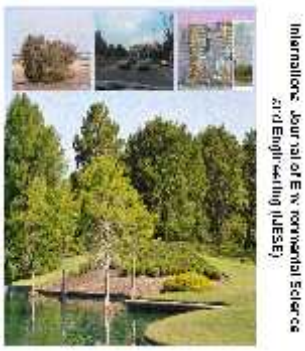
INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCE AND ENGINEERING (IJESE)
Vol. 6: 47 - 57 (2015)
http://www.pvamu.edu/research/activeresearch/researchcenters/texged/international-journal
Prairie View A&M University, Texas, USA



Variation in taxonomical position and biofertilizing efficiency of some seaweed on germination of *Vigna unguiculata* (L)

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ARTICLE INFO
Article History
Received: July 8 2015
Accepted: Aug. 9 2015
Available online: March 2016

Keywords:
Biochemical composition
Germination
Growth parameters
Seaweed Liquid Fertilizer
Vigna unguiculata.

ABSTRACT

In the present investigation, the effect of seaweeds liquid fertilizer (SLF) prepared from fresh and dry seaweeds on different growth parameters of *Vigna unguiculata* (L) were determined. The maximum root length, shoot length, number of lateral root branches, seed weight and percentage of seed germination were observed in treatment with *Sargassum vulgare* (Phayophyta), *Laurencia obtuse* (Rhodophyta) and *Caulerpa racemosa* (Chlorophyta) in both fresh and dry extract of SLF. Phenols, protein, carbohydrates, nitrogen and phosphorus were determined in *Sargassum vulgare*, *Laurencia obtuse* and *Caulerpa racemosa*. The highest protein and nitrogen content were recorded in *Laurencia obtuse* however, phenols and carbohydrates found to be maximum in *Caulerpa racemosa*.

1. INTRODUCTION

Seaweeds are the macroscopic marine algae found attached to the bottom in relatively shallow coastal waters. They grow in the intertidal, shallow and deep sea areas up to 180 meter depth and also in estuaries and backwaters on the solid substrate such as rocks, dead corals and pebbles. Seaweed zone is one of the conspicuous and wide-spread biotope in the shallow marine environment (Thirumaran *et al.*, 2009). Marine algae are classified by the researchers as the most important group of organisms which can be widely used in plants nutrition (Tuhy *et al.*, 2013).

Marine algae are used as fertilizers on farmlands close to the sea, examples include the large brown and red algae used as organic fertilizers; which are usually richer in potassium but poorer in nitrogen and phosphorus **(**Waaland, 1981**).** The value of marine algae as agriculture fertilizer was recognized since fourth century as a partial substitute for manure (Chapman and Chapman, 1980). Seaweed extracts act as biostimulants mainly due to the presence of plant hormones: auxins, cytokinins, gibberelins, abscisic acid, ethylene and macronutrients (Matysiak and Adamczewski, 2009).

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ISSN 2156-7530

Auxins are responsible for elongational growth of plant tissues and apical dominance, cell division, plant movements and plant aging (Matysiak and Adamczewski, 2009; Lewak *et al.,* 2009).

Cytokinins are involved in cell division regulation affecting plant growth and rest period (Khan *et al.,* 2009). These substances can influence shoot and root system development (Durand *et al.,* 2003; Stirk *et al.,* 2004). As well, macronutrients and micronutrients can help promote the growth of various vegetables, fruits, and other crops (Moller and Smith, 1998). Many beneficial effects have been reported on the use of seaweed extracts. Positive responses include improved germination, root development; leaf quality, general plant vigor, and resistance to pathogens (Khan *et al.,* 2009). Seaweed contain all the trace elements and plant growth hormones required by plant, regulators promoters available to enhance yield attributes (Crouch and Van staden, 1991; 1993). The SLF obtained from brown, red and green seaweeds are now available commercially in trade names such as Maxicrop (SEA BORN), Algifert (Manure), Golmar, GA 14, Kelpak 66, Seaspray, Seasol SM3, Cytex and Sea Crop 16 for used in agriculture (Jeanin *et al.,* 1991). The present study intends to investigate the effect of seaweed liquid fertilizer (SLF) of some green, red and brown seaweeds on germination and some growth parameters of *V. unguiculata* (L).

