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COMPARATIVE STUDIES ON GROWTH, METABOLISM AND YIELD OF SESAME PLANT BY USING SEAWEED, PLANT EXTRACTS AND SOME GROWTH REGULATORS

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ABSTRACT

A field experiments were carried out in season of 2016/2017 at Botanical garden, Botany and Microbiology Department, Faculty of Science, Al- Azhar University, Nasr City, Cairo, to study the role of bio stimulant (seaweed and plant leaves extracts as a liquid fertilizer) and some growth regulators (indole acetic acid and benzyl adenine) as comparative studies to select the better for improving the growth, biochemical constituents and yield of sesame plants. The results revealed that application leaves extracts of Punica granatum showed significant improvement effects on shoot length, number of pods/plant, weight of seeds / plant, contents of chlorophyll a; b; total chlorophyll (a+ b), carotenoids, total lipids, amylases and peroxidase activities of sesame plants as compared to the other treatments. Fresh and dry weight of shoot was significant increases by using Olea europaea leave and Sargassum latifolium water extracts. Carotenoids content was significant increase in response to all of bio stimulant growth regulators. Olea europaea, Carolina elongata leaves water extracts (5g/L) and benzyl adenine (50 ppm) caused significant decrease of chlorophyll a, b and a+b. Total soluble carbohydrates of shoots of sesame plants significantly decreased in response to Psidium guajava leaves extract compared to the control and other treatments. However, Olea europaea and benzyl adenine caused significant increase in total soluble carbohydrates at yield stage. All treatments caused significant increase of total lipids of sesame plants. Data cleared that, amylase and peroxidase activities significantly increased by all treatments.

INTRODUCTION

Sesame which is known as one of the oldest oilseed crops worldwide used for consumption **(Weiss, 2000)**. Sesame seeds use as a traditional health food in the making of tahini (sesame butter) and halva, and for the preparation of rolls, crackers, cakes and pastry products in commercial bakeries **(Nzikou *et al*. 2009).**

Seaweed extracts are often regarded as soft or natural products that can influence crop growth and development **(Norrie and Hiltz, 1999**). A wide range of beneficial effects has been observed including increasing crop yield, nutrient uptake, resistance to frost and stress conditions, longer shelf life of fruit, improved seed germination, and reduced incidence of fungal and insect attack and reduced the effect of salinity stress on membrane permeability (**Wang *et al*., 2005**).

Several researchers, mentioned that benzyl adenine (BA) improve vegetative growth and yield quality, such as **Mazrou (1992)** on datura, **Menesi *et al*. (1994)** on *Tagetes erecta*, *Zinna elegans* and *Celusia argentia*, **Farahat *et al*. (2002)** on fennels, **El-Abagy *et al*. (2003)** on faba bean. **El-Maadawy *et al*. (2006)** indicated that treating pot marigold plants with BA at 100 ppm gave the highest number of inflorescences, which was significantly higher than the control in both seasons. Different benzyl adenine concentrations significantly increased inflorescence diameter, compared to control. Spraying plants with BA had also generally favorable effect on fresh and dry weight of inflorescences as compared to unsprayed plants.

Plants are known to have antibacterial, antifungal, and other ethnomedicinal uses **(Ogunjobi and Abiala, 2013).** Few investigations into the promotion effects of crude extracts from plants on germination, growth and development of other plants include the works of **Tsao *et al.* (2002)**, which showed phytotoxicity of *Ailanthus altissima* extract on

Medicago sativa and **Roy *et al.* (2006)** that showcased the inhibitory effects of crude extracts from banana on lettuce, red amaranth, amaranth, radish, cucumber, ribbed gourd, bean and okra. On the other hand, earliness in flowering and other reproductive growth have been in *Arachis hypogea* and *Vigna unguiculata* by treating seedlings of these species with water extracts of *Senna alata* **(Onofeghara, 1981)**. **Agbagwa *et al.* (2003)** investigated the efficacy of spraying seedlings of *Celosia argentea* with crude extracts of *Senna alata* and recorded tremendous success ranging from promotion of germination, vegetative and reproductive growth. Efforts to increase the yield of this vegetable by application of organic and inorganic manure have been noted earlier. Against this background, this research further aims at providing economically sustainable means of improving the cultivation of sesame plants and by implication other vegetable crops. Guava (*Psidium guajava* L.) is good source of vitamin-C, pectin, also contains fair amount of calcium. The ascorbic acid content of guava is four-five times higher than the citrus fruit **(Mitra and Bose, 1990).**

