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A. Role of Zeolite and Magnetite Combined with Biofertilizers Alleviating Water Deficiency on *Oenothera Biennis* plant (Morphology and oil yield)

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ABSTRACT
The concept of safety production of medicinal and aromatic plants under water deficiency present experimental research was conducted in pots experimental farmyard at Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, Egypt during two successive seasons 2015/2016 and 2016/2017 to compare the effects of biofertilizers (*Azotobacter chroococcum* and *Bacillus megaterium*), soil additives (zeolite & magnetite), mixture of them, and chemical NPK fertilizer (control) on growth parameters, floral characteristics and oil yield of *Oenothera biennis* L. (evening primrose) plants under water deficiency. the outcome data revealed that mixture of biofertilizers and soil additives (zeolite & magnetite) led to significant increment in morphological growth (plant height, number of branches, number of leaves, leaves area, leaves fresh weight, leaves dry weight), floral characteristics (number of flower, number of capsules, seed yield, as well as oil yield) in comparison with the recommended dose of chemical fertilizer NPK (control) under the same conditions. These results disclose that mixture biofertilizers and natural resources of soil additives could reduce or replace the addition of chemical fertilizers, accordingly improve the quality and quantity of medicinal and aromatic plants, besides minimizing economic costs and pollution of the agricultural environment.

Keywords: Evening primrose, Soil additives, Biofertilizers, Growth parameters, oil yield.

1. Introduction

Nowadays the time period "opportunity medicine" have become very common in western tradition, it cognizance at the concept of the use of the plants for medicinal reason. However the contemporary belief that drugs which come in pills or drugs are the only drugs that we will consider and use. Nevertheless most of these pills and tablets we take and use all through our everyday lifestyles came from plants. Medicinal vegetation regularly used as raw substances for extraction of lively components which used within the synthesis of various tablets. Like in case of laxatives, blood thinners, antibiotics and antimalarial medicines, include ingredients from plant life. Furthermore the lively substances of Taxol, vincristine, and morphine remoted from foxglove, periwinkle, yew, and opium poppy, respectively.

Plants had been used for medicative functions protracted before recorded history. Primitive guys found and favored the nice type of flora to be had to them. Plants offer food, apparel, refuge, and medicament. A full ton of the medicative use of vegetation seems to be advanced via observations of wild animals, and with the help of trial and mistakes. As time went on, each tribe additional the medicative strength of herbs of their place to its experience base. They methodically concentrated statistics on herbs and advanced nicely-described natural pharmacopoeias. The terminology "Medicinal Plant", also called "Medical Herbs", encompasses diverse forms of flowers used in herbalism ("herbology" or "herbal medicinal drug"). It's far the use of flowers for medicinal purposes, and the study of such uses. The phrase "herb" has been derived from the Latin word, "herba" and a vintage

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French word “herbe”. Nowadays, herb refers to any part of the plant like fruit, seed, stem, bark, flower, leaf, stigma or a root, as well as a non-woody plant. Earlier, the term “herb” was simplest applied to non-woody plant life, such as people who come from trees and shrubs. These medicinal floras are also used as food, flavonoid, medication or fragrance and additionally in certain spiritual sports. Vegetation was used for medicinal purposes lengthy earlier than prehistoric period.

It was mentioned that the plants tolerant to drought stress show different responses, including increment root/shoot ratio, growth reduction, leaf anatomy change, reduction of leaf size , total leaf area to limit water loss and guarantee photosynthesis Toscano *et al.,* (2019). The reduction of photosynthetic activity is related to the mechanisms of stomatal conductance. So, the first response of plants to water stress is stomatal closure for water potential adjustment resulting in a reduction in photosynthetic activity, which in turn leads to a decrease in plant growth and production Shi *et al.,* (2019).

