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Research paper

Effect of seaweed fertilizer on growth and photosynthetic characteristic of groundnut (*Arachis hypogaea* L.)

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The seaweed is one of the important growth promoting hormonal effects on crop plants which has been proven for many decades. Some of the plant hormones have been recorded in seaweeds such as IAA, IBA and cytokinins along with minerals and vitamins. Seaweed liquid fertilizer has been shown to have a wide range of beneficial impacts. In the present study, the effect of different concentrations of (SLF 0, 0.5, 1.0, 1.5 and 2.0%) and (SLF + CF 0.5, 1.0, 1.5 and 2.0%) Seed germination, photosynthetic pigments, fresh and dry weight, and shoot and root length were all measured on a treated groundnut plant. The results found a gradual increase of seedling growth and photosynthetic pigments at increasing concentrations, however, higher concentrations 1.0 and 1.2 per cent were decreasing trends in groundnut plants.

Key words: *seaweeds, ground nut, hormonal effect, morphological characteristics*

INTRODUCTION

The widespread use of chemical fertilizer causes significant pollution in societies, with negative socioeconomic and environmental consequences. Recent increases in greenhouse gas emissions have exacerbated global warming and groundwater pollution, both of which are primarily caused by climatic changes and have a direct impact on the future of agricultural businesses (Layek, et al., 2018). For modern plant production, achieving a safer, more ecologically friendly, and brighter future is a top objective (Shubha et al., 2017). Plant bioeffectors, also known as plant biostimulants, have become more widely welcomed and employed in a variety of agricultural activities, providing a number of benefits in encouraging plant growth and alleviating stressors (Hassan et al., 2017). One of the most important renewable marine life resources is marine algae. Several varieties of green, brown, and red algae are used as fertilizer in coastal areas around the world. They contain a lot of potassium but very little nitrogen and phosphorus. Concentrated seaweed is beneficial to plants since it includes growth hormones as well as other trace minerals, vitamins, and amino acids (Khan et al., 2009). Liquid seaweed extracts have been associated to a number of favourable outcomes, including higher agricultural yields, increased inorganic element absorption from the soil, and better stress tolerance. Seaweed species have been identified as possible fertilizer suppliers. The usage of sea weed liquid fertilizer in conjunction with chemical fertilizer, as well as their right management, is critical for improved growth and productivity (Amalesh Ghosh et al., 2020). Currently, some researches are being conducted to convert algae into high-value biomass co-products in the form of extracts (FAO, 2010). Because their unique polysaccharide-enriched extracts contain a significant collection of biostimulants that increase seed germination, plant growth, and development without affecting crop quality, seaweeds are an environmentally beneficial natural resource (Mzibra et al., 2020; Jannin et al., 2013; Castellanos-Barriga et al., 2017). The beneficial effects of seaweed extracts as plant biostimulants have been documented in *Pterocladia capillacea* (Ashour et al., 2020), *Ascophyllum nodosum* (Xu et al., 2015), *Ecklonia maxima*, *Sargassum* spp. (Battacharyya et al., 2015), *Ulva lactuca*, *Padina gymnospora*, *Sargassum liebmannii* (Harnandenz Herrera et al., 2014), *Ulva lactuca* (Drobek et al., 2019). Seaweed extracts contain unidentified physiologically useful chemicals that commonly cause plants to produce phytohormones via internal signaling. Seaweed extracts are not biologically equivalent to chemical fertilizers. They are biodegradable and non-hazardous, making them ecologically benign substances with no chemical residues or risks (Ashour et al., 2020). The major goal of this research is to see how different concentrations of seaweed extract and seaweed+ chemical extract affect the growth, quality, and nutrient uptake of groundnut plants.

MATERIALS AND METHODS

Preparation of seaweed liquid fertilizer extract

The seaweeds were chopped into small pieces and cooked in distilled water at 60 degrees Celsius; after cooling, the extract was filtered through what man filter paper and stored at 4 degrees Celsius for subsequent examination. The filtrate solution was assumed to contain 100% of the seaweed liquid fertilizer (SLF). Various quantities of (SLF 0, 0.5, 1.0, 1.5 and 2.0%) and (SLF + CF 0.5, 1.0, 1.5 and 2.0%) were generated from this extract by diluting with distilled water.

Experimental design and treatments

Groundnut seeds were collected and surface sterilized with 0.1 percent mercuric chloride, and then thoroughly washed with distilled water to remove the mercuric chloride. The seeds were shocked for 24 hours at different concentrations of (SLF 0, 0.5, 1.0, 1.5 and 2.0%) and (SLF + CF 0.5, 1.0, 1.5 and 2.0%). For control, the ingested seeds were placed in pot culture with purified water. Seed germination, plant height, shoot length, root length, total fresh weight, dry weight and branch number were all investigated in the groundnut plant. Shoot and root length of groundnut plant. The plant seedling height was calculated at different concentration of (SLF 0, 0.5, 1.0, 1.5, 2.0%) and (SLF + CF 0.5, 1.0, 1.5 and 2.0%) treated groundnut plant.

Fresh and dry weight of groundnut plant

Seedlings were collected from triplicates of seedlings. Three seedlings of each replicates were taken and from respective concentrations with control (SLF 0, 0.5, 1.0, 1.5, 2.0%) and (SLF + CF 0.5, 1.0, 1.5, 2.0%) the fresh weight was weighed and dried in an oven at 60^{o}C until constant dry weight was obtained.

Seed germination percentage of groundnut plant

The following formula was used to calculate GP, accordingly (Bajji et al., 2002).

100 GP= (Ni/S)

The germination percentage (GP), the number of seeds germinated each day (Ni), and the total number of seeds planted (S) are all used in this equation.

Photosynthetic pigments

The photosynthetic pigments such as cholorophyll a, b, carotenoids, and total cholorophyll content were determined using Lichtenthaler's (1987) methods with minor modifications. The fresh leaf material 100 mg was mixed with 5 mL of 80% ice-cold acetone and grained using a mortar and pestle. The resulting solution was centrifuged at 5000 rpm for 10 minutes at 4 °C. A UV–vis spectrophotometer was used to measure the absorbance of the solution at 470, 645, and 662 nm. Chlorophyll (chl) and carotenoid content were calculated as µg/g FW using the equations:

Chl a = 11.23A662–2.04A645

Chl b = 20.13A645–4.19A662

Chl a + b = 7.05A662 + 18.09A645

Total carotenoid = (1000A470–1.90Chla–63.14Chlb)/214.

RESULTS AND DISCUSSION

Seed germination

Cent percent seed germination was recorded at 1% SLF with or without chemical Fertilizer and other concentrations of 0.5, 1.5 and 2% SLF treatments showed 97, 98 and 97% of seed germination respectively. 90% of seed germination was found in control (Figure 1).

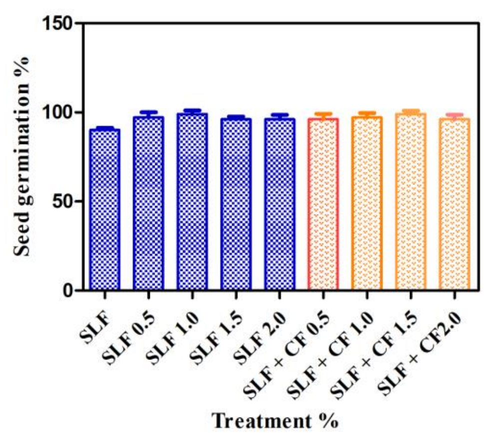

Figure 1. Mean and Standard Deviation (SD) values of SLFs with or without Chemical fertilizer treated plant Seed germination

These present results shows, less amount of seaweed extracts enhanced high level of seed germination percentage. Signaling pathways such as indole-3-acetic acid, indole butyric acid, gibberellins, cytokinins, and micronutrients may be involved.

Vitamins, minerals (Fe, Cu, Co, Zn, Mn, Mo, and Ni), and amino acids (Shahbazi et al., 2015).

