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Influence of Mixed Minerals Ores and Seaweed Liquid Extract on Growth, Yield and Chemical Constituents of Dill (*Anethum graveolens*, L.) Plants

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ABSTRACT

A field experiment was conducted during two successive seasons 2013/2014 and 2014/2015 to determine the influence of mixed minerals ores; control, 400, 600 and 800 Kg/fed.and recommended dose of NPK fertilizers and seaweed liquid extract; control, 1, 2 and 3 ml/liter and their combinations on vegetative growth, yield, volatile oil (percentage & yield), nitrogen, phosphorus and potassium percentages of *Anethum graveolens* plants. The obtained data showed that plant height, branch number, herb dry weight, umbels number, fruit yield/plant and per fed., volatile oil (percentage & yield), N, P and K percentages, were generally increased as a result of applying mixed minerals ores. The highest values of the previous parameters were observed due to the use of the high rate of mixed minerals ores (800 kg /fed.). In regard to seaweed liquid extract treatments, it was noticed that all concentrations led to a significant increase in plant height, branch number, herb dry weight, umbels number, fruit yield / (plant & fed.), volatile oil (percentage & yield per plant and per fed.) as well as N, P and K percentages. The highest values of these previous characters were obtained when using seaweed liquid extract at the high concentration. Generally, the combined effect among mixed minerals ores and seaweed liquid extract treatments on *Anethum graveolens,* L. plants parameters were statistically significant. In most cases, the addition of high rate of mixed minerals ores plus high concentration of seaweed liquid extract was the most effective treatment in increasing these parameters.

Key words: Mixed Minerals Ores, Seaweed liquid Extract, dill and *Anethum graveolens*

Introduction

Anethum graveolens, L., is believed to have its beginnings in the Mediterranean region. It is belonging to Family Apiaceae (Umbellifera), the plant has along and ancient history in many countries as a culinary and medicinal herb. The earliest known record of dill as a medicinal herb was found in Egypt 5,000 years ago when the plant was referred to as a “soothing medicine.” Gladiators were fed meals covered with dill because it was hoped that the herb would grant them valor and courage. Dill seeds are often called “meetinghouse seeds” because they were chewed during long church services to keep members awake or kids quiet. The seeds were also chewed in order to fresh the breath and quiet noisy stomachs. Dill was believed to provide protection from witchcraft, most likely because of its strong smell. Charms were often made from sprigs of dill to provide protection from witchcraft; they were hung around the house or worn on the clothing. Dill was often added to love potions and aphrodisiacs to make them more effective. Essential oils plants are potential source of antimicrobials of natural origin (Valero and Giner, 2006). Essential oil plants include a wide range of plant species, mainly used in the preparation of perfumes, cosmetics, everages, medicinal foods, disinfectants, insecticides, fungicides, smoking, chewing, tobacco and condiments. Essential oils are extracted from aromatic plants of many genera, which are distributed of the worldwide. These oils are found in various parts (seeds, leaves, fruits barks & roots) of aromatic plants.

The english name of *Anethum graveolens* is dill and in subcontinent it is called as sowa. It is used as flavoring and preservative agent. Its edicinal uses are as an antispasmodic, carminative, diuretic, stimulant and stomachic (Simon *et al.,* 1984). Some of the earlier studies had shown the antimicrobial activity of *Anethum graveolens* against *Saccharomyces cerevisia* and *Listeria monocytogenes* (Pascal *et al.,* 2002). Keeping in view this fact it was hypothesized that *Anethum graveolens* can have antimicrobial activity against other microbes.

Mixed minerals ores are major essential macronutrients for plant growth, soluble P and K fertilizers are commonly applied to replace removed minerals and to optimize yield. When phosphate is added into soils as a fertilizer in relatively soluble and plant available forms, it is easily converted especially in alkaline soil like in Egyption soil, into insoluble complexes. Consequently, to achieve optimum crop yields, soluble phosphate, fertilizers have to be applied at high rates which cause unmanageable excess of phosphate application and environmental and economic problems (Brady, 1990). On the other hand, K deficiencies become a problem

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because K decreases easily in soils due to crop uptake, runoff, leaching and soil erosion (Sheng and Huang, 2002). Direct application of rock phosphate (rock P) and potassium (rock K) materials may be agronomically more useful and environmentally more feasible than soluble P and K (Rajan *et al* 1996). Rock P and K materials are cheaper sources of P and K; however, most of them are not readily available to a plant because the minerals are released slowly and their use as fertilizer often causes insignificant yield increases of current crop (Zapata and Roy, 2004). PSB have been used to improve rock P value because they convert insoluble rock P into soluble forms available for plant growth (Bojinova *et al* 1997).