2. MATERIAL AND METHODS

2.1 Collection and identification of algal species

In the present study, six species of seaweeds (three Rhodophyceae, two Chlorophyceae and one Phaeophyceae) were collected in summer 2014 at depth of 0.2 m or less for Chlorophyceae and 1m for Rhodophyceae and Phaeophyceae from Rocky Bay of Abu Qir (30° 00/and 31° 31/E) and lat. (31° 20/and 31° 30/ N) (Fig. 1). All samples were brought to the laboratory in plastic bags containing sea water to prevent evaporation. Algae were then cleaned from epiphytes and rock debris and given a quick fresh water rinse to remove surface salts. Some of fresh samples were processed as herbarium specimens on the same day of collection; others were preserved in 4% formalin in seawater for taxonomic classification. Seaweeds were identified by examination of their thallus architecture and special morphological characters: Fronds, branching, and reproductive structures following the methods of Abbott and Hollenberg (1976); Taylor (1960); Aleem (1993) and Jha *et al.* (2009). The names of the species were used according to Guiry and Guiry (2011).

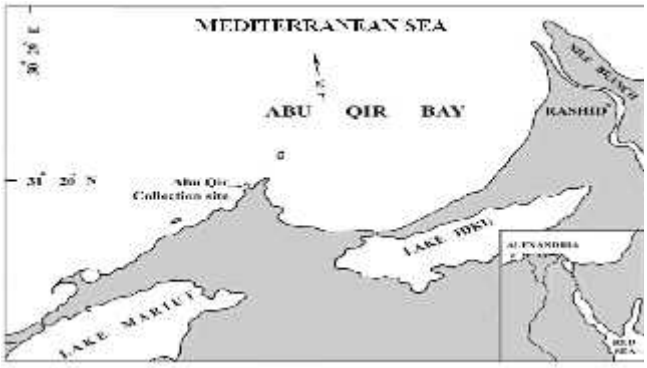

Fig. 1: Map of Abu Qir Bay showing collection sites.

2.2 Preparation of Seaweed Liquid Extracts (SLE) from fresh seaweeds

One kilograms of fresh seaweed was finely chopped and mixed with 1 L of distilled water for 24 h and then extract was

filtered through muslin cloth followed by Whatmann No. 41 (pore size 20-25 µm) filter paper (Bhosle *et al.,* 1975). The filtrate was 100 % seaweed extract. From this, different concentrations of seaweed liquid extract (10, 20, 40, 60, 80 and 100%) were prepared by diluting with distilled water. The seaweed extract was stored at 4˚C for further studies.

2.3 Preparation of SLE from dry seaweeds

Freshly collected seaweeds were shade dried for five days. Dried material was finely powdered. One kilogram gram of finely powdered material was extracted as fresh seaweeds as described previously.

2.4 Physico-Chemical Analyses of Seaweed Liquid Extract

The colour of the SLE was observed visually and recorded and the pH was measured by pH meter (Elico, India).The chemical composition of best seaweeds were estimated e.g. carbohydrate content of the tested algae was estimated by method of Dubois (1956), total nitrogen was carried out with Micro-Kjeldahel method (Anonymous, 1990) and total phenolic content was estimated according to the method of described in Lim *et al.* (2002). Phosphorus concentration was determined spectrophotometrically by method of Aspila *et al.* (1976).

2.5 Seed Soaking

One hundred seeds of *V. unguiculata* (L) Kaha1 obtained from Agricultural Research Center (ARC) Cairo, Egypt were soaked for each concentration of Seaweed liquid extracts (10, 20, 40, 60, 80 and 100%) for 24 hours. Control seeds were soaked in distilled water for 24 h. After a period of 24 hrs at room temperature (28 ± 2˚C), seeds were placed on Petri dishes containing filter paper. Seed containing Petri plates were placed at room temperature (28 ± 1˚C). The filter paper was kept moist by regular addition of tap water for control seeds and treatment seeds. The germination percentage and growth parameter were recorded after 7 days of sowing.

2.6 Statistical analysis:

Results are presented as mean ± standard deviation (SD) from three replicates. The statistical analyses were carried out using SAS (v 6.12). Data obtained were analyzed statistically to determine the degree of significance using one way analysis of variance (ANOVA) at probability level $p \leq 0.05$.