Root length

The root length recorded in the experimental plants on 15, 30, 45, 60, 75, and 90 DAS is shown in (Table 1). The SLF treatments increased the root length at all concentrations when compared to control. The highest root length observed was 19.1 cm in 1% SLF with chemical Fertilizer and 19.0 cm in without chemical Fertilizer treatment on 90 DAS. In the control plants, the root length was 15.7 cm on the same sampling dry. The use of seaweed liquid fertilizer increased shoot length, dry weight, root, number of leaves, number of flowers, number of pods, and annual Capsicum production (Jayasinghe et al., 2016). SLF is a good source of secondary nutrients including Mg, which helps with root growth. The interaction effect suggests that the relationship between root weight and SLF concentration varies by species. Endogenous auxin and other compounds in the extracts may have an influence on root system enhancement (Bonkowski and Brandt, 2006).

Shoot length

The effect of different concentrations of seaweed liquid treatments on the shoot length is shown in (Table 2). The height shoot length of 30.1 cm was recorded in 1% SLF with chemical Fertilizer and 29.1 cm in 1% SLF without chemical Fertilizer on 90 DAS. Both treatments were compared to control. The lowest value (26.5cm) was recorded in control plants. Other concentrations viz., 0.5%, 1.5% and 2%

Table 1. Mean and Standard Deviation (SD) values of SLFs with or without Chemical fertilizer treated plant Root length

	Days					
SLF%	**15**	**30**	**45**	**60**	**75**	**90**
C	6.0±1.0	8.5±1.2	11.9±1.2	13.8±1.3	15.4±1	15.7±1.7
0.5	7.3±0.7	9.1±1.15	14.2±1.5	16.3±2.5	17.2±1.3	17.7± 2.14
1.0	8.3±1.2	10.3±1.2	15.5±1.5	17.4±1.7	18.4±1.8	19.0±1.9
1.5	7.8±.7	9.6±1.1	14.5±1.2	16.4±1.6	17.7±1.7	17.9±1.9
2.0	7.2±0.7	9.6±1.2	14.2±1.4	16.1±1.7	17.4±1.2	17.5±2.1
SLF+CF%						
0.5	7.8±.7	9.1±1.1	15.5±1.2	16.±1.6	17.7±1.7	17.9±1.9
1.0	9.1±.7	10.9±2.1	15.8±1.2	17.9±1.6	18.8±1.7	19±1.9
1.5	8.1±.7	9.6±1.3	15.5±1.2	16.4±1.6	17.7±1.9	18.09±0.8
2.0	7.6±0.8	9.6±0.9	14.5±1.1	16.0±0.9	17.8±1.6	17.95±1.1

Table 2. Mean and Standard Deviation (SD) values of SLFs with or without Chemical fertilizer treated plant shoot length

	Days					
SLF%	**15**	**30**	**45**	**60**	**75**	**90**
C	7.1±1.0	10.5±1.2	16.4±1.2	21.3±1.3	25.4±1	26.7±1.7
0.5	9.3±0.7	11.1±1.15	17.2±1.5	21.3±2.5	26.2±1.3	27.7± 2.14
1.0	11.6±1.2	15.6±1.2	19.5±1.5	23.6±1.7	28.7±1.8	29.1±1.9
1.5	10.3±0.7	14.1±1.2	18.2±1.4	22.2±1.7	27±1.2	27.9±2.1
2.0	7.8±.7	9.6±1.1	14.5±1.2	16.4±1.6	17.7±1.7	17.9±1.9
SLF+CF%						
0.5	10.3±1.4	12.1±0.5	17.6.5±1.1	22.2±1.9	27.4±2.1	27.9±1.1
1.0	12.9±09	15.9±0.7	19.8±1.2	23.9±1.1	28.9±1.6	30.1±1.9
1.5	11.6±0.6	15.4±0.9	19.3±0.9	22.4±1.4	27.7±1.7	28.01±1.2
2.0	8.0±0.6	12.1±0.9	17.3±0.9	22.5±1.6	27.7±1.7	27.01±1.2

Table 3. Mean and Standard Deviation (SD) values of SLFs with or without Chemical fertilizer treated plant lateral roots