The application of seaweed extract for different crops was a great importance due to contain high levels of organic matter, micro elements, vitamins , fatty acids and also rich in growth regulators such as auxins, cytokinin and gibberellins (Crouch and Van Staden, 1994). The beneficial effect of seaweed extract application is as a result of many components that may work synergistically at different concentrations, although the mode of action still remains unknown (Fornes *et al*., 2002). Extracts derived from seaweeds are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animals and birds. These fertilizers are often found to be more successful than chemical fertilizers (Booth, 1969) .However, the application of seaweed extract increased chlorophyll content (Whapham *et al*., 1993 and Thirumaran *et al*., 2009). Turan and Köse (2004) on grapevine, Mancuso *et al*. (2006) and Rathore *et al*. (2009) on soybean observed increases in yield as well as N, P and K with application of seaweed extract. Gajewski *et al*. (2008) on Chinese cabbage revealed that application of Goteo (an organic-mineral fertilizer which contains algae extract *Ascophyllum nodosum* with addition of phosphorus)increased yield, marketable heads as well as vitamin C content compared to the untreated cabbagewhereas, slightly higher nitrate content was noted. Zodape *et al*. (2008) on okra, Arthur *et al.* (2003) on pepper and Zodape *et al*. (2010) on mung bean, indicated that application of seaweed extract significantly increased seed yield and pod weight as well as improved nutrional values of seeds, i.e., protein and carbohydrates. Also, Eyszkowska *et al.* (2008) reported that nitrate in lettuce of examined cultivars insignificantly increased after the treatments with Goteo and Amino (an organic fertilizer which contains amino acids and short peptide chains). Abdel Mawgoud *et al.* (2010) cleared that the application of seaweed extract at concentrations of 1, 2 and 3 g/L increased the response of all growth parameters and yield of watermelon.
It was found wide application in modern agriculture for the use of marine macroalgae as fertilizer. Seaweed contain all the trace elements and plant growth hormones required by plant, regulators promoters available to enhance yield attributes (Crouch and Van staden, 1991; Crouch and Van staden, 1993).

Materials and Methods

The present investigation was carried out at the Experimental Farm of Faculty of Agriculture, Al-Azhar University, Assiut, Egypt during the two successive seasons of 2013/2014 and 2014/2015. The present work aimed to study the responses of Dill (*Anethum graveolens*) *plants* to mixed minerals ores (MO) and Seaweed liquid extract (SE) which may affect on growth and/or yield as well as chemical constituents. A splite plot design with three replicates was followed in this study, mixed minerals ores treatments; control, MO1 = 400, MO2 = 600 and MO3 = 800 Kg/fed. side banding in one dose before sowing and recommended dose of NPK fertilizers (NPK r) "200kg ammonium sulphate (20.6% N), 100 kg / fed. calcium super phosphate (15.5 % P2 O5) and 50 kg / fed. potassium sulphate (48.0 % K2O)" were the main plots, while seaweed liquid extract; control, SE1 = 1, SE2 = 2 and SE3 = 3 ml/liter were accepted the sub plots. On 30th October, fruits of dill were sown in experimental units; each was 3.6 × 3.2 square meter including 6 rows with 60 cm apart and each row contained five hills at 40 cm distance in one side. After eight weeks, the thinning was done leaving one seedling/hill. The plants were sprayed with Seaweed liquid extract two times at two week intervals starting December, 20th for both seasons. Physical and chemical properties of the experimental soil and mixed minerals ores are shown in Tables (1&2). All agricultural practices were performed as usual. At the end of the experiment, (April 15th and April 7th for the first and second seasons, respectively.) The following data were recorded: plant height, number of branches/plant, herb dry weight (g)/plant, number of umbels/plant, seed yield (g)/plant and the seed yield/fed. were calculated.

