



Enhancing Growth and Yield of Sesame Plant (*Sesamum indicum* L.) by the Amendment of Benzyladenine, Yeast Extract and Mixed Amino Acids.

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Abstract

The aim of this research is to study the effects of foliar application of some growth stimulants, such as benzyladenine (BA), yeast extract (YE) and a mixed amino acids (MAA) on growth, Endogenous phytohormones, chemical content of leaves, yield characteristics, and chemical content of seeds, as well as seed yield, and oil yield of sesame plant (*Sesamum indicum* L. var. Sandawel 3) plants.

The received results were explained that the foliar application of growth stimulants as BA (25 and 50 mg L⁻¹), YE (50 and 100 ml L⁻¹) and MAA (4 and 6 ml L⁻¹) significant increased in all growth parameters (i.e., stem length (cm), leaf area(cm²)/plant, fresh & dry weights (g) of stems and leaves, No. of flowers/plant, No. of capsules/plant, fruiting zone length (cm)/plant and seed yield (g)/pot).

Additionally chemical composition represented in photosynthetic pigments, minerals, crude protein contents, total sugars and carbohydrate and total free amino acids in sesame leaves and seeds were also increased by all studies treatments compared with the control, the highest value were MAA at 4 ml L⁻¹ followed by YE at 100 ml L⁻¹ in the two seasons. This increased improved seeds yield and it's components along with oil percentage and seed oil yield /plant.

Key words: Sesame (*Sesamum indicum*, L.), benzyladenine (BA), yeast extract (YE), mixed amino acids (MAA).

Introduction

Sesame (*Sesamum indicum* L.) is considered an important oil crop that is grown mainly to obtain its seeds, which are used in the production of some foodstuffs. Its seeds are rich in protein (15-25%), percentage of crude fibers, mineral substances especially (iron, calcium, phosphorus, zinc, and magnesium), oxalic acid, vitamin B-complex, amino acids and antioxidants **Hussain et al., (2023)**.

Sesame (*Sesamum indicum* L.) is an important oil seed crop mainly cultivated in the tropics. It contains a high percentage of oil, reaching 55-60%. The oil contains unsaturated fatty acids, particularly linoleic acid (37 - 47%), oleic acid (35 - 43%), palmitic acid (9 - 11%), and stearic acid (5 -10%) **Jahan et al., (2019)**.

According to the United Nations Food and Agriculture Organization (**FAO, 2020**) for the sesame crop in Egypt for the year 2020; Area harvested 29000 fed. , Yield 13103 tons, Production 38000 tons. (**FAO statistics 2020**).

Egypt imports large amounts of oil to face the great needs of the local oil production is a target to reduce the increasing gap between production and consumption of oil crops in Egypt. This could be achieved by increasing the cultivated areas of sesame and oil crops should be done outside the Nile Valley

due to the competition of other main crops, and its productivity by application of some growth stimulants to improve growth and development, flowering, fruit set, seed formation and yield of sesame seed oil **Abd El-Dayem et al.,(2012)**.

In recent years a great deal of attention has been focused upon the application of certain bio regulators in order to improve productivity the yield of many crop plants. Positive response could be achieved depending on the plant species, the type and applied concentration of bio-regulators employed. Bio-regulators (plant growth regulators) such as benzyladenine (traditional plant growth regulator), putrescine and salicylic acid (non-traditional or new plant growth regulators) are among the growth regulators which in small amount induce a great changes the various morphological and physiological processes, increase yields and improve quality of plant products, as well as, they can increase number of buds, branches, flowers, pod/plant, seed index and yields with one application, alter growth patterns, nutritional components, chlorophyll contents and resistance to different kinds of stress (cold, heat, drought, insects and disease) when applied at extremely low levels **Abd El-Dayem et al.,(2012)**.

Benzyladenine is one of the most important growth regulators, which belongs to the group of cytokinins. It stimulates cell division and dilation and

causes the stimulation of cell dilation laterally, and plays a role in delaying leaf aging and stimulating the transport of nutrients in addition to its effects in activating the synthesis of mRNA and protein in cells and in this field clarified **Al-Hamdani and Al-Jubouri (2014)** and **Hamza and Al-Taey (2020)**.

Amino acids and small peptide-based bio stimulants have received increased attention for their positive effects on plant performance (**Colla *et al.*, 2017**). As a result, amino acids are emerging in many foliarly applied products superintendents and sports turf managers with claims of enhanced growth, greening, and increased resistance to stress. Using ¹⁵N-labeled glycine, L-glutamate, and L-proline, it was previously demonstrated that the nitrogen from these applied amino acids was absorbed into creeping bentgrass (*Agrostis stolonifera* L.) foliage to similar degrees as other nitrogen. (**McCoy *et al.*, 2020**).

Yeast contains significant levels of protein, carbohydrates, reducing sugars, amino acids, enzymes, mineral elements (N, P, K, Mg, Ca, Na, Mn, Zn, Cu, B, and Mo), and a natural source of many growth substances (thiamine, riboflavin, niacin, pyridoxine, and vitamins B1, B2, B3, and B12) (**Abdelaal *et al.*, 2017**). Yeast extract acts as a natural biological stimulant that improves the growth and yield of different crops (**Mahmoud *et al.*, 2016**). The effective influence of yeast may be attributed to its effect on enzymatic activity.

Yeast extract has a beneficial role during the vegetative growth and productivity stages through improving flower formation in some plants due to its high auxin and cytokinin contents. It also enhances carbohydrate accumulation (**Zewail *et al.*, 2019**).

Yeast extract improved the vegetative growth, chemical constituents of plant foliage, enzyme activity, phytohormones content, fruit yield productivity, and fruit quality of sweet pepper plant cv Zidenka grown under greenhouse conditions by using a foliar spray yeast extract (**Mohamed *et al.*, 2021**).

The aim of this study is to increase the growth, performing productivity and quality of sesame seeds per unit cultivated area by using some growth stimulants.

Material and methods

Two pot experiments were conducted at the experimental station of Agricultural Botany Department Faculty of Agriculture Moshtohor, Benha University during two growing successive 2022 and 2023 seasons to study the effect of foliar application with benzyladenine (BA) at 25 and 50 mg L⁻¹, yeast extract (YE) at 50 and 100 ml L⁻¹ and Mixed amino acids (MAA) at 4 and 6 ml L⁻¹ comparing with the control plant (sprayed with tap water) on the growth, morphological, physiological, anatomical, flowering and yield characteristics as well as seed quality, seed yield, oil content and

chemical compositions of sesame (*Sesamum indicum* L. var. Shandawel 3) plant.