3. RESULTS

3.1 Taxonomic description of the used seaweeds:

Algal collection were made from different sites along the Bay of Abu Qir, identified as presented in the literatures, checked for synonyms and latest accepted names, referred to its systematic groups and described. The collected species were identified as *Amphiroa fragilissima* (Linnaeus) Lamouroux, *Laurencia obtuse* (Hudson) Lamouroux and *Pterocladia capillacea* (S.G.Gmelin) Bornet *ex* Bornet from Rhodophyceae, *Caulerpa racemosa* var. *turbinata-unifera* and *Codium decorticatum* (Woodward) Howe from Chlorophyceaes and *Sargassum vulgare* Agardh from Phaeophyceae.

3.2 Taxonomic position:

Phylum (1): Rhodophyta;
Class: Rhodophyceae;
Order (1): Corallinales;
Family: Corallinaceae;
Genus: ***Amphiroa fragilissima*** **(Linnaeus)**
(Fig. 2)

Synonyms: *Amphiroa cuspidata* (Ellis and Solander) J.V. Lamouroux, *A. cyathifera* J.V. Lamouroux.

Morphology: The frond of thallus is red in colour, up to 4 cm tall, cylindrical, rigid, erect, fragile and regularly dichotomously branched with apices obtuse, reach to 1 cm tall. Plant calcified except at the node, cream colour.

Remarks: It is epizoic on and in gastropod shells and present in moderate amount along the beach during summer season.

Order (2): Ceramiales;
Family: Rhodomelaceae;
Genus: ***Laurencia obtuse*** **(Hudson)**
Lamouroux (Fig. 3)

Synonyms: *Fucus obtusus* Hudson; *Chondria obtusa* (Hudson) C. Agardh; *Sphaerococcus obtusus* (Hudson) Wahlenberg.
Morphology: Thallus red to brownish red in colour, 5- 10 cm tall, axis erect, bushy, cartilaginous, cylindrical branching pinnate, opposite attached by discoid holdfasts.
Remarks: Plants form a distinct community in mid and lower littoral on rocks associate with *Jania rubens* and some shells.

Order (3): Gelidiales; Family: Gelidiaceae;
Genus: ***Pterocladia capillacea*** **(S.G.Gmelin) (Fig. 4)**
Synonyms: *Gelidium capillaceum* (S.G.Gmel.) Kütz; *Pterocladia capillacea* (S.G. Gmel.) Bornet and Thur.; *P. pinnata* (Huds.) Papenf.
Morphology: Thalli up to 5-7 cm high, consisting of erect and prostrate dark red axes. Branches alternate on the main axis and the lateral branches reached to 0.5-1.5 cm tall
Remarks: It is epilithic on bed rock grow near the water level down to a depth of 1 m in dense amount and associated with *Ulva compressa***.**

3.3 Taxonomical position:

Phylum (2): Chlorophyta;
Class: Chlorophyceae;
Order: Bryopsidales;
Family (1): Caulerpaceae;
Genus: *Caulerpa racemosa* var. *turbinata-unifera* (Fig. 5)

Synonyms: *Caulerpa racemosa* (Förssk) in the Mediterranean has morphological has been regarded as an Indian Ocean species immigrated via the Suez Canal since its opening in 1869. *C. racemosa* varturbinata (J.Agardh) Eubank. (Papenfuss).*C. racemosa* var. *turbinate* (J. Agardh).
Morphology: Thallus green; stolon is densely branched, 2-4 mm thick; erect branches are 0.5- 5 cm long; branchlets are more frequent, alternate to spirally arranged, ovoid to caveat shape with a flattened apex.
Remarks: It forms green cushion in shallow subtidal zone and associated with *Griffithsia equisetifolia* C. Agardh in moderate amount.

Family (2): Codiaceae;
Genus: ***Codium decorticatum*** **(Woodward) Howe (Fig. 6)**
Synonyms: (*Codium decorticatum* (Silva) Taylor, *C. elongatum* (Turner) C. Agardh, *C. tomentosum* (Stackh.) var. *elongatum* (Turner) Ardissone.
Morphology: Plants dark green in colour, 10 – 30 cm tall, 3 – 5 mm broad, bushy, seldom proliferous, attached by basal discs, regularly Remiform and spongy dichotomous, younger branches of the thallus terate, apices rounded, truncate or depressed, hair scars variable.
Remarks: It is epilithic on rock in small amounts and *Jania rubens* epiphytic on it.