Volatile oil in the seeds was determined according to Guenther (1961). Oil yield (ml/plant) was calculated by multiplying the oil percentage by the fruit yield per plant, then a yield / fed. was calculated.

Determination of some nutrient content:

The sample (0.5g) was performed to determine nutrient content according to Jackson (1978). Nitrogen percentage in the dried leaves, was determined in the digestion using the micro-Kjeldhl method (Black *et. al.,* 1965). Phosphorus percentage was determined colorimetrically by using the stannous chloride phosphomolibdicsulforic acid system and measured at 660 nm wave length according to Jackson (1978).Potassium percentage was determined by using a flame photometer as described by Jackson (1978).The obtained data were statistically analyzed according to Snedecor and Cochran (1973).

Foliar Spraying of Seaweed Extract

A commercial seaweed extract product "OLIGO- X" contains N (1%), K (18.5%), Ca (0.17%), Mg (0.42%), Fe (0.06%), S (2.2%), alganic acids (10-12%) and plant hormones (600 ppm). This product source the Arabian Group of Agricultural Services. 105 Faisal Street - Giza-Egypt.

Mixed Minerals Ores sources were obtained from El-Ahram Company for Mining and Natural Fertilizers.

Table 1: Physico-chemical properties of the used soil.

Texture	pH	E.C. (ds /m)	$CaCO_3$%	Available nutrients (ppm)			Water soluble Ions (meq /L) in the soil paste				
				N	P	K	Ca	Mg	CO_3+ HCO_3	CL	SO_4
Loamy	7.9	1.2	2.7	62.4	9.2	356	3.4	1.9	2.9	2.2	6.6

Table 2: Chemical analysis for mixed minerals ores

Item	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	Cao	Na_2O	K_2O	P_2O_5	SO_3	L.O.I
(%)	39.36	0.81	7.68	4.05	0.68	3.20	15.07	1.76	4.24	7.33	5.83	8.08

Results and Discussion

Vegetative growth:

Plant height:

The presented data in Table (3) revealed that plant height of *Anethum graveolens* was significantly influenced by mixed minerals ores and NPK treatments in the second season only. From the obtained results it could be noticed that by increasing the rates of mixed minerals ores treatments, the plant height was augmented therefore, the tallest plants were obtained due to receiving the plants high rate of mixed minerals ores treatments which increased the plant height by 11.57 and 14.14 % over the check treatment in the first and second seasons, respectively.

As for seaweed liquid extract treatments, data in Table (3) showed that all of them caused a significant increase in plant height of *Anethum graveolens* in both seasons. Foliar spray with seaweed extract at high concentration gave the best results of plant height in comparison with untreated ones in the two consecutive seasons. This above concentration used reached 14.80 and 14.73 % over the control plants in the two growing seasons, respectively.

Concerning the interaction effect between mixed minerals ores, NPK and seaweed extracted treatments; it was significant on plant height of *Anethum graveolens* in the two successive seasons. as clearly declare in Table (3).

Number of branches:

Table (3) indicate that supplying *Anethum graveolens* plants with mixed minerals ores at all rates and NPK except MO2 in the first season led to a significant augment in branch number for the two seasons. Utilizing the high rate of mixed minerals ores recorded the highest number of branches ranged 57.14 and 85.55 % than control in the two experimental seasons,
respectively.

In regard to seaweed liquid extract treatments, data in Table (3) pointed out that branch number of *Anethum graveolans* was significantly augmented by all concentrations of seaweed liquid extract in the two growing seasons. The data reveal that adding the high concentration of gave the maximum number of branches which increased it by 46.35 and by 40.27 % over the control treatment in the first and the second seasons, respectively.

The combined effect between the two factors on branch number of *Anethum graveolans* had significant in the two seasons. Treating the plants with the high rate of mixed minerals ores and the high concentration of seaweed liquid extract recorded better results of branch number of *Anethum graveolens* in comparison with other treatments in both seasons, as clearly shown in Table (3).