This investigation was carried out on sesame plants (*Sesamum indicum* L. var. Shandawel 3). Seeds of sesame plant were obtained from Agricultural Research Center, Giza, Egypt.

3.1. Plant material and procedure:

(*Sesamum indicum* L. var. Shandawel 3) were sown on 19th April 2022 and 2023 in the two successive seasons, in The Experimental Station of Agricultural Botany Department Faculty of Agriculture Moshtohor, Benha University. The used of plastic pots were 40 cm in diameter and filled with 8 kg of soil from mixture of clay and sand 2:1 w/w. Phosphorus fertilizers in the form of super phosphate (1.4 g) was added to each pot, ten seeds were sown in each pot. Then, pots irrigation was carried out according the usual practice by adding equal amounts of tap water after for each pot. After seedling emergence, three weeks after sowing, plant were thinned to four uniformed seedlings/pot. The plants were exposed to natural illumination. After thinning, plants were fertilized as recommended for this plant with 5gm ammonium nitrate (as two dose, first after thinning (2.5g) and the second at the beginning of flowering stage (2.5g)). The pots were arranged in a complete randomized design was with 10 replicates Block (RCBD).

The experiment randomized complete block design (RCBD) with three replicates. This experiment included 6 treatments in addition to the control (tap water) all pots practices of growing *Sesamum indicum* L. plants including fertilization irrigation, manual weed control and soon were carried out as usual according to crop requirement recommended.

3.2. The experiment treatments were as follows:

This experiment included seven treatments as follows:

1. Control (tap water).
2. Benzyladenine (BA) at 25 and 50 mg L⁻¹.
3. Yeast extract at 50 and 100 ml L⁻¹.
4. Mixed amino acids at 4 and 6 ml L⁻¹.

3.3. Treatments source and preparing:

1-Benzyladenine (BA) was exported from TITAN Bio Tech Laboratory Chemicals INDIA, Authorized distributor in Egypt: Future Modern Lab 13, Elpetrol St, In front of El Marg El Gedida Station 7th floor.

2-Yeast extracts were prepared according to (**Abd EI-Rahim *et al.*, 1988**).

3- Mixed amino acids was exported from El Nagmateen Company, 38 St., Gamal Salem, Dokky, Giza, Egypt (combination via grow Amino Tonic Liquid), chemical composition 25% amino acids and 10 % nitrogen.

Through plant growth and development, the growth substances treatments were applying as foliar

spray three times started at 30 days after planting, then the spraying is repeated at an interval of 20 days for second and third one, respectively. The plants were sprayed with a hand pump. A surfactant (Tween 20) at a concentration of 0.01% was added to all tested solutions the control. The foliar spraying solution were added to the point of runoff.

3.4. Sampling and collecting data: -

3.4.1. Morphological measurements: -

Different morphological characteristics of sesame (*Sesamum indicum* L. var. Shandawel 3) plants at 82 days after sowing (DAS) were measured (flowering and fruiting stage) during 2022 and 2023 seasons.

Three plants from each replicate were randomly taken and then separated into their organs and the following characteristics were recorded:

- (Stem plant height cm/plant, No. of leaves/plant, total leaves area cm²/plant by using disk methods according to (Brouwer *et al.*, 1973), fresh and dry weight of stems g/plant, fresh and dry weight of leaves g/plant, No. of flowers/plant and No. of capsules/plant).

The samples of the above ground i.e., vegetative parts were dried in the oven-dried for 48 h in 70°C to a constant weight and then the dry weight/plant was calculated. These dry samples of stems and leaves were kept for chemical analysis.

3.4.2. Photosynthetic pigments determination:

The photosynthetic pigments (chlorophyll a, b. and carotenoids) were extracted from fresh leaf sample (in the 4th apical leaves) at 82 days after sowing (DAS) by pure acetone according to Fadeel's method (Fadeel 1962).

3.4.3. Endogenous phytohormones determination:

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Endogenous phytohormones were quantitatively determined in *sesamum indicum* L. shoot at 82 DAS during 2022 season, only in the best treatments (i.e., BA at 25 mg L⁻¹, YE at 100 ml L⁻¹ and MAA at 4 ml L⁻¹) compared with the control. According to the method of Koshioka *et al.*, (1983) used for HPLC (High- Performance Liquid Chromatography) for the determination of auxin (IAA), gibberellic acid (GA₃) and abscisic acid (ABA). Meanwhile, cytokinins were determined by HPLC according to Nicander *et al.*, (1993)

3.4.4. Flowering stage zone measurements: -

At flowering stage, flowers numbers, flower setting percentage, flower abscission percentage, capsules number/ plants were recorded and calculated.

a) Total number of flowers / plant.

b) Abscission percentage: was calculated .

4. Yield and its component:

At harvest time (120 DAS in 2022 and 2023 seasons) three randomly plants from each replicate

were taken for estimating the following characteristics:

- No. of capsules/plant, No. of seeds/capsules, weight of intact capsules g/plant, weight of empty capsules g/plant, total seed weight g/plant, weight of 1000 seeds g, seed yield g/pot, seed oil % yield/plant.

5. Chemical composition: -

Chemical analysis was carried out on the samples of dry shoot and seeds during two seasons (2022 and 2023).

5.1. Determination of certain nutrient elements: -

Determination of N, P and K concentrations were carried out. The wet digestion of 0.2 g plant material with sulphuric and per-chloric acids was carried out on leaves and dry seeds according to Piper, (1947) during 2022 and 2023 seasons.

1. Total nitrogen and crude protein: -

Total nitrogen was determined in the dry matter using microkjeldahl method as described by Horneck and Miller (1998), then calculated as percentage % of dry weight. Then, the crude protein was calculated according to the equation of A.O.A.C. (2005).

Crude protein = Total nitrogen x 5.30

2. Phosphorus: -

It was determined calorimetrically according to the method of Sandell (1950) and calculated as mg g⁻¹ dry weight.

3. Potassium: -

It was determined by the flame photometer model Carl-Zeiss according to the method described by Hornbeck (1987) and calculated as percentage % of dry weight.

5.2. Total carbohydrates content: -

Total carbohydrates were determined in the dry shoot at 82 DAS and in seeds at harvest time (120 DAS) in the second growing season by using phenol-sulphuric acid method according to Dubois *et al.*, (1956) and calculated as mg g⁻¹ dry weight.

5.3. Determination of total sugars content:

The total sugars expressed as glucose were determined calorimetrically according to the method of Dubois *et al.*, (1956)

5.4. Total free amino acids:

Total free amino acid was determined in the ethanolic extract with ninhydrine, buffer, solvent and boiling time calorimetrically according to Muting and Kaiser (1963).

