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Effect of Nitrogen and Magnesium Fertilization on the Production of *Trachyspermum ammi* L (Ajowan) Plants under Sinai Conditions

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Abstract: The nitrogen fertilization with ammonium sulphate at 300 or 450 kg/fed. Plus magnesium sulphate fertilization at 25 or 50 kg/fed. in the sandy soil at El-Magara region, middle of Sinai were applied to Trachyspermum ammi L. plant. The effective treatment was 450 kg/fed. nitrogen fertilization plus 25 kg magnesium sulphate fertilization. This treatment increased the vegetative growth and resulted in significant increase in fruit and oil yield comparing to application of 10 m3/fed. chicken or 300 kg/fed. nitrogen fertilization alone or plus magnesium sulphate at 25 or 25 kg/fed. The thymol compound was the highest component in the oil. The oil constituents did not largely affect by the applied treatments. Total nitrogen, phosphorus, potassium and magnesium percentages in the leaves in additional to leaf pