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EVALUATION OF DIFFERENT RATES OF NITROGEN AND POTASSIUM AND AZOTOBACTER ON GROWTH, SEEDS, OIL YIELD AND COMPOSITION OF *CARUM CARVI* IN LOAMY SOILS UNDER SALINE CONDITION

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Field experiments were carried out for testing the adaptability of Caraway (*Carum carvi)* irrigated by saline water to be grown in desert loamy soils, evaluating different rates of N and K in the presence or absence of *Azotobacter* and estimating their effect on yield and plant and oil composition. Saline water decreased plant growth and increased Na concentration in plants in general.

Higher rates of N (184kg urea fed^{-1}) and K (150kg potassium sulphate fed^{-1}) in combination with *Azotobacter* proved to be suitable for improving plant growth , seed , and oil yield and composition in such poor fertility soil. Carbohydrates and sugar content were similarly improved by the same treatments. Nine components could be isolated by GLC investigation out of which five components could be identified namely limonene, fenchone, thujone, compher and anethol. Identification of such oil components are useful in evaluating the quality of oil produced, a point that needs further investigation.

Keywords: Salinity, nitrogen, potassium, sodium, *Azotobacter*, Caraway (*Carum carvi*), seed oil, carbohydrate, sugar.

Caraway is a biennial plant that widely cultivated throughout the world and is native to Europe, Asia and North Africa. The ripe fruits or seeds are medicinally beneficial. Caraway belongs to a class of herbs called carminatives, which are plants helpful in easing gastroin testinal discomfort, including gas. The volatile oils derived from this group of plants may help alleviate bowelspasm. There are no human clinical trials on caraway as a single entity.

However, it has been successfully used in combination with enteric-coated peppermint oil in the treatment of irritable bowel syndrome (May *et al.*, 1996; Freise and Kohlev,1999).

Land reclamation in Egypt has been progressing in the last decades. Water scarcity retards using the most promising reclaimable areas in the desert which forces the search for substitutes. Poor quality water may be a solution in some cases. Extra efforts are required to select new crops that can succeed under water stress condition or tolerate harmful hazards of poor quality water. Introduction of medicinal herbs in such areas may serve double purposes. The first is their expected tolerance to water stress and hard condition in the new land and the second is their promising market and increasing demand. One of such crops is caraway which has many usages.

Fertilizer sources and rates always form a controversial issue as they change in accordance with type of soil and its fertility status, crops and their expected level of production, water quality and environmental conditions in general. This work aimed therefore, at testing the adaptability of caraway irrigated with saline water, evaluating the suggested rates of N, K and biofertilizer (*Azotobacter*) and estimating their effect on yield and plant chemical composition.

MATERIALS AND METHODS

A field experiment was carried out in two successive seasons of 1999/2000 and 2000/2001 at Maryout Experimental farm belongs to the Desert Research Center in the western desert of Egypt. Caraway (*Carum carvi*) was used as a task crop in this experiment. In each season seeds were sown in hills 25cm apart on 60cm wide ridges early in October. Plants were thinned to two plants per each hill three weeks after germination. The experimental soil was loamy in texture and high in calcium carbonate content table (1). Drainage water of a salinity fluctuating between 4000 to 5000ppm was used for irrigation due to the scarcity of better quality water in the site. The analysis of the used water for irrigation was given in table (2) . Nitrogen was applied at 92 and 184 kg urea per fedden and potassium sulphate at75 and 150 kg per feddan. *Azotobacter* was applied in combination with each of N and K treatment. Mineral fertilizer was directly applied to the soil in four monthly equal doses starting one month after sowing. All treatments were arranged in a completely randomized block design according to Snedecor and Cochran (1984) . Each treatment was replicated 3 times and each experiment had 42 plots of a net size of 20m^2 each. All recommended practices for this crop in similar nearby areas were adhered to. Harvesting was carried out early in May in each season.

TABLE (1). Soil properties of the experimental site.

EC dS/m in soil paste	pH	Particle size distribution			Texture class	CEC me/100g	$CaCO_3$ %	O.M. %	Available nutrients (ppm)						
		Sand %	Silt %	Clay %					N	P	K	Fe	Mn	Zn	Cu
8.6	7.9	45	22	33	Loamy	13.1	35	0.40	35	8	29	2.5	1.6	1.3	0.5

O.M. = Organic matter

Crop parameters namely plant height, number of branches and plant dry weight were estimated at harvesting time. Yield of seeds and oil contents were also estimated. Total carbohydrate and sugars were determined according to Herbert *et al.*(1971) while oil fractionation was estimated according to British Pharmacopoeia (1963). All plant chemical analysis were carried out on the aerial part of the full matured plants after removing the seeds. Wet ash digestion by a three acid mixture of sulphoric, perochloric and nitric acids was used according to Chapman and Pratt (1961). Fe, Zn, Mn and Na in the digest were determined by atomic absorption spectrophotometer while K by flame photometer. Extractable bases were extracted with N neutral NH_4 OAc in accordance with Juo (1975) for the available nutrients. Available P was extracted by sodium bicarbonate according to Olsen *et al.*(1954). Nitrogen was extracted by 2M potassium chloride extraction according Mulvancy (1996).

TABLE (2). Mean analysis of the irrigation water.

EC dS/m	pH	TDS	Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	SAR
5.6	2.3	35.84	29	190	2200	39	8	117	220	1929	13.7

SAR= Sodium adsorption ratio

Separation Conditions of Essential Oil

Instrument: Gas Liquid chromatography/Pye Unicam Pro-GC.
Column:Ov-17 (Methyl phenyl silicone) Dimensios 1.5×4mm.
Temperature programming:

Initial temp	70°C
Rate	8°C /min
Final temp	200°C
Final time	25 min
Injector	250°C
Detector	300°C

Gases Flow Rate:

N_2	30 ml/min
H_2	33 ml/min
Air	33 ml/min
Chart speed:	0.4 cm/min

RESULTS AND DISCUSSION

Experimental site located at Maryout was loamy in texture (Table 1). Calcium carbonate content of the soil reached 35% by weight. The soil contained low level of nitrogen, phosphorus and iron. Soil contents of manganese, zinc and cupper were considered moderate or adequate for normal growth of field crops.

The only available water for irrigation during the course of these experiments was drainage water. This water contained high concentration of salts fluctuating from 4000 to 5000ppm depending on time of discharge and the flow of water into the drain. Growth parameters, yield of seeds, oil content and plant composition of caraway were affected by all treatments.

Plant Growth

Plant phonological measurements such as plant height, number of branches per plant and dry weight of the aerial parts of the plant were recorded in this study to compare the effects of different treatments.

The first rate of nitrogen (92kg urea) increased plant height from 62cm to 91cm in the first season and from 66cm to 97cm in the second season. The second rate of nitrogen (184kg urea) further increased the plant height to 107cm and 109cm in the first and second seasons, respectively. Number of branches per plant was also increased with the application of N. This may be expected since branches are carried on elongated plant stem in response to nitrogen application. The increases in number of branches were two folds the number of the control by the first rate of N and were further greater with the second one in both seasons. Dry weight of plants followed almost the same trends which explain the relation between plant height, number of branches and dry weight. The improvement in plant growth caused by N is an indication of the role of nitrogen in plant metabolism in general. In addition to the formation of proteins, nitrogen is an integral part of chlorophyll, which is the primary absorber of light energy needed for photosynthesis. Therefore, an adequate supply of N is associated with high photosynthetic activity, vigorous vegetative growth, and a dark green color (Havlin *et al.*, 1999). Improvements of plant growth of caraway by nitrogen application were similarly reported by Aflatuni *et al.* (1993), Pralu *et al.* (2002), Oliveira *et al.* (2003) and Osman and El-Mogy (2005) .

Potassium application increased plant height, number of branches and dry weight of plants. Such increases were more pronounced with the application of the second dose of K (150kg / fed^{-1}). Available K in the soil seemed to be low (29ppm) and less than plant requirement as shown in table (1). However, the response to K was less than that of nitrogen in improving plant growth though the treatment was almost similar. *Azotobacter* effect followed the same trend with each of N and K. The response of plant growth to treatment by N, K and *Azotobacter* seemed to be expected in such soil that lacks adequate supply of essential elements particularly N, P, K and Fe. The poor fertility status of the soil as indicated in table (1) may be responsible for the positive response observed by any nutrient of fertilizer used alone. There was a response for each of N, K and *Azotobacter*.

TABLE (3). Growth parameters as affected by N,K and *Azotobacter* in the two seasons.

Treatments	1999 / 2000			2000 / 2001		
	Control	First rate	Second rate	Control	First rate	Second rate
Plant height (cm)						
N	62	91	107	66	97	109
K	62	75	79	66	78	82
Azotobacter	62	78	78	66	80	80
No. of branches / plant						
N	7	15	21	10	16	22
K	7	11	12	10	13	13
Azotobacter	7	11	11	10	11	11
Dry weight (g/ plant)						
N	10	18	25	11	20	29
K	10	14	17	11	16	18
Azotobacter	10	14	14	11	14	14
LSD(5%)	Plant height		No. of branches/plant		Dry weight (g/plant)	
2000	6.60		1.4		3.6	
2001	6.85		1.73		450	

First rate : N_1 92 kg / fed^{-1} urea, K_1 75kg / fed^{-1} potassium sulphate.
Second rate : N_2 184 kg / fed^{-1} urea, K_2 150kg / fed^{-1} potassium sulphat

However. further investigation on the interaction effect of all treatments may be necessary. The interaction effects of *Azotobacter* with each of nitrogen and potassium were significant as shown in table (4). Plant growth in general was improved when *Azotobacter* was applied in combination with each element (N and K) as reflected on all growth parameters namely plant height, number of branches and dry weight.

TABLE (4). Interaction effect of *Azotobacter* and each of N and K on growth parameters.

Treatment	Plant height /cm			No . of branches / plant			Dry weight (gm / plant)		
	Azotobacter			Azotobacter			Azotobacter		
	1999/2000	2000/2001	Mean	1999/2000	2000/2001	Mean	1999/2000	2000/2001	Mean
Control	61.6	65.5	63.5	7.3	9.6	8.5	10.0	11.3	10.6
N_1	97.0	102.3	99.6	17.6	19.6	18.6	22.6	26.6	24.6
N_2	113.3	115.8	114.5	21.6	22.7	22.1	27.9	29.7	28.8
K_1	80.0	94.6	87.3	15.6	17.3	16.5	17.8	18.9	18.3
K_2	85.6	97.3	91.5	19.3	21.1	20.2	19.2	21.4	20.3
LSD (5%)	6.6	8.8		1.4	1.7		3.6	4.8	

N_1: 92 kg / fed^{-1} urea, N_2 184 kg / fed^{-1} urea,
K_1 75kg / fed^{-1}potassium sulphate, K_2 :150kg / fed^{-1} potassium sulphat

Also, the combination of *Azotobacter* and both nitrogen and potassium improved plant growth as shown in table (5). The improvement in plant growth with the combination of all treatments (*Azotobacter* + N + K) may be due to the role of each of them individually as well as the combined supply of all of them in such a poor soil that lacks enough supply of essential nutrients. Since higher rates of each of nitrogen and potassium gave the highest response, it is therefore improper to consider these rates as the recommended rates for this crop in this soil unless further higher rates are included. However, comparison between the data obtained here with the data in the literature showed that the performance of the plants in term of plant growth could be considered excellent under the higher rates used in these experiments. Therefore it may be possible to consider the higher rates of N and K (184 kg / fed $^{-1}$N and 150 kg / fed^{-1}K per feddan) used in this experiment together with *Azotobacter* suitable rates for improving plant growth of caraway in such soil.

TABLE (5). Interaction effect of N, K and Azotobacter on growth parameters of Caraway.

Treatment	Plant height /cm			No . of branches / plant			Dry weight (gm / plant)		
	Azotobacter			Azotobacter			Azotobacter		
	1999/2000	2000/2001	Mean	1999/2000	2000/2001	Mean	1999/2000	2000/2001	Mean
Control	61.7	65.5	63.6	7.3	9.7	8.5	10.0	11.3	10.7
N_1K_1	116.0	119.0	117.8	24.6	26.3	25.5	28.8	30.9	29.9
N_1K_2	118.3	120.7	119.5	25.7	27.2	26.4	31.3	32.2	31.8
N_2K_1	124.4	128.7	126.5	26.3	27.5	26.9	33.5	35.6	34.5
N_2K_2	134.7	139.1	136.9	28.4	29.6	28.9	36.4	37.8	37.1
LSD(5%)	6.4	8.9		1.6	1.8		3.9	4.9	

N_1: 92 kg / fed^{-1} urea, N_2 184 kg / fed^{-1} urea,
K_1 75kg / fed^{-1}potassium sulphate, K_2 :150kg / fed^{-1} potassium sulphat

Seed Yield and Oil

Seed yield was significantly increased by the application of nitrogen, potassium and *Azotobacter* in the two seasons. The highest seed yield was obtained in response to nitrogen application followed by that of potassium and then azotobacter in descending order. The response of seed yield was more pronounced with the application of higher rates of all treatments. This was expected since seed yield reflect the plant growth condition. The higher the plant growth the greater is the seed yield provided that other factors remain the same.

Seed oil contents ranged from 1.5 % to 2.5%. This range was very narrow and the differences appeared in table (6) may not reflect significant changes. This agreed with Guenther (1972). However, it was noticed that higher oil content accompanied application of nitrogen. Venskutonis *et al.* (1999) showed that higher nitrogen rates increased seeds yield from 984 to 2673 kg /ha and oil percentage from 1.9 to 4.3 in the seeds.

TABLE (6). Seed and oil yield as affected by N, K and Azotobacter in the two seasons.

Tretments	1999 / 2000				2000 / 2001			
	Control	first rate	second rate	Mean	Control	first rate	Second rate	Mean
Yield of seeds (kg / fed.)								
N	165.30	268.50	308.50	247.43	188.30	295.60	338.80	274.33
K	165.30	211.20	228.35	201.62	188.30	228.35	250.50	222.83
Azotobacter	165.30	206.50	206.50	192.77	188.30	214.80	214.80	205.97
Seed oil content (%)								
N	1.40	2.00	2.10	1.83	1.50	2.50	2.40	2.13
K	1.40	1.60	1.70	1.57	1.50	2.00	1.90	1.80
Azotobacter	1.40	1.50	1.50	1.47	1.50	1.60	1.60	1.57
Oil yield (litre/fed^{-1})								
N	2.31	5.37	6.48	4.72	2.82	6.80	8.47	6.03
K	2.31	3.38	4.09	3.26	2.82	4.11	5.01	3.98
Azotobacter	2.31	3.09	3.09	2.83	2.82	3.43	3.43	3.23
LSD (5%)								
Yield of seed	36.7				42.5			
Oil content	0.1				0.2			
Oil yield	2.1				2.8			

First rate : N_1: 92 kg / fed^{-1} urea, Second rate : N_2: 184 kg / fed^{-1} urea,
K_1: 75kg / fed^{-1} potassium sulphate, K_2:150kg / fed^{-1} potassium sulphat

Oil yield as a multiple of seed yield by oil percentage in the seeds followed almost the same trend as shown in table (6). Combination of nitrogen, potassium and *Azotobacter* as shown in tables (7 and 8) caused significant improvement in seed yield though inconsistent. Oil content did not change much suggesting that oil content of seeds may depend mainly on genetic character of the plant rather than on the fertility status of the soil or the type of fertilizer applied to the soil.

TABLE (7). Combination effect of *Azotobacter* and each of N and K on seed parameters in the two seasons .

Treatments	Yield of seed(kg / fed) Azotobacter			Oil content % Azotobacter			Oil yield(L/fed) Azotobacter		
	1999/2000	2000/2001	Mean	1999/2000	2000/2001	Mean	1999/2000	2000/2001	Mean
Control	165.30	188.30	176.80	1.40	1.50	1.45	2.31	2.82	2.56
N_1	350.50	365.80	358.15	2.10	2.30	2.20	7.63	8.41	7.89
N_2	402.70	410.20	406.45	2.30	2.40	2.35	8.86	9.85	9.36
K_1	309.60	330.50	320.05	2.00	2.20	2.10	6.19	7.27	6.73
K_2	325.10	345.10	335.10	2.10	2.20	2.15	6.82	7.94	7.38
LSD(5%)	28.80	32.50		0.16	0.19		1.20	1.50	

N_1: 92 kg / fed^{-1} urea, N_2 184 kg / fed^{-1} urea,
K_1 75kg / fed^{-1}potassium sulphate, K_2 :150kg / fed^{-1} potassium sulphat

The large increase in seed oil yield recorded in the different combinations of fertilizers used was a reflection to the increase in the seed yield obtained when combination of higher rate of nitrogen and potassium with *Azotobacter* was used . This was followed by the combination of N (184g N/ fed) and K (75g K per fed) when *Azotobacter* was used. Similar results were reported by Munshi *et al.* (1990) and El-Gamal *et al.* (1983)

TABLE (8). Combination effect of *Azotobacter* N and K on seed parameters in the two seasons.

Treatments	Yield of seed (kg / fed) Azotobacter			Oil content (%) Azotobacter			Oil yield (L/fed) Azotobacter		
	1999/2000	2000/2001	Mean	1999/2000	2000/2001	Mean	1999/2000	2000/2001	Mean
Control	165.30	188.30	176.80	1.40	1.50	1.45	2.31	2.82	2.56
N_1K_1	335.50	350.10	342.85	2.40	2.70	2.55	8.05	9.46	8.76
N_1K_2	360.30	383.40	371.85	2.60	2.80	2.70	9.37	10.74	10.06
N_2K_1	388.60	397.80	393.20	3.10	3.30	3.20	12.05	13.13	12.59
N_2K_2	412.80	425.50	418.85	3.50	3.60	3.55	14.43	15.32	14.88
LSD(5%)	36.20	42.50		0.20	0.40		2.09	2.30	

N_1: 92 kg / fed^{-1} urea, N_2 184 kg / fed^{-1} urea,
K_1 75kg / fed^{-1}potassium sulphate, K_2 :150kg / fed^{-1} potassium sulphat

In conclusion, seed yield increased significantly with the application of higher rates of N (184kg), K (150kg) and *Azotobacter* whether applied individually or in combination. The latter condition provided higher improvement though inconsistent. Oil content of seeds showed little inconsistent changes. However oil yield improved as a result of improvement in the seed yield rather than a result to oil content.

Nutrient Content of Plants

Plants content of the most pertinent nutrients as affected by combined application of nitrogen, potassium and *Azotobacter* were reported in table (9). These contents were determined on full aerial parts of the full matured plants at harvesting time. Nitrogen content increased from 1.08% in the control to 2.95% in the combined treatment of *Azotobacter* and higher rates of N and K (184kg N and 150kg K /fed^{-1}) in the first year. It was clear that all the combined treatments increased plant nitrogen content which supported the hypothesis that soil content of N was not sufficient to support good plant growth. Similar trend was observed in the second year.

Phosphorus content of plant was improved by the combined treatments from 0.1% in the first season and 0.14% in the second season to as much as 0.5% at most. This improvement seemed, however, limited as plant content of P could reach more than that. The limited improvement of the plant P content may in part be due to the low level of available P in the soil or on the other on the limited effect of the treatments used in releasing enough quantities of the complex phosphorus in the soil. Higher rates of calcium carbonate in the soil may also be responsible for reducing the effectiveness of the applied nutrients in releasing more phosphorus. However, plant content of P reached to the threshold of being adequate for normal plant growth as a result of the combined treatments as shown in table (9). Treatment with P dissolving bacteria could possibly help in obtaining better result.

TABLE (9). Interaction effect of treatments on plant chemical composition in 1999/2000 and 2000/2001 seasons.

Treatments	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
	N%		P%		K%		Na%		Fe(ppm)		Zn(ppm)		Mn(ppm)	
Control	1.1	1.2	0.1	0.1	1.8	2	5.4	5.5	123	125	105	110	5.0	9.5
$Az+N_1+K_1$	2.5	2.4	0.3	0.3	3.5	3.4	8.7	8.7	151	152	175	169	13.0	12.6
$Az+N_1+K_2$	2.5	2.8	0.3	0.4	3.8	3.8	9.8	8.8	155	156	177	182	13.7	14.0
$Az+N_2+K_1$	2.7	2.6	0.3	0.4	3.7	3.7	8.7	8.8	151	153	173	180	13.9	13.5
$Az+N_2+K_2$	2.9	2.8	0.5	0.4	3.9	3.9	10.5	10.3	160	160	190	183	15.0	14.8
LSD(5%)	0.2	0.2	0.01	0.02	0.1	0.2	1.1	1.3	4.1	2.5	16	13	0.4	0.9

Az : *Azotobacter*,
N_1: 92 kg / fed^{-1} urea, N_2: 184 kg / fed^{-1} urea,
K_1: 75kg / fed^{-1} potassium sulphate, K_2 : 150kg / fed^{-1} potassium sulphate

Potassium content of plants was improved much by all combined treatment. Plant content of K increased from 1.9% to as much as above 3% which was considered high enough for normal plant growth. Low level of available K in the oil may be responsible for the higher response recorded for K content by all treatments. The response for K application was more or less similar to that of N.

Plant content of Fe, Zn, and Mn were improved by all the combined treatments. Such improvement was not striking and also the difference between the effect of all treatments seemed to be negligible. The content of the control plots of these elements seemed to be very low and reflect the poor plant growth in general rather than the poor soil supplying power for these elements. The only exception was the soil Fe content that was considered low and thus the response to that element seemed acceptable. Soil analysis for these elements as shown in table (1) revealed that soil content of Zn and Mn could be considered adequate for normal plant growth while that of Fe was inadequate. This was reflected in the result obtained as explained earlier. It could be concluded that application of micronutrients (Fe, Zn, and Mn) to that crop may be recommended particularly when additional application of N,K and *Azotobacter* are added for the improvement of plant growth. These results agreed with those obtained by Ughreja and Chundawat (1992) and Sivakumaran *et al.* (1996) on *Coriandrum stavium* and Migahed *et al.* (2004) on *Apium graveolens* .

