

EFFECT OF BIO-FERTILIZER AND SOME MICROELEMENTS ON GROWTH AND YIELD OF *PLANTAGO PSYLLIUM* L. PLANTS

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This experiment was carried out during the two successive seasons of 2019/2020 and 2020/2021 at El-Kasasin Research Station. The current study was conducted to determine the effect of bio-fertilizer and some microelements on the growth, yield, and active ingredients of *Plantago psyllium* plants. This experiment included five treatments, as following: Control, bio-fertilizer + (Zn and Mn), bio-fertilizer + (Fe and Mn), bio-fertilizer + (Fe and Zn) and bio-fertilizer + (Fe, Mn, and Zn). The treatments were arranged in a complete randomized block design with three replicates. The best treatment was bio-fertilizer + (Fe, Mn, and Zn), which recorded the highest values in vegetative growth including plant height (40.41 and 41.68 cm) and number of branches/plant (22.67 and 24.33), in the first and second seasons, respectively. Also, there was a significant increase in seed yield; seed weight per plant was 8.23 g and 8.57 g, and the seed weight per feddan was 276.64 kg and 287.84 kg, in the first and second seasons, respectively, when using the same treatment. Furthermore, the results showed that an increase in oil yield; fixed oil percentage of 15.64% and 15.95%, oil yield per plant of 1.29 ml and 1.37 ml, and oil yield per feddan of 43.27l and 45.91l when treated with bio-fertilizer + (Fe, Mn, and Zn) and gave a significant increase in the active ingredients (mucilage of 30.20% and 30.26%, protein of 22.33% and 22.83%, seed husk/plant of 27.60 g and 27.72 g and carbohydrates of 49.87% and 51.23% when using the same treatment, in the first and second seasons, respectively.

Keywords: *Plantago psyllium*, biofertilization, microelements

INTRODUCTION

Plantago psyllium L. belongs to the family Plantaginaceae. It is a low annual plant native to Asia, Europe and North Africa. It reaches a height of about 50 cm as a maximum. However, it bears tiny white leaves and clusters of flowers. The seeds are collected in the fall and summer. The husk is separated from the psyllium seeds by sifting. The husks are a natural source

of non-starchy carbohydrates that dissolve quickly in water, so they are included in weight-loss medications (Turnbull and Thomas, 1995).

The seeds and seed husks are the economic parts of the plant. Seeds contain many active substances such as resins and fixed oil at a ratio of 2:5% and some acids such as ascorbic, linoleic, oleic and oxalic acids (Fischer et al., 2004) and some nutrients such as selenium, phosphorous, tin, potassium, sodium, zinc, chromium, cobalt, calcium, magnesium and manganese (Bruneton, 1999), some vitamins such as riboflavin, thiamine, niacin, and vitamin C is a major component of it (Guil et al., 1997). It also contains organic acids, acid fumaric acid, vanillic acid, ferulic acid, salicylic acid, benzoic acid and cinnamic acid (Pailer and Haschke-Hofmeister, 1969).

Due to the presence of a group of flavonoids, alkaloids, terpenoids, phenols, and their derivatives that have a therapeutic effect, the plant is used for constipation (Voderholzer et al., 1997) and relief of chronic diarrhea (Bliss et al., 2001). Also, it is useful in hemorrhoids (Perez et al., 1996), irritable bowel syndrome; IBS (Bouchoucha et al., 2004), diabetes mellitus, and cancer (Yu et al., 2009). Also, it helps reducing weight, appetite (Turnbull and Thomas, 1995) and cholesterol (Terpstra et al., 2000).

Bio-fertilizers are additives of microbial origin that contain nitrogen-fixing bacteria cells and phosphorous-softeners or both. It also contains bacteria that stimulate and increase plant growth by increasing the production of phytohormones (Abd El-Azim et al., 2017; Omar et al., 2017 and Ibrahim et al., 2019).

