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Effect of Bio, Organic and Chemical Fertilization on Growth, Productivity and Oil Consituents of Caraway (*Carum carvi*, L.).

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ABSTRACT

A field trial was carried out during 2013/2014 and 2014/2015 seasons at the Experimental Farm of Faculty of Agriculture, Kafr El- Sheikh University to study the effect of bio, organic and chemical fertilization on growth, seed yield, essential oil and its main components as well as some chemical constituents (N, P and K) of Caraway plants. Compost was applied at the rate of 10 m^3 /fed., during soil preparation. NPK, active dry yeast, seaweed extract, amino acids free and triamin plus were added as folair spray. The common agricultural practices i.e. watering, weed control, etc. were done whenever plants needed and the obtained results could be summarized as follows: Compost in combinations with active dry yeast or amino acids free or triamin plus significantly enhanced both *Caraway* plant growth and productivity of seeds or essential seed oil contents. GCM (gas chromatography) analyses for oil components shown the presence of σ–guaiene, 2,6- dihydroxyacetophenone, hydrocinnamic acid, α – gurjunene, chamigrene and caryophyllene in the seeds volatile oil. All treatments didn't succeed in improving the main components of the volatile oil (carvone) but the plants fertilized with seaweed extract treatment gave high means of most component of the volatile oil.

Keywords: Caraway, fertilization, vegetative growth, seed yield, essential oil.

INTRODUCTION

Nowadays, a great tendency for cultivation of both medicinal and aromatic plants has been shown in Egypt in order to cover the increasing demands for the local industries and as a good source of hard currency.

Caraway (*Carum carvi*, L.) is one of the important aromatic plants belongs to Apiaceae family. The dried fruit (commonly called seeds) contain approximately 1-6% essential oil, with carvone and limonene as the principal components. Caraway seeds contain also lipids (13-21%), nitrogen compounds (25-35%), fiber (13-19%) and water (9-13%) Kocourkova *et al*., (1999). Caraway seed is well-known used in meat, food and distillery industries due to its pleasant flavor and intense taste. Its antibacterial and fungicidal properties are important in pharmaceutical applications and also in human and veterinary medicine Sedlakova *et al*., (1998). Caraway is considered a feedstuff that increases milk production, improves taste and digestibility and reduces flatulence of cattle.

Caraway essential oil is used as a natural inhibitor of sprouting, mainly in stored potatoes as mentioned by Kleinkopf *et al*., (2003). It has also antiseptic, pain sedative, antispasmodic, depletive and antioxidant properties as reported by Dyduch *et al*., (2006) and Sembratowicz and Czech, (2005).

Recently, unusual efforts are used to minimize the amounts of chemical fertilizers practical to medicinal and aromatic plants to obtain safe production besides reducing production costs and environmental pollution without reduction of yield.

Many researchers have reported the nutritional requirements of macronutrients for some plants. They revealed that NPK fertilizers had important physiological and biochemical functions on structure of photosynthetic pigments, metabolism of carbohydrates and protein. These effects were noticed with significant increase in vegetative growth, seed yield and essential oil content of the different plant species. The nutritional requirements of NPK for *Apiaceae* family, in this concern, Nofal *et al*., (2001), Kenawy (2010) and Sabra (2014) on *Ammi visnaga* L., and Milica *et al*., (2015) on Caraway, anise and coriander.

Composts are organic products containing living cells of different types of microorganisms that have an ability to convert nutritionally important elements from unavailable to available form through biological processes and are known to help with expansion of the root system and better seed germination (Vessey, 2003; Ebrahimi *et al*., 2010). Furthermore, compost benefits water absorption and retention by the soil, reducing erosion and run-off and help blinding agricultural chemicals, and defending ground water from contamination (Hussein *et al*., 20o6).

Active dry yeast is a natural safety bio-fertilizer causes various primitive effects on plants. It is considered as a natural source of cytokinins which stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and B-vitamin, as stated by Amer (2004) on *Phaseolus vulgaris* L. It also releases CO2 which reproduced in improving net photosynthesis, as indicated by Kutzman and Fell, (2005). Abdelaziz *et al.,* (2007) reported that plants of *Rosmarinus officinalis,* L. treated with a mixture of compost and microorganisms showed significant increases in total N, P and carbohydrate contents.