Although no report has been given on the use of plant extracts of *Punica granatum* and *Pisidium guajava* as a medicinal plant for improvement plant growth, bio chemical components and yield of sesame plants, several extracts from other plants have been used to enhancement growth of other crops. **Ikechukwu (2014)** studied the efficacy of crude extracts of *Senna alata* in the improvement of vegetative and reproductive growth in *Celosia aregentea*. Different concentrations (75%, 50%, 40%, 30%, 25%, 12%, 10%, and 5%) were prepared from the 100% crude extract. Seeds of *Celosia argentea* were presoaked in these different concentrations including a control (0%) and planted out after 24 hours. Results obtained showed that seedling height, leaf area, dry weight and leaf area ratio were promoted and enhanced by presoaking seeds in the extract. At the end of the experimental period (six weeks), seedling height in 75% and 100% treatments were 109 ± 16.12 cm and 117 ± 19.32 cm, leaf area 128 ± 17.91 cm2 and 125 ± 18.12 cm2, dry weight 7.48 kg and 7.0 kg respectively. Seedlings raised from seeds presoaked in water (control) however, flowered earlier (8 weeks) than the treatments (10 weeks in 75% and 100%). Presoaking seeds of *Celosia argentea* in crude extracts of *Senna alata* before planting is recommended for optimum production of the leafy vegetable.

This study was conducted to investigate the influence of field application of bio stimulant (seaweed and plant leaves extracts) on some growth, yield criteria and some biochemical constituents of sesame plant, as compared of synthetic growth regulators (indo lactic acid and benzyl adenine) in order to select a suitable treatment to the applied fairly to enhance growth and yield quality of sesame.

MATERIALS AND METHODS

This study was carried out in season of 2016/2017 at Botanical garden, Botany and Microbiology Department, Faculty of Science, Al- Azhar University, Nasr City, Cairo, to study the role of seaweed and plant leaves extracts growth regulators for improving the growth, biochemical constituents and yield of sesame plants.

The experiment was arranged as follows:

Plant material: Seeds of sesame "*Sesamum indicum*" (Shandawil 3) plants were obtained from Agricultural Research Centre, Ministry of Agriculture, Giza, Egypt.

Algal and plant leaves collection: *Sargassum latifolium* (Turner) C. Agardii was collected from Hurgada Red Sea coast in June 2013 and *Ulva rigida* C. Agardii from Baltim, Mediterranean coast in June 2013 in Egypt. Plant leaves collected from Botanical garden, Botany and Microbiology Department, Faculty of Science, Al- Azhar University, Nasr City, Cairo.

Seaweed and plant leaves extracts:

After collection, algae and plant leaves were washed with fresh water then they were

dried then, hand crushed and powdered with coffee-grinder then, heated with sterile distilled water in a ratio 1: 100 (w/v) at 60^{o} C for 45 min. Then the extracts were filtered through a filter paper and stored at 4 °C for further experimental studies. Different concentrations of extracts were prepared by diluting of these extracts with distilled water **(Mikhail *et al*. (2013)).** The extracts were applied as a foliar treatment at the rate of 5 gm. powdered /L twice (after 30 and 60 days). Seed sowing was carried out on April 20th.

Uniform sesame seeds were planted in natural loamy soil conditions in a plot (8 m width and 5 m. length) containing 8 groups representing the following treatments: *Olea europaea* (5g/l), *Punica granatum* (5g/l) and *Psidium guajava* (5g/l) were applied to the 2nd , 3rd and 4th groups respectively; *Sargassum latifolium* (5g/l), *Corallina elongate* (5g/l), indol acetic acid (50 ppm) and benzyl adenine(50 ppm) applied to the 5th , 6^{th,} 7th and 8th groups, respectively. The first group was left aside untreated serving as control. The seeds were sown on one side of the ridge, with 10 cm apart between the hills. Developed plants were irrigated whenever required. Concentrations of the used treatments were chosen according to a preliminary experiment. The plants were sprayed twice with the above mentioned treatments, the first and second were added at 30 and 60 days of plant age respectively. The plant samples were collected for analysis when the plants were 37 (Stage I) and 67 (Stage II) days old. At the end of the growth season, analysis of the seeds yielded from the different treatments and the control were done**.** This experiment carried out by completely randomized design.