Foliar fertilization has become common and is recommended to increase production and improving different crops. Foliar feeding is also an effective way to meet the plant needs of microelements and reduce the use of chemical fertilizers. The deficiency in any of the microelements is due to the base soil, high soil pH, and low organic matter content in the soil. Also, foliar feeding is 10 or 20 times more effective than soil drench, as it is a quick way to solve the problems of micronutrient deficiency and reduce toxicity in the soil, as the leaves along with the roots play an important role in feeding the plant with various nutrients, whether large or small elements, as these, absorb these elements through the leaves and the absorption process takes place through the stomata spread on the surface of the leaf, especially the lower surface and is the smallest main passage for these various nutrients found in foliar fertilization (Khater and Abd-Allah, 2017; Ibrahim et al., 2019 and Khater, 2020),

Microelements are very important for the plant in its various stages of growth, and it is essential for growth and development in a basic way, as it has a major role in enzymatic activity. Microelements play an important role in all stages of plant development and are essential for growth, mainly because of their function as necessary elements for different enzymatic systems. However, its presence in the soil or not being added in sufficient quantities,

foliar feeding is necessary to improve plant growth and plant production in quantity and quality (Abd El-Azim et al., 2017 and Omar et al., 2017).

The main objective of the research is to study the use of bio-fertilizer by spraying with some microelements such as iron, manganese, and zinc on *Plantago psyllium* plant and their effect on the vegetative growth and productivity of the active substances of this plant.

MATERIALS AND METHODS

This experiment was carried out during the two successive seasons of 2019/2020 and 2020/2021 at El-Kasasin Research Station belonging to Ismailia Governorate, Agricultural Research Center, Department of Medicinal and Aromatic plants. The current study was conducted to determine the effect of bio-fertilizer and some microelements on the growth, yield and active ingredients of *Plantago psyllium* plant.

The seeds were sown on October 15th and 20th, while the harvest dates were 10th and 15th of May in both seasons; respectively. The seeds of *Plantago psyllium* were obtained from the Department of Medicinal and Aromatic Plants, Agricultural Research Center, Dokkey, Cairo, Egypt. The experimental soil was sandy in texture; 87.20% sand, 7.24% silt and 5.56% clay according to Jackson (1973), while the chemical properties were estimated according to Blacket al. (1982). The physical and chemical properties of the experimental farm soil are shown in Table (1).

Table (1). The soil physical and chemical properties in El-Kasasin Research Station.

Physical analyses				Mechanical analyses									
Saturation capacity (%)	Field capacity (%)	Wilting coefficient point (%)	Available water (%)	Sand (%)	Silt (%)	Clay (%)	Soil texture						
25	11	6	5	87.13	7.24	5.63	Sandy						
Chemical properties													
Salt analysis		Cations (meq/l)			Anions (meq/l)			Available elements (mg/kg)	Organic matter (OM) %				
EC (dSm ⁻¹)	pH	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Cl ⁻	CO ₃ ²⁻	HCO ₃	SO ₄ ²⁻	N	P	K	
1.6	7.08	5.7	2.6	7	0.8	7.6	0	2.8	5.7	7.1	2.1	13.4	0.01

This experiment included five treatments, as following:

1. Control
2. Bio-fertilizer + (Zn and Mn)
3. Bio-fertilizer + (Fe and Mn)
4. Bio-fertilizer + (Fe and Zn)
5. Bio-fertilizer + (Fe, Mn and Zn)

The treatments were arranged in a complete randomized block design with three replicates using the computer program of Statistics version9

(Analytical Software, 1985). The recorded data were statistically analyzed according to Snedecor and Cochran (1980).

The bio-fertilizer was added four times, the first time mixed with seeds, then the soil was drenched once a month during the growing season. The bio-fertilizer was prepared in the Department of Soil Fertility and Microbiology, Desert Research Center and consisted of *Azotobacter chocoococcum*, *Azospirillum lipoferum*, and *Bacillus megatherium*. The plants were sprayed with microelements after 30, 45 and 60 days from sowing, and the untreated plants were sprayed with tap water until the runoff. The microelements as Fe, Mn, and Zn EDTA (50 ppm). Conventional regular agricultural practices were used when needed. The distance between plants was 25 cm and 50 cm between rows [the feddan contained 33600 plants].