5.5. Statistical analysis:

Data of morphological, flowering and yield characteristics were statistically analyzed and the means were compared using the Least Significant Difference test (L.S.D) at 5% according to Duncan (1980) and Snedecor and Cochran (1989).

Results and Discussion

The following results distinctly display the effects of foliar spraying of some growth stimulants such as benzyladenine (BA), yeast extract (YE) and mixed amino acids (MAA) on sesame plants for increasing the growth, productivity and quality of sesame seeds per unit cultivated area by using some growth stimulants.

1. Effect of applied treatments on vegetative growth characteristics: -

Data in **Table (1)** presented that each of stem height (cm), stems fresh and dry weight (g) /plant were gradually increased to reach the 5% level of significance with different applied treatments during 2022 and 2023 seasons compared with the control.

In connection with the stem height (cm), stem fresh and dry weight (g) /plant significant increase existed with all applied treatments during 2022 and 2023 seasons compared with the control treatment. The most surpassing treatments were mixed amino acids at 4 ml L⁻¹ followed by yeast extract at 100 ml L⁻¹ compared with control treatment, during both seasons.

With respect to the No. of leaves/plant, leaves fresh and dry weight (g)/plant and total leaf area (cm²)/plant were significantly increased existed with all applied treatments during 2022 and 2023 seasons compared with the control treatment. The most superior treatments were mixed amino acids at 4 ml L⁻¹ followed by yeast extract at 100 ml L⁻¹ compared with the control, respectively.

In this regard, the results obtained clearly showed the effect of the different treatments used to improve the vegetative growth characteristics of sesame plants during 2022 and 2023 seasons. These results are of great importance, because at this early stage of growth there were significant simulation effects with the different applied treatments. This can extend to advanced growth stages including both the flowering stage and the final crop and its components.

In weaning growth measurements including plant height could be attributed to benzyl adenine effectiveness showed the increase in cell division and elongation; it also effect on the activation of RNA, thus increasing the vital reactions in the cell. It also affects the activation of enzymes necessary for vital reactions, and increases the building of chlorophyll and proteins, thus delaying the aging of leaves and increasing the transfer of nutrients to active tissues and their representation. (Al-Waeli- Fatimah and Al-Khyyat 2023).

Cytokinins allow the optimal growth and development of plants by promoting cell division and tissue growth and delaying leaf senescence (Davies, 2010). Furthermore, 6-BA is in a class of synthetic cytokinin PGRs that can significantly increase levels of endogenous cytokinins in crop plants (Prerostova *et al.*, 2020).

The impact of yeast extract on plant growth is due to some important chemical characters of yeast extract analysis (a natural source of phytohormones, especially gibberellins, auxins and cytokinins, amino acids (i.e., lysine, tryptophan, etc.), a source of nutrients for plants because it contains many macro elements, micronutrient and vitamins (i.e., B1, B2, B6, and B12)) Mahmoud (2001); Abou El Yazied and Mady (2011) and Adam *et al.*, (2022).

The profound effects of applied foliar application of mixed amino acid on increased plant growth may be because parameters providing readily source of growing substances which form the constitutes of protein in the living tissues. In general, Amino acids were found to increase No. of flowers, fruit setting and fruit yield (Neeraja *et al.*, 2005). In addition, Amino acids can affect the content of other compounds in plants (Amin *et al.*, 2012).

In contrast, it was reported that amino acids increased the transcription of genes involved in the transport of nitrates, ammonium, phosphates, magnesium, and iron (Santi *et al.*, 2017).

2. Effect of applied treatments on chemical compositions of leaves:

2.1 Photosynthetic pigments:

Data in **Table (2)** records the effect of different applied treatments (i.e., benzyladenine at 25 and 50 mg L⁻¹, yeast extract at 50 and 100 ml L⁻¹, as well as mixed amino acids at 4 and 6 ml L⁻¹) on photosynthetic pigments (i.e., chlorophyll a & b, Chl. (a + b) and Carotenoids) estimated in sesame plants at 82 DAS compared with those of the untreated plants in both seasons of this study. All treatments significantly enhanced all photosynthetic pigments content compared with the control treatment during both seasons.

Chlorophyll a and b were increased with different applied treatments compared with the control at 82 DAS during 2022 and 2023 seasons in **Table (2)**. The highest value of these traits was with BA at 50 mg L⁻¹ (1.58 & 1.36 mg g⁻¹ F.W.) and (0.48 & 0.49 mg g⁻¹ F.W.) followed by MAA at 4 ml L⁻¹ (1.57 & 1.17mg g⁻¹ F.W.) and (0.36 & 0.40 mg g⁻¹ F.W.) at 82 DAS during 2022 and 2023 seasons respectively. Meanwhile, control treatment gave (1.04 & 0.89 mg g⁻¹ F.W.) and (0.15 & 0.20 mg g⁻¹ F.W.) at 82 DAS during 2022 and 2023 seasons respectively.

Carotenoids were promoted with different applied treatments compared with control at 82 DAS during 2022 and 2023 seasons in **Table (2)**. The highest value of these characteristics with MAA at 4 ml L⁻¹ (0.75 and 0.65 mg g⁻¹ F.W.) followed by MAA at 6 ml L⁻¹ (0.72 and 0.63 mg g⁻¹ F.W.) at 82 DAS during 2022 and 2023 seasons respectively. Meanwhile, control treatment gave (0.53 and 0.44 mg g⁻¹ F.W.) at 82 DAS during 2022 and 2023 seasons, respectively. Also, it could be noticed that maximum significantly increasing of all these pigments was existed with MAA at 4 ml L⁻¹, straight.

In this respect, the stimulation of photosynthetic pigments formation could be attributed to the vigorous growth obtained in **Tables (1)**. These results are of great importance, because they are lightly considered direct for more dry matter production and distribution in shoots of sesame plants as affected by different applied treatments.

These results are in agreement with those reported by **Bondok (1996)** on sugar beet plants and **Abd El-Dayem (1999)** on fodder beet plants; However, similar promoting effect of BA on photosynthetic pigments content in different plants was reported by **Abd El-Dayem et al., (2012)** and **Ismail and Halmy (2018)**.

In addition to, **Zewail et al., (2019)** indicated that foliar application of benzyladenin and yeast extract increased photosynthetic pigments content (chlorophyll a, b, carotenoids and total chlorophylls) in soybean leaves.