Zeolites overcome the effects of drought in arid regions by acting as water distributors throughout the soil, that in turn affecting water conduction in plants (Ghazavi, 2015). Also, Rastogi *et al.,* (2019) mentioned that nano zeolites may be effectively used in agriculture to facilitate water infiltration and retention in the soil due to their porous and capillary properties which act as a slow-release source for water as well as macro and micro elements into the environments. Hidayat *et al.,* (2015) evaluated zeolite as slow release fertilizer nitrogen from urea. The results concluded that the zeolite is capable of retarding the release of urea and potential to be developed as a control release of nitrogen from urea.
Magnetite is a natural row rock that has very high iron content, Magnetite has a black or brownish-red, and it has hardness about 6 on the Mohs hardness scale, it is one of two natural row rocks in the world that is naturally magnetic Taha *et al.,* (2011). Also, magnetic iron increased plant growth and leaf mineral content on cauliflower Mansour (2007) and in Roselle plants (*Hibiscus Sabdariffal*), Yasser *et al.,* (2011). In addition, application of a magnetic field to irrigation water was shown to increase plant nutrient content, Moon and Chung (2000).

Microorganisms in the form of biofertilizers exist in pure or mixed product containing cells of microorganisms which perhaps nitrogen fixers, solubilizers of phosphorus, sulphur oxidisers or organic matter decomposers have served the human beings to correct problems emerge as a result of their synthetic products and its remarkable effects in human and animal health, food processing safety and quality, environmental and ecosystem. Hence soil microbiologists and microbial ecologists have separated many beneficial microorganisms which play essential role in soil quality, plant growth and yield, can fix atmospheric nitrogen, decomposes organic compounds, remove toxic substances from pesticides, repress plant diseases and soil-borne pathogens, boost nutrient cycling and produce bioactive materials like vitamins, hormones and enzymes that stimulate plant growth. T.Satyanarayana and Bhavdish Narain Johri (2012).

Oenothera biennis L. (Evening primrose) belongs to family Onagraceae. It is an edible and medicinal plant and has a long history of use as an alternative medicine.
Evening primrose is a biennial with a roselte of long oval leaves in the first year and a vertical hairy stem with spear-shaped soft leaves in the second year. Yellow flowers, reputed to open only after 6 o'clock in the evening, appear in midsummer. Ghasemnezhad and Honermeier (2007) reported that some *Oenothera* species grown as oil seed crops and to provide drugs for the pharmaceutical industry. Wettasinghe *et al.,* (2002) reviewed various constituents isolated from *Oenothera species*. These include steriods, terpenoids, fatty acids, flavonoids, tannins, mucilage, resin, bitter principle and potassium salts.

The purpose of present research was to examine the effect of zeolite and magnetite combined with biofertilizers on *oenothera biennis* L. (evening primrose) plant subjected to water deficiency and grown in sandy soil compared with commercial NPK fertilizers.

2. Material and Methods

Present investigation was carried out at the nursery of ornamental department; faculty of agriculture, Giza, Egypt, during two frequently seasons (2015/2016 and 2016/2017). Mechanical and chemical analyses of the reclaimed soil were performed according to Richards (1954) and Jackson (1973) as shown in Table (1) at Soil, Water and Environment Research Institute, Agriculture Research Center (A.R.C).

Table 1: Some physical and chemical properties of soil experimental

Physical properties		Chemical properties	
Particle size distribution (%)		Electrical conductivity (EC) (dS/m)	1.68
Coarse sand 2000–200 µ	80.20	pH (1:2.5) soil : water suspension	7.68
Fine sand 200–20 µ	12.50	**Soluble cations (meq/l):**	
Silt 20–2 µ	4.25	Ca^{2+}	5.20
Clay < 2 µ	3.05	Mg^{2+}	4.18
Bulk density [g/cm^3]	1.52	K^+	2.40
Total porosity [%]	52.8	Na^+	5.20
Pore size distribution as % of total porosity		**Soluble anions (meq/l):**	
Macro (drainable) pores (> 28.8 µ)	82.98	CO_3^{2-}	0
Micro pores (< 28.8 µ)	17.02	HCO^{3-}	1.7
Water Holding Capacity (WHC)*	20.33	Cl^-	3.6
Field capacity (FC)*	8.55	SO_4^{2-}	11.50
Wilting percentage (WP)*	4.10	Total $CaCO_3$ [%]	0.2
Available moisture (FC-WP)*	4.45	Organic matter [%]	0.2
Hydraulic conductivity [cm/h]	6.25		

Oenothera biennis L. seeds were obtained from experimental farm of Faculty of Pharmacy, Cairo University, and sown in pots (35 cm) at the end of October and harvested in May in both seasons.

