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# Research Article
# Improving Peanut Productivity by Using Algae Extract Foliar Spray as Bio-Stimulant Under Reclamation Sandy Soils

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## Abstract

**Background and Objective:** Green technology has been used to generate bio-fertilizers in the most environmentally friendly way possible. The objective of this study was to study the effect of foliar application of algal extracts as bio-stimulants for improved groundnut growth and seed yield parameters. **Materials and Methods:** During the two growing summer seasons of 2019 and 2020, two field experiments were conducted in South Tahrir Province, El-Beheira Governorate, Egypt to investigate the impact of foliar spraying with fresh and dried green algae extracts on groundnut (*Arachis hypogaea* L.). A complete randomized block design with three replications was utilized, with foliar sprays of fresh green algae (1, 2, 3 and 4 g $L^{-1}$), dried green algae (1, 2, 3 and 4 g $L^{-1}$) and control (spray with water). **Results:** All foliar sprays with algal extracts significantly boosted all of the examined parameters. The use of fresh green algae significantly improved plant vegetative growth characteristics, chlorophyll, N, P and K content of leaves and seed production quantity and quality. Fresh green algae treatment with 2 g $L^{-1}$ surpassed other treatments in seed yield, pod yield and oil yield. The percentage of increase over control treatment are 60.6, 62.4 and 74.5% in seed, pod and oil yield per fed, respectively. **Conclusion:** It can be concluded that this study pays attention to using green algae extracts as bio-stimulant due to the presence of some plant growth-stimulating compounds and their nitrogen, phosphorus and potash content. Foliar application of fresh green algae proved to improve the growth, yield and oil content of groundnut.

Key words: Peanuts, bio-stimulants, algae extracts, fresh green algae, dry green algae, yield and oil, quality, sandy soils

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

The agriculture sector has recently been confronted with new and concurrent challenges to increase productivity to feed the world's growing population while also reducing environmental impact and preserving natural resources for future generations, all while maintaining low production costs to compete in a globalized economy[1,2]. Modern agriculture must reconsider its techniques to provide food in a sustainable manner[3]. The use of plant bio-stimulants is an innovative and environmentally beneficial strategy that can minimize reliance on chemical inputs, particularly synthetic fertilizers, while also ensuring production stability under unfavourable environmental and edaphic factors[4-6]. Plant bio-stimulants, according to the most recent European Union Regulation (2019/1009), are "Fertilizing products capable of stimulating plant nutrition process irrespective of the product's nutritional content[7]. Algal extracts, which include both macro-and microalgae, account for up to 40% of the overall bio-stimulant industry[8].

Groundnut ranks thirteenth among food crops, fourth among oilseeds and third among protein sources for humans globally[9]. The cultivated area of groundnut was 27.94 million hectares of land, with an average production of 47.1 million tons per year and global production of about 1.7 t $ha^{-1}$, but its average productivity in Africa was assessed[10] to be 1.10 t $ha^{-1}$.

Foliar sprays of biostimulants can be quite successful since the nutrients can transfer from plant leaves to their roots in a very short time. Some algal extracts can be utilized as a foliar spray and are classified as biostimulants[11]. It produces a variety of favourable effects, including increased root and shoot development, higher yields and enhanced tolerance to abiotic and biotic conditions[12]. Previously, the algal extracts were found to contain cytokinins, auxins and polyamines. There are plant growth regulators that have been detected in algae extracts recently, for example, gibberellins, abscisic acid and brassinosteroids[13]. The positive impact of algal extracts foliar application on beans was shown in increased growth parameters and seed yield and quality, as compared to the control[14-16].

The objective of this research was to assist farmers in easy approaches for increasing groundnut crop output potential. As a result, we studied the effect of foliar application of algal extracts as bio-stimulants for improved groundnut growth and seed yield parameters.