Phylum (3): Phaeophyta;
Class: Phaeophyceae;
Order: Fucales; Family: Sargassaceae;
Genus: ***Sargassum vulgare*** **Agardh (Fig. 7)**
Synonyms: *Sargassum albertisii*.; *S. boryanum* Mont.; *S. endiviaefolium* Bory; *S.cheirifolium* Kütz.; *S. dichocarpum* Kütz.; *S. diversifolium* Kunth; *S. fissifolium* Kütz.; *S. lendigerum* (L.) C. Agardh; *S. obtusatum* Bory; *S. salicifolium* f. *Diversifolia* (Bory) Grunow; *S. tenue*var. *Gabonensis* Grunow.
Morphology: Thalli are dark brown in colour. Fronds are pyramidical in shape; they reach about 20-25 cm in length. The stipe is small and cylindrical; it is attached to the substratum by a small disk and gives rise from the distal end to caespitose primary branches. Leaves are large, linear or serrate, with dentate or undulate margin, reach 4 cm tall and spirally arranged. There are one or more air bladders which are be modified from basal members of the axillary branch.
Remarks: Thallus is epilithic on bed rock in the lower littoral and it is form a distinct and dense community, whereas *J. rubens* and *Colpomenia sinuosa* epiphetic on stipe of it.

Fig. 2

Fig. 3

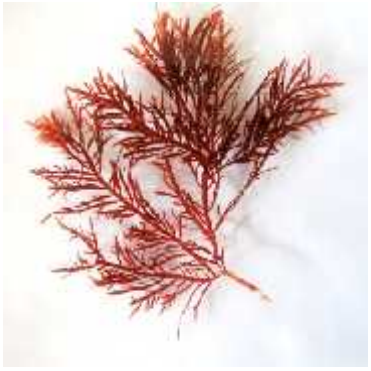

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Plate1. Photos of the studied seaweeds Fig. (2) *Amphiroa fragilissima*, (3) *Laurencia obtuse*, (4) *Pterocladia capillacea*, (5) *Caulerpa racemosa*, (6) *Codium decorticatum* and (7) *Sargassum vulgare*.

Biofertilzing efficiency of the tested seaweeds. Physical properties of SLF of all tested seaweed before preparation of different concentrations were shown in Table 1.

Table 1: Physical analysis of the tested seaweeds extract.

Species	Color	pH	
		fresh	dry
A. fragilissima	Faint red (pink)	7.84	6.8
L. papillosa	Dark brown	7.38	7.99
P. capillacea	Dark red	6.91	7.2
C. racemosa	Dark green	7.68	7.06
Codium decorticatum	Dark green	7.16	7.11
S. vulgaris	Dark brown	7.63	7.67

In the present investigation100% seed germination was found to be at 20% fresh SLF extract of *S. vulgare* (Table 2A), and great percentage of germination was attained with 20% dry SLF of *C. racemosa* (Table 2B). As observed from Table (2B), 10% dry SLF extract of *L. obtuse* provide meaningful effect on shoot height compared to the control plant and 20% fresh SLF extract of *C. racemosa* provide the significant effects on shoot height. The data recorded in Table (2A) showed that 40% fresh SLF extracts of *P. capillacea* and *L. obtuse* have significant effect on root depth, on the other hand, 40% dry SLF extract of *C. decorticatum* and *P. capillacea* was the best concentration for root depth (Table 2B). 10% fresh and dry SLF of *C. decorticatum* was the ideal concentration for the lateral root branches, in addition, 10% fresh (Table 2A) and 20% dry SLF extract of *C. racemosa* significally affected lateral root lets formation (Table 2B). The maximum seed weight recorded at 10% dry SLF extract of *S. vulgare* and 10%

fresh SLF extract of *C. racemosa* (Table 2A).

Table 2: Effect of different concentration of (A) fresh and (B) dry seaweed liquid extracts on germination percentage and some growth parameters of *Vigna unguiculata* (L).