2.1. Chemical fertilizers were added at the rate of 150 k/fed as ammonium nitrate (33%) both Calcium superphosphate (15.5%) at the rate of 60 k/fed and Potassium sulphate (48%) at the rate of 60 k/fed were added one day before transplanting.

2.2. Zeolite and compost

Zeolite was added at the rate of 210 k/fed. It was loaded with nitrogen as granules While compost add at the rate 5 ton /fed. Both were obtained from Soil Department in the A.R.C as shown in Table (2, 3) and added 15 days before transplanting.

Table 2: Chemical composition of zeolite.

Chemical composition (%)												
SiO_2	**TiO_2**	**Al_2O_3**	**Fe_2O_3**	**FeO**	**MnO**	**MgO**	**CaO**	**Na_2O**	**K_2O**	**SrO**	**P_2O_3**	**N**
45.50	2.81	13.30	5.40	8.31	0.51	6.30	9.52	2.83	0.87	0.22	0.67	2.70
Trace elements (ppm)												
Ba	**Co**	**Cr**	**Se**	**Cu**	**Zn**	**Zr**	**Nb**	**Ni**	**Rb**	**Y**	**-**	**-**
10	1.2	35	0.8	19	64	257	13	55	15	22	-	-

Table 3: Chemical composition of compost

Chemical analysis							
pH (1:5)	**EC (1: 5 extract) ds/m**	**Organic matter (%)**	**Organic-C %**	**Total content of Bacteria**	**Phosphate dissolving Bacteria**	**Humidity (%)**	**Weed seeds**
7.5	3.1	44.3	25.5	2.5 x 10^7	2.5 x 10^4	20	0
Chemical analysis							
Total-N %	**Total-K %**	**Total-P %**	**C/N ratio**	**Fe Ppm**	**Mn ppm**	**Cu ppm**	**Zn ppm**
1.82	1.25	1.06	18.1	784.12	96.31	31.05	251.23

2.3. Magnetite

Magnetite added to the soil (150 kg/fed.), added one week before transplanting. It was provided from El-Ahram Company for Mining- Egypt as shown in Table (4).

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Table 4: Some Physical and Chemical Properties of Magnetite

Physical Properties	
Color	Black to silvery gray
Streak	Black.
Luster	Metallic to sub metallic.
Diaphaneity	Opaque.
Mohs Hardness	5 to 6.5
Specific Gravity	5.2
Diagnostic Properties	Strongly magnetic, color, streak, octahedral crystal habit.
Tenacity	Brittle.
Fracture	Sub conchoidal to uneven.
Transparency	Opaque.
Crystal System	Isometric.
Uses	The most important ore of iron.
Chemical composition	
Chemical formula	Fe_3O_4.
Chemical Composition	Fe++, Fe+++
	Mn, Zn, Mg (trace).

2.4. Biofertilizers

Mixture of biofertilizers (*Bacillus megaterium* and *Azotobacter chroococcum*) were obtained from Soils Water and Environ. Res. Inst., Dept. of Microbiology (A. R. C.), Giza, Egypt.

Treatments

1	NPK control	**7**	Magnetite 50% + Bio
2	Magnetite 50%	**8**	Magnetite 100% + Bio
3	Magnetite 100%	**9**	Zeolite 50% + Bio
4	Biofertilizers	**10**	Zeolite 100% + Bio
5	Zeolite 50%	**11**	Magnetite 50% + Zeolite 50%+ Bio
6	Zeolite 100%	**12**	Magnetite 100% + Zeolite 100%+ Bio

2.5. Fixed oil content (% of the seeds):

Fixed oil extracted from seeds by using a Soxhlet apparatus. The oil percentage was determined according to the methylation (change fixed oil into fatty acid) and G.L.C analysis was also recorded by G.C. mass in Medicinal and Aromatic Plant Laboratory. Dokki (A.R.C) according to Kinsella, J.E., 1966 then oil yield/ha was estimated in a hectare.