## MATERIALS AND METHODS

**Study area:** Two field experiments were conducted in the summers of 2019 and 2020 in South Tahrir Province, El-Beheira Governorate, Egypt, to examine the effects of foliar application of green algae extracts (fresh and dry) on groundnut growth, seed yield and seed quality on sandy soil. Groundnut (*Arachis hypogaea* L.) variety c.v. Giza 6 was covered with bacteria inoculants soon before sowing and planted in two seasons, April, 2019 and May, 2020.

**Sample collection:** Samples were collected from 0-30 depth and examined according to the method defined by Estefan *et al.*[17] as shown in Table 1.

Algae treatments were (control, 1, 2, 3 and 4 g $L^{-1}$) in both fresh and dry green algae (control plants spray with tap water) where the treatments were added in two doses, the first dosage (30 days after sowing) and the second dose throughout the pod development period (60 days after sowing). Samples were taken randomly at vegetative growth, 75 days after sowing, to measure plant height, plant fresh weight, root length, root circumference and total chlorophyll.

Potassium, phosphorus and nitrogen fertilizer were applied at the recommended rates in the forms of potassium sulfate (50% $K_2O$) at a rate of 25 kg $K_2O$/fed, calcium superphosphate (15.5% $P_2O_5$) at a rate of 60 kg $P_2O_5$/fed during seedbed preparation and nitrogen fertilizer in the form of urea at a rate of 45 kg N/fed in two equal doses.

In the first and second seasons, groundnut was harvested on September 5th. The experimental design was a complete randomized block design with three replications, with a 16 $m^2$ experimental unit area (4 rows, 4 m long and 60 cm between rows).

Table 1: Physical and chemical properties of the experiment soil

| | | | | Particle size distribution | | | |
|---|---|---|---|---|---|---|---|
| pH (1:2.5) | EC (dS $m^{-1}$) | OM (%) | $CaCO_3$ (%) | Sand (%) | Silt (%) | Clay (%) | Texture class |
| 8.53 | 1.1 | 0.95 | 1.5 | 93 | 4.7 | 2.3 | Sandy |
| **Cations (meq $L^{-1}$)** | | | | **Anion (meq $L^{-1}$)** | | | |
| $Na^+$ | $K^+$ | $Ca^{++}$ | $Mg^{++}$ | $CO_3^-$ | $HCO_3^-$ | $Cl^-$ | $SO_4^-$ |
| 3.50 | 1.51 | 3.32 | 1.20 | 0.40 | 3.90 | 1.78 | 3.54 |
| **Available macronutrients (mg/100 g soil)** | | | | **Available micronutrients (mg $kg^{-1}$)** | | | |
| N | P | K | | Fe | Zn | Mn | Cu |
| 16.30 | 4.00 | 17.10 | | 10.60 | 0.08 | 4.90 | 0.02 |

Table 2: Chemical composition and mineral of algae extract and HPLC chromatogram hormones of algae extract

| Element | Concentration |
|---|---|
| N (%) | 13.30 |
| P (%) | 2.22 |
| K (%) | 2.13 |
| Mg (%) | 0.22 |
| Na (%) | 0.01 |
| Ca (%) | 0.33 |
| Fe (ppm) | 1936.00 |
| Zn (ppm) | 68.00 |
| Mn (ppm) | 21.00 |
| Cu (ppm) | 18.00 |
| Protein (%) | 19.06 |
| **HPLC chromatogram hormones of algae extract a sample (mg $g^{-1}$)** | |
| Indole acetic acid | 13.66 |
| Indole butyric acid | 3.25 |
| Gibberellic acid | 1.19 |

Table 3: Amino acids content of the used algae extract

| Amino acid | Abbreviation | Concentration |
|---|---|---|
| Aspartic | ASP | 1.85 |
| Serine | SER | 0.70 |
| Proline | PRO | 0.67 |
| Alanine | ALA | 1.55 |
| Methionine | MET | 0.33 |
| Leucine | LEU | 0.29 |
| Phenylalanine | PHE | 0.87 |
| Lysine | LYS | 0.70 |
| Cysteine | CYC | 0.22 |
| Threonine | THR | 0.83 |
| Glutamic | GLU | 2.24 |
| Glycine | GLY | 1.07 |
| Valine | VAL | 1.11 |
| Isoleucine | ISOL | 0.71 |
| Tyrosine | TYR | 0.53 |
| Histidine | HIS | 0.24 |
| Arginine | ARG | 0.98 |
| Total amino acids | | 15.89 |