Algal spp.	Conc. (%)	A				
		Germination percentage (%)	**No. of rootlets**	**Shoot height (cm)**	**Root depth (cm)**	**Seed weight (gm)**
	cont	64.0±3.60	4.67±0.57	1.33±0.06	0.96±0.06	0.257±0.001
S. vulgaris	**10**	57.67±2.51**	3.67±0.57**	1.1±0.10**	2.60±0.2**	0.303±0.065**
	20	100±0.00**	7.67±0.57**	2.06±0.11**	3.13±0.11**	0.384±0.005**
	40	97.67±2.04**	6.67±0.57**	2.03±0.06**	2.87±0.15**	0.38±0.008**
	60	97.00±2.19**	8.0±1.00**	1.36±0.06 ns	2.60±0.10**	0.35±0.001**
	80	97.00±2.19**	8.0±1.00**	1.46±0.06**	2.43±0.11**	0.346±0.004**
	100	88.67±3.21**	6.3±1.15**	1.56±0.06**	2.03±0.06**	0.297±0.007**
C. decorticatum	**10**	96.00±2.6**	8.67±0.57**	2.0±0.20**	2.93±0.11**	0.398±0.005**
	20	90.67±1.15**	6.67±0.57**	1.93±0.11**	2.60±0.10**	0.38±0.0015**
	40	81.33±1.15**	5.67±0.57**	1.53±0.06**	2.57±0.06**	0.304±0.007**
	60	67.33±2.51**	3.67±0.57**	1.16±0.15**	2.20±0.10**	0.282±0.009**
	80	61.33±2.3**	3.67±0.57**	0.93±0.11**	1.53±0.15**	0.276±0.001**
	100	63.0±1.73ns	2.67±0.57**	0.83±0.06**	1.13±0.15*	0.270±0.001**
C. racemosa	**10**	98.0±3.46**	8.40±1.15**	3.0±0.62**	2.90±0.10**	0.432±0.011**
	20	87.33±2.61**	7.67±0.57**	3.06±0.11**	2.70±0.10**	0.359±0.011**
	40	86.00±1.58**	8.33±1.15**	2.83±0.15**	2.50±0.10**	0.359±0.008**
	60	87.00±2.64**	5.67±0.57**	2.67±0.15**	2.30±0.10**	0.351±0.007**
	80	80.67±1.15**	5.00±0.00**	2.40±0.10**	1.93±0.11**	0.342±0.012**
	100	80.67±1.15**	3.00±0.00**	2.03±0.06**	1.73±0.11**	0.306±0.015**
P. capillacea	**10**	62.67±2.3**	3.00±1.00**	1.4±0.10**	2.63±0.06**	0.339±0.016**
	20	66.00±1.0**	6.67±0.57**	1.36±0.11 ns	2.93±0.20**	0.377±0.014**
	40	69.00±1.73**	8.33±1.15**	2.90±0.10**	3.67±0.06**	0.386±0.01**
	60	69.00±1.73**	5.67±0.57**	1.43±0.15**	2.63±0.11**	0.386±0.008**
	80	66.33±1.52**	6.67±0.57**	1.43±0.11**	2.36±0.15**	0.307±0.007**
	100	62.67±2.3**	8.00±1.00**	1.46±0.06**	2.16±0.06**	0.277±0.011**
A. fragilissima	**10**	91.67±0.57**	8.00±0.57**	1.97±0.1**	2.93±0.11**	0.366±0.009**
	20	90.67±2.30**	7.67±0.57**	1.96±0.15**	2.67±0.15**	0.35±0.005**
	40	90.67±2.00**	6.67±0.52**	1.63±0.15**	2.46±0.06**	0.354±0.008**
	60	90.00±2.00**	4.33±0.57ns	1.53±0.06**	2.40±0.10**	0.327±0.01**
	80	62.67±2.3**	4.30±0.57ns	1.06±0.11**	2.30±0.20**	0.288±0.011**
	100	54.33±1.15**	3.67±0.57**	1.03±0.06**	1.90±0.10**	0.267±0.003*
L. obtuse	**10**	81.33±1.15**	6.00±1.00**	1.96±0.06**	3.33±0.11**	0.303±0.007**
	20	95.00±2.00**	7.60±1.52**	2.2±0.20**	3.47±0.06**	0.414±0.024**
	40	99.33±1.15**	8.33±1.15**	1.43±0.06**	3.93±0.11**	0.419±0.022**
	60	81.33±1.15**	7.33±0.57**	1.43±0.11**	3.10±0.10**	0.295±0.016**
	80	80.67±0.57**	7.33±0.57**	1.96±0.06**	3.33±0.15**	0.289±0.001**
	100	66.67±2.88*	7.67±0.57**	1.46±0.06**	2.46±0.06**	0.262±0.015 ns
F-value		72.37	14.52	48.62	142.46	12.13