Sodium content of plants in the experiment ranged from 5.4%to as much as 10.5% which was considered too high compared with other elements. However this range fell within the wide range given by Havlin *et al.* (1999) of 0.01% to 10% in leaf tissue dry matter of plants .The high rate of Na plant content recorded here may be as a direct result of the high salinity of the used irrigation water. Though changes in Na within all treatments were inconsistent. The inconsistent changes in Na concentration may be attributed partly to the high salinity irrigation water and to the possible indiscriminate uptake of nutrients by plant on the other hand .

Carbohydrates and Sugar Content

As shown in table (10) total carbohydrate content of plants was increased by all combined treatments. Total carbohydrates ranged from 4.2%to 6.5% in the first and second seasons, respectively. These figures increased up to over 12% by the combined treatment of *Azotobacter* and 184kg N and 150kg K per feddan in the two seasons. Other treatments gave also higher concentration that fell within a narrow range of 10.6% to 11.3% irrespective of the applied treatment. This narrow range may imply that carbohydrate content in plants may largely depend on genetic characteristic of plants rather than rates of fertilizers used. However, application of fertilizers encourages the building up of the carbohydrates as a result of successful photosynthesis by healthy vegetative growth. The improvement mentioned earlier in plant growth as a result of different treatments may explain well the improvement on the building up of the carbohydrates in this experiment.

TABLE (10). Interaction effect of treatments on carbohydrates and sugars of plants.

Treatments	Total carbohydrates		Soluble sugars(%)		Insoluble sugars(%)	
	1999/2000	2000/2001	1999/2000	2000/2001	1999/2000	2000/2001
Control	4.2	6.5	1.8	2.0	2.4	4.6
$Az+N_1+K_1$	10.6	10.9	3.0	3.0	7.6	7.9
$Az+N_1+K_2$	11.7	11.9	3.1	3.2	8.6	8.7
$Az+N_2+K_1$	11.2	11.3	3.1	3.1	8.1	8.2
$Az+N_2+K_2$	12.5	12.9	3.5	3.5	9.1	9.4
LSD(5%)	0.8	1.1	0.6	0.8	1.0	1.2

Az : *Azotobacter*.
N_1 : 92 kg / fed^{-1} urea, N_2 : 184 kg / fed^{-1} urea,
K_1 : 75kg / fed^{-1} potassium sulphate, K_2 : 150kg / fed^{-1} potassium sulphate

Concerning soluble and insoluble sugars presented in table (10), it seemed that plant sugar content in general followed nearly the same trend as that of total carbohydrates. This was not unexpected since carbohydrates is the final product of the formed sugars in plants. Sugars is the primary and direct product of photosynthesis that relies on plant growth. Plant growth could be improved by the use of sufficient fertilizer as the situation of the experiment in hand. Similar views were reported by Fiad (1993) for *Carum carvi*, Ibrahem (2000) for Fennel and Migahed and El-kassed (2005) for celery.

GLC Investigation of Oil

Oil mentioned in this investigation was the oil extracted from the plots that received higher rates of N and K in combination with *Azotobacter*. This investigation aimed at identifying the different components of the oil that reflect its value as medicinal crop.

GLC investigation revealed that nine components could be isolated quantitatively. Out of the nine isolated components only five components could be identified namely limonene (29%), frenchone (2%), thujine (1%), carvone (68%) and anethol (0.1%). Different details of retention time, area, height and base for the GLC investigation were recorded in table (11) and fig (1). Venskutonis *et al.* (1999), Srivastava *et al.* (1999) and Nagalakshmi *et al.* (2000) found that percentage concentration of the main caraway compounds limonene and carvone were in the range of 38-52 and 45-78, respectively. Regards the usefulness and uses of caraway and oil components Oosterhaven *et al.* (2000) reported that carvone, a common monoterpene found in caraway inhibits the sprouting of potatoes very efficiently at continuous low head space concentrations. In addition, growth of the plant–pathogenic fungi *Fusarium solani* and *Fusarium sulphureum* was found to be inhibited by S-carvone. Distilled caraway water is a useful remedy in the flatulent colic of infants, and is excellent for children medicines when sweetened their flavor .

TABLE (11). Results of the GLC investigation of the oil Carum curvi

Peak	Name	RT (Min)	Area	Height	Base	(%)
1	Limonene	5.133	3836.482	73.390	3.046	28.750
2	Fenchone	11.650	260.627	8.450	4.220	1.953
3	Thujone	12.417	122.874	8.636	4.323	0.921
4	Carvone	13.633	9030.503	95.512	4.488	67.672
5	Anethole	18.517	16.609	0.053	4.941	0.124
6	Unknown	20.683	23.457	0.532	4.726	0.176
7	Unknown	21.383	5.435	0.244	4.859	0.041
8	Unknown	22.467	27.986	0.593	4.166	0.210
9	Unknown	26.133	20.499	0.429	3.604	0.154

RT: Retention time / minute

Fig (1). GLC analysis of *Carum carvi* essential oil.