### Preparation of algae extract:

**Alga extract:** The Cyanophyta blue-green alga Spirulina platensis was mass-produced in continuous cultures at the NRC's Algal Biotechnology Unit. Alga extract was prepared as early described by Enan *et al.*[18]. Alga extract was subjected to chemical analysis according to Chapman and Pratt[19]. Chemical analysis concerning available macro-and micro-nutrients is listed in Table 2. Quantification of hormones (Table 2), indole acetic acid, indole butyric acid and gibberellic acid was performed by High-Performance Liquid Chromatography (HPLC), LC- 10AD, Shimadzu. Furthermore, amino acid content (Table 3) was determined according to El-Sayed *et al.*[20].

At harvest, a random sample of 6 plants from each experimental unit was taken, plants were uprooted from the soil and pods were manually removed. The pods were air-dried until the full dry was constant and the number of pods/plant, the number of seeds/plant, the weight of pods/plant (g) and weight of seeds/plant (g) were determined. The entire plot was harvested and the pods were air-dried to measure seed yield/fed, pod yield and oil production/fed.

Chemical analysis of seed and leaves was performed using Chapman and Pratt's[19] procedures. The El-Nasharty *et al.*[21] was used to determine the oil content of the seeds. Using R version 4.0.2, data were statistically evaluated according to Snecdecor and Cochran[22].

## RESULTS

### Effect of algae extract on growth parameters and yield characteristics of groundnut

**Growth parameters:** Table 4 indicate that all growth factors such as plant height (cm), shoot fresh and dry weight (g/plant), branches numbers, Total chlorophyll and root circumference recorded the highest values with foliar application of fresh algae extract (2, 3, 4 and 1), respectively and followed by dry algae (4, 3, 2 and 1) and control. Both fresh and dry algae significantly increased groundnut growth and yield characters compared with control. Fresh algae extract at rate 2 g $L^{-1}$ (Fresh 2) recorded the greatest value in plant height, shoot fresh and dry weight of groundnut with relative increase 20, 17 and 26%, respectively while dry algae at rate 4 g $L^{-1}$ (dry 4) recorded 16, 9,11% compared to control. When compared to control plants, the algae extract exhibited a substantial promoter impact on the examined growth parameters of groundnut at varied rates, notably fresh algae 2 g $L^{-1}$ and dried algae 4 g $L^{-1}$.

**Yield characteristics:** Table 5 and Fig. 1 observed that application of algae with different rates gradually increased yield production of groundnut. It was noticed that the application of fresh algae with 2 g $L^{-1}$ increased the pod yield production of groundnut by about 62% as compared with control. The increasing rate of dry algae to 4 g $L^{-1}$ gives a 22% relative increase in the pod yield production compared with control. The oil yield production of groundnut increased by 74% with the treatment of 2 g $L^{-1}$ fresh algae as compared with control and 38% relative increase with dry algae at a rate of 4 g $L^{-1}$.

Table 5 and Fig. 1 showed a highly significant increase in seed yield and its components of groundnut cultivated in sandy soil with foliar application of fresh and dry algae extract. Fresh algae at a rate of 2 g $L^{-1}$ surpassed other treatments in seed yield, pod yield and oil yield. The percentage of increases above the control treatment are 60.6, 62.4 and 74.5% in seed, pod and oil production per fed., respectively. These increases were caused by an increase in growth (plant height, number of branches and pods per plant).