Yeast extract activity as a bio-growth regulator may be responsible for the enhancement of photosynthetic pigments **Mahmoud (2001); Abou El Yazied and Mady (2011) and Adam et al., (2022)**, because its influences on the balance among photosynthesis in plants (**Olaiya 2010**). Furthermore, using yeast extract can improve chlorophyll a and b concentrations due to its rich contents from many essential vitamins, elements and amino acids, which (**Abdelaal et al., 2019**). Simultaneously, yeast extract works on CO₂ release, which is positively reflected on the increase of the total production of photosynthesis (**Khalil and Ismael 2010**).

Obviously; the increase in leaf photosynthetic pigments, due to application of amino acids, has been reported in other studies (**Fahimi et al., 2016; Mohammadipour and Souri 2019**). The maximum chlorophyll content of leaves may be due to the effect of amino acids on chlorophyll biosynthesis and decrease in chlorophyll degradation, as well (**Souri et al., 2017**). Amino acids can probably act against oxidation, peroxidation and degradation of cell components, particularly chlorophylls, and therefore they increase the life span of cells. The bio-protection effect of amino acids has been based on several studies (**Khan et al., 2012; Souri and Hatamian 2019**).

2.2 Chemical constituents of leaves on sesame plant:

2.2.1. Minerals concentration of sesame leaves:

Data in **Tables (3)** illustrate that all spray foliar treatments were effectively increased N, P and K concentrations of treated plants compared with those of the untreated plant during 2022 and 2023 seasons. In this respect the most effective treatments were MAA at 4 ml L⁻¹ followed by MAA at 6 ml L⁻¹.

The stimulative effect of these treatments may be due to the higher mineral metabolic requirements to face the higher obtained vigorous growth and yield potentialities there by more

minerals uptake and translocation **Hafez et al., (2021)**.

2.2.2. Crude Protein content of leaves in sesame plants:

Furthermore, crude protein concentration, data in **Table (3)** recorded that different applied treatments were effectively increased crude protein concentration during 2022 and 2023 seasons compared with control treatment. The most effective treatments were MAA at 4 ml L⁻¹ followed by MAA at 6 ml L⁻¹.

2.2.3. Total carbohydrates of leaves in sesame plants:

In the same data in **Table (4)** indicates that all applied treatments increased total carbohydrates content in sesame leaves during 2023 season compared with control. In addition the most effective treatments for increasing total carbohydrates, was recorded with YE at 100 ml L⁻¹ followed by YE at 50 ml L⁻¹ compared with the control, consecutively.

In this regard, increase total carbohydrates with different applied treatments considered as a direct result of increasing both photosynthesis rate and efficiency. Also, this is preceded with large photosynthetic area and high concentration of photosynthetic pigments **Hammad and Ali (2014)**.

2.2.4. Total soluble sugars of leaves in sesame plants:

As data in **Table (4)** clearly records that total soluble sugars in sesame leaves were highly increased with different applied treatments at 82 DAS during 2023 season compared with those of control. Also, the highest value of these traits was with YE at 100 ml L⁻¹; followed by YE at 50 ml L⁻¹ compared with the control.

Increment of total soluble sugars in leaves on sesame plants with different applied treatments considered a direct result of the obtained vigorous growth that being accompanied with high photosynthesis efficiency. Thereby, could be give high yield with high quality (**Ewais et al., (2013); Eid-Rania (2020) and Živanović et al., (2020)**).

2.2.5. Total free Amino acids of leaves in sesame plants:

Concerning data in **Table (4)** distinctly shows that total free amino acids in sesame leaves were highly increased with different applied treatments at 82 DAS during 2023 season compared with those of control. Like that, the most effective treatments were MAA at 4 ml L⁻¹ followed by MAA at 6 ml L⁻¹ compared with the control, sequentially.

However, the increase in protein and total free amino acids in leaves was accompanied by increase in total N (**Table, 3**) parallel to growth rate, stimulation of amino acids into protein and translocation of sugars and free amino acids to young leaves.

These increases in total sugars, total carbohydrate and crude protein content in leaves of sesame plants in response to benzyladenine, yeast extract and mixed amino acids application were supported by stimulation of total leaves area (**Table, 1**) and photosynthetic pigments (**Table, 2**) and accumulation of leaves dry weight (**Table, 1**). In addition, the increment in minerals content (N, P and K) of sesame plants leaves may be attribute to increasing in absorption with different applied treatments.

In this respect, the notability of some applied treatments in increasing the percentage of determined N, P, K, total soluble sugars and total carbohydrate as well as crude protein percentage may be due to its effects on root absorption to macro elements and carbohydrates assimilation during photosynthesis and accumulation in plant. (**Ewais *et al.*, 2013; Zewail 2014 and Eid-Rania 2020**).

Foliar application with benzyladenine significantly increased lupine plant chemical composition (**Mahmoud *et al.*, 2016**). These results of benzyladenine are in conformity with those obtained by (**Zewail *et al.*, 2019**) on soybean plants. Like this increase in the bio constituent's content with benzyladenine application may be attributed to the role of benzyladenine in the promotion effects on chlorophyll biosynthesis and/or inhibition of chlorophyll degradation also retard the senescence of leaves (**Duszka *et al.*, 2009**).

Many investigators found that growth stimulants benzyladenine not only promote photosynthetic activity, but also increased RNA and protein synthesis by **Abo El-Saoud (2005); Papadakis and Roubelakis-Angelakis (2005); Ibraheem (2007)**.

On the other hand, application of yeast extract resulted an increase in nitrogen, potassium and calcium contents of faba bean leaves reported by **Abdel-Gawad and Youssef (2019) and Eid-Rania (2020)**.

Conserves, the effect of yeast extract application on protein was previously studied in other lupine plant species by **Mahmoud *et al.*, (2016)** and on sugar beet plants by **Eid-Rania (2020)**.

Foliar application with amino acids increased total soluble sugars content compared with control treatment this reported by **Sadak- Mervat *et al.*, (2015) and Rashid and Al-Atrushy (2023)**. Foliar application of amino acids significantly increase the concentration of amino acids in plant this in agreement with **Amin *et al.*, (2011) and Teixeira *et al.*, (2017)**. Foliar applications of amino acids led to a significant increase in N,P, K, concentrations comparing with the control this is in harmony with (**Abo Sedera *et al.*, (2014); Zewail (2014); Mohammadipour and Souri (2019); Noroozlo *et al.*, (2019); Salim *et al.*, (2021) and Hussain *et al.*, (2022)**).