REFERENCES

Aflatuni, A.; D. Palevitah; E.D. Putlevsky (1993). The effect of manure composted with drum composter on aromatic plants. *Proceedings International symposium on medicinal and aromatic plants, Tiberias on the sea of Galilee, Israel*, 22-25 Mar, 1993 (Acta Horti., 1993, No. 344: 63-86).

British Pharmacopoeia (1963). In "*Determination of volatile oil in drugs*". The Pharmaceutical Press I, Bloomsberry Square, W.C.I, London.

Chapman, S.R. and P.F. Pratt (1961). In "*Method of analysis for soils, Plants and Waters*" .Univ. of California, 317 pp.

El-Gamal, E.A.; A.M. Mahmoud and F.A. Omar (1983). Effect of some fertilizer treatments on yield and volatile oil content of *Carum carvi* L. *Annals of Agricultural Science, Ain Shams University*, 28 (3): 1605-1614.

Fiad, A.M. (1993). Physiological study on caraway. *M. Sc. thesis*, Fac. Agric., Zagazig University , Egypt.

Freise, J. and S. Kohler (1999). Peppermint oil / caraway oil – fixed combination in non ulcer dyspepsia: equivalent efficacy of the drug combination in an enteric coated or enteric soluble formula. *Pharmazie*, 54: 210-215.

Guenther, E. (1972). In *"The essential oils"*. 4th ed., Puplished by Dven Nostrand Comp. Inc., Toronto, New York, London .

Havlin, J.L.; J.D. Beaton; S. Tisdale and W.L. Nelson (1999). Soil fertility and fertilizers. 6th ed., Pearson Education, 499 pp.

Herbert, D.; P.J. Philipps and R.E.S. Irang (1971). In *"Determination of total carbohydrate"*. Methods in Microbial, 5B, p. 204-234

Ibrahem, Z.T.Z. (2000). Effect of some cultural practices on growth and chemical composition of some medicinal plants under condition of Northern Sinai. *Ph.D. thesis*, Fac. Agric., Kafer El-Sheike, Tanta University, Egypt.

Juo, A.S.R. (1975). In *"Select methods for soil and plant analysis"*. International Institute of Tropical Agriculture, Ibadan, 44 pp.

May, B.; H.D. Kuntz; M. Kieser and S. Kohler (1996). Efficacy of a fixed peppermint oil / caraway oil combination in non – ulcer dyspepsia . *Arzneimittel Forsch*, 46:1149-53.

Migahed, H.A.M.; Amal E. Ahmed and Bouthina F. Abdel Ghany (2004). Effect of different bacterial strains as biofertilizer agents on growth, production and oil of *Apium Graveolens* under calcareous soil. *Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo,* 12 (2): 211 – 225.

Migahed, H.A.M. and F.A. El-kassed (2005). Effect of sources and rates of nitrogen and potassium on celery on saline calcareous soils *Egypt. J. Appl. Sci.*, 20(3): 357- 366.

Mulvancy, R.L. (1996). In *"Methods of soil analysis: Nitrogen- Inorganic forms"*. Part 3, chemical methods. Soil Science Society of America, Book Series No.5, (Sparks, R.L., ed.), Madison, WI, U.S.A., 1123-1184.

Munshi, A.M.; G.H. Zargar; G.H. Baba and G.N. Bhat (1990). Effect of plant density and fertilized levels on the growth and seed yield of Black Zeera under rain-fed conditions. *Indian Cocoa, Arecanut and Spices Journal*, 13(4): 134-136 .

Nagalakshmi, S.; N.B. Shanlearacharya; J.Nalk and W. A. Mchan (2000). Studies on chemical and technological aspects of ajowan (*Trachys permumvammi* L.). *Seeds Journal of Food Science and Technology,* May- June, 2000, 37(3): 277-281.

Oliveira A.P.; A. P.de.S.dePaiva-Sobrinho; J.K.A. Barboso; C.L. Ranalho; A.L.P. Oliveira; A P. Oliveira and S. Sobrinho (2003). Yield of Conriander cultivated with increasing nitrogen levels. *Horticulture Brasileira*, 21(1): 81-83.

Olsen, S.R.; C.V. Cole; F.S. Watanabe and L.A. Dean (1954). In *"Estimation of available phosphorus in soils by extraction with sodium bicarbonate"* .U.S. Dep. Agric., Ciac., 939pp.