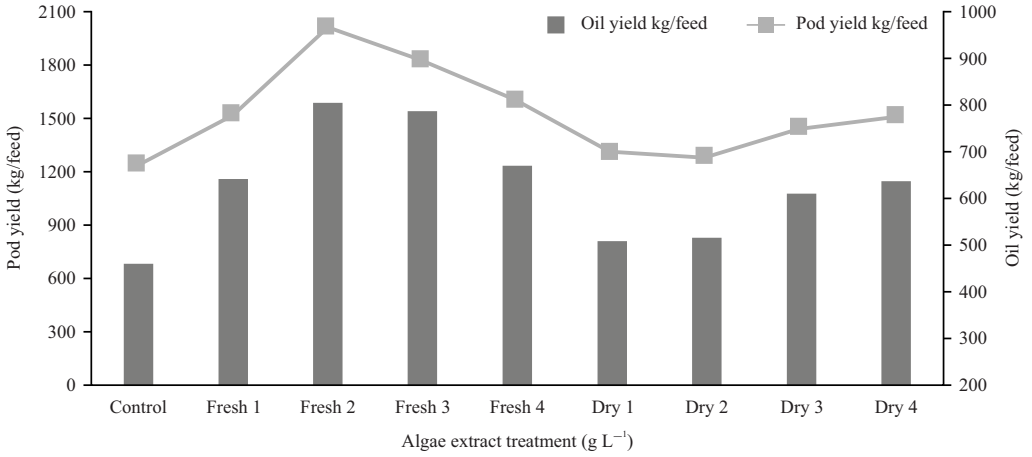


Fig. 1: Effect of green and dry algae extract application on oil yield kg/fed and pod yield kg/fed of groundnut grown on sandy soil

Table 4: Effect of green algae extracts application (fresh and dry) on growth parameters of groundnut grown on sandy soil (combined analysis of two successive summer seasons of 2019 and 2020)

| Algae extract treatments (g $L^{-1}$) | Shoot fresh weight (g) | Shoot dry weight (g) | Number of branches/plant | Root circumference (cm) | Root length (cm) | Plant height (cm) | Total chlorophyll (SPAD) |
|---|---|---|---|---|---|---|---|
| Control | 115 | 74.0 | 7.0 | 20.0 | 16.6 | 50.0 | 44.6 |
| Fresh 1 | 128 | 85.3 | 8.0 | 24.0 | 20.3 | 58.6 | 52.6 |
| Fresh 2 | 135 | 93.3 | 9.3 | 29.0 | 22.3 | 60.0 | 59.6 |
| Fresh 3 | 130 | 90.3 | 8.3 | 26.0 | 22.0 | 60.0 | 58.0 |
| Fresh 4 | 130 | 88.6 | 8.0 | 24.6 | 20.3 | 60.0 | 55.6 |
| Dry 1 | 118 | 77.0 | 7.6 | 18.0 | 16.6 | 56.0 | 48.0 |
| Dry 2 | 120 | 78.6 | 8.0 | 20.0 | 18.3 | 57.6 | 50.3 |
| Dry 3 | 120 | 80.6 | 8.3 | 24.0 | 18.3 | 58.0 | 51.3 |
| Dry 4 | 125 | 82.3 | 8.3 | 23.0 | 19.6 | 58.0 | 52.6 |
| LSD | 2.6805 | 2.7795 | 0.79 | 1.452 | 1.5491 | 2.7266 | 1.3985 |

Table 5: Effect of green algae extracts application (fresh and dry) on seed yield and its components of groundnut grown on sandy soil (combined analysis of two successive summer seasons of 2019 and 2020)