Data recorded

1. Vegetative growth
 - Plant height (cm)
 - Number of branches/plant
2. Seed yield
 - Seed weight per plant (g)
 - Seed weight per feddan (kg)
3. Oil yield
 - Fixed oil percentage according to A.O.C.S. (1998)
 - Oil yield per plant (ml) by multiplying the weight of seeds per plant for each treatment by a fixed oil percentage
 - Oil yield per feddan (l) by multiplying oil yield per plant for each treatment by a number of plants per feddan (33600 plants)
4. Active ingredients
 - Mucilage percentage according to Khullar et al. (1998)
 - Protein percentage by multiplying total nitrogen percentage according to Horneck and Miller (1998) by the factor 6.25 to obtain the percentage of total protein.
 - Seed husk/plant (g)
 - Total carbohydrates percentage according to Chaphlin and Kennedy (1994)

RESULTS AND DISCUSSION

1. Vegetative Growth

1.1. Plant height (cm)

All treatments increased the plant height of *Plantago psyllium* highly significant in both seasons compared with the control (Table 2). The highest value of plant height came from the treatment of biological fertilization with the three microelements. Treatment of bio-fertilizer + (Fe, Mn, and Zn) increased plant height by 40.41 cm and 41.68 cm during the first and second seasons, respectively, compared to control.

Table (2). Effect of bio-fertilizer and some microelements on vegetative growth of *Plantago psyllium* during the 2019/2020 and 2020/2021 seasons.

Treatment	Plant height (cm)		Number of branches/plant	
	Season 1	Season 2	Season 1	Season 2
Control	20.41 ^E	21.49 ^E	18.33 ^E	19.33 ^E
Bio-fertilizer + (Zn and Mn)	25.32 ^D	25.47 ^D	19.33 ^D	20.67 ^D
Bio-fertilizer + (Fe and Mn)	30.41 ^C	31.68 ^C	21.33 ^B	22.00 ^C
Bio-fertilizer + (Fe and Zn)	35.41 ^B	36.66 ^B	22.00 ^{AB}	23.00 ^B
Bio-fertilizer + (Fe, Mn, and Zn)	40.41 ^A	41.68 ^A	22.67 ^A	24.33 ^A

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

The treatments of bio-fertilizer + (Fe and Mn) and bio-fertilizer + (Fe and Zn) recorded the best significant increase in plant height reaching 35.41 cm and 30.41 cm in the first season, respectively, while 36.66 cm and 31.68 cm were recorded in the second season, respectively, compared to the treatment of bio-fertilizer + (Zn and Mn) and control. While the treatment of bio-fertilizer + (Zn and Mn) and the control reached 25.32 cm and 20.41 cm in the first season, respectively, while they scored 25.47 cm and 21.49 cm in the second season, respectively.

1.2. Number of branches/plant

All treatments increased the number of branches for each plant, but this increase was not significant in the first season, while in the second season the increase was significant compared to the control plants (Table 2). The highest increase in number of plants caused by the treatment of bio-fertilizer + (Fe, Mn, and Zn), where it recorded 22.67 and 24.33 branches/plant, compared to the control that recorded 18.33 and 19.33 branches/plant during the first and second seasons, respectively.

The reason of this result may be attributed to the ability of microorganisms to fix atmospheric nitrogen freely, and this provides the plants need for the nutrient element that enters the construction of the chlorophyll molecule and nucleic acids (RNA and DNA) and in the composition of amino acids and proteins that contribute to increasing the height of the plant and the number of branches. In addition, biofertilization improves the growth of the root system and increases the production of some growth regulators and auxins, which increases the plant's ability to absorb water and nutrients from the soil surrounding the roots of plants. Similar results were recorded by Abd El-Azim et al. (2017) on *Foeniculum vulgare*, Khater and Abd-Allah (2017) on *Ocimum basilicum*, Omar et al. (2017) on *Mentha viridis*. Mohamed and Ghatas (2020) stated that the combinations of humic acid at 5 m/l with Zn at 200 ppm could be used to improve vegetative growth of *Salvia hispanica*.

2. Seed Yield

Seed weight per plant (g) and feddan (kg)

Data in Table (3) indicate that all treatments led to a significant increase in seed weight per plant (g) and feddan (kg), the highest values of increase was when adding bio-fertilizer and spraying with the three microelements (Fe, Mn, and Zn). It is noticed that the treatment of bio-fertilizer + (Fe, Mn, and Zn) registered the highest value for the increase in seed yield per plant (g) and feddan (kg), they were 8.23 g and 276.64 kg in the first season, respectively, followed by the treatment of bio-fertilizer + (Fe and Zn), which recorded 7.57 g and 254.24 kg compared to control, which recorded 5.23 g and 175.84 kg during the first season, respectively. While the same result was found in the second season, the treatment of bio-fertilizer + (Fe, Mn, and Zn) recorded the highest value for the increase in seed weight per plant (g) and feddan (kg). they were 8.57 g and 287.84 kg followed by treatment of bio-fertilizer + (Fe and Zn), which recorded 7.84 g and 263.54 kg, compared to control which recorded 5.47 g and 183.68 kg during the second season, respectively.