2.3. Endogenous phytohormones:

Data in **Table (5)** recorded change in endogenous phytohormones, as gibberellins, auxins, cytokinins and abscisic acid of sesame plant treated with (i.e., benzyladenine at 25 and 50 mg L⁻¹, yeast extract at 50 and 100 ml L⁻¹, as well as mixed amino acids at 4 and 6 ml L⁻¹). The most effective treatments, which greatly improved the morphological, metabolic performances of sesame plant as obvious from the previously mentioned and discussed results obtained in the present study) at 82 DAS during 2022 season.

Regarding to gibberellins, different applied treatments were significantly increased gibberellins concentration in sesame plant leaves at 82 DAS during 2022 season. In this respect, yeast extract at 100 ml L⁻¹ gave the highest value followed by mixed amino acids at 4 ml L⁻¹, when compared with control during 2022 season.

For auxin level, it was highly increased in sesame leaves with different assigned treatments compared with that of untreated plant. Yeast extract at 100 ml L⁻¹ was the most effective value followed mixed amino acids at 4 ml L⁻¹ during 2022 season, respectively compared with control.

Concerning cytokinins, different applied foliar treatments increased cytokinins concentration in leaves of sesame plant compared with control treatment. Also, benzyladenine at 25 mg L⁻¹ gave the highest value followed by yeast extract at 100 ml L⁻¹ during 2022 season, respectively compared with control.

Generally, total phytohormones those promote growth aspects i.e., growth promoters (gibberellins, auxins and cytokinins) were increased with different applied foliar treatments during 2022 season, when compared with control treatment. Here, yeast extract at 50 ml L⁻¹ gave the highest value of total promoters followed by mixed amino acids at 4 ml L⁻¹ of sesame leaves during 2022 season, when compared with control. Also, increment of endogenous hormones in sesame plant obtained in the present study could be interpret both of the obtained improvement of growth (**Table, 1**) and photosynthetic pigments content (**Table, 2**) as well as yield characteristics (**Table, 7**) and may be stimulate cell division and enlargement as well as No. of flower and set %. For example, increasing endogenously cytokinins could be in favor of increasing No. of formed branches and that could also increase growth on the longitudinal one as well as increasing of sink organs (i.e., seeds) ability to accumulate and storage more assimilates (**Souri and Hatamian 2019; El-Anany 2020 and Mohamed *et al.*, 2021**).

With regard to, the growth inhibitor, (abscisic acid) its level was recorded with various assigned treatments during 2022 season compared with control, this reduction was more obvious with yeast extract at 50 ml L⁻¹ followed by benzyladenine

at 25 mg L⁻¹ of sesame leaves during 2022 season, compared with control.

In this respect, these results being of great interest for interpreting each of the obtained vigorous growth and improving yield of sesame plant attained in the present study.

This increase in the endogenous growth promoters and decreases in growth inhibitor substances in response to applied treatments may be attributed to their effect on enhancing the biosynthesis of growth promoters and decreasing the biosynthesis and action of growth inhibitors (abscisic acid).

These results are in agreement with those reported by (Mahmoud *et al.*, 2016; Zewail *et al.*, 2019; El-Anany 2020; Mohamed *et al.*, 2021 and Khater *et al.*, 2023) for yeast extract; (Amin *et al.*, 2011 ; Abd El-Aal and Eid-Rania 2018 and Souri and Hatamian 2019) for mixed amino acid; (Haroun *et al.*, 2011; Mahmoud *et al.*, 2016; Zewail *et al.*, 2019; El-Anany 2020 and Hussein-Suzan and Al-Doori 2021) for benzyladenine.

3. Effect of applied treatments on flowering Characteristics of sesame plants at flowering stage during 2022 and 2023 seasons:

Data in Table (6) appeared that all applied spray treatments were significantly increased No. of flowers/plant, No. of capsules/plant and flower setting percentage during flowering stage when compared with the control during 2022 and 2023 seasons. Also, it could be noticed that maximum increase of No. of flowers/plant, No. of capsules/plant, flower setting percentage during this stage was existed in case of MAA at 4 m L⁻¹ followed by YE at 100 m L⁻¹ treatments during the two growing seasons when compared with the control. Meanwhile, flowers abscission percentage was decreased with all applied treatments during the two seasons compared with control.

Increasing of flower measurements during flowering stage specially No. of flowers plant, flowers setting percentage and reducing of flowers abscission are considered a good indicators for role of different applied treatments for increasing yield and yield measurements (Table 7). The stimulating effect of BA, YE and MAA on No. of flowers/plant, No. of capsules/plant, flower setting percentage may be due to the critical role of growth stimulants in enhance various processes of reproductive growth such as: a) Increasing flowers bud formation (flower bud initiation differentiation and development), b) Delaying flower abscission (decrease shedding %), c) Enhancing pollination, fertilization and development of fruit, d) Increasing fruit set which in turn increasing capsules/plant, e) Enhancing transport of photo assimilates and nutrients from leaf towards fruits (sinks) there by, which reflect on the fruits formation (Abd El-Aal and Eid Rania 2018; Hussein-Suzan and Al-Doori 2021 and Mohamed *et al.*, 2021).

4. Effect of applied treatments on yield and its components:

With regard to data in Table (7), cleared that different applied foliar treatments increased yield characters during 2022 and 2023 seasons compared with control treatment; MAA at 4 ml L⁻¹ gave the highest significant increase in all yield characteristics followed by YE at 100 ml L⁻¹ when compared with control during 2022 and 2023 seasons. In addition, we can concerning that the seed yield in the first year (2022) of the experiment was higher than in the second year (2023).

This results are in harmony with Mahmoud *et al.*, (2016) who reported that yeast extract reached a significant increase in No. of seeds/pod and weight of 100 green seeds of pea plants and this found by Mahmoud *et al.*, (2013) on pea plants and Abo-El-Hamd *et al.*, (2015) on faba bean.

Meanwhile, these increases in capsules No. were accompanied by increasing flowers numbers and decreased shedding of flowers. The primitively effect of growth stimulants BA treatments on capsules numbers may be attributed to its effect on multiple No. of flowers on node, floral bud formation and opposite leaf arrangement encourages multiple flowering in the leaf axils of lower and middle nods on the main stem (Abd El-Dayem *et al.*, 2012).

As well as, mixed Amino acids are essential ingredients in the action of protein synthesis. The elicitation requirements of mixed amino acids are of extremely important to reinforce yield quality and overall the plant growth especially at the critical stages of growth. (Khodair and Abd El-Rahman 2021).

5. Effect of applied treatments on chemical composition of sesame seeds (seeds quality):

Data in Table (8) illustrate that all applied treatments were effectively increased all chemical composition of seeds of treated plants compared with those of the untreated plant during 2022 and 2023 seasons.