Seaweed (*Laminaria saccharina, Fucus vesiculosus* and *Ascophyllum nodosum*) extracts contain alginic acid and its salts were shown as being the main organic compounds accountable for reducing the effect of the metals with mustard plants. It is suggested that alginic acid competes with the plants by ion-exchange for the metals in the extract (Blunden, *et al* 2006).

Amino acids can play wide roles in plants including acting as regulatory and signaling molecules. Amino acids also affect synthesis and activity of some enzymes and gene expression (Rai, 2002). Many studies have reported that foliar application of amino acids caused an increase in the growth and development of plants. Omer *et al*. (2013) reported that foliar spray with amino acids improved the growth and chemical composition of chamomile plant.

Therefore, the objective of this study was to substitute chemical fertilizers by some natural materials to achieve safe Caraway production.

MATERIALS AND METHODS

A field experiment was conducted at the Experimental Farm, Faculty of Agriculture at Kfrelsheikh Univ., during 2013/2014 and 2014/2015 seasons, to study the effect of bio-organic, chemical fertilization and their mixtures on growth, seed yield , essential oil productivity and some chemical constituents of *Carum carvi*, L. plants.

Caraway seeds were supplied from the National Research Center, Dokki, Egypt and sown in a clay soil for two seasons on November 15th in plots 2 × 2m with four rows at 50 cm apart in each plot and 50 cm between the seed hills within the row. One month later, the hills were thinned at two plants/ hill as every plot contained 16 hills / plot and replicated 3 times in a completely randomized block design.

Mechanical and chemical analyses of the experimental soils and compost analysis are presented in Tables (A, B and C).

Table A. Mechanical analysis of the experimental soil:

Parameters	Unit	Season	
Depth 0-20 cm		2013/2014	2014/2015
Coarse sand	%	14.24	13.48
Silt	%	36.65	48.53
Clay	%	50.11	52.11
Textural class	-	Clayey loam	Clayey loam

Table B. Chemical analysis of the experimental soil:

Seasons	pH	ECe	Soluble cations (meq / l)				Soluble Anions (meq / S)			
		(ds \ m)	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	Co_3^{2-}	Hco^{3-}	CL -	So_4^{2-}
2013/2014	8.10	6.16	20.84	9.91	0.28	30.26	-	3.00	50.20	11.09
2014/2015	8.10	7.01	19.15	17.65	0.24	40.32	-	2.25	48.80	26.31

Table C. Chemical analysis of the used compost (average of both seasons).

N	P	K	Ca	Mg	Fe	Zn	Mn	O.M	C/N ratio	pH	EC (ds/m)
		(%)			(ppm)			(%)			
1.47	0.95	1.185	4.63	0.89	4309.35	215.4	461	37.1	15.45:1	7.55	5.35

Fertilization treatments were conducted as follows:

Organic fertilizer (compost) was applied at the rate of 10 m^3 /fed., during soil preparation on November of both seasons. Foliar applications were four equal doses at 30, 45, 60 and 75 days after sowing as follow:

1- NPK (19:19:19) was added at the rate of 1g/l.
2- Active dry yeast (*Saccharomyces cerevisiae*) was added at the rate of 5g per one liter of water (Ahmed, 1998).
3- Seaweed extract was added at the rate of 2ml from the commercial product algreen per one liter of water (recommended dose).
4- Amino acids free were added monthly at the rate of 2g from the commercial product called amino total (40% total amino acids) per one liter of water (recommended dose).
5- Amino acids free + triamin plus (added at the rate of 5ml from the commercial product).
6- Compost + active dry yeast + seaweed extract.
7- Compost + active dry yeast + amino acids free.
8- Compost + active dry yeast + amino acids free + triamin plus.
9- Compost + active dry yeast.
10- Control (untreated plants).

The common agricultural practices i.e. watering, weed control, etc. were done whenever plants needed.

Data recorded.

Complete blooming was occurred in March 1st of both seasons as data of plant height, branchs number/plant and umbel number/plant were recorded. At the end of the experiment (after seeds ripening), data of umbels weight/ plant, weight of 100 seeds, seed yield/ plant and fed; harvest index (the ratio of seed yield / plant to the total above ground according to Ullah *et al*., 2006), herb fresh and dry weight/plant were recorded. Also, chlorophyll a and b were determined in fresh leaves according to Moran (1982). Total nitrogen was determined in dried samples of plant aerial parts (A.O.A.C., 2000). Phosphorus was determined colorimetrically according to Murphy & Riley (1962). Potassium (K+) was determined using Sherwood 410 flame photometer. (Chapman, and pratt. 1961).