Table (3). Effect of bio-fertilizer and some microelements on seed yield of *Plantago psyllium* during the 2019/2020 and 2020/2021 seasons.

Treatment	Seed weight / plant (g)		Seed weight / feddan (kg)	
	Season 1	Season 2	Season 1	Season 2
Control	5.23 ^E	5.47 ^E	175.84 ^E	183.68 ^E
Bio-fertilizer + (Zn and Mn)	5.93 ^D	6.10 ^D	199.36 ^D	204.96 ^D
Bio-fertilizer + (Fe and Mn)	6.85 ^C	6.98 ^C	230.16 ^C	234.64 ^C
Bio-fertilizer + (Fe and Zn)	7.57 ^B	7.84 ^B	254.24 ^B	263.54 ^B
Bio-fertilizer + (Fe, Mn, and Zn)	8.23 ^A	8.57 ^A	276.64 ^A	287.84 ^A

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

The reason for the increase in seed yield by the application of bio-fertilization may be attributed to the ability of microorganisms to secrete growth-stimulating substances such as gibberellin, auxin, and IAA. These results agree with those obtained by Khater and Abd-Allah (2017) on *Ocimum basilicum*, Omar et al. (2017) on *Mentha viridis*, Ibrahim et al. (2019) on black cumin and Mohamed and Ghatas (2020) on *Salvia hispanica*.

3. Oil yield

3.1. Fixed oil percentage

Data in Table (4) show a significant increase in fixed oil % as a result of bio-fertilization and spraying with microelements; Fe, Mn, and Zn, where the treatment of bio-fertilizer + (Fe, Mn, and Zn) gave 15.64% and 19.95%, compared to the control of 11.91% and 11.97% during the first and second seasons, respectively.

Table (4). Effect of bio-fertilizer and some microelements on oil yield of *Plantago psyllium* during the 2019/2020 and 2020/2021 seasons.

Treatment	Fixed oil		Oil yield/plant		Oil yield/feddan	
	%		(ml)		(l)	
	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control	11.91 ^E	11.97 ^E	0.62 ^E	0.65 ^E	20.96 ^E	22.00 ^E
Bio-fertilizer + (Zn and Mn)	12.84 ^D	12.92 ^D	0.76 ^D	0.79 ^D	25.61 ^D	26.49 ^D
Bio-fertilizer + (Fe and Mn)	14.06 ^C	14.08 ^C	0.96 ^C	0.98 ^C	32.37 ^C	33.05 ^C
Bio-fertilizer + (Fe and Zn)	14.87 ^B	14.92 ^B	1.13 ^B	1.17 ^B	37.81 ^B	39.34 ^B
Bio-fertilizer + (Fe, Mn and Zn)	15.64 ^A	15.95 ^A	1.29 ^A	1.37 ^A	43.27 ^A	45.91 ^A

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

3.2. Oil yield per plant (ml) and feddan (l)

Statistics disclosed that all treatments gave a significant increase in oil yield per plant (ml) and feddan (l). The highest values of increase in oil yield/plant (ml) and feddan (l) were observed when adding bio-fertilizer + (Fe, Mn, and Zn), they had the values of 1.29 ml and 43.27 l, respectively, during the first season, while recorded 1.37 ml and 45.91 l during the second season (Table 4).