2.6. Data recorded

2.6.1. Growth parameters

Plant height (cm).	Leaves area cm^2 /$plant^{-1}$	Number of flower/plant.
Number of branches.	Leaves fresh weight (gram).	Number of Capsules / plant.
Number of leaves.	Leaves dry weight (gram).	Seed yield/fed.

2.7. Statistical analysis:

The experimental design was Randomized Complete Blocks Design (RCBD) with ten replicates. The data were analyzed using ANOVA at 5% significance level; the difference between treatments, then analyzed using DMRT (Duncan Multiple Range Test) at 5%.

3. Results and Discussion

All growth characters of *O. biennis* represented in [plant height, number of branches, number of leaves, leave area, leaves fresh and dry weight /plant (g)] as shown in Table (5 and 6) significant variation with mixture application treatment (Magnetite 100% + Zeolite 100%+ Biofertilizers) compared with control and all other treatments. It was clear that (Magnetite 100% + Zeolite 100%+ Biofertilizers) significant increased plant height 37% and 45% through first and second season respectively compared to control plants under 50% water. Same trend was found under 100% water irrigation where same previous treatment gave 10% and 12% for first and second season respectively compared to control.

Number of leaves also increased significantly with (Magnetite 100% + Zeolite 100%+ Biofertilizers) treatment by 17.5 % under 50% water and 11% under 100% water irrigation compared with control treatment for first season. Also in the second season the increments were 34% and 12% for 50% and 100% irrigation water respectively in comparison to control.

Moreover, application of (Magnetite 100% + Zeolite 100%+ Biofertilizers) treatment increased number of branches per plant by 37% under 50% water and 27% under 100% water respectively for the first season, 126% under 50% water and 43% under 100% water respectively for the second season.

Table 5: Effect of magnetite, biofertilizers and zeolite and their combinations on growth parameters of *Oenothera biennis* L. plant growing under 50 or 100% water irrigation regime during first season 2015/2016

Treatment	Plant height (cm)		Number of leaves/plant		Number of branches/ Plant		Area of leaves/plant (cm^2)	
	50%	100%	50%	100%	50%	100%	50%	100%
NPK control	89.1f	115.3d	118.3c	131.6c	6.2b	8.3b	149.5f	172.3e
Magnetite 50%	91.6f	113.2e	117c	125.5d	5.5b	7.3c	146.4f	168.2e
Magnetite 100%	94.6e	114.5d	119.2c	127.6d	5.2b	7.6c	148.2f	170.5e
Biofertilizers	80.7g	112.6e	116.7c	125.2d	4.7c	6.4d	137.6g	162.4e
Zeolite 50%	97.2e	119.3c	129.5b	138.1b	7.3a	8b	195.3e	220.9d
Zeolite 100%	104.8d	120.5c	131.8b	140.4b	8.2a	8.1b	203.5d	226.3c
Magnetite 50% + Bio	99.3e	120.4c	130.2b	138.7b	6.7b	7.8b	204.1d	227.8c
Magnetite 100% + Bio	101.5d	121.6c	132.5b	139.8b	6.5b	7.9b	207.5d	230.6c
Zeolite 50% + Bio	107.2d	122.3b	133.5b	139.6b	7.1a	8.4b	211.2c	234.6b
Zeolite 100% + Bio	111.5c	122.8b	136.1a	141.5b	7.6a	8.8b	215.7c	238.5b
Magnetite 50% + Zeolite 50%+ Bio	116.6b	125.3a	137.3a	145.5a	8.2a	10.2a	227.2b	250.5a
Magnetite 100% + Zeolite 100%+ Bio	122.2a	127.8a	139a	146.2a	8.5a	10.6a	234.6a	256.8a

Means with the same letter in a column are not significantly different by DMRT at level 5%

Table 6: Effect of magnetite, biofertilizers and zeolite and their combinations on growth parameters of *Oenothera biennis* plant growing under 50 or 100% water irrigation regime during second season 2016/2017