| Algae extract Treatments (g $L^{-1}$) | Number of pods/plant | Weight of pods/plant (g) | Empty pods | Pod yield (kg/fed) | Number of seeds/plant | Weight of seeds/plant (g) | Seed yield (kg/fed) | Oil (%) | Oil yield (kg/fed) |
|---|---|---|---|---|---|---|---|---|---|
| Control | 26.0 | 31.0 | 9.0 | 1240.0 | 35.6 | 22.0 | 880.0 | 52.2 | 460.3 |
| Fresh 1 | 34.3 | 38.0 | 9.0 | 1520.0 | 55.0 | 29.0C | 1160.0 | 55.2 | 641.1 |
| Fresh 2 | 45.0 | 50.3 | 15.0 | 2013.3 | 65.3 | 35.3 | 1413.3 | 56.8 | 803.2 |
| Fresh 3 | 40.6 | 45.6 | 12.0 | 1826.7 | 61.0 | 33.6 | 1346.7 | 58.3 | 785.2 |
| Fresh 4 | 38.0 | 40.0 | 8.6 | 1600.0 | 58.0 | 31.3 | 1253.3 | 53.4 | 669.7 |
| Dry 1 | 27.0 | 32.6 | 8.3 | 1306.7 | 41.0 | 24.3 | 973.3 | 52.0 | 506.4 |
| Dry 2 | 27.6 | 32.0 | 8.0 | 1280.0 | 44.6 | 24.0 | 960.0 | 53.6 | 514.5 |
| Dry 3 | 30.0 | 36.0 | 9.0 | 1440.0 | 50.0 | 27.0 | 1080.0 | 56.3 | 609.1 |
| Dry 4 | 33.0 | 37.6 | 8.3 | 1506.7 | 53.6 | 29.3 | 1173.3 | 54.1 | 635.4 |
| LSD | 2.0262 | 1.9208 | 1.0334 | 76.832 | 1.7148 | 2.1684 | 86.737 | 0.9309 | 51.468 |

**Effect of algae extract on nutritional status in leaves and seeds of groundnut:** Effects of investigated treatments on the nutrients content are presented in Table 6. From which it was noticed that application of fresh algae treatments at different rates had markedly increased the nutrients content in leaves of groundnut, with a relative increase of 34% N, 43% P and 20% K when treated with fresh algae at the rate of 2 g $L^{-1}$ compared with control and 16% N, 11% P and 7% K for dry algae at the rate of 4 g $L^{-1}$.

Application treatments of fresh algae at different rates had markedly increased the nutrients content in seeds of groundnut Table 6, with a relative increase of 42% N, 64% P and 16% K when treated with fresh algae at the rate of 2 g $L^{-1}$ compared with control and 28% N, 19% P and 12% K with dry algae at the rate of 4 g $L^{-1}$.

Table 6: Effect of fresh and dry algae extract application on some macro (%) and micro (ppm) nutrients content in groundnut leaves and seeds grown on sandy soil (combined analysis of two successive summer seasons of 2019 and 2020)

| Algae extract treatments | Leaves | | | | | | | Seeds | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (g $L^{-1}$) | N (%) | P (%) | K (%) | Fe (ppm) | Mn (ppm) | Zn (ppm) | Cu (ppm) | N (%) | P (%) | K (%) | Fe (ppm) | Mn (ppm) | Zn (ppm) | Cu (ppm) |
| Control | 3.2 | 0.37 | 1.83 | 74.0 | 66.0 | 21.7 | 2.0 | 3.23 | 0.036 | 0.43 | 11.0 | 2.33 | 31.3 | 3.00 |
| Fresh 1 | 3.8 | 0.42 | 1.93 | 146.7 | 195.0 | 29.7 | 5.0 | 4.20 | 0.045 | 0.49 | 14.0 | 4.67 | 37.0 | 4.67 |
| Fresh 2 | 4.3 | 0.53 | 2.20 | 238.3 | 212.3 | 39.7 | 9.7 | 4.60 | 0.059 | 0.50 | 18.3 | 7.33 | 39.7 | 6.33 |
| Fresh 3 | 3.9 | 0.44 | 2.03 | 162.3 | 208.7 | 35.3 | 8.7 | 4.50 | 0.049 | 0.49 | 15.3 | 6.00 | 37.7 | 4.67 |
| Fresh 4 | 3.9 | 0.44 | 2.00 | 149.0 | 199.3 | 30.0 | 5.3 | 4.37 | 0.047 | 0.50 | 15.0 | 5.00 | 37.7 | 4.67 |
| Dry 1 | 3.3 | 0.39 | 1.87 | 90.0 | 94.0 | 25.3 | 3.3 | 3.63 | 0.039 | 0.44 | 11.3 | 2.33 | 31.3 | 3.33 |
| Dry 2 | 3.5 | 0.40 | 1.93 | 98.3 | 97.0 | 26.7 | 3.3 | 3.50 | 0.040 | 0.46 | 12.3 | 2.67 | 32.3 | 3.33 |
| Dry 3 | 3.6 | 0.40 | 1.93 | 101.3 | 99.7 | 27.3 | 3.7 | 4.00 | 0.042 | 0.46 | 12.7 | 4.00 | 33.3 | 3.67 |
| Dry 4 | 3.7 | 0.41 | 1.97 | 125.3 | 175.3 | 27.3 | 4.0 | 4.13 | 0.043 | 0.48 | 14.0 | 4.33 | 36.0 | 4.33 |
| LSD | 0.0461 | 0.0298 | 0.1353 | 3.6012 | 2.6805 | 2.2252 | 1.4125 | 0.2961 | 0.0032 | 0.0245 | 1.2575 | 0.9712 | 2.376 | 1.0401 |