Determination of Metabolites content of sesame

Chlorophylls contents of were estimated using the method of **Vernon and Selly (1966)**. Carotenoids contents were estimated according to **Lichtentahler (1981).** Soluble carbohydrates were measured according to the method of **Umbriet *et al.* (1969).** Contents of soluble proteins were estimated according to the methods of **lowery *et al*. (1951).** Activities of amylases were determined using the method of **Afifi *et al*. (1986).** Protease activity was determined using the method of **Ong and Gauchier (1973).** Activities of peroxidase were determined using the method of **Castillo *et al*. (1984).** Activities of catalase were determined using the method of **Aebi (1984).** Total lipids determined by using a soxhlet apparatus according to **Guenther (1972).**

Statistical Analysis

Results were statistically analyzed by calculating the analysis of variance, in completely randomized design **(Snedecor and Cochran 1982).**

RESULTS

Growth and yield parameters

The obtained results (figures 1 and 2) revealed that application of leaves extracts of *Punica granatum* showed significant improvement effects on shoot length, number of pods/plant and weight of seeds / plant of sesame plants as compared to the other treatments. In this concept with other plant extract, **Hasan *et al*., (2017)** found that cowpea plants treated with *Moringa oleifera* leaves extract (moringa extract) had the highest mean of stems, number of leaves and branches, length of leaves and branches, and thickness of stem. Then followed by those treated urea fertilizer mean and finally those treated with distilled water. Our result shows that *Punica granatum* leaves extract has an improving effects on the growth of sesame, These results may be due to that *Punica granatum* leaf extract is rich in vitamin E (α-tocopherol), vitamin C (ascorbic acid) and β-carotene **(Noda *et al*., 2002)**. According to **Mvumi *et al*., (2012 and 2013)** showed that moringa extract increased growth and yield of tomato, maize and Common beans, Moringa extract significantly increased above ground dry matter yield, root dry matter weight and plant height for the crops. In table (1) Fresh and dry weight of shoot was significant increase by using *Olea europaea* leave and *Sargassum latifolium* water extract. This results are in a harmony with

Youssef (1997), stated that soaking seeds in Aloe extract at 50 and 100% concentrations increased fresh and dry weights of leaves and number of florets per spike of *Delphinium ajacis* and flower head of *Callisteephus chinensis*. These results may be due to that the olive leaves contain tannins, essential oil, organic acids and resin. Infusions (5%) of the leaves **(Baytop, 1999).** The leaves of the olive are rich in phenolic compounds **Hashmi, *et al*., (2015)**. **Dongzhi *et al*. (2004)** concluded that the aqueous leaf extract of *Aloe vera* could be useful as a natural plant growth regulator. **Padmaja *et al*. (2007)** stated that *Aloe vera* peelings powder at 140 g/pot significantly increased fresh and dry weights of Lady's Finger (*Abelmoschus esculentus*) plants. **El-Shayeb (2009)** declared that all concentration of *Aloe vera* extract increased fresh and dry weights of flowers of *Oenthera biennis*. **Awad and Refaat (2017)** showed that the higher concentration of Moringa *olifera* leaf extract (1 ml of juice + 10 ml of distilled water) caused significant increases in growth and forages (*Sorghum bicolor* L. Moench, *Penisetum typhoideum* Rich and *Sorghum Sudanese*)yields in both seasons compared to others. Results in table 1 showed that *Corallina elongata* extract caused significant decrease in fresh and dry weight of shoot and root.