Finally, The increase in yield and its components in sesame plants with some growth stimulant used in this experiment may be attributed to an increase in the vigorous growth (Table, 1), photosynthetic pigments content (Table, 3), the amount of metabolites synthesis (carbohydrates, protein and free amino acid in leaves (Table, 5), absorption and translocation of nutrient elements (Table, 4) and enhance sink activity by increasing the rate of net amount of photo assimilates transport from sites of synthesis in leaf tissue (source) to sites of accumulation in developing seeds or storage organs (sink) and decrease shedding of reproductive organs, which reflected upon yield and its contains (Eisa- Salwa 2011; Amin 2018 and Ahmed *et al.*, 2023).

Table 1. Effect of different applied treatments on some morphological characteristics (Stem and Leaves) of sesame plants (*Sesamum indicum* L. var. Shandawel 3) at 82 DAS during 2022 and 2023 seasons.

Characters	Stem height (cm)	Stem fresh weight (g)	Stem dry weight (g)	No. of Leaves/ plant	Leaves fresh weight (g)	Leaves dry weight (g)	Total leave area (cm ²)/ plant
Treatments							
1 st season (2022)							
BA at 25 mg L ⁻¹	67.67	30.64	5.81	20.00	31.03	4.70	5.37
BA at 50 mg L ⁻¹	62.00	29.39	4.50	16.67	25.73	4.19	3.70
YE at 50 ml L ⁻¹	75.00	31.48	5.33	24.00	28.47	4.67	5.86
YE at 100 ml L ⁻¹	80.00	41.46	8.39	28.67	31.09	4.80	10.75
MAA at 4 ml L ⁻¹	83.00	47.68	8.96	29.67	35.98	6.04	12.00
MAA at 6 ml L ⁻¹	78.67	36.19	5.60	25.33	26.21	4.25	6.72
Control	54.00	26.64	3.77	12.00	16.02	2.68	3.23
L.S.D. at 5 %	4.51	4.76	0.71	3.63	7.66	1.61	2.32
2 nd season (2023)							
BA at 25 mg L ⁻¹	54.67	24.65	5.07	26.00	21.85	4.12	12.24
BA at 50 mg L ⁻¹	52.67	22.39	4.15	20.00	18.43	2.87	9.87
YE at 50 ml L ⁻¹	58.00	25.52	5.73	30.00	30.34	7.04	13.21
YE at 100 ml L ⁻¹	64.00	31.66	7.19	38.00	41.49	8.60	16.47
MAA at 4 ml L ⁻¹	70.00	35.42	7.69	42.00	53.89	10.78	16.66
MAA at 6 ml L ⁻¹	59.33	27.61	6.46	34.00	34.15	7.59	14.31
Control	47.00	19.49	4.01	14.00	10.61	2.61	8.40
L.S.D. at 5 %	4.75	2.32	0.94	3.29	6.18	1.27	2.15

Table 2. Effect of different applied treatments on photosynthetic pigments mg/g F.W. of sesame plants (*Sesamum indicum* L. var. Shandawel 3) at 82 DAS during 2022 and 2023 seasons.

Characters	Chlorophyll a (mg g ⁻¹ F.W.)	Chlorophyll b (mg g ⁻¹ F.W.)	Chlorophyll (a + b) (mg g ⁻¹ F.W.)	Carotenoids (mg g ⁻¹ F.W.)
Treatments				
1 st season (2022)				
BA at 25 mg L ⁻¹	1.54	0.39	1.93	0.67
BA at 50 mg L ⁻¹	1.58	0.48	2.06	0.66
YE at 50 ml L ⁻¹	1.29	0.18	1.47	0.69
YE at 100 ml L ⁻¹	1.55	0.30	1.85	0.70
MAA at 4 ml L ⁻¹	1.57	0.36	1.93	0.75
MAA at 6 ml L ⁻¹	1.38	0.19	1.57	0.72
Control	1.04	0.15	1.19	0.53
2 nd season (2023)				
BA at 25 mg L ⁻¹	1.14	0.32	1.46	0.49
BA at 50 mg L ⁻¹	1.36	0.49	1.85	0.48
YE at 50 ml L ⁻¹	1.00	0.22	1.22	0.50
YE at 100 ml L ⁻¹	1.15	0.30	1.45	0.61
MAA at 4 ml L ⁻¹	1.17	0.40	1.57	0.65
MAA at 6 ml L ⁻¹	1.07	0.24	1.31	0.63
Control	0.89	0.20	1.09	0.44

Table 3 Effect of different applied treatments on some macro nutrient and crude protein in leaves of sesame plants (*Sesamum indicum* L. var. Shandawel 3) at 82 DAS during 2022 and 2023 season.

Characters	N %	P %	K %	crude Protein %
Treatment				
1 st season (2022)				
BA at 25 mg L ⁻¹	2.54	0.43	2.00	13.46
BA at 50 mg L ⁻¹	2.45	0.42	1.89	12.99
YE at 50 ml L ⁻¹	2.50	0.44	2.22	13.25
YE at 100 ml L ⁻¹	2.60	0.45	2.30	13.78
MAA at 4 ml L ⁻¹	2.80	0.49	2.45	14.84
MAA at 6 ml L ⁻¹	2.66	0.46	2.41	14.10
Control	2.31	0.40	1.83	12.24
2 nd season (2023)				
BA at 25 mg L ⁻¹	2.50	0.32	2.48	13.25
BA at 50 mg L ⁻¹	2.38	0.31	2.37	12.61
YE at 50 ml L ⁻¹	2.51	0.33	2.51	13.30
YE at 100 ml L ⁻¹	2.80	0.34	2.54	14.84
MAA at 4 ml L ⁻¹	3.02	0.37	2.87	16.01
MAA at 6 ml L ⁻¹	2.99	0.35	2.61	15.85
Control	2.21	0.29	2.30	11.71

Table 4. Effect of different applied treatments on total carbohydrate , total sugars and total free amino acids in Leaves of sesame plants (*Sesamum indicum* L. var. Shandawel 3) at 82 DAS during 2022 and 2023 seasons.