	Days					
SLF%	15	30	45	60	75	90
C	4.0±0.9	16.6± 1.0	29.0±1.2	39.6±3.4	45.0±3.9	49.0± 4.1
0.5	5.6±0.5	19.3±1.9	35.3±3.1	42.0±3.1	49.0±4.1	52.3±5.1
1.0	8.0±0.8	26.6±2.4	40.6±4	48.3±4.8	54.7±4.7	59.0±5.5
1.5	6.6±0.9	23.6±2.3	36.1±3.4	45.3±4.1	47.0±4.1	51.0±5.0
2.0	5.3±0.5	17.6±1.7	34.0±3.1	40.3±3.9	46.3±4.1	51.0±4.9
SLF+CF%						
0.5	6.3±0.9	19.6±1.9	35.0±3.1	44.3±4.1	50.0±3.9	53.0±5.1
1.0	9.0±1.9	27.6±2.1	43.0±4.1	49.0±4.1	55.6±5.1	60.0±6.1
1.5	8.0±0.8	25.0±2.1	38.7±3.1	46.3±4.6	50.0±5.1	53.3±5.7
2.0	6.0±0.7	18.0±1.8	35.7±3.1	42.7±4.2	47.6±4.1	51.6±4.5

Table 5. Mean and Standard Deviation (SD) values of SLFs with or without Chemical fertilizer treated plant leaves

	Days					
SLF%	**15**	**30**	**45**	**60**	**75**	**90**
C	5±0.5	11.56±1	43.56±4	58.81±5	76±7	73.46±7.1
0.5	7.0±0.7	12.43±1.2	48.0±4.1	68.0±6.1	80.83±	73.26±.2
1.0	9±0.1	13.0±1.3	58.33±3.1	82.23±5.6	96.23±4.1	84.7±3.1
1.5	8.0±0.8	12.7±1.2	51.23±2.2	76.67±2.17	91.20±2.4	80.23±3.1
2.0	6±04	12.13±1.2	46.34±3.4	72.34±2.1	82±3.1	74.12±1.4
			SLF+CF%			
0.5	8±0.9	12.84±1.2	47.10±2.1	69.0±2.1	81.20±3.1	75.43±2.1
1.0	10±1.0	13.86±1.3	59.10±2.1	82.34±2.1	97.40±2.9	85±3.1
1.5	9±0.9	12.3±1.3	51±4.3	7624±1.7	92.45±4.1	80.76±3.1
2.0	7±0.9	12.73±1.2	46.90±2.1	72.86±1.5	83.34±2.4	75.73±2.1

Table 6. Mean and Standard Deviation (SD) values of SLFs with or without Chemical fertilizer treated plant Chlorophyll "a"

	Days					
SLF%	**15**	**30**	**45**	**60**	**75**	**90**
C	0.832±0.77	0.913±0.52	0.854±0.52	0.745±0.52	0.616±0.55	0.486±00
0.5	0.864±0.52	0.943±0.55	0.865±0.00	0.761±0.15	0.632±0.77	0.516±0.52
1.0	0.909±0.00	0.964±0.52	0.890±0.00	0.790±0.77	0.685±0.57	0.537±0.77
1.5	0.909±0.77	0.951±0.77	0.883±0.77	0.779±0.74	0.671±0.73	0.523±0.52
2.0	0.853±0.55	0.922±0.57	0.874±0.82	0.764±0.00	0.634±0.68	0.504±0.55
			SLF+CF%			
0.5	0.873±0.15	0.954±0.00	0.874±0.82	0.764±0.00	0.634±0.68	0.504±0.55
1.0	0.913±0.55	0.972±0.00	0.895±0.77	0.797±0.15	0.692±0.00	0.576±0.74
1.5	0.904±0.52	0.963±0.82	0.889±0.77	0.784±0.52	0.682±0.00	0.529±0.77
2.0	0.878±0.77	0.955±0.77	0.873±0.74	0.771±0.00	0.642±0.77	0.505±0.77

exhibited 27.43 cm, 27.93 cm, and 27.00 cm in SLF without chemical fertilizer and 27.83 cm, 28.71 cm and 27.57 cm with chemical fertilizer respectively on 90 DAS. The previous author reported that the presence of plant growth regulators, trace elements, vitamins and micronutrients in the low concentration of SLF enhance the growth of root and shoot (Rajkumar Immanuel & Subramanian, 1999). The amount of cytokinin was found high compared to auxin in SLFs. These hormones play an important role in enhancement of cell size and cell division, and together they complement each other as cytokinins are effective in shoot generation and auxins in root development, while micro-nutrients improve (Liu & Lijun, 2011). Similar results were recorded in Phaseolus aureus (Johnsi Christobel, 2008), Cajanus cajan (Mohan et al., 1994) and red gram (Venkataraman Kumar et al., 1993).