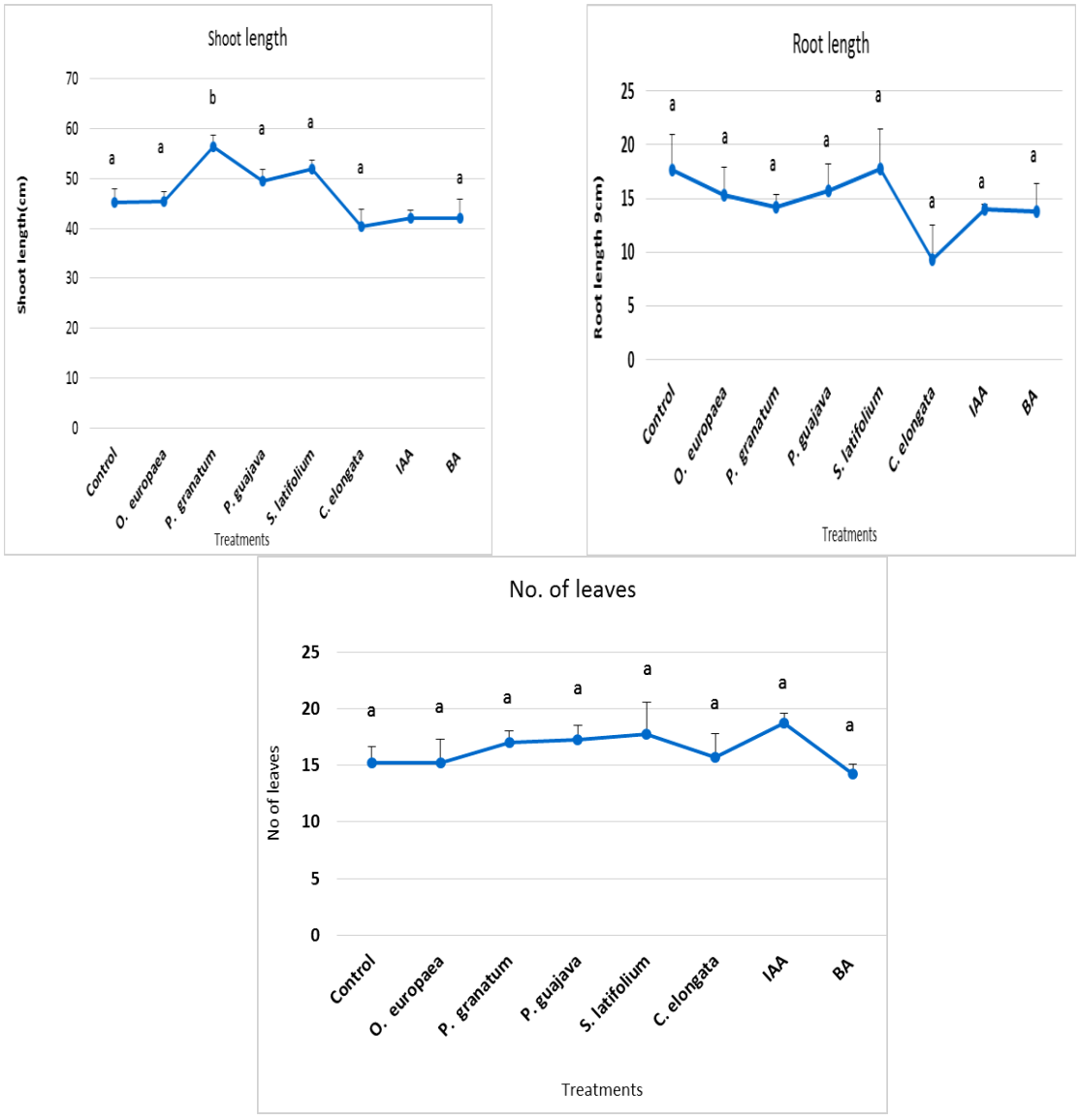

Figure (1): Effect of *Olea europaea*, *Punica granatum*, *Psidium guajava*, *Sargassum latifolium*, *Corallina elongata*, indol acetic acid and benzyl adenine on shoot length, root length and number of leaves of sesame plants. Values given are means of ten replicates. Similar symbols have no significant value, but different symbols have significant value.

Table (1): Effect of *Olea europaea*, *Punica granatum*, *Psidium guajava*, *Sargassum latifolium*, *Corallina elongata*, indol acetic acid and benzyl adenine on fresh and dry weight of shoot and root of sesame plants. Values given are means of ten replicates.