Extraction of the essential oil:

The seeds of carawy were hydrodistilled in a Clevenger's type apparatus for 6 h. Yellow colored oil, with characteristic odor and sharp taste, was obtained. It was dried over anhydrous sodium sulphate to eliminate traces of moisture and stored in a refrigerator in the dark at 4 oC until use. Essential oil percentage, yield/ plant and per fed were calculated (European Pharmacopoeia procedure, 1983).

GC–MS analysis of essential oil:

The chemical analysis of carawy essential oil was undertaken by Gas Chromatography–Mass Spectroscopy (GC–MS) techniques in National Research Center, Giza, Egypt according to the methods outlined by Singh *et al*. (2006).

Statistical analysis.

The obtained data in both seasons of the study were exposed to analysis of variance as a complete randomized design with three replicates Duncan's multiple range test was performed for comparing means (Duncan, 1955).

RESULTS AND DISCUSSION

Effect of the used treatments on growth, seeds and oil production and oil consituents of caraway (*Carum carvi*, L.):

a- Effect on growth characters:

Data presented in Table (1) showed that, there were a significant increases in plant height and branch and umbel numers of caraway plant over control in both seasons (Table, 1). NPK, active dry yeast (ADY) treatments gave the tallest plants, wherease,the treatment of C + ADY + AAF+TAP excedded all other treatments in both branch and umbel numbers beside plant dry weight. The other treatments recorded an intermediate values in both seasons.

Table 1. Effect of bio, organic and chemical fertilization treatments on some vegetative growth characters and plant dy weight of *Carum carvi*, L. during the two seasons of 2013/2014 and 2014/2015.

Treatments	Plant height (cm)		Branch No. /plant		Umbels No. /plant		D.W. /plant (g)	
	1st S	2nd S	1st S	2nd S	1st S	2nd S	1st S	2nd S
NPK (19:19:19)	102.2a	100.7a	9bc	9bc	19ab	20ab	59.92d	51.66ef
Active dry yeast (ADY)	101.3a	100.0a	9bc	10bc	17bc	15bc	73.91bc	65.65bc
Seaweed extract (SE)	87.20bc	86.92c	8cd	8cd	14cd	14cd	46.08ef	37.82fg
Amino acids free (AAF)	99.87ab	96.25ab	8cd	8cd	14cd	13cd	77.43b	69.17bc
AAF + triamin plus (TAP)	91.87bc	92.75bc	7cd	7cd	12cd	12cd	41.08fg	32.82g
Compost (C) + ADY+SE	95.67abc	92.92bc	9bc	10bc	15bc	15bc	63.42cd	55.16de
C + ADY+ AAF	85.87c	86.08c	9bc	7cd	16bc	11cd	56.81de	48.55de
C + ADY+ AAF+TAP	98.73abc	92.67bc	18a	16a	25a	20a	88.91a	80.65a
C + ADY	93.60bc	95.25c	11b	12b	14cd	14cd	41.66fg	33.40g
Control	42.00d	66.25d	6d	7cd	9d	12cd	34.00g	25.74g

Means in the same column followed by the same letter are not significantly different according to DMRT at (P > 0.05). S= season

These results are in covenant with those of Kandeel (2004) on Basil , El-Sayed *et al*., (2002) on spearmint and majoran, Niakan *et al*., (2004) on *Mentha piperita*; Mostafa (2006) on chamomile; El-Maadawy (2007) on *Amaranthus* sp, Gomaa and youssef (2007) on fennel and Badran *et al*., (2007) on cumin.

b- Effect on seed measurements:

It was noticed from presented data in Table (2) that, highest seeds yield per plant and per fedan were recorded when the treatments of compost + active dry yeast + amino acids free + triamin plus (C + ADY+ AAF+TAP) and amino acids free (AAF) were used followed by compost + active dry yeast + seaweed extract (C + ADY+SE) applied without significancy among them in both seasons.