Treatment	Plant height (cm)		Number of leaves/plant		Number of branches/ Plant		Area of leaves/plant (cm^2)	
	50%	100%	50%	100%	50%	100%	50%	100%
NPK control	77.6e	122.8c	98.4d	137.8c	4.2c	9.6b	119.2d	193.5f
Magnetite 50%	79.3d	120.7c	101.5d	132.6d	4.5c	8.8c	116.4d	191.5f
Magnetite 100%	83.2d	122.5c	103.1d	134.8d	4.1c	9.5b	120.1d	193.1f
Biofertilizers	69.2e	116.2d	91.3e	130.5d	2.3d	7.8c	109.5e	180.5g
Zeolite 50%	85.6d	122.3c	115.2c	145.2b	6.1b	9b	175.8c	241.4e
Zeolite 100%	93.5c	127.4b	122.4b	147.6b	8.5a	10.3b	179.2c	249.7d
Magnetite 50% + Bio	87.5d	127.3b	112c	144.5b	5b	8.6c	172.8c	247.2d
Magnetite 100% + Bio	90.5c	129.2b	115.8c	142.7c	5.2b	9.7b	181.6c	251.3d
Zeolite 50% + Bio	95.3c	129.8b	118.7c	148.3b	8.3a	10.5b	185.5b	255.3d
Zeolite 100% + Bio	101.2b	132.2b	124.5b	146.5b	8.6a	10.3b	189.3b	262.6c
Magnetite 50% + Zeolite 50%+ Bio	107.2a	135.5a	125.6a	151.3a	7.3a	12.3a	205.8a	275.2b
Magnetite 100% + Zeolite 100%+ Bio	113.1a	138.3a	132a	154.4a	9.5a	13.8a	210.3a	284.5a

Means with the same letter in a column are not significantly different by DMRT at level 5%

Regarding leaves area table (6), revealed that, application of mixed treatment was significantly increased leaves area under 50% water irrigation by 56% and under 100% water irrigation by 49% over control plants for the first season, same trend was obtained in the second season where (Magnetite 100% + Zeolite 100%+ Biofertilizers) treatment significantly raised leaves area by 76% under 50% irrigation water and 47% under 100% water.

Going with number of flower table (7), it was found that, appliance of (Magnetite 100% + Zeolite 100%+ Biofertilizers) treatment significantly boosted number of flowers by 38% under 50% water irrigation and 33% under 100% water irrigation compared to control for the first season and 57% under 50% irrigation water and 32% under 100% irrigation water for the second season in comparison with control.

Leaves fresh weight table (8) gave the highest value 43% under 50% irrigation water and 31% under 100% irrigation water while in the second season the value was 59% under 50% irrigation water and 30% under 100% irrigation water as a result of (Magnetite 100% + Zeolite 100%+ Biofertilizers) treatment application compared to control treatment.

Table 7: Effect of magnetite, biofertilizers and zeolite and their combinations on growth parameters of *Oenothera biennis* plant growing under 50 or 100% water irrigation regime during first season 2015/2016

Treatment	Number of flowers/plant		Leaves F.W g/plant		Leaves D.W g/plant	
	50%	100%	50%	100%	50%	100%
NPK control	146.5e	168.5d	178.5e	214.7e	43.5c	51.7c
Magnitite 50%	144.8e	162.6e	177.3e	212.5e	44.2c	51.1c
Magnitite 100%	145.1e	169.3d	180.5e	214.2e	46.5c	50.3c
Biofertilizers	124.3f	149.8f	164.3f	197.6f	40.3d	47.5d
Zeolite 50%	147.2e	168.6d	186.6d	218.8d	48.4c	52.2c
Zeolite 100%	150.8e	173.5d	188.2d	220.5d	51.5b	54.7c
Magnetite 50% + Bio	158.5d	183c	182.5d	220.9d	45.3	55.2c
Magnetite 100% + Bio	156.8d	185c	185.3d	223.7d	50.1b	54.7c
Zeolite 50% + Bio	165.5c	188.4c	206.7c	240.4c	55.3b	58.5b
Zeolite 100% + Bio	168.3c	190.5c	211c	244.2c	58.5a	60.2b
Magnitite 50% + Zeolite 50%+ Bio	188.3b	212.7b	246.8b	278.5a	62.4a	68.8a
Magnitite 100% + Zeolite 100%+ Bio	203.2a	224.5a	255.5a	281.3a	65.3a	71.6a

