g FW)	26.99±0.5	39.15±0.7*	43.62±0.4*	42.12±0.3*
Free amino acid (mg/g FW)	4.00±0.03	5.26±0.05*	5.07±0.07*	5.96±0.07*
Total chlorophyll (mg/g FW)	0.80±0.01	1.13±0.006*	1.09±0.003*	1.34±0.008*

*Note: *indicates mean values significant at p<0.05 level.*

Values are the mean of three replicates ±S.D.

All the variables were recorded on 30 days old plants

Control = Control plants were irrigated with water.

SLF = 1% seaweed liquid fertilizer.

mg GAEs/g FW = milligram gallic acid equivalents.

mg QEs/g FW = milligram quercetin acid equivalents.

mg AAEs/g FW = milligram ascorbic acid equivalents.

Table2. *Effect of soil application of SLF on antioxidant activity of Amaranthus caudatus L.*

Soil application				
Parameters	Control	*Padina pavonia*	*Padina tetrastromatica*	*Stoechospermum marginatum*
Free radical scavenging activity(%)	37.33±0.6	61.00±1*(63%)	62.66±0.6* (67.8%)	56±0.5*(50%)
Ferric ion reducing antioxidant activity (Absorbance)	0.2±0.002	0.53±0.002* (165%)	0.48±0.005*(140%)	0.55±0.01*(175%)
Superoxide radical scavenging activity (%)	44.66±1.5	73±1.2* (63%)	75.33±1* (68%)	69.33±0.8* (55%)
Standard – Ascorbic acid (1mg/ml) Free radical scavenging activity (DPPH) – 98.27% Ferric ion reducing antioxidant activity (FRAP)- 0.853 Superoxide radical scavenging activity – 65%				

*Note: * indicates mean values significant at p<0.05 level.*

Values are the mean of three replicates ±S.D.

All the variables were recorded on 30 days old plants.

Values within parenthesis indicate percentage increase over control.

Control = Control plants were irrigated with water.

SLF = 1% seaweed liquid fertilizer.

3. RESULTS AND DISCUSSION

The results showed that soil application of SLF of among three seaweeds of *Padina pavonia* increased the shoot length (83%), root length (131%) and leaf area (79%) when compared to control plants. SLF of *Padina tetrastromatica* enhanced the number of leaves (56.8%) and above ground biomass (145%) with respect to control (Fig.1). Plants can take up biologically active compounds of seaweed concentrates through root and leaves [24 and 25]. The rooting response was attributed to endogenous indoles which were probably present in the aqueous seaweed extract, resulting in healthy root and shoot. [26] Reported that lower concentration of SLF from *Stoechospermum marginatum* promoted the growth of brinjal and [27] also reported similar effect in Cow pea and [28] reported linear growth of both root and shoot in black gram seeds. The seaweed extracts improve the absorption of nutrients through the roots causing additional and strong overall growth of the plant [29]. In the present investigation, more carotenoid level was recorded in SLF of *Stoechospermum marginatum* (60%), *Padina pavonia* (43%) and *Padina tetrastromatica* (30%) when compared to control plants (Table-1). A similar observation was made in *Vigna catajung* and *Dolichos biflorus* [30 and 31], C*yamopsis tetragonoloba* [32]. In the present investigation, SLF of *Stoechospermum marginatum* enhanced the total soluble protein (63%) and free amino acid (49%) when compared to untreated plants (Table 1). It was reported that total soluble protein and free amino acid contents were increased in *Vigna mungo* [33], *Cyamopsis tetragonoloba* [34] *and Brassica nigra* [35] by SLF of *Stoechospermum marginatum and Padina tetrastromatica.* In the present study the highest carbohydrate was observed in the soil application of SLF of *Padina tetrastromatica* (61.6%), *Stoechospermum* (56.05%) and *Padina pavonia* (49.9%) than control (Table 1). Total carbohydrate increased upto 50% concentration of SLF of *Hypnea musiformis* with NPK application in black gram [36], *Vigna catajung* and *Dolichous biflorus* [30 and 31]. In the present study soil application of SLF of *Stoechospermum marginatum,* enhanced remarkably in vitamin C (44.2%), total phenolic content (51.8%) and ferric ion reducing power activity (140%) in relation to control (Table 1and 2). Vitamin C, one of the most important of all vitamins, plays an important role in various biochemical processes, such as collagen formation, iron absorption and is involved in neurotransmission and immune response in humans [37]. In the present study soil application of SLF of *Padina t*e*trastromatica* highly increased flavonoid content, free radical scavenging activity (DPPH) and superoxide radical scavenging activity by 91.8%, 66% and 67% respectively

with respect to control (Table 2). Free radicals are responsible for aging and causing various human diseases. Reactive oxygen species such as hydroxyl superoxide and peroxyl radicals are formed in human cells by endogenous factors and result in extensive oxidative damage which can lead to select degenerate conditions and other human diseases [38]. Phenolic compounds can act as antioxidants by chelating metal ions, preventing radical formation and improving antioxidant endogenous system [39]. Phenols are present in seaweeds and plants are found to be new natural and they are acting as new natural source of antioxidants [40].

4. CONCLUSION

The study revealed that SLF of *Stoechospermum marginatum*, *Padina tetrastrastromatica* and *Padina pavonia* could be effectively used in agriculture as an environmentally healthy organic to increase yield and nutrient status of crop plants.

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