The tratment of compost + active dry yeast + amino acids free + triamin plus (C + ADY+ AAF+TAP) recorded the heaviest 100 seeds at all. Likewise, the treatment of compost + active dry yeast + seaweed extract (C + ADY+SE) recorded the highest harvest index percentage. This may be due to that amino acids or active dry yeast affect synthesis and activity of some enzymes and gene expression. These results are in harmony with those of Amer (2004) on *Phaseolus vulgaris*, Blunden, (2006) on black mustard and Omer *et al*.(2013) on chamomile plants.

Table 2. Effect of of bio, organic and chemical fertilization on fruts (seeds) measurments of *Carum carvi,* L. during the two seasons of 2013/2014 and 2014/2015.

Treatments	Seed yield /plant (g)		Seed yield /fed. (kg)		Weight of 100 Seeds (g)		Harvest Index (HI) %	
	1st S	2nd S	1st S	2nd S	1st S	2nd S	1st S	2nd S
NPK (19:19:19)	12.93c	11.66c	297c	268c	1.85b	1.98b	21.77c	22.83c
Active dry yeast (ADY)	16.59bc	15.32bc	382bc	352bc	1.92b	2.04a	22.34c	23.20c
Seaweed extract (SE)	13.16c	11.89c	303c	273c	1.50d	1.63cd	28.92bc	32.16b
Amino acids free (AAF)	23.16a	21.89a	533a	503a	1.59cd	1.72cd	30.03b	31.81b
AAF + triamin plus (TAP)	11.59c	10.32c	267c	237c	1.44d	1.57cd	28.19bc	31.42b
Compost (C) + ADY+SE	21.52ab	20.25ab	495ab	466ab	1.80bc	1.93b	34.08a	36.95a
C + ADY+ AAF	13.33c	12.06c	307c	277c	1.82bc	1.95b	22.93c	24.13c
C + ADY+ AAF+TAP	26.75a	25.48a	615a	586a	2.20a	2.33a	30.02bc	31.51bc
C + ADY	11.83c	10.56c	272c	243c	1.47d	1.60cd	28.83bc	32.39b
Control	13.66c	7.06c	314c	162c	0.95e	1.08d	30.02bc	27.67c

Means in the same column followed by the same letter are not significantly different according to DMRT at (P > 0.05). S= season

c- Effect on content and components of essential oil:

Data presented in Table (3) show that, the treatment of compost + active dry yeast + amino acids free (C + ADY+ AAF) followed by the treatment of amino acids free + triamin plus (AAF + TAP) gave the significantly highest essential oil percentage and yield per plant and per feddan in both seasons as recorded 2.00 - 2.06, 1.6 - 1.65 and 36.8 - 37.95, followed by 1.87 - 1.93, 1.5 - 1.54b and 34.5 - 35.42 in both seasons respectively.

Table 3. Effect of bio, organic and chemical fertilization treatments on essential oil productivity of *Carum carvi,* L. during the two seasons of 2013/2014 and 2014/2015.

Treatments	Essential oil (%)		Essential oil yield /plant (ml)		Essential oil yield /fed (l)	
	1st S	2nd S	1st S	2nd S	1st S	2nd S
NPK (19:19:19)	1.70c	1.50d	1.4d	1.20d	32.2c	27.60d
Active dry yeast (ADY)	1.25e	1.23e	1.0e	0.98e	23.0d	22.54e
Seaweed extract (SE)	1.87b	1.68c	1.5d	1.34c	34.5c	30.82c
Amino acids free (AAF)	1.25e	1.38e	1.0e	1.1d	23.0d	25.30d
AAF + triamin plus (TAP)	1.87b	1.93b	1.5b	1.54b	34.5b	35.42b
Compost (C) + ADY+SE	1.50d	1.65d	1.2d	1.32cd	27.6d	30.36c
C + ADY+ AAF	2.00a	2.06a	1.6a	1.65a	36.8a	37.95a
C + ADY+ AAF+TAP	1.50d	1.40d	1.2d	1.12d	27.6d	25.76d
C + ADY	1.70c	1.53d	1.4d	1.22d	32.2c	28.06d
Control	1.37e	1.23e	1.1e	0.98e	25.3e	22.54e

Means in the same column followed by the same letter are not significantly different according to DMRT at (P > 0.05). S= season

On the contrary, active dry yeast (ADY) and control treatments recorded the absolutely least values without signifant differences in between in both seasons while the other treatments recorded intermediate values in both seasons. These are in agreement with those of (Rai, 2002),

Kutzman and Fell, (2005) and Blunden, (2006) on black mustard.