Means with the same letter in a column are not significantly different by DMRT at level 5%

Table 8: Effect of magnetite, biofertilizers and zeolite and their combinations on growth parameters of *Oenothera biennis* plant growing under 50 or 100% water irrigation regime during second season 2016/2017

Treatment	Number of flowers/plant		Leaves F.W g/plant		Leaves D.W g/plant	
	50%	100%	50%	100%	50%	100%
NPK control	110.5f	171.6d	80.6e	220.3c	22.3c	56.1c
Magnitite 50%	115.8f	170.2d	82.5e	217.8c	20.5c	54.5c
Magnitite 100%	118.4e	172.5d	85.8e	219.5c	21.3c	54.8c
Biofertilizers	94.3g	157.3e	65.7f	202.7d	16.5d	47.8d
Zeolite 50%	122.5e	172.5d	88.2e	224.2c	22.6c	55.7c
Zeolite 100%	125.3d	176.3d	96.6d	226.5c	25.3b	54.7c
Magnetite 50% + Bio	127.3d	185c	86.3e	224.6c	22.8c	56.5c
Magnetite 100% + Bio	129.6d	188c	89.5e	227.3c	24.3b	56.8c
Zeolite 50% + Bio	133.2d	186.5c	98.8c	245.7b	25.6b	61.6b
Zeolite 100% + Bio	141.5c	189.7c	109.5c	248.5b	27.2b	62.1b
Magnitite 50% + Zeolite 50%+ Bio	161.5b	211.5b	115.6b	284.2a	28.5b	71.3a
Magnitite 100% + Zeolite 100%+ Bio	174.3a	227.3a	128.3a	286.7a	34.8a	71.8a

Means with the same letter in a column are not significantly different by DMRT at level 5%

Same tendency with leaves dry weight table (8) where application of mixed treatment donated 50% under 50% irrigation water and 38% under 100% irrigation water contrast with control plants for the first season. In the second season the percentage was 56% under 50% irrigation water and 28% under 100% irrigation water as a result of previous treatment applied.

These results are in accordance with the findings of Mahmoud and Amira (2017), Ahmed *et al.,* (2011) on roselle plants; Ramadan (2012) on cabbage and Salama (2015) on berseem clover and annual rye-grass. Present results could be attributed to the positive effects of mixture application treatment (Magnetite 100% + Zeolite 100%+ Biofertilizers) on the improve physical and chemical properties of soil, high available water-holding and high adsorption capacities, decreased soil pH, higher CEC, increased soil organic matter which, enhance absorption of available nutrients, in turn, enhanced plant growth and production, may affect phytohormone production leading to improve cell activity and plant growth Fiorentino *et al.,* (2006); Kavoosia, (2007); Castrillion *et al.,* (2009); Indraratne *et al.,* (2009); Ramadan, (2012).

3.1. Number of Capsules, seed yield and seed oil

Data in table (9, 10) showed that application of (Magnetite 100% + Zeolite 100%+ Biofertilizers) treatment significant increased number of capsules, seed yield and seed oil compared to control plants in both seasons first and second. the increments were 38%, 39 % and 23% under 50% irrigation water respectively and 28%, 29% and 17% under 100% irrigation water for first season, the increments in the second season were 30%, 35% and 34% under 50% irrigation water respectively. Under 100% irrigation water the augmentations were 28%, 29% and 17% respectively for the first season, at the same time the increments were 29%, 21% and 20% respectively for the second season.