Treatment	Fresh weight of shoot (gm)	Dry weight of shoot (gm)	Fresh weight of root (gm)	Dry weight of root (gm)
Control	40.91±5.49 a	6.32±1.26 a	7.48±2.96 a	1.37±0.45 a
O. europaea	56.40±7.38 b*	9.16±0.90 b*	5.42±1.51 a	0.87±0.25 a
P. granatum	52.96±8.25 a	6.28±1.16a	7.16±1.89 a	1.14±0.27 a
P. guajava	43.21±6.78 a	6.27±1.11a	6.36±1.98 a	1.02±0.30 a
S. latifolium	56.87±5.59 b*	*9.44±0.30b	8.15±1.69 a	1.27±0.17 a
C. elongata	17.00±4.83 c*	2.46±0.59 c*	1.77±0.25 b*	0.58±0.09 b*
IAA	29.57±2.22 a	3.39±0.40 c*	4.31±1.12 a	0.77±0.13 a
BA	34.54±8.47 a	5.43±1.17 a	7.03±1.84 a	0.91±0.24 a
LSD at 0.05	18.72	2.73	5.27	0.77

* Significant at 5% confidence level compare by healthy control group.
Similar symbols have no significant value, but different symbols have significant value.

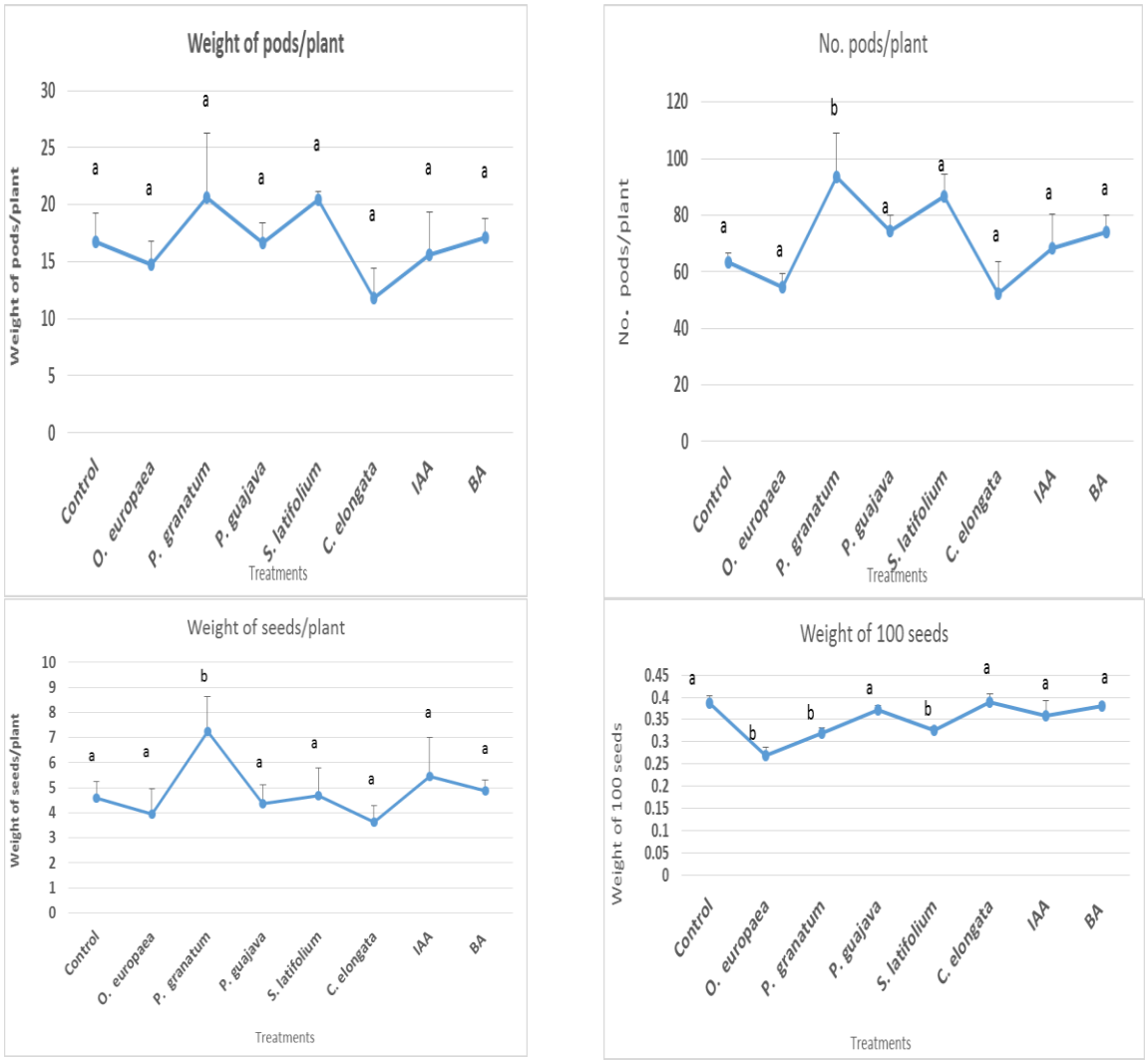

Figure (2): Effect of *O. europaea*, *P. granatum*, *P. guajava*, *S. latifolium*, *C. elongata*, IAA and BA on number of pods, weight of pods/plant (gm), weight of seeds/plant (gm) and weight of 100 seeds (gm) of sesame plants. Values given are means of ten replicates. Similar symbols have no significant value, but different symbols have significant value.

Photosynthetic Pigments:

The contents of chlorophyll a; b; total chlorophyll (a+ b) and carotenoids of sesame plants (Table 2) showed significant increases in chlorophyll a, b and a+ b content in response to *Punica granatum* leaves water extract as a compared with the control treatment. Carotenoids content was significant increase in response to *all of bio stimulant growth regulators*. The positive effect of seaweeds were obtained by a number of investigators, **Rawheya *et al*. 2008)** indicated that pigment content of faba bean was also increased as a result of seaweed (*Sargassum latifolium, Halimeda opuntia* and *Ulva rigida*) foliar application. Also, **Blunden *et al*. (1996)** found that the seaweed concentrate increase the overall photosynthetic accumulation efficiency of the plant.