As for oil components data presented in Table (4) reveal that, the main constituents of caraway essential oil of plants treated with seaweed extract (SE) was σ- guaiene (6.95%) followed by hydrocinnamic acid (3.98%), 2,6-dihydroxyacetophenone (3.9%) and caryophyllene (3.35%), other constituents were less than (3%). However, the main components of essential oil of caraway plants treated with amino acids free + triamin plus (AAF + TAP) was α- gurjunene at a relative percent of 5.08% followed by p-cresol,2,2,- methylenebis (6- tert–butyl) with (3.81%), σ- guaiene (3.59%), and chamigrene (3.41 %).

The main constituents of essential oil plants treated with compost + active dry yeast + amino acids free (C +ADY+AAF) was σ- guaiene (7.63%) followed by caryophyllene (4.79%), M-cresol, 5-ethyl (3.31%) and acoradien (3.02) and the other constituents were less than 3%. The main constituents of essential oil plants treated with compost + active dry yeast + amino acids free + triamin plus (C+ADY+AAF+TAP) was σ- guaiene (4.84%) followed by estragole (4.04%) and α– gurjunene (3.69%), other constituents were less than 3%.

The main constituents essential oil of control plants was σ- guaiene (5.94%) followed by caryophyllene (5.1%), acoradien (4.5%), estragole (3.84%) and α– gurjunene (3.22%), other constituents were less than 3%. Therfore, σ-guaiene was the main component of all stutdied treatment exept for the treatments of amino acids free + triamin plus (AAF +TAP) as the main constituent was α – gurjunene. Foliar spray with seaweed extract, active dry yeast or amino acids improved plant growth and chemical composition according to Blunden, (2006) on black mustard, Abdelaziz *et al.,* (2007) and Omer *et al*., 2013.

Table 4. Effect of bio, organic and chemical fertilization treatments on essential oil consituents of *Carum carvi*, L. during the season of 2014/2015.

Treatments Oil consituents	3	5	7	8	10
2,6- dihydroxyacetophenone	3.90	0.89	1.59	1.38	0.79
Hydrocinnamic acid	3.98	1.96	2.18	1.86	1.13
Sinapyl alcohol	2.80	3.11	2.35	1.84	0.93
β- ocimene	2.70	2.52	1.48	2.09	1.51
Carveol	1.89	3.08	1.32	1.69	0.79
m - cresol ,5 - ethyl-	3.05	1.47	3.31	1.92	2.10
Caryophyllene	3.35	2.78	4.79	4.30	5.10
Terpinolene	1.89	2.33	1.81	2.47	1.65
Acoradien	2.29	1.31	3.02	0.72	4.50
Phellandral	2.21	0.49	1.41	0.88	0.70
σ - guaiene	6.95	3.59	7.63	4.84	5.94
l- pirilladegyde	2.31	-----	1.11	1.20	1.38
3- tgujen - 2- one	1.44	0.84	1.48	1.06	1.45
Estragole	2.15	1.19	0.94	4.04	3.84
Longifolene	2.54	1.82	0.45	1.86	2.02
Chamigrene	2.62	3.41	1.70	2.54	2.21
Resveratol	2.63	3.00	2.19	2.59	2.18
Ledene	2.75	3.28	2.25	2.17	2.56
α - gurjunene	2.72	5.08	2.52	3.69	3.22
p- cresol ,2,2 ,- methylenebis	3.20	3.81	0.44	2.14	2.87

3= SE, 5= AAF + TAP, 7= C + ADY+ AAF, 8= C + ADY+ AAF+TAP, 10= control.

d-Effect on some chemical consituents.

Caraway plants applied with amino acids free recorded the highest percentage of both nitrogen and phosphorus (3.2 and 3.39, 0.47 and 0.48%, respectively), followed by that apllied with compost + active dry yeast (C + ADY) as recorded 3.3 and 3.42% in the first season. Active dry yeast (ADY) gave the absolutely highest potassium means (4.78 and 4.53 in both seasons respectively). These results are coordination with the findings of Kandeel (2004) on basil, Niakan *et al*., (2004) on *Mentha* sp, El-Maadawy (2007) on *Amaranthus tricolor*, and Gomaa and Youssef (2007) on fennel.

Table 5. Effect of bio, organic and chemical fertilization treatments on on some chemical consituents of *Carum carvi*, L. plants during 2013/2014 and 2014/2015 seasons.