Number of lateral roots

The number of lateral roots per plant was recorded on different DAS is shown in (Table 3). In general, the number of lateral roots significantly increased due to the treatments. 1% SLF with chemical fertilizer induced the maximum number of lateral roots than control plants and plants treated with other concentrations on 90 DAS. After seed sowings the maximum number of lateral roots was 59 in plants treated with 1% SLF alone. In plants treated with the different concentration of SLF viz: 0.5%, 1.5% and 2% the lateral roots were 52, 51 and 50 respectively on 90 DAS. In plants treated with 1% SLF with chemical Fertilizer. The lateral roots were 35, 52, and 51, respectively. In control plants the number of lateral roots recorded per plant was 49 on 90 DAS. Blunden & Wildgoose (1977) reported a marked increase in lateral root development in potato plants as a result of treatment with seaweed extract.

Number of Branches

The number of branches per plant was noted on different DAS of sampling is shown in (Table 4). In general, the number of branches significantly increased due to the treatments on 90 DAS. In 1% SLF with chemical fertilizer included the number of branches was recorded than control plants and treated with other concentrations. Sridhar & Rengasamy (2010 b) studied the *Arachis hypogaea* as an increase in plant height and number of branches compared to chemical treatment in application of *Sargassum wightii.*

Number of leaves

The number of leaves per plant recorded on different DAS of sampling is shown in (Table 5). The number of leaves significantly increased in the plants with received 1% of SLF with or without chemical Fertilizer. But higher concentration of 2% of SLF with or without chemical Fertilizer resulted in lesser number of leaves. With or without chemical fertilizer, 1 percent of SLF had the largest number of leaves per plant. The largest number of leaves per plant was 96 in the 1% SLF treatment, compared to 80, 91, and 82 in the 1% SLF with chemical Fertilizer and 81, 92, and 83 in the 1% SLF without chemical Fertilizer, respectively. The current study discovered that using a lesser amount of seaweed in combination with chemical fertilizer resulted in a significant increase in average

Table 7. Mean and Standard Deviation (SD) values of SLFs with or without Chemical fertilizer treated plant Chlorophyll "b"

SLF%	Days					
	15	30	45	60	75	90
C	0.721±0.00	0.872±0.00	0.613±1.55	0.488±0.77	0.398±0.77	0.373±0.74
0.5	0.748±0.00	0.904±1.73	0.924±0.00	0.519±0.00	0.427±0.77	0.404±0.74
1.0	0.854±0.00	0.944±0.00	0.654±1.52	0.552±0.52	0.452±0.57	0.433±0.73
1.5	0.833±0.77	0.928±0.77	0.643±0.00	0.532±0.00	0.433±0.52	0.423±0.71
2.0	0.823±0.36	0.909±0.00	0.636±0.77	0.521±0.52	0.428±0.57	0.409±0.00
			SLF+CF%			
0.5	0.751±1.15	0.908±1.00	0.634±0.52	0.520±0.15	0.432±0.00	0.407±0.00
1.0	0.862±0.00	0.952±0.77	0.661±0.77	0.554±0.00	0.467±0.77	0.435±0.77
1.5	0.833±0.77	0.934±0.00	0.656±0.77	0.532±0.77	0.448±0.77	0.423±0.00
2.0	0.826±0.53	0.913±0.00	0.639±0.52	0.527±0.52	0.433±0.52	0.412±0.51

Table 8. Mean and Standard Deviation (SD) values of SLFs with or without Chemical fertilizer treated plant Chlorophyll "Total Chlorophyll"