Table 6 reveal that the addition of different ways of algae extract significantly increases the content of some macro and micronutrients in shoots and seeds which result in better seed yield and quality of groundnut, while the control gave the lowest values. The effect of fresh algae at a rate of 2 g $L^{-1}$ caused significantly increased elements nutrition content in shoots and seeds of groundnut plants grown under sandy soil compared with other treatments. Which gives the highest values of N, P and K% and increased elements nutrition content in shoots and seeds of (Fe, Mn and Cu ppm). While dry algae at rate 1 g $L^{-1}$ and control gave the lowest values of elements nutrition content in shoots and seeds.

## DISCUSSION

In this field experiment, the effects of fresh and dry algae on groundnut vegetative development were explored. Growth characteristics (plant height, leaf number and branch number) were determined to be greater than the control, as indicated in Table 4. Micro and macronutrients abound in algae. Algal extracts, unlike chemical fertilizers, are decomposable, non-toxic, non-contaminating and non-harmful to humans and other living organisms[23]. This is one of the reasons why algae extracts have become increasingly popular in organic and sustainable agriculture in recent years[24]. Algae extracts as a novel biofertilizer comprising nitrogen, phosphorus, potassium, calcium, magnesium and sulphur, as well as zinc, iron, manganese, copper, molybdenum and cobalt, as well as growth regulators, polyamines, natural enzymes, carbohydrates, proteins and vitamins, have been used to boost growth and yield[25]. Because of the presence of a variety of plant growth stimulating chemicals as well as their nitrogen, phosphorus and potash content, algae extracts have been applied as foliar and soil treatments in crop production systems for decades[26,27].

Algal bio-fertilizer has demonstrated several benefits and numerous studies suggest that it has a positive impact on plant development[28,29]. Algae extracts fertilizers increase the concentration of macro and micro-nutrients, amino acids, growth regulators and vitamins, which promote the growth development of plants[30,31]. According to Bandonill *et al.*[32], algae extract of blue-green algae were able to boost rice plant development in terms of plant height, the number of panicles $m^{-2}$ and the number of spikelets $m^{-2}$. The experiment looked at the effect of blue-green algae on rice plant development and reported that there was a 2-3 quintal $ha^{-1}$ increase in grain output when compared to the control[33].

In terms of the response of groundnut plants to foliar applications of fresh and dry algae, it is obvious that foliar application of fresh algae considerably boosted plant length in both seasons, followed by dry algae, when compared to the control treatment (spraying with fresh water). Green algae extract boosting impact can be attributed to its high quantities of amino acids, organic matter, vitamins and growth hormones such as cytokinins, gibberellins and auxins (IBA and IAA), all of which promote cell division and enlargement. It also includes macronutrients like nitrogen, phosphorus and potassium, which are necessary for plant growth development, as well as micronutrients such as Ca, Cu, Fe, Mg, Mn, P and Zn, which play an important role in the division of the cell and elongation and promote photosynthesis, which affects the growth of plants. These results agree with those found by the previous studies[14,34-37].