Treatments	N (%)		P (%)		K (%)	
	1st S	2nd S	1st S	2nd S	1st S	2nd S
NPK (19:19:19)	2.46	2.58	0.21	0.22	2.10	2.20
Active dry yeast (ADY)	2.53	2.14	0.15	0.13	4.78a	4.53a
Seaweed extract (SE)	2.73	2.84	0.25	0.26	2.33	3.17
Amino acids free (AAF)	3.2a	3.39a	0.47a	0.48a	2.95	2.34
AAF + triamin plus (TAP)	2.53	2.65	0.15	0.16	3.3	4.25
Compost (C) + ADY+SE	3.00b	3.04	0.20	0.21	1.96	2.14
C + ADY+ AAF	2.87	2.87	0.42a	0.43b	3.67b	3.00
C + ADY+ AAF+TAP	2.8	2.92b	0.13	0.14	3.41	3.75b
C + ADY	3.3a	3.42a	0.28b	0.29	2.44	2.63
Control	1.8	1.89	0.10	0.11	1.8	1.68

Means in the same column followed by the same letter are not significantly different according to DMRT at (P > 0.05). S= season

CONCLUSION AND RECOMMENDATION

Compost in combination with seaweed extrac (added at the rate of 2ml from the commercial product algreen per one liter of water (recommended dose)), active dry yeast (added at the rate of 5g per one liter of water) or amino acids (added monthly at the rate of 2g from the commercial product called amino total (40% total amino acids) per one liter of water (recommended dose)), can be a safe substitute to the chemical fertilizers for medicinal plants. It can minimize the amounts of chemical fertilizers besides reducing production costs and environmental pollution without reduction of yield. It can recommended that, compost in combinations with active dry yeast or amino acids free or triamin plus or seaweed extract for obtaining the best growth and productivity Caraway plants.

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تأثير التسميد الحيوي والعضوي والكيماوي علي النمو والانتاجية ومكونات الزيت العطري لنبات الكراوية.

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أجريت تجربة حقلية خلال عامي ٢٠١٤/٢٠١٣ & ٢٠١٥/٢٠١٤ بالمزرعة التجريبية لكلية الزراعة جامعة كفر الشيخ لدراسة تأثير كل من التسميد الحيوي والعضوى و الكيماوي علي النمو ومحصول البذور والزيت العطرى ومكوناته الاساسية وبعض المكونات الكيميائية لنبات الكراوية. تم اضافة الكمبوست اثناء اعداد التربة للزراعة بمعدل ١٠م٣ للفدان. تم اضافة كل من NPK والخميرة ومستخلص الطحالب والاحماض الامينية الحرة رشا على الاوراق. جميع العمليات الزراعية من رى وتنقية الحشائش ...الخ اجريت عند الحاجة وتتلخص أهم النتائج المتحصل عليها فيما يلي: - الجمع بين سماد الكمبوست وكل من الخميرة او الاحماض الامينية او triamin plus حسن معنويا كل من النمو فى نبات الكراوية وانتاجيتها من البذور وايضا محتويات الزيت العطرى.- اظهرت نتائج التحاليل بجهاز (GLC) للزيت الطيار لبذور الكراوية وجود المكونات الآتية: σ– guaiene, 2,6- dihydroxyacetophenone, hydrocinnamic acid, α – gurjunene, chamigrene and caryophyllene كما اظهرت ان جميع المعاملات لم تؤدى إلي ارتفاع فى النسبة المئوية لمكونات الزيت الطيار فى بذور نبات الكراوية ولكن معاملة مستخلص الطحالب البحرية أدت الى زيادة معظم هذه المكونات. - بناء علي نتائج هذه الدراسة فإنه يوصي بتسميد نباتات الكراوية بالمعاملة المختلطة بين التسميد الحيوي (كمبوست (بمعدل ١٠م٣ للفدان) + مستخلص خميرة (بمعدل ٥ جرام/لتر) + triamin plus (بمعدل ٥مل من المنتج التجارى/ لتر) + أحماض امينية (بمعدل 2 جم من المنتج التجارى40% / لتر)) للحصول علي أفضل النتائج وأفضل جودة للنمو الخضري ومحصول البذرة والزيت الطيار والمحتوي الكيماوي لنباتات الكراوية.