Herb dry weight:

Herb dry weight of *Anethum graveolens* was significantly increased by utilizing of mixed minerals ores and NPK except MO1 in the two seasons. The obtained data indicate that by increasing the rates of mixed minerals ores the herb dry weight was significant augmented in the two consecutive seasons. Therefore, receiving *Anethum graveolans* the high rate of mixed minerals ores produced heaviest herb dry weight and ranged 42.34 and 58.32 % over the check treatment in the two growing seasons, respectively, as clearly reveal in Table (3).

The illustrated data in Table (3) shows that all seaweed liquid extract concentrations significantly augmented herb dry weight of *Anethum graveolans* in the two seasons. It was found that the highest herb dry weight was obtained due to spraying the plants with the high concentration of seaweed liquid extract as increased it by 27.78 and by 20.13 % over untreated ones in both seasons, respectively.

With respect to the interaction between mixed minerals ores and NPK and seaweed liquid extract treatments on herb dry weight of *Anethum graveolens* was significant effect for the second season only. It is clear that the most effective treatments was observed when fertilizing the plants with mixed minerals ores at the high rate and seaweed extract at the high concentration in comparison with other combination treatments, as shown in Table (3).

Table 3: The interaction effect of mixed minerals ores (MO) with seaweed liquid extract (SE) on vegetative parameters of dill (*Anethum graveolens*, L.) plants during 2013/2014 and 2014/2015 seasons

Mixed minerals ores levels(A)	Seaweed liquid extract concentrations(B)									
	Plant height (cm.)									
	First season					Second season				
	Cont.	SE1	SE2	SE3	Mean	Cont.	SE1	SE2	SE3	Mean
Cont.	91.0	95.3	106.0	112.0	101.1	92.0	94.7	107.3	110.3	101.1
NPK R	107.0	108.3	114.3	118.7	112.1	102.3	111.3	113.3	119.0	111.5
MO1	94.7	106.3	109.7	112.7	105.9	99.7	106.7	108.7	111.0	106.6
MO2	104.3	109.0	110.3	114.3	109.5	100.0	109.3	114.0	116.7	110.0
MO3	106.3	107.3	117.3	120.3	112.8	108.3	114.0	120.0	119.3	115.4
Mean	100.7	105.3	111.5	115.6		100.5	107.2	112.7	115.3	
L.S.D.0.05	A : NS B : 4.1 AB : NS					A : 5.3 B : 3.5 AB :NS				
	Number of branches									
Cont.	6.17	6.57	7.30	7.67	6.93	5.17	6.40	6.33	6.73	6.16
NPK R	8.50	9.83	10.73	13.00	10.52	9.50	10.93	11.57	12.33	11.08
MO1	6.33	9.00	9.73	10.73	8.95	6.37	7.33	7.73	8.27	7.59
MO2	7.33	8.00	8.73	9.40	8.37	7.03	9.70	10.23	10.83	9.28
MO3	8.67	10.40	11.67	13.33	10.89	8.93	11.03	12.00	13.73	11.43
Mean	7.40	8.76	9.53	10.83		7.40	9.08	9.57	10.38	
L.S.D.0.05	A : 1.63 B : 0.50 AB :1.13					A :1.24 B :0.52 AB :1.17				
	Herb dry weight (g/plant)									
Cont.	13.80	14.40	15.40	18.83	15.61	12.60	13.63	14.73	15.57	14.13
NPK R	19.07	20.50	22.00	24.30	21.47	20.23	20.63	21.37	23.40	21.41
MO1	14.57	15.47	15.97	17.40	15.85	13.67	14.97	15.73	17.27	15.41
MO2	17.40	18.23	20.30	22.43	19.59	16.73	17.63	19.47	21.50	18.83
MO3	19.57	21.50	22.93	24.87	22.22	21.23	21.67	22.83	23.73	22.37
Mean	16.88	18.02	19.32	21.57		16.89	17.71	18.83	20.29	
L.S.D.0.05	A :2.78 B :0.69 AB :NS					A : 1.98 B :0.39 AB :0.87				

(MO) = Mixed minerals ores, (SE) = Seaweed liquid extract

The yield parameters:

Number of umbels

The recorded data in Table (4) reveal that umbels number / plant was significantly augmented due to mixed minerals ores and NPK treatments at the high level (MO3) only and NPK treatment in the two growing seasons.