The increase in oil yield that attributed to the treatment of bio-fertilization in addition to spraying with three microelements (Fe, Mn, and Zn) was significant compared to the other treatments and control, and this was evident in all the phenotypic, physiological, and productive characteristics that were studied=

On the other hand, bio-fertilization in adding to spraying with microelements has a role in many physiological processes, such as increasing the content of chlorophyll in leaves, which is necessary to raise the efficiency of the photosynthesis process and the formation of the amino acid tryptophan and is necessary for the elongation of cells. Also, works to stimulate the absorption of nutrients, including phosphorous, nitrogen, and potassium in plants. Conversely, the role of zinc, iron, and manganese appears in the formation of amino acids, carbohydrates, energy compounds, and increasing the process of respiration and photosynthesis in plants. These results are in accordance with those obtained by Khater and Abd-Allah (2017) on *Ocimum basilicum*, Omar et al. (2017) on *Mentha viridis* and Khater (2020) on *Trigonella foenum-graecum*. At the same time, Mohamed and Ghatas (2020) demonstrated that using humic acid at 5 m/l + Zn at 200 ppm could be used to improve fixed oil productivity and fixed oil constituents of chia (*Salvia*

hispanica) plant. In this concern, Ghatas and Mohamed (2020) indicated that using monoammonium phosphate (MAP) or monopotassium phosphate with EM or phosphorein was the best for improving, fixed oil productivity and fixed oil constituents of the evening primrose (*Oenothera biennis*) plant.

4. Active Ingredients

4.1. Mucilage percentage

All treatments tended to increase mucilage percentage in seeds of *Plantago psyllium*. The increase was significant in both seasons. The best value for mucilage percentage came from the treatment of biofertilizer + (Fe, Mn and Zn) as represented in Table (5). Results showed that in the first season, an increase in mucilage percentage in the seeds was a significant increase for all treatments, while in the second season there was an increase, but the increase was not significant compared to the control and the other treatments. Alternatively, the treatment of bio-fertilizer + (Fe, Mn, and Zn) recorded the highest values for the mucilage percentage of 30.20% and 30.26% during the first and second seasons, respectively.

Table (5). Effect of bio-fertilizer and some microelements on active ingredients of *Plantago psyllium*, during the 2019/2020 and 2020/2021 seasons.

Treatment	Mucilage		Protein		Seed husk/plant		Carbohydrates	
	%		%		(g)		(%)	
	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Control	20.96 ^E	20.96 ^D	12.17 ^E	12.67 ^E	17.40 ^E	17.53 ^E	40.73 ^E	41.04 ^E
Bio-fertilizer + (Zn and Mn)	23.32 ^D	23.36 ^C	14.22 ^D	14.74 ^D	19.88 ^D	20.07 ^D	42.71 ^D	43.58 ^D
Bio-fertilizer + (Fe and Mn)	26.59 ^C	26.64 ^B	18.24 ^C	18.74 ^C	23.39 ^C	23.52 ^C	46.54 ^C	47.03 ^C
Bio-fertilizer + (Fe and Zn)	28.00 ^B	28.19 ^B	20.14 ^B	20.63 ^B	25.61 ^B	25.76 ^B	48.44 ^B	49.27 ^B
Bio-fertilizer + (Fe, Mn and Zn)	30.20 ^A	30.26 ^A	22.33 ^A	22.83 ^A	27.60 ^A	27.72 ^A	49.87 ^A	51.23 ^A

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

4.2. Protein percentage

Statistics in Table (5) show a significant increase in the protein content of *Plantago psyllium* seeds in both seasons. The treatment of bio-fertilizer + (Fe, Mn, and Zn) recorded the highest values of the protein percentage in seeds of 22.33% and 22.86%, while the controls recorded the lowest values of 12.17% and 12.67% during the first and second seasons, respectively.

4.3. Seed husk/plant (g)

Data in Table (5) show a significant increase of seed husk/plant (g) during the first and second seasons of *Plantago psyllium* plants. The maximum values were observed by the treatment of bio-fertilizer + (Fe, Mn, and Zn), which recorded 27.60 g and 27.72 g, followed by the treatment of bio-fertilizer + (Fe and Zn) that recorded 25.61 g and 25.76 g, then the treatment of bio-fertilizer + (Fe and Mn) which recorded 23.39 g and 23.52 g during the first and second seasons, respectively.

4.4. Carbohydrates percentage

Data in Table (5) represent a significant increase in carbohydrates percentage as a result of adding bio-fertilizer + (Fe, Mn, and Zn), the treatment of bio-fertilizer + (Fe, Mn, and Zn) gave the maximum values of carbohydrates percentage of 49.87% and 51.23%, while the control plants gave minimum values of 40.73% and 41.04%, during the first and second seasons, respectively.