In our results, *Olea europaea*, *Carolina elongata* leaves water extract(5g /L) and benzyl adenine (50 ppm) caused significant decrease of chlorophyll a, b and a+b. In this conclusion, **Filemon *et al*.,** (2013) found that the total chlorophyll content of *Neonotonia wightii* was significantly reduced in all plants treated with both aqueous seed and leaf extracts of *Datura stramonium*. In *Cenchrus ciliaris*, the total chlorophyll content was also significantly reduced for those plants treated with aqueous seed extract and leaf extract from *Datura stramonium*. **El-Maadawy *et al*. (2006)** who observed that the lowest BA concentration (50 ppm) caused a decrease in the total chlorophyll content of *Calendula afficinalis* L. plants compared with that of untreated plants.

3- Metabolic responses:-

The obtained results (Table 3) indicated that total soluble carbohydrates of shoots of sesame plants significantly decreased in response to *Psidium guajava* leaves water extract as a compared with the control and other treatments however, *Olea europaea* and benzyl adenine (in table 4) caused significant increase in total soluble carbohydrates at yield stage. There is no any significant effect of all treatments on total soluble protein of root and shoot. In this concept**, El-Abagy *et al*. (2003)** found that spraying faba bean plants with benzyl adenine (25 and 50 ppm) decreased carbohydrate percentage content.

On the contrast of this, **El-Sheekh and El-Saied (2000)** who studied the effect of crude seaweed extracts of three green seaweeds (*Cladophora dalmatica*, *Enteromorpha intestinalis*, *Ulva lactuca*) and the three red algae (*Corallina mediterranea*, *Jania rubens*,

Table (2): Effect of *O. europaea*, *P. granatum*, *P. guajava*, *S. latifolium*, *C. elongata*, IAA and BA on chlorophyll and carotenoids contents (mg/g. F. wt) of sesame plants. Values given are means of three replicates.