Moreover, the highest numbers of umbels number were obtained when supplying dill plants with mixed minerals ores at the high rate which increased of it over the control plants by 54.37, and by 41.97 % in the first and the second seasons, respectively.

Concerning seaweed liquid extract treatments, data in Table (4) show that the influence of them on number of umbels / plant was significant in both seasons. From the obtained data, it is noticed that the highest number of umbels were detected due to addition the plants with high concentration of seaweed extract reached 20.83 and 23.76 % over the check control for the two seasons, respectively.

The interacting effect between mixed minerals ores fertilizer and seaweed liquid extract treatments on umbels number / plant was significant in two seasons. The most effective treatments were obtained from treating the plants with mixed minerals ores at the high rate in combination with the high concentration of seaweed extract followed by recommended dose of NPK with high concentration of seaweed extract, as clearly shown in Table (4).

Fruit yield per plant and per feddan:

The presented in Table (4) reveal that the main effect of mixed minerals ores and NPK treatments on fruit yield of dill / plant and / feddan was statistically significant in the two experimental seasons. It is concluded that all mixed minerals ores fertilizer treatments significantly increased fruit yield/ plant and / feddan in comparison with no received ones in both seasons.

Moreover, the maximum seed yield / plant and / feddan were observed when receiving the plants mixed minerals ores treatments at the high rate compared to other ones in the two seasons. Numerically, these previous treatments led to increase fruit yield by 43.50 and by 45.03 % than untreated control in the first and the second seasons, respectively and amounted 664.3 and 664.4 Kg / feddan fruit compared to the check treatment (463.2 and 458.2) Kg / feddan seed in both seasons, respectively.

Fruit yield of dill per plant and per feddan was significantly augmented by addition the plants with all concentrations of seaweed extract as treatments in the two experimental seasons.

From the obtained results, it could be noticed that the highest fruit yield / plant and / feddan were observed when treating dill plants with the high concentration of seaweed extract which increased it by 14.44 and by 15.54 % over the control in the two seasons, respectively. These aforementioned treatments recorded 621.3 and 614.5 Kg / feddan fruit in comparison with untreated ones (544.9 and 531.8) Kg / feddan fruit in the first and the second seasons, respectively, as clearly illustrated in Table (4).

The interaction between mixed minerals ores fertilizer and seaweed liquid extract treatments on fruit yield / plant and / feddan had significant effect in the second season only. From the obtained data it is clear that inoculating the plants with high concentration of seaweed extract and receiving high rate of mixed minerals ores produced the maximum seed yield compared to other combination treatments.

Table 4: The interaction effect of mixed minerals ores with seaweed liquid extract on yield parameters of dill (*Anethum graveolens*, L.) plants during 2013/2014 and 2014/2015 seasons