SLF%	Days					
	15	30	45	60	75	90
C	1.549±0.72	1.787±0.10	1.466±1.30	1.235± 0.60	1.014±0.577	0.859±0.477
0.5	1.609±0.57	1.842±0.62	1.486±0.522	1.276±0.23	1.059±0.12	0.917±0.31
1.0	1.763±0.13	1.907±0.31	1.544±0.41	1.343±0.51	1.137±0.32	0.976±0.13
1.5	1.734±0.52	1.880±0.25	1.523±0.45	1.31±0.34	1.104±0.53	0.944±0.34
2.0	1.677±0.23	1.83±0.23	1.508±0.34	1.283±0.12	1.065±0.26	0.912±0.43
			SLF+CF%			
0.5	1.626±0.22	1.859±0.33	1.503±0.2	1.286±0.34	1.073±0.15	0.926±0.24
1.0	1.774±0.42	1.922±0.23	1.556±0.34	1.348±0.41	1.158±0.43	0.978±0.36
1.5	1.738±0.21	1.895±0.24	1.546±0.32	1.316±0.32	1.128±0.12	0.951±0.12
2.0	1.704±0.32	1.872±0.42	1.513±0.36	1.311±0.23	1.074±0.251	0.913±0.200

Table 9. Mean and Standard Deviation (SD) values of SLFs with or without Chemical fertilizer treated plant Carotenoids

SLF%	Days					
	15	30	45	60	75	90
C	0.502±0.077	0.516±0.011	0.418±0.05	0.358±0.00	0.312±0.042	0.248±0.03
0.5	0.545±0.07	0.550±0.05	0.438±0.00	0.371±0.00	0.328±0.05	0.266±0.05
1.0	0.611±0.03	0.578±0.05	0.458±0.03	0.395±0.032	0.349±0.02	0.288±0.02
1.5	0.561±0.043	0.568±0.021	0.441±0.012	0.382±0.041	0.332±0.043	0.272±0.21
2.0	0.542±0.054	0.547±0.08	0.434±0.04	0.366±0.05	0.326±0.03	0.254±0.021
			SLF+CF%			
0.5	0.548±0.006	0.560±0.06	0.441±0.052	0.372±0.03	0.330±0.01	0.270±0.03
1.0	0.615±0.006	0.580±0.004	0.459±0.02	0.433±0.063	0.353±0.005	0.290±0.02
1.5	0.562±0.009	0.568±0.053	0.449±0.007	0.384±0.052	0.353±0.052	0.273±0.076
2.0	0.545±0.009	0.547±0.02	0.439±0.002	0.366±0.05	0.328±0.005	0.303±0.04

leaf number per plant. These results were similar to those of Bluden (1997) and Sidhar and Rengasamy (2001).

Chlorophyll 'a'

The chlorophyll 'a' values are shown in (Table 6). The highest chlorophyll 'a' content was recorded in 1% of SLF with or without chemical Fertilizer treated plants. The values were 0.909, 0.964, 0.890, 0.790, 0.685 and 0.537 mg/g respectively on 15, 30, 45, 60, 75 and 90 DAS in the plants treated without chemical Fertilizer, whereas the values were 0.913, 0.972, 0.895, 0.797, 0.692, 0.546 mg/g on 15, 30, 45, 60, 75 and 90 DAS in the plants treated with 1% SLF with Fertilizer. In other concentration of 0.55, 1.5% and 2% SLF without chemical Fertilizer the values were 0.943, 0.951 and 0.922 mg/g on the 30 DAS, the values were 0.954, 0.963 and 0.955 mg/g on the 30th day of the plant treated with chemical Fertilizer. In control plants, the values on 15th, 30, 45, 60, 75, 90 DAS were 0.832, 0.913, 0.854, 0.745, 0.616 and 0.486 mg/g respectively. Spraying seaweed fertilizer on plant leaves can boost photosynthesis by increasing the chlorophyll content of the leaves. Treatments with seaweed liquid fertilizer, for example, increased net photosynthetic rate (de Carvalho et al., 2019). Thirumaran et al., (2009) found that the *Sargassum wightii* SLF treatment boosted total chlorophyll and carotenoids content of the test plants with or without chemical fertilizer at lower concentrations (20%).