Treatment	Characters	Total Carbohydrates %	Total sugars %	Total free Amino acids (mg g ⁻¹ F.W.)
1 st season(2022)				
BA at 25 mg L ⁻¹		38.31	2.09	37.81
BA at 50 mg L ⁻¹		36.51	1.67	36.31
YE at 50 ml L ⁻¹		39.03	2.49	43.71
YE at 100 ml L ⁻¹		44.23	2.61	44.95
MAA at 4 ml L ⁻¹		38.85	2.31	54.55
MAA at 6 ml L ⁻¹		38.67	2.22	46.75
Control		35.51	1.55	35.05
2 nd season (2023)				
BA at 25 mg L ⁻¹		34.05	6.29	45.83
BA at 50 mg L ⁻¹		33.66	6.28	38.34
YE at 50 ml L ⁻¹		35.59	6.45	46.35
YE at 100 ml L ⁻¹		35.72	6.53	49.53
MAA at 4 ml L ⁻¹		35.04	6.32	69.01
MAA at 6 ml L ⁻¹		34.62	6.30	54.82
Control		32.24	6.09	36.25

Table 5. Effect of different applied treatments on endogenous phytohormones content in sesame (*Sesamum indicum* L. var. Shandawel 3) shoot at 82 days after sowing during 2022 season.

Plant hormones	Gibberellins $\mu\text{g g}^{-1}$ F.w.	Auxins $\mu\text{g g}^{-1}$ F. w.	Cytokinins $\mu\text{g g}^{-1}$ F.w	Total Promoters $\mu\text{g g}^{-1}$ F.w.	Absciscic acid $\mu\text{g g}^{-1}$ F.w.	Total Promoters/ Inhibitors $\mu\text{g g}^{-1}$ F. w.
Treatments						
Benzyladenine at 25 mg L^{-1}	25.54	22.20	30.41	78.15	3.80	20.57
yeast extract at 100 ml L^{-1}	63.51	28.23	29.78	121.52	4.19	29.00
Mixed amino acids at 4 m L^{-1}	37.45	27.46	28.27	93.18	2.38	39.15
Control	24.49	10.91	23.52	58.92	6.14	9.59

Table 6. Effect of different applied treatments on flowering characteristics of Sesame plant (*Sesamum indicum* L. var. Shandawel 3) at flowering stage zone during 2022 and 2023 seasons.

Treatments	Characters	No. of flowers / plant	No. of capsules/plant	Flowers setting (%)	Flowers abscission (%)
1 st season (2022)					
BA at 25 mg L ⁻¹		95.00	84.00	88.42	11.58
BA at 50 mg L ⁻¹		88.00	77.33	87.88	12.12
YE at 50 ml L ⁻¹		102.67	89.67	87.34	12.66
YE at 100 ml L ⁻¹		115.67	102.00	88.18	11.82
MAA at 4 ml L ⁻¹		112.67	105.00	93.19	6.81
MAA at 6 ml L ⁻¹		109.00	95.33	87.46	12.54
Control		75.00	65.67	87.56	12.44
L.S.D. at 5 %		6.10	5.10	1.12	1.66
2 nd season (2023)					
BA at 25 mg L ⁻¹		95.00	87.67	92.28	7.70
BA at 50 mg L ⁻¹		85.00	79.67	93.73	6.22
YE at 50 ml L ⁻¹		104.67	96.33	92.03	7.94
YE at 100 ml L ⁻¹		120.00	115.33	96.11	3.89
MAA at 4 ml L ⁻¹		130.00	125.00	96.15	3.85
MAA at 6 ml L ⁻¹		117.67	113.00	96.03	3.97
Control		63.67	53.00	83.24	16.82
L.S.D. at 5 %		7.96	6.96	1.90	1.90

Table 7. Effect of different applied treatments on yield and yield components of sesame plants (*Sesamum indicum* L. var. Shandawel 3) at 120 DAS (at harvest) during 2022 and 2023 seasons.

Characters	Fruiting zone length (cm)	No. of Terminal capsules	No. of Intermediate capsules	No. of Basal capsules	Weight of intact capsule (g)	Weight of empty capsules (g)	No. of seeds in one capsule	Total seed weight (g)	1000 seed weight (g)	Seed yield/pot (g)
Treatments										
1 st season (2022)										
BA at 25 mg L ⁻¹	97.67	35.00	37.00	18.00	40.73	0.31	44.00	15.94	2.73	124.67
BA at 50 mg L ⁻¹	89.00	28.00	34.00	17.00	36.67	0.33	43.00	13.50	2.67	118.00
YE at 50 ml L ⁻¹	103.00	42.00	40.00	19.00	42.50	0.27	47.67	18.03	3.40	151.33
YE at 100 ml L ⁻¹	112.00	54.00	49.00	23.00	48.73	0.25	63.00	26.13	3.60	154.00
MAA at 4 ml L ⁻¹	120.33	62.00	52.33	26.00	60.17	0.22	72.00	31.80	4.20	161.67
MAA at 6 ml L ⁻¹	105.00	49.00	46.00	22.00	47.57	0.26	56.00	21.41	4.10	152.67
Control	78.67	20.00	29.67	14.00	31.87	0.42	35.00	11.74	2.23	103.00
L.S.D. at 5 %	5.89	6.59	3.68	3.47	4.47	0.04	6.11	2.54	0.20	9.39
2 nd season (2023)										
BA at 25 mg L ⁻¹	115.33	35.00	23.00	16.00	43.63	0.32	58.67	20.94	3.20	39.00
BA at 50 mg L ⁻¹	114.00	32.00	21.00	15.00	40.07	0.33	56.00	17.70	2.90	33.33
YE at 50 ml L ⁻¹	116.33	45.00	24.00	17.00	48.17	0.28	58.00	21.92	3.20	47.00
YE at 100 ml L ⁻¹	119.33	49.00	35.00	19.00	51.63	0.25	66.00	27.20	3.50	64.33
MAA at 4 ml L ⁻¹	122.33	72.00	44.33	22.33	56.73	0.22	68.00	33.38	4.27	70.00
MAA at 6 ml L ⁻¹	118.00	46.00	32.00	18.00	50.53	0.26	63.67	23.09	4.20	60.67
Control	86.00	22.67	15.00	12.00	35.33	0.44	45.67	12.41	2.20	32.67
L.S.D. at 5 %	6.03	6.63	5.39	3.15	6.62	0.04	7.23	2.76	0.35	5.71

Table 8. Effect of different applied treatments on some macro nutrients, crude protein, total carbohydrate, total sugars and oil % in seeds of sesame plants (*Sesamum indicum* L. var. Shandawel 3) during 2022 and 2023 season.