Algal spp.	Conc. (%)	B				
		Germination percentage (%)	No. of rootlets	Shoot height (cm)	root depth (cm)	seed weight (gm)
S. vulgaris	**cont**	64.33±3.78	5.30±0.57	1.26±0.15	1.03±0.06	0.257±0.001
	10	80.33±2.51**	4.60±0.57*	1.83±0.11**	1.70±0.1**	0.357±0.009**
	20	76.67±2.88**	4.30±0.57ns	1.73±0.11**	1.43±0.06*	0.335± 0.012**
	40	74.0±1.00**	3.60±0.57**	1.56±0.06**	1.27±0.06*	0.31 ±0.001**
	60	69.33±0.57*	2.00±0.10**	1.46±0.06**	1.30±0.11*	0.301±0.002**
	80	66.67±1.52ns	0.00±0.00**	1.26±0.06ns	1.06±0.06ns	0.299±0.001**
	100	66.33±1.15ns	4.60±0.57*	1.200±1.0ns	1.03±0.11ns	0.294±0.004**
C. decorticatum	**10**	80.33±0.57**	8.00±1.0**	2.00±0.1**	2.23±0.20**	0.298±0.005**
	20	78.33±1.52**	6.00±1.0**	1.76±0.15**	1.50±0.10*	0.298± 0.003**
	40	72.67±2.51**	6.00±1.0**	1.67±0.15**	1.23±0.20*	0.289±0.001**
	60	71.33±1.15**	5.60±0.57*	1.56±0.06**	1.13±0.11ns	0.280±0.003**
	80	63.0±2.64ns	4.30±0.57ns	1.4±0.10*	1.03±0.06ns	0.270 ±0.007*
	100	64.0±2.16ns	4.60±0.57*	1.36±0.06ns	1.03±0.06ns	0.269±0.002*
C. racemosa	**10**	85.67±3.05**	6.30±0.57*	1.4±0.10ns	1.43±0.06*	0.285±0.009**
	20	97.33±2.51**	8.00±1.0**	1.73±0.06**	2.00±0.10**	0.321±0.001**
	40	88.33±3.51**	7.30±0.57**	1.60±0.10**	1.90±0.10**	0.313± 0.003**
	60	87.67±2.51**	6.60±0.57**	1.46±0.06**	1.73±0.20**	0.305±0.005**
	80	81.33±3.21**	5.00±10ns	1.4±0.10^{0*}	1.56±0.06*	0.279±0.003**
	100	78.33±3.51**	4.60±0.57ns	1.3±0.06ns	1.36±0.06*	0.266±0.001ns
P. capillacea	**10**	84.33±3.05**	6.60±0.57*	1.73±0.15**	2.20±0.10**	0.301±0.013**
	20	80.00±2.00**	6.60±0.57*	1.73±0.15**	1.96±0.06**	0.310±0.002**
	40	76.33±3.2**	5.60±.57ns	1.43±0.11*	1.80±0.20**	0.290±0.006**
	60	61.0±1.00ns	5.00±1.0ns	1.43±0.11*	1.50±0.10*	0.282±0.004**
	80	63.33±1.52ns	5.00±1.0ns	1.20±0.20ns	1.23±0.20*	0.277±0.003**
	100	61.00±1.73ns	4.00±1.0*	1.00±0.10^{0*}	0.96±0.15ns	0.265±0.001*
A. fragilissima	**10**	81.67±1.15**	7.30±0.57**	1.30±0.1ns	1.40±0.10*	0.331±0.001**
	20	81. 0±1.73**	7.60±0.57**	1.03±0.06*	1.40±0.20*	0.298±0.005**
	40	80.33±0.57**	6.60±0.57**	0.96±0.06**	1.20±0.10*	0.296±0.001**
	60	71.33±3.21**	5.60±0.57ns	0.93±0.11**	0.90±0.10ns	0.285±0.001**
	80	65.00±2.00ns	4.60±0.57*	0.76±0.15**	0.90±0.10ns	0.278±0.006**
	100	62.33±2.08ns	4.60±0.57*	0.67±0.06**	1.06±0.20ns	0.266±0.003*
L. obtuse	**10**	94.33±1.15**	7.30±0.57**	1.97±0.15**	1.90±0.10**	0.296±0.001**
	20	82.67±2.51**	6.60±0.57**	1.70±0.10**	1.63±0.15*	0.276±0.004**
	40	80.33±0.57**	6.60±0.57**	1.20±0.10ns	1.36±0.15*	0.276±0.003**
	60	74.33±2.08**	5.60±0.57ns	1.03±0.06*	1.23±0.20*	0.275±0.003**
	80	72.33±3.05**	5.30±0.57ns	0.96±0.06*	1.16±0.15ns	0.275±0.003**
	100	63.33±2.08ns	4.60±0.57ns	0.86±0.06**	1.03±0.06ns	0.269±0.008**
F-value		43.32	15.55	24.14	29.45	58.91