Chlorophyll 'b'

The chlorophyll 'b' values are shown in (7). The highest chlorophyll b content was recorded in 1% of SLF with or without chemical fertilizer treated plants. The values were 0.862, 0,952, 0.661, 0.467 and 0.435 mg/g on 15, 30, 45, 60, 75 and 90 DAS on the plants treated with 1% SLF and chemical fertilizer whereas the values were 0.854, 0.944, 0.654, 0.552, 0.452 and 0.433 mg/g on 15, 30, 45, 60, 75, and 90 DAS in the plant treated with 1% SLF without chemical fertilizer. In other concentrations of 0.5, 1.5, and 2% SLF with chemical fertilizer the values were 0.908, 0.952, 0.934 and 0.913 mg/g on the 30 DAS. The values were 0.904, 0.944, 0.928, and 0.909 mg/g on the 30 DAS of the plants treated without fertilizer. In the control plants 0.721, 0.872, 0.613, 0.488, 0.398 and 0.373 mg/g were recorded on 15, 30, 45, 60, 75, and 90 DAS respectively. The SLF treatment also increased total chlorophyll and carotenoids content of both the test plants at lower concentration (1%) SLF with or without chemical fertilizer. Our findings coincide with some earlier findings. Whapham et al. (1993) observed that the application of SLF of *Ascophyllum nodosum* increased the chlorophyll of Cucumber cotyledons and tomato plants.

Total chlorophyll

The effect of different concentrations of seaweed liquid fertilizer on total chlorophyll content of leaves is shown in (Table 8). The highest total chlorophyll content was recorded in 1% of SLF with or without chemical fertilizer treated plants. The values were 1.774, 1.922, 1.556, 1.348, 1.158, and 0.978 mg/g respectively on 15, 30, 45, 60, 75, and 90 DAS of the plant treated with 1% SLF with chemical fertilizer. The values were 1.763, 1.907, 1.544, 1.343, 1.137 and 0.976 mg/g on 15, 30, 45, 60, 75, and 90 DAS of the plant treated with SLF without chemical fertilizer. The values in control plants on 15, 30, 45, 60, 75, and 90, DAS were 1.549, 1.787, 1.466, 1.235, 1.014 and 0.859 mg/g respectively. These findings may be explained. Because seaweed extracts with increased magnesium and mineral concentration increase leaf total chlorophyll and carotenoids content, low SLF induces high chlorophyll content (Mohy El-Din 2015). Due to the presence of glycine betaines, which are responsible for slowing down the degradation of chlorophyll rather than increasing its content, application of seaweed extract significantly increased the chlorophyll and other pigments in various crops. This can play an important role in maintaining the greenness of photosynthetic activity (Singh, 2016).

Carotenoid

The carotenoid contents in the leaves of experimental plants recorded on different DAS are shown in (Table 9); the SLF treatment increased the carotenoids content at all the concentrations when compared to the control. The highest carotene content was 0.615 mg/g in 1% of SLF with chemical fertilizer and 0.611 mg/g in 1% SLF without chemical fertilizer treatments on 30 DAS. The control plants recorded 0.516 mg/g on 30 DAS. At lower concentration of *Gracilaria edulis* seaweed liquid fertilizer with or without chemical fertilizer increased total chlorophyll and carotenoids contents in *Vigna unguiculata* and *Phaseolus mungo* (Lingakumar et al., 2002).

CONCLUSION

Seaweeds are proved a potential growth promoting hormonal effect on groundnuts in the present study. Groundnut is one of the important pulse crops and is commercially cultivated for its edible seeds and oils. The preset investigation was studied on the effect of seaweed liquid fertilizer on growth and photosynthetic pigments of groundnut. The study shows that the gradual increase was observed in lower doses of SLF which increases the growth and photosynthetic pigments. Hence, SLF proved as a promising promoting hormone which enhances the growth and nutrient management of groundnut.

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AUTHOR CONTRIBUTIONS

NT: conceptualized this project and produced this manuscript.

COMPETING INTERESTS

The author declares that there is no competing interest.

ETHICS APPROVAL

Not applicable

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