Table 9: Effect of magnetite, biofertilizers and zeolite and their combinations on yield and its components of *Oenothera biennis* L. plant under 50 or 100% water irrigation regime during first season 2015/2016

Treatment	Number of Capsules/ plant		Seed yield g/plant		Seed oil %	
	50%	100%	50%	100%	50%	100%
NPK control	127.2e	152.6d	16.36d	18.45c	1.47c	1.68c
Magnitite 50%	132.5d	155.2d	13.43e	15.52d	1.30d	1.51d
Magnitite 100%	133.2d	157.5d	16.14d	17.23c	1.31d	1.50d
Biofertilizers	118.4f	144.5c	12.71e	14.80d	1.21e	1.42e
Zeolite 50%	151.6c	177c	15.54d	17.63c	1.46c	1.67c
Zeolite 100%	156.3c	179.5c	18.59c	19.68b	1.51b	1.72b
Magnetite 50% + Bio	155.6c	180.2c	15.68d	17.77c	1.41c	1.70b
Magnetite 100% + Bio	158.8c	181.5c	18.24c	19.33b	1.49b	1.70b
Zeolite 50% + Bio	161.2b	184.7b	18.78c	19.89b	1.50b	1.71b
Zeolite 100% + Bio	166.8b	186b	19.72b	21.81a	1.51b	1.72b
Magnitite 50% + Zeolite 50%+ Bio	168.5b	190.3a	20.46b	22.67a	1.77a	1.94a
Magnitite 100% + Zeolite 100%+ Bio	176.5a	195.4a	22.74a	23.92a	1.81a	1.96a

Means with the same letter in a column are not significantly different by DMRT at level 5%

Table 10: Effect of magnetite, biofertilizers and zeolite and their combinations on yield and its components of *Oenothera biennis* L.plant under 50 or 100% water irrigation regime during second season 2016/2017

Treatment	Number of Capsules/ plant		Seed yield g/plant		Seed oil %	
	50%	100%	50%	100%	50%	100%
NPK control	108.5e	157.3d	15.25d	20.61b	1.26c	1.84b
Magnitite 50%	109.3e	159.5d	11.32f	17.73d	1.10e	1.59b
Magnitite 100%	113.6e	162.6d	15.03d	19.54c	1.18d	1.62b
Biofertilizers	89.5f	148.6e	10.60f	15.39e	1.09e	1.48b
Zeolite 50%	120.3d	180c	13.43e	19.86c	1.28c	1.75b
Zeolite 100%	122.6d	185.3b	16.38c	21.77b	1.37b	1.83b
Magnetite 50% + Bio	121.4d	183.4c	15.57d	18.68c	1.24c	1.79b
Magnetite 100% + Bio	123.6d	186.2b	16.13c	20.41b	1.26c	1.82b
Zeolite 50% + Bio	128.4d	189.5b	17.67c	22.42a	1.35b	1.88b
Zeolite 100% + Bio	135.5c	191.2b	18.61b	23.05a	1.38b	1.91b
Magnitite 50% + Zeolite 50%+ Bio	141.2b	197.5a	18.35b	23.15a	1.58a	2.06a
Magnitite 100% + Zeolite 100%+ Bio	152.6a	204.1a	20.63a	24.88a	1.69a	2.21a

Means with the same letter in a column are not significantly different by DMRT at level 5%

The increases in Number of Capsules, seed yield and seed oil of *O. biennis* plants in our experiment could be explained by increase the microbial populations resulting from biofertilizers in soils. These microorganisms can produce materials that may affect plant growth, such as substances acting as plant hormone analogs or growth regulators Mahmoud and Amira (2017). Also, Mansour (2007) and Mosa *et al.,* (2015) reported that this increase might be attributed to stimulating effect of magnetite on plant growth and the absorption of N, P, K, and Ca. The previous result was supported by, Mohamed *et al.,* [58] on Orange trees with magnetite and some biofertilizers application and Mahmoud and Amira (2017) on *Oenothera biennis* L.

4. Conclusion

The Addition of mixture treatment (Magnetite 100% + Zeolite 100%+ Biofertilizers) to the soil and plant boosted growth parameters and oil yield of *O. biennis* plants under water deficiency and that led to decrease the addition of chemical fertilizer rate to the level that could replace it with mentioned Mix treatment and reduce the production cost. Additionally, developments in using such safety and natural products in this sector could have large-scale economic implications and multiple benefits for consumers, producers, farmers, and the ecosystem. Therefore, a mentioned mixture application can be considered as an economical fertilization for *O. biennis* plants.

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