Mixed minerals ores levels(A)	Seaweed liquid extract concentrations(B)									
	umbels number/plant									
	First season					Second season				
	Cont.	SE1	SE2	SE3	Mean	Cont.	SE1	SE2	SE3	Mean
Cont.	12.57	13.57	14.40	15.30	13.96	13.67	14.63	15.50	15.97	14.94
NPK R	18.07	19.40	22.50	24.23	21.05	17.73	19.23	22.13	24.00	20.78
MO1	13.90	14.83	15.73	16.80	15.32	15.07	15.90	16.90	17.23	16.28
MO2	15.07	16.17	17.17	18.23	16.66	15.63	16.40	17.57	18.07	16.92
MO3	18.40	19.73	23.40	24.67	21.55	18.30	19.90	22.40	24.23	21.21
Mean	15.60	16.74	18.64	19.85		16.08	17.21	18.90	19.90	
L.S.D.0.05	A : 2.75 B :0.24 AB : 0.53					A :2.24 B :0.35 AB :0.77				
Fruit yield/plant (gm)										
Cont.	26.17	27.37	28.33	29.30	27.79	26.13	26.90	28.03	28.90	27.49
NPK R	36.30	37.57	39.40	42.57	38.96	35.23	36.73	39.00	41.23	38.05
MO1	31.13	32.30	32.90	33.97	32.58	29.97	31.07	32.23	32.87	31.53
MO2	33.07	34.67	35.73	37.40	35.22	31.63	33.17	35.23	37.83	34.47
MO3	36.80	38.50	40.40	43.83	39.88	36.57	38.30	41.07	43.53	39.87
Mean	32.69	34.08	35.35	37.41		31.91	33.23	35.11	36.87	
L.S.D.0.05	A :2.92 B :1.01 AB :NS					A : 3.82 B :0.40 AB :0.90				
Fruit yield/fed. (kg)										
Cont.	436.1	456.1	472.2	488.3	463.2	435.5	448.3	467.2	481.6	458.2
NPK R	605.0	626.1	656.6	698.3	646.5	587.2	612.2	650.0	687.2	634.1
MO1	519.9	538.3	548.3	566.1	542.9	499.4	517.8	537.2	547.8	525.5
MO2	551.1	577.8	595.5	623.3	586.9	527.2	552.8	587.2	630.5	574.4
MO3	613.3	641.6	673.3	730.5	664.7	609.4	638.3	684.4	725.5	664.4
Mean	544.9	568.0	589.2	621.3		531.8	553.9	585.2	614.5	
L.S.D.0.05	A : 47.3 B :18.1 AB :NS					A : 63.6 B :6.7 AB :14.9				

(MO) = Mixed minerals ores, (SE) = Seaweed liquid extract

Chemical constituents

Volatile oil percentage

The recorded data in Table (5) show that the main effect of mixed minerals ores fertilizer treatments on volatile oil percentage of dill fruit was statistically significant in both seasons. From the obtained results, it was found that all of them led to a significant increase in volatile oil percentage in comparison with unfertilized control in the two seasons.

Moreover, the maximum values of volatile oil percentage were detected due to fertilizing the plants with mixed minerals ores at the high rate or recommended dose of NPK which increase it by 20.85, 21.09, 18.24 and by 18.85 % over the check treatment in the first and the second seasons, respectively.

According to seaweed liquid extract treatments, data in Table (5) reveal that all of them significantly augmented volatile oil percentage compared to control in the two seasons. It could be concluded that the best results were obtained when addition of dill plants with high concentration of seaweed extract reached 12.81 and 13.80 % over untreated ones in the two experimental seasons, respectively.

Table (5) pointed out that combined effect between mixed minerals ores and NPK fertilizer and seaweed liquid extract treatments on volatile oil percentage was significant in the two growing seasons. It is clear that treating dill plants with mixed minerals ores at the high rate in combination with high concentration of seaweed extract resulted the most effective treatments concerning volatile oil percentage of dill fruit comparing to other combination treatments in the two experimental seasons.

Volatile oil yield / plant and / feddan

The presented data in Table (5) indicate that mixed minerals ores and NPK treatments caused a significant effect on volatile oil yield of dill per plant and per feddan in the two successive seasons. From the obtained results, it seems that all led to a significant increase in volatile oil yield / plant and / feddan compared to untreated control in the two seasons.

Moreover, the data show that receiving the plants the high level of mixed minerals ores produced the highest volatile oil yield ranged 74.74 and 74.14 % over control in the two seasons and yielded 24.76 and 25.25 liter/ feddan oil in comparison with the check treatment (14.17 and 14.50) liter / feddan oil in the first and the second seasons, respectively.

As for seaweed extract treatments, all of them significantly augmented volatile oil yield/ plant and/ feddan in comparison with control ones in the two experimental seasons. It is noticed that the application of high concentration of seaweed liquid extract gave the maximum volatile oil yield / plant and / feddan reached 29.25 and 33.33 % than untreated plants in both seasons and amounted 22.80 and 23.24 liter / feddan oil while, the control gave 17.58 and 17.47 liter/ feddan oil for the two consecutive seasons, respectively, as shown in Table (5).