The addition of microelements and bio-fertilization in balanced quantities may achieve a state of equilibrium in the plant that leads to improve growth, which is reflected in productivity after that in terms of the production of leaves or seeds for the plant and for the feddan, were spraying with microelements allowed the plant to absorb the largest possible amount of the added elements. The biological fertilization also gave a great opportunity for the microorganisms in the soil to be active and to facilitate the absorption of the elements inside the soil solution, and therefore the maximum benefit was by using the biological fertilization with the soil and the foliar spray of the microelements.

The above-mentioned results are nearly similar to those obtained by Abd El-Azim et al. (2017) on *Foeniculum vulgare*, Khater and Abd-Allah (2017) on *Ocimum basilicum* and Omar et al. (2017) on *Mentha viridis*. On the other hand, Mohamed and Ghatas (2020) declared that using humic acid at 5 m/l and Zn at 200 ppm could be used to improve the chemical constituents of *Salvia hispanica* plant. Also, Ghatas and Mohamed (2020) showed that using mono ammonium phosphate (MAP) or monopotassium phosphate with EM or phosphorein was the best for improving the chemical constituents of the evening primrose (*Oenothera biennis*) plant.

RECOMMENDATIONS

According to the present research, it is recommended that to obtain the highest production of the psyllium seeds and husks, it is necessary to add bio-fertilizers mixed with the seeds by spraying with microelements as well to obtain the highest percentage of protein and carbohydrates in the seeds. Also, it is recommended to conduct several field experiments by adding bio-fertilizers and spraying with other microelements at other concentrations to clarify their effect on the growth and productivity of most medicinal and

aromatic plants, while studying the effect of microelements on the absorption of other elements.

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تأثير السماد الحيوي وبعض العناصر الصغرى على النمو والمحصول لنبات القاطونة

رانية مرتضى خاطر
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أجريت التجربة خلال الموسمين المتتاليين ٢٠٢٠/٢٠٢١ و ٢٠١٩/٢٠٢٠ بمحطة بحوث القصاصين. أجريت الدراسة لتحديد تأثير الأسمدة الحيوية وبعض العناصر الصغرى على النمو والمحصول والمكونات الفعالة لنبات القاطونة. اشتملت التجربة على خمسة معاملات هي: الكنترول، السماد الحيوي، السماد الحيوي و(المنجنيز والزنك)، السماد الحيوي و(الحديد والمنجنيز)، السماد الحيوي و(الحديد والزنك)، السماد الحيوي و(المنجنيز والزنك). تم ترتيب المعاملات في التصميم الإحصائي القطاعات العشوائية الكاملة بثلاث مكررات. أوضحت النتائج أن المعاملة الأفضل عند استخدام التسميد الحيوي مع (الحديد والمنجنيز والزنك) والتي سجلت أعلى القيم في النمو الخضري والتي تضمنت ٤٠.٤١ سم و٤١.٦٨ سم ارتفاع النبات و٢٢.٦٧ و٢٤.٣٣ عدد الأفرع / نبات في الموسم الأول والثاني على التوالي. كما كانت هناك زيادة معنوية في وزن البذرة للنبات بلغت ٨.٢٣ جم و٨.٥٧ جم ووزن البذور للفدان ٢٧٦.٦٤ كجم و٢٨٧.٨٤ كجم عند استخدام نفس المعاملة في الموسم الأول والثاني على التوالي. ومن ناحية أخرى وجدت زيادة في نسبة الزيت الثابت للمحصول بنسبة ١٥.٦٤٪ و١٥.٩٥٪، وإنتاج الزيت لكل نبات ١.٢٩ مل و١.٣٧ مل، ومحصول الزيت للفدان ٤٣.٢٧ لتر و٤٥.٩١ لتر عند معاملته بواسطة استخدام التسميد الحيوي مع (الحديد والمنجنيز والزنك) وأعطى زيادة معنوية في المكونات الفعالة "٣٠.٢٠٪ و٣٠.٢٩٪ مسيولاج، ٢٢.٣٣٪ و٢٢.٨٣٪ بروتين، ٢٧.٦٠ جرام و٢٧.٧٢ جرام قشور البذور/نبات، و٤٩.٨٧٪ و٥١.٢٣٪ كربوهيدرات عند استخدام نفس المعاملة، في الموسم الأول والثاني على التوالي.