Treatment	Chlorophyll a	Chlorophyll b	Chlorophyll a+b	Carotenoids
Control	6.18±0.23 a	6.60±0.08 a	12.79±0.21 a	1.96±0.21 a
O. europaea	5.98±0.54 b*	6.13±0.05 b*	12.21±0.21 b*	2.10±0.02 b*
P. granatum	6.40±0.45 c*	7.21±0.07 c	13.61±0.54c	2.06±0.024 b*
P. guajava	6.27±0.12 a	6.72±0.06 a	13.00±0.25 a	2.04±0.015 b*
S. latifolium	6.26±0.36 a	6.49±0.32 a	12.76±0.36 a	2.12±0.031 b*
C. elongata	5.94±0.26 b	5.73±0.28 b	11.67±0.45 b	2.28±0.048 b*
IAA	6.18±0.24 a	6.55±0.47 a	12.74±0.94 a	2.02±0.054 a
BA	5.72±0.02 b	6.16±0.01 b	11.89±0.024 b	2.03±0.065 a
LSD at 0.05	0.19	0.16	0.22	0.08

* Significant at 5% confidence level compare by healthy control group.

Similar symbols have no significant value, but different symbols have significant value.

Pterocladia pinnate) from the Egyptian Mediterranean Sea coast on metabolic activities of *Vicia faba*. They found that, all the crude extracts of seaweed increased protein content in root and shoot systems and total soluble sugars in leaves, **Elgayar (2004)** revealed that treatment of soybean with benzyl adenine (25 and 50 ppm) resulted in slight effects on carbohydrate.

It is clear from table 4 that all treatments caused significant increase of total lipids of sesame plants. . In this regard, Talaat and Youssef (1998) showed that oil in seeds of rosella plants were significantly increased as a result of BA application, especially at 40 mg/L. **Abed (2001)** observed that BA significantly increased oil and protein % in seeds of cotton plants. Data in table (5) cleared that, amylases and peroxidase activities increased significantly by all treatments. In this respect, **Husein (1993)** showed that the activities of amylases in Datura plants were significantly increased as a result of treatments with benzyl adenine. All used treatments caused significant decreased of protease and catalase enzymes.

Table (3): Effect of *O. europaea*, *P. granatum*, *P. guajava*, *S. latifolium*, *C. elongata*, IAA and BA on total soluble carbohydrates and protein contents of root and shoot of sesame plants. Values given are means of three replicates.

Treatment	Carbohydrates		Proteins	
	Root	Shoot	Root	Shoot
Control	27.46±2.21 a	21.29±1.36 a	7.52±0.42 a	7.52±0.36 a
O. europaea	22.72±3.21 a	17.83±3.87 a	7.60±0.63 a	6.85±0.24 a
P. granatum	22.79±1.56 a	22.48±3.45 a	7.85±0.85 a	7.18±0.39 a
P. guajava	12.77±1.65 b*	16.42±1.98 b*	7.93±0.39 a	6.89±0.45 a
S. latifolium	26.98±3.21 a	18.77±4.78 a	8.02±0.25 a	7.27±0.95 a
C. elongata	26.26±4.32 a	22.84±3.12 a	7.52±0.63 a	8.23±0.68 a
IAA	26.69±2.35 a	22.38±2.54 a	7.77±0.84 a	7.47±0.46 a
BA	26.07±3.21 a	18.5±4.32 a	7.52±0.73 a	7.65±0.75 a
LSD at 0.05	12.25	4.89	1.02	0.94

* Significant at 5% confidence level compare by healthy control group.
Similar symbols have no significant value, but different symbols have significant value.

Table (4): Effect of O*. europaea*, *P. granatum*, *P. guajava*, *S. latifolium*, *C. elongata*, IAA and BA on total soluble carbohydrates, proteins and lipids contents of yield of sesame plants. Values given are means of three replicates.

Treatment	Yield		
	carbohydrates	Proteins	Lipids
Control	16.37±1.32 a	11.52±0.25 a	42.2±0.25a
O. europaea	23.92±2.21 b*	8.85±0.64 a	54.8±0.45b*
P. granatum	19.33±2.14 a	9.18±0.75 a	53.54±2.14b*
P. guajava	17.22±2.14 a	8.89±0.45 a	62.82±2.01b*
S. latifolium	18.77±0.98 a	9.27±0.98 a	55.87±0.54b*
C. elongata	19.37±0.54 a	11.23±0.54 a	77.42±3.01b*
IAA	19.73±0.69 a	9.47±0.36a	66.51±0.21b*
BA	23.80±2.32 b*	8.65±0.25a	55.36±0.25b*
LSD at 0.05	5.45	1.52	10.21

* Significant at 5% confidence level compare by healthy control group.
Similar symbols have no significant value, but different symbols have significant value.