The interaction between mixed minerals ores and NPK fertilizer and seaweed extract treatments on volatile oil yield / plant and / feddan had significant effect in the second season only. The data in Table (5) reveal that the most effective treatments of volatile oil yield were obtained from treating dill plants with the high level of mixed minerals ores and the high concentration of seaweed liquid extract followed by the recommended dose of NPK with high concentration of seaweed liquid extract as they yielded 29.67 , 28.11. 30.33 and 28.56 liter / feddan oil, respectively, in comparison with the check control (12.83 and 13.22 liter/ feddan) oil in the first and second seasons, respectively.

Table 5: The interaction effect of mixed minerals ores with seaweed liquid extract on volatile oil percentage, volatile oil yield/plant(ml) and volatile oil yield/fed(L) of dill(*Anethum graveolens*, L.) plants during 2013/2014 and 2014/2015 seasons

Mixed minerals ores levels(A)	Seaweed liquid extract concentrations(B)									
	Volatile oil percentage									
	First season					Second season				
	Cont.	SE1	SE2	SE3	Mean	Cont.	SE1	SE2	SE3	Mean
Cont.	2.95	3.04	3.10	3.18	3.07	3.02	3.12	3.14	3.23	3.13
NPK R	3.43	3.52	3.62	3.96	3.63	3.47	3.59	3.68	4.15	3.72
MO1	3.03	3.10	3.21	3.24	3.15	3.07	3.22	3.30	3.35	3.23
MO2	3.13	3.27	3.42	3.58	3.35	3.20	3.33	3.51	3.65	3.42
MO3	3.46	3.60	3.72	4.06	3.71	3.54	3.66	3.77	4.18	3.79
Mean	3.20	3.30	3.41	3.61		3.26	3.38	3.48	3.71	
L.S.D.0.05	A : 0.07 B :0.03 AB : 0.08					A : 0.04 B :0.02 AB :0.04				
	Volatile oil yield/plant(ml)									
Cont.	0.77	0.83	0.88	0.93	0.85	0.79	0.84	0.88	0.96	0.87
NPK R	1.24	1.32	1.43	1.69	1.42	1.23	1.32	1.44	1.71	1.42
MO1	0.95	1.00	1.05	1.10	1.03	0.92	1.00	1.06	1.10	1.02
MO2	1.04	1.13	1.22	1.34	1.18	1.01	1.10	1.23	1.38	1.18
MO3	1.27	1.39	1.50	1.78	1.49	1.29	1.40	1.55	1.82	1.52
Mean	1.06	1.13	1.22	1.37		1.05	1.13	1.23	1.40	
L.S.D.0.05	A :0.10 B : 0.04 AB : 0.10					A : 0.13 B : 0.02 AB :0.04				
	Volatile oil yield/fed(L)									
Cont.	12.83	13.78	14.61	15.44	14.17	13.22	14.06	14.72	16.00	14.50
NPK R	20.72	22.00	23.78	28.11	23.65	20.44	22.00	23.94	28.56	23.74
MO1	15.78	16.67	17.55	18.39	17.10	15.28	16.67	17.67	18.33	16.99
MO2	17.33	18.89	20.33	22.39	19.74	16.83	18.39	20.55	23.00	19.69
MO3	21.22	23.11	25.06	29.67	24.76	21.56	23.33	25.78	30.33	25.25
Mean	17.58	18.89	20.27	22.80		17.47	18.89	20.53	23.24	
L.S.D.0.05	A : 1.62 B : 0.71 AB :1.58					A : 2.10 B : 0.32 AB :0.71				

(MO) = Mixed minerals ores, (SE) = Seaweed liquid extract

Nitrogen, phosphorus and potassium percentages:

The recorded data in Table (6) reveal that nitrogen, phosphorus and potassium percentages of *Anethum graveolens* was significantly affected by mixed minerals ores and NPK treatments in the two experimental seasons. It is obvious that all rates of mixed minerals ores significantly augmented nitrogen, phosphorus and potassium percentages in the two seasons, except MO1 in the first season, MO1 and MO2 in both season concerning N% and MO1 in the two seasons concerning K%. However, the maximum values of the three elements (N, P and K) percentages was obtained due to receiving the plants mixed minerals ores at the high rate in the two seasons. This above rate of mixed minerals ores increased nitrogen percentage by 25.26 and by 22.61

%, also increased phosphorus percentage by 80.26 and by 80.00 % and increased potassium percentage by 9.44 and by 14.10 over untreated ones in the two seasons, respectively.