± Standard deviation; * significant at $p < 0.0001$ level

With regard to dry extract (SLF), 10% extract of the all tested algae except *C. racemosa* was the ideal concentration for the all growth parameters (root depth, shoot length, number of lateral branches, seed weight and percentage of germination). In *C. racemosa* 20% dry extract (SLF) was the best treatment for the all studied parameters. In general, the highest concentrations of the both fresh and dry extracts (SLF) positively affected on the all studied parameters.

Phenols, protein, carbohydrates, nitrogen and phosphorus were measured in the three seaweeds that induced the highest increase in growth parameter of *V. unguiculata* (L) (Table 3). The highest phenols were recorded in *C. racemosa* (0.039±0.001 mg/g DW and 108.79± 0.135 mg/g FW). However, *S. vulgare* showed the minimum content of the phenols (0.017± 0.001 mg/g DW and 40.064 ± 0.131 mg/g FW).

Table 3: Biochemical analysis of the best biofertilizers (*Sargassum vulgaris*, *Laurenica obtuse* and *Caulerpa racemosa*).

Spp.	Phenol		Carbohydrate		Protein		Nitrogen		Phosphorous	
	mg/g DW	mg/g FW	mg/g DW	mg/g FW	mg/g DW	mg/g FW	mg/g DW	mg/g FW	mg/g DW	mg/g FW
S. vulgare	0.017± 0.001	40.064± 0.131	137.676± 0.89	233.572± 0.111	18.640± 2.87	58.323± 8.982	2.982± 0.463	9.332±1. 437	2.123± 0.177	6.403± 0.467
L. obtuse	0.016±0. 002	44.197± 1.020	182.492± 4.90	436.698± 0.36	38.646± 0.36	120.923 ±1.14	6.183± 0.058	19.348± 0.182	4.170± 0.070	12.550± 0.470
C. racemosa	0.039± 0.001	108.79± 0.135	196.805± 2.47	645.573±1 .451	27.710± 0.742	86.704± 3.704	4.434± 0.118	13.873± 0.593	4.047± 0.387	12.277± 0.347

With respected to protein content, *L. obtuse* have the highest protein content (38.646 ± 0.36 mg/g DW and 120.923 ± 1.14 mg/g FW). On the other hand, *S. vulgare* has the lowest protein content (18.640 ± 2.87 mg/g DW and 58.323 ± 8.982 mg/g FW). *C. racemosa* showed the highest carbohydrates content (196.805 ± 2.47 mg/g DW and 645.573 ± 1.451 mg/g FW). The minimum carbohydrates were observed in *S. vulgare* (137.676 ± 0.89 mg/g DW and 233.572 ± 0.111 mg/g FW). Among the three selected seaweed *L. obtuse* record high nitrogen content (6.183±0.058 mg/g DW and 19.348 ± 0.182 mg/g FW). *S. vulgare* contains the lowest nitrogen (2.982 ± 0.463 mg/g DW and 9.332 ±1.437 mg/g FW). In addition, greatest phosphorus quantity was recorded in *L. obtuse* (4.170 ± 0.070 mg/g DW and12.550 ± 0.470 mg/g FW).Whereas, the minimum phosphorus was observed in *S. vulgare* (2.123 ± 0.177mg/g DW and 6.403 ± 0.467 mg/g FW).