Characters	N %	P %	K %	crude Protein %	Total Carbohydrates %	Total sugars %	oil percentage %	oil yield / plant %
Treatment								
1st season(2022)								
BA at 25 mg L ⁻¹	5.03	0.52	1.47	26.66	22.85	7.29	50.11	7.99
BA at 50 mg L ⁻¹	4.83	0.50	1.45	25.60	21.95	7.24	43.88	5.92
YE at 50 ml L ⁻¹	5.54	0.54	1.49	29.36	23.87	7.32	51.37	9.26
YE at 100 ml L ⁻¹	5.80	0.58	1.53	30.74	26.89	7.35	53.48	13.97
MAA at 4 ml L ⁻¹	5.90	0.60	1.61	31.27	30.23	7.37	53.71	17.08
MAA at 6 ml L ⁻¹	5.60	0.57	1.52	29.68	25.01	7.34	51.92	11.12
Control	4.02	0.48	1.40	21.31	19.50	7.20	42.03	4.93
2nd season (2023)								
BA at 25 mg L ⁻¹	4.85	0.52	1.58	25.71	24.11	7.28	41.70	8.73
BA at 50 mg L ⁻¹	4.78	0.51	1.55	25.33	23.83	7.25	39.50	6.99
YE at 50 ml L ⁻¹	5.05	0.53	1.61	26.77	25.28	7.33	43.80	9.60
YE at 100 ml L ⁻¹	5.85	0.55	1.65	31.01	26.74	7.52	47.30	12.87
MAA at 4 ml L ⁻¹	5.99	0.56	1.68	31.75	27.37	7.54	48.80	16.29
MAA at 6 ml L ⁻¹	5.54	0.54	1.63	29.36	25.34	7.43	44.60	10.30
Control	4.04	0.47	1.50	21.41	21.72	7.18	36.90	4.58

Concerning, the effect of BA on mineral contents in sesame seeds may be due to their effects on membrane permeability, ions uptake and increase the rate of ion entry through the membrane, which reflected on translocation of mineral nutrients to shoot and consequently to fruits. Also, these growth stimulants treatment improved photosynthetic efficiency, activity and consequently more synthesis of sugars and increases the mobilization, partitioning and translocation of photosynthetic material (sugars) to seeds in fruits of sesame plants (Abd El-Dayem *et al.*, 2012).

In this regard, mixed amino acids are essential ingredients in the action of protein synthesis Khodair and Abd El-Rahman, (2021).

Concerning, Nassar- Rania *et al.*, (2011) cleared that foliar application with yeast extract at 100 and 150 ml L⁻¹ improved significantly the percentage of crude protein in seeds of Kidney bean 'Giza 6' in both studied seasons. However, high used concentration of 10 g L⁻¹; induced significant enhancement in the percentages of total carbohydrates and protein in fresh pods of snap beans compared to the control.

Conclusions

Ultimately, it could be recommended that spraying sesame plants with a growth stimulant mixed amino acids at a concentration of 4 ml L⁻¹ or yeast extract at a concentration of 100 ml L⁻¹ at the ages of 30 60 and 85 DAS, to enhance growth, seed quality and oil yields and improve the productivity and quality of the oil seed of sesame plant, variety Shandawel "3".

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تحسين نمو و محصول نبات السمسم باستخدام البنزويل أدنين و مستخلص الخميرة و مخلوط الأحماض الأمينية

تم إجراء هذه الدراسة في أصص خلال موسمي 2022 و 2023 في المحطة البحثية الخاصة بقسم النبات الزراعي بكلية الزراعة بمشهور - جامعة بنها - بمحافظة القليوبية بهدف دراسة تأثير الرش الورقي ببعض منشطات النمو كالبنزويل أدنين بتركيزات 25 و 50 ملجم لتر⁻¹ و مستخلص الخميرة بتركيزات 50 و 100 مل لتر⁻¹ و مخلوط الأحماض الأمينية بتركيزات 4 و 6 مل لتر⁻¹ علي النمو و المحتوى الهرموني والمحتوي الكيميائي للأوراق و صفات المحصول و المحتوى الكيميائي للبذور ومحصول البذرة والزيوت لنبات السمسم صنف شندويل "3".

وتم الرش الورقي لنباتات السمسم بمنشطات النمو السابقة الذكر بعد 30 و 60 وكذلك 85 يوم من الزراعة خلال موسمي الدراسة 2022 و 2023؛ و أدى الرش الورقي بمنشطات النمو كالبنزويل أدنين ، مستخلص الخميرة و مخلوط الأحماض الأمينية إلي زيادة معنوية في صفات النمو الخضري التي تم دراستها مثل (طول الساق ، مساحة الأوراق ، الوزن الطازج والجاف لكل من الساق والأوراق/ نبات و عدد الأزهار و الكبسولات للنبات) في عمر 82 يوم من الزراعة و أيضاً محصول البذور و مكوناته مثل (عدد الكبسولات والوزن الكلي للبذور بالجرام و عدد البذور في الكبسولة الواحدة و وزن البذرة 1000 بذرة ومحصول البذرة بالجرام للأصيص) لنبات السمسم خلال موسمي الدراسة 2022 و 2023 . كما أدى الرش الورقي بمنشطات النمو إلي زيادة محتوى الأوراق من صبغات البناء الضوئي وهي الكلورفيلات (أ ، ب) وكذلك الكاروتينويدات ، كما أدت جميع المعاملات المختلفة المستخدمة من منشطات النمو إلي زيادة النسبة المئوية من محتوى العناصر المعدنية (النيتروجين والفوسفور والبوتاسيوم) في أوراق نبات السمسم ، و زيادة محتوى الأوراق من السكريات الكلية والذائبة والأحماض الأمينية الكلية والبروتين الخام والكربوهيدرات الكلية في عمر 82 يوم من الزراعة في موسمي النمو 2022 و 2023، كما أدى الرش بجميع المعاملات المختلفة المستخدمة من منشطات النمو إلي زيادة النسبة المئوية من محتوى العناصر المعدنية (النيتروجين والفوسفور والبوتاسيوم) في بذور نبات السمسم ، و زيادة محتوى البذور من السكريات الكلية والذائبة والبروتين الخام والكربوهيدرات الكلية و النسبة المئوية للزيوت من البذور .

عموماً أوضحت النتائج أن معاملات الرش الورقي لنبات السمسم بالتركيز المنخفض من منشط النمو مخلوط الأحماض الأمينية بتركيز 4 مل لتر⁻¹ و التركيز المرتفع من مستخلص الخميرة بتركيز 100 مل لتر⁻¹ في عمر 30 و 60 وكذلك 85 يوم من الزراعة أفضل المعاملات لزيادة النمو و محصول البذور والزيوت وتحسين إنتاجية و جودة زيت البذرة لنبات السمسم صنف شندويل "3".