As for seaweed extract treatments, data in Table (6) shows that nitrogen, phosphorus and potassium percentage of *Anethum graveolens* was significantly affected by these treatments in both seasons. From the obtained results, it could be noticed that all of them significantly augmented the three elements (N, P and K) percentages, except SE1 in the second season concerning N% and SE1 and SE2 in the first one concerning K% . The high concentration seaweed extract gave the best results which the two seasons. This above rate of seaweed extract increased nitrogen percentage by 14.93 and by 14.42 %, also increased phosphorus percentage by 25.00 and by 23.81 % and increased potassium percentage by 7.79 and by 3.83 over untreated ones in the two seasons, respectively.

The interaction effect between mixed minerals ores and NPK treatments and seaweed extract concentrations on the three elements (N, P and K) percentages had significant in the first season concerning nitrogen percentage and the second season concerning potassium percentage . The most effective treatments, detected due to treating *Anethum graveolens* with mixed minerals ores at the high rate and seaweed extract at the high concentration in comparison with other combination treatments, as clearly reveal in Table (6).

Table 6: The interaction effect of mixed minerals ores with seaweed liquid extract on N, P and K percentages of dill(*Anethum graveolens*, L.) plants during 2013/2014 and 2014/2015 seasons

Mixed minerals ores levels (A)	Seaweed liquid extract concentrations(B)									
	N %									
	First season					Second season				
	Cont.	SE1	SE2	SE3	Mean	Cont.	SE1	SE2	SE3	Mean
Cont.	1.70	1.75	2.06	2.08	1.90	1.78	1.84	2.15	2.19	1.99
NPK R	2.15	2.23	2.32	2.42	2.28	2.55	2.35	2.40	2.52	2.46
MO1	2.00	2.03	2.10	2.12	2.06	2.05	2.10	2.15	2.53	2.21
MO2	2.04	2.12	2.28	2.33	2.19	2.14	2.20	2.31	2.38	2.26
MO3	2.17	2.22	2.52	2.60	2.38	2.25	2.33	2.54	2.65	2.44
Mean	2.01	2.07	2.26	2.31		2.15	2.16	2.31	2.46	
L.S.D.0.05	A : 0.23 B :0.06 AB : 0.13					A : 0.30 B :0.15 AB :NS				
	P %									
Cont.	0.12	0.14	0.15	0.19	0.15	0.13	0.14	0.15	0.20	0.15
NPK R	0.24	0.26	0.27	0.28	0.27	0.26	0.27	0.28	0.30	0.28
MO1	0.19	0.21	0.22	0.22	0.21	0.20	0.22	0.23	0.25	0.23
MO2	0.20	0.22	0.23	0.24	0.22	0.21	0.23	0.24	0.26	0.23
MO3	0.24	0.26	0.27	0.29	0.27	0.25	0.26	0.28	0.29	0.27
Mean	0.20	0.22	0.23	0.25		0.21	0.22	0.24	0.26	
L.S.D.0.05	A : 0.05 B :0.01 AB : NS					A : 0.06 B :0.01 AB :NS				
	K %									
Cont.	2.14	2.24	2.27	2.68	2.33	2.17	2.25	2.28	2.36	2.27
NPK R	2.47	2.51	2.56	2.61	2.53	2.53	2.56	2.58	2.61	2.57
MO1	2.21	2.23	2.24	2.26	2.24	2.23	2.25	2.27	2.29	2.26
MO2	2.24	2.25	2.27	2.29	2.26	2.26	2.28	2.29	2.31	2.28
MO3	2.47	2.53	2.58	2.62	2.55	2.54	2.56	2.60	2.64	2.59
Mean	2.31	2.35	2.38	2.49		2.35	2.38	2.41	2.44	
L.S.D.0.05	A :0.11 B :0.10 AB : NS					A : 0.03 B : 0.01 AB :0.02				

(MO) = Mixed minerals ores, (SE) = Seaweed liquid extract

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