Oosterhaven, B.; B. Poolman and E.J. Smid (2000). S-Carvone as a natural potato sprout inhibiting, fungistatic and bacteristatic compound. *Available online 21March 2000.*

Osman, A.A. and E.A.M. El-Mogy (2005). Evaluation of fast and slow. Release nitrogen fertilizers with or without water capture fertilizer (WCF) and N- Fixing bacteria on Coriander plants on a sandy soil . *Egypt . J . Appl. Sci.,* 20 (3): 274-291.

Pralu, T.; P.R. Narwadker; A. K. Sajindranath and N. G. Rathad (2002). Effect of integrated nutrient management on growth and yield of coriander. *South Indian Hortic.*, 2000, 50: (4-6): 680- 684.

Sivakumaran, S.; Hunsigi Gururaj; H . K. Basavaraju; S. Sridhara and G. Hunsigi (1996). Study on nutrientent uptake, seed and oil yield of *Coriander* as influenced by nitrogen, phosphorus and sulphur. *Indian Agric.*, 40 (2): 89-92.

Snedecor, G.W and W.G. Cochran (1984). In *"Statistical methods"*. 6th edition. The lowa State University Press, U.S.A., 607pp.

Srivastava, M.; A. Saxena; Paca Baby (1999). GC –Ms investigation and antimicrobial activity of the essential oil of *Carum* compticum Benth and Hook. *Acta – Alimentaria*, 28(3): 291-295.

Ughreja, P.P and B.S. Chundawat (1992). Nutritional Studies in *Coriander sativum* .Total nutrient uptake. *Gujarat Agric. Univ.Res. Jour.,* 17 (2): 82- 86.

Venskutonis, R.; D. K. Vietkauskaite; E. Bylaite and A. Siuliauskas (1999). Characterization of *Carum carvi* L. cultivated in Lithuanis. *Sodininkyste Darzininkyste*, 18 (3): 85-92.

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تقييم استخدام معدلات مختلفة من النيتروجين والبوتاسيوم والازوتوباكتر علىالنمو والمحصول ومكونات الزيت لنبات الكراويه فى الأراضي الطمييه تحت ظروف الملوحة

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أجريت تجربة حقلية فى محطة بحوث مريوط في موسمين متتاليين لعامي ١٩٩٩/٢٠٠٠ و ٢٠٠٠/٢٠٠١ في تربة طمييه لدراسة مدى نجاح نبات الكراويه في هذه البيئة الصحراوية والذى يروى بمياه مالحة مصدرها مصرف زراعى بالمنطقة لعدم توافر المياه فى هذه المنطقة مع استخدام معدلات مختلفة من النيتروجين والبوتاسيوم في حالة إضافة الازوتوباكتر أو عدم إضافته كمصدر للتسميد البيولوجي على نمو النباتات والمحصول وتركيب النبات ومكونات الزيت . وقد انتهت الدراسة إلى تأثر النباتات بالملوحة الزائدة و زيادة نسبة الصوديوم بالنبات إلا أن هذا التأثر لم يكن بدرجة كبيرة حيث كان نمو النباتات تقارب النمو الطبيعي لهذا الصنف في نفس المنطقة . كما أن استخدام معدل عالي من النيتروجين والبوتاسيوم (١٨٤ كجم يوريا +١٥٠ كجم سلفات بوتاسيوم) وعند الرش بالازوتوباكتر أعطى أفضل نمو خضري وأعلى إنتاج من البذور والزيت مما يشير إلى استجابة النباتات لهذا المعدل من التسميد في ارض تتصف بقلة خصوبتها وانخفاض محتواها من هذه العناصر . كما أن هذه المعاملات كان لها تأثير ايجابي ايضا على محتوى النباتات من الكربوهيدرات والسكريات . وعند استخدام جهاز الكروماتوجرافى امكن فصل تسعة مركبات في الزيت المستخلص كما أمكن التعرف على خمسة منها وتحديد نسبتها المئوية فى الزيت وهى٢٨,٧٥% ليمونين و ١,٩٥% الفينشون و٠,٩٢١% الثياجون و٦٧,٦٧% الكارفون و ٠,١٢% الانيثول. ويعتبر التعرف على مكونات الزيت مفيد فى تقييم الزيت الناتج ومن المعلوم أن مركب الكارفون الأعلى نسبة مئوية في هذا الزيت يستخدم في تثبيط نمو البراعم في البطاطس وكذلك يستخدم كمضادات للفطريات المسببة للأمراض أثناء نمو النبات كما يستخدم محلول بذور الكراوية فى تحلية ادويه الاطفال.