Table (5): Effect of *O. europaea*, *P. granatum*, *P. guajava*, *S. latifolium*, *C. elongata*, IAA and BA on amylases, protease, Catalase and Peroxidase enzymes (mg/g. dry weight) of sesame plants. Values given are means of three replicates.

Treatments	Amylase	Protease	Catalase	Peroxidase
Control	0.62±0.07 a	0.47±0.32 a	0.75±0.05 a	0.15±0.12 a
O. europaea	0.77±0.06 b*	0.24±0.21 b*	0.52±0.08 b*	0.45±0.03 b*
P. granatum	0.75±0.025 b*	0.02±0.45 b*	0.15±0.07 b*	0.37±0.02 b*
P. guajava	1.21±0.21 b*	0.17±0.12 b*	0.07±0.024 b*	0.60±0.06 b*
S. latifolium	1.10±0.058 b*	0.19±0.05 b*	0.22±0.12 b*	0.82±0.09 b*
C. elongata	1.52±0.32 b*	0.16±0.06 b*	0.07±0.025 b*	0.52±0.36 b*
IAA	0.79±0.214 b*	0.10±0.08 b*	0.30±0.21 b*	1.120.21± b*
BA	0.73±0.235 b*	0.09±0.21 b*	0.52±0.012 b*	1.27±0.025 b*
LSD at 0.05	0.10	0.13	0.16	0.21

* Significant at 5% confidence level compare by healthy control group.
Similar symbols have no significant value, but different symbols have significant value.

CONCLUSION

In conclusion, the present study showed the important role of bio agents (*Punica granatum*) for growth, biochemical changes and yield promotion of sesame plants. Treatment plants with bio stimulants showed significant improvement effects on fresh and dry weight of root of sesame plants. Application leaves extracts of *Punica granatum* showed significant improvement effects on shoot length, number of pods/plant, weight of seeds / plant, contents of chlorophyll a; b; total chlorophyll (a+ b), carotenoids, total lipids, amylases and peroxidase activities of sesame plants. These results suggest that *Punica granatum* are very effective than other treatments. Moreover, results indicated the effectiveness of *Punica granatum* leaf extract in improving growth and increasing productivity of sesame plants.

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دراسات مقارنة علي نمو وأيض وانتاجية نبات السمسم باستخدام بعض المستخلصات الطحلبية والنباتية وبعض منظمات النمو

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أجريت تجربة حقلية في الحديقة النباتية بقسم النبات والميكروبيولوجي بكلية العلوم جامعة الأزهر أثناء الموسم الصيفي ٢٠١٦/ ٢٠١٧ لدراسة تأثير الرش الورقي للمستخلصات الطحلبية والنباتية و بعض منظمات النمو على النمو والمحصول و بعض النشاطات الأيضية لنبات السمسم. أظهرت النتائج التي تم الحصول عليها أن استخدام مستخلص اوراق الرمان (٥جرام/ لتر) ادي الي حدوث زيادة معنوية في كلا من طول المجموع الخضري وعدد القرون ووزن البذور لكل نبات و محتوي الكلوروفيل والكاروتين والدهون الكلية ونشاط كلا من انزيمي الاميليز والبيروكسيديز لنبات السمسم. المستخلص المائي لاوراق نبات الزيتون وطحلب السرجاسوم اظهرت زيادات معنوية في الوزن الرطب والجاف للمجموع الخضري. كانت جميع المستخلصات الطحلبية والنباتية المستخدمة فعالة في زيادة محتوي الاوراق من اصباغ الكاروتين. ادت جميع المعاملات المستخدمه لزيادة معنوية في محتوي الدهون الكلية. استخدام مستخلص اوراق الزيتون والبنزيل ادينين ادي لزيادة معنوية في محتوي البذور من الكربوهيدرات الذائبة. بينما ادي استخدام مستخلص اوراق الزيتون وطحلب الكارولينا والبنزيل ادينين الي نقص معنوي في محتوي المجموع الخضري الجاف من الكربوهيدرات الذائبة. مستخلص اوراق الرمان كان افضل المعاملات لمعظم القياسات المورفولوجية والبيوكيميائية..