4. DISCUSSION

Utilization of seaweed as Liquid Seaweed Fertilizer (LSF) is one of the excellent means to get the lost nutrients back to the land. As a step toward the expansion of nature source of other manures seaweed fertilizer application will be useful in enriching, the soil and achieving higher production in the place of costly chemical fertilizer. In the developing world, the use of seaweed liquid fertilizer should be urged to avoid environmental pollution by heavy doses of chemical fertilizer in the soil. Application of LSF plays a significant role in improving the yield of crop plants by about 20-30%. Fatma *et al.* (2014) concluded that using red algae as biofertilizers improved the vegetative characters and grain quality of Maize plants. The lower concentration of SLE of *C. scalpelliformis* (25%) enhanced the percentage of germination, shoot height, and root depth (Kalaivanan *et al.*, 2012).

In the present investigation the percentage of seed germination changed according to seaweed species, nature of seaweeds (fresh or dry) and their concentration, however, the low concentrations of *S. vulgare* (60%) had higher biofertilizer activity than the high concentration. The obtained results were coinciding with previous studies of *S.*

tenerrimum algal extracts at low concentration promoted the crop growth (Bhosle, 1975, Kalaivanan *et al.,* 2012) stated that the seaweed extract of *S. myriocystum* showed better response at lower concentration on seedling of *V. mungo* while higher concentrations of seaweed extract showed a decreasing trend, The highest seed germination (98%), shoot length, root depth seedling fresh and dry weight were found in the SLF 10% of *S. myriocystum* concentration. The application of seaweed liquid extract of *C. scalpelliformis* increased the seed germination rate at lower concentration, while the higher concentrations of these extracts decreased the rate of germination. This enhanced growth effect is thought to be due to various organic compounds present in the seaweed extract such phytohormones, mainly cytokinins in the seaweed extracts (Wrightman and Thimann, 1980).

Moreover, the increased growth parameters at lower concentration may be due to the presence of higher levels of N, P in tested seaweed extract as shown in Table 3. The present result are agreement with Selvam and Sivakumar (2014) who stated that the increased growth parameters of *Arachis hypogea* at lower concentration may be due to the presence of higher levels of N, P, K in the seaweed extract of *C. scalpelliformis*.

In the present investigation, seeds treated with lower concentration of dry and fresh SLF shows better response in terms of shoot and root length, number of lateral roots and number of lateral branches.The present results agreed with the results of Anantharaj and Venkatesalu (2001) who reported that the LSF of *C. recemosa* and *Gracilaria edulis* on *V. catajung* showed that the low concentrations of aqueous extracts promoted the seedling growth, fresh and dry weight, chlorophyll content, protein, amino acids and total sugar than higher concentration of SLF. Sivasankari *et al.* (2006) stated that the low concentration (20%) of aqueous extracts of *S. wightii* and *C. chemnitzia* promoted the seedling growth (shoot length, root length, fresh weight and dry weight) of *V. sinensis*). Erulan *et al.* (2009) stated that the lower concentration (1.5%) of *S. polycystum* dry extract increased the germination percentage, shoot length, root length, leaf area, fresh weight and dry weight than higher concentration. Anisimov *et al.* (2013) noted that the higher concentrations (10^{-3} mg/ml) of dry *S. wightii* and *Codium fragile* extract inhibited development of seedling roots of Buckwheat. Jennings (1968) stated that green and brown algae contain gibberelic acid, which plays an important role in seed germination. Thus non-toxicity and growth promoting effect of seaweed concentrates in dictated their possible use as bio-fertilizer in agriculture.

In the present investigation, the highest growth parameters were observed with SLF extracted from *S. Vulgare* (Phaeophyta), *C. racemosa* (Chlorophyta) and *Laurencia obtuse* (Rhodophyta) which may be correlated to their biochemical composition e.g. (Nitrogen, carbohydrate, phenol content) that play a significant role in crop quality (Sisson *et al.*, 1991). The growth enhancing potential of seaweed might be attributed to the presence of carbohydrate (Booth, 1965), Phenyl acetic acid (Taylor and Wilkinson, 1977). Nitrogen and growth promoting hormones, micronutrients present in seaweeds make it as excellent fertilizer (Mishra *et al.,* 2013).

5. CONCLUSION

Finally, we conclude that seaweeds from Abu Qir coast in Alexandria are potential sources of biofertilizer activity. Furthermore, the great increase in all studied parameters of *V. unguiculata* (L) were observed by treatment with *S. Vulgare* (Phayophyta), *L. obtuse* (Rhodophyta) and *C. racemosa* (Chlorophyta), separately as compared with other tested seaweeds and their lower concentration was more effective than higher concentration due to their nature of chemical composition.

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