Table 6 shows the influence of green and dried algae extracts on the mineral content of groundnut leaves. The findings presented demonstrated that foliar spraying with fresh algae extracts increased N, P and K levels in groundnut leaves when compared to dry algae and the control. With 2 g $L^{-1}$ fresh algae extract, the maximum nitrogen,

phosphorous and potassium levels in leaves were obtained. Algae liquid extract improves nutrient absorption and is regarded as an excellent source of nutrients for plants. This liquid provides nutrients to plants and increases plant production. All the essential minerals are provided by algae, these essential minerals may be sometimes absent in fresh water and food crops grown in mineral-depleted soils. Algae extracts contain 20-50% minerals in their dry weight[38].

Micronutrients in Groundnut treated with the fresh algal extract (2 g $L^{-1}$) had higher levels of Fe, Mn and Zn. Iron is essential for chlorophyll production. Furthermore, Fe is found in many plant enzymes that play important roles in the oxide redox processes of photosynthesis and respiration[39]. Manganese (Mn) is an activator of several enzyme activities and assists in photosynthesis. Manganese is a component of the complex PSII protein, SOD and phosphatase and it stimulates decarboxylase and dehydrogenase. The Mn deficiency causes growth inhibition, chlorosis and necrosis, early leaf fall and poor re-utilization[40]. It is possible to conclude that liquid algae extracts might be used as a low-cost eco-friendly product for sustainable agriculture. This conclusion is consistent with the findings of Rudresh *et al.*[41], who discovered that the use of bio-stimulants such as algae extracts increases the production and quality of the bean plant.

Table 4 shows that the chlorophyll content of groundnut leaves is high. In terms of the influence of foliar application, the findings demonstrate that spraying plants with the two types of algal extracts (fresh and dried) considerably enhanced the chlorophyll content of the leaves when compared to the control treatment over the two studied seasons. The application of fresh algal extract (2, 3, 4 and 1) resulted in the maximum chlorophyll concentration, followed by dry algae (4, 3, 2 and 1) and control. These findings might be explained by the presence of some nutritional elements in fresh extracts of algae, such as N and Mg, which play an important role in chlorophyll molecule structure. They also contain betaines and cytokinins, which aid in the decreased breakdown of chlorophyll. These results agree with those of Abou El-Yazied *et al.*[14] on the bean, Sarhan[35] on cucumber and Nawar and Ibraheim[42] on pea.

Under normal conditions, the groundnut plant fixes enough nitrogen through a symbiotic interaction with bacteria of the genus Bradyrhizobium. Groundnut plants can fix up to 297 kg/ha/year of N by biological N fixing. In an area with an anticipated pod output of 3 t $ha^{-1}$, about 190 kg of N are removed[14]. The maximum concentration of photosynthetic pigments in maize and wheat leaves, according to Sary *et al.*[43], was observed in plants with the most vegetative growth. Abou El-Yazied *et al.*[14] attributes the rise in groundnut output to an increase in chlorophyll content in the leaves as a result of higher N absorption. Foliar application of fresh green algae proved to be efficient to improve growth traits, increasing the yield and oil content of groundnut plants. For that, the recommendation of this study is to use green algae extracts as bio-stimulant due to the presence of some plant growth-stimulating compounds and their nitrogen, phosphorus and potash content.

## CONCLUSION

Results of this study pay attention to the use of green algae extract as bio-stimulant due to the presence of some plant growth-stimulating compounds and their nitrogen, phosphorus and potash content. Foliar application of fresh green algae proved to be efficient to improve growth traits, increasing the yield and oil content of groundnut plants.

## SIGNIFICANCE STATEMENT

This study pays attention to using green algae extracts as bio-stimulant due to the presence of some plant growth-stimulating compounds and their nitrogen, phosphorus and potash content. Foliar application of fresh green algae proved to be efficient to improve growth traits, increasing the yield and oil content of groundnut plants. This study will help the researcher to uncover the important role of algae extracts as bio-stimulants that many researchers were not able to explore. Thus, a new theory on these bio-stimulants concentrations and combinations and possibly other combinations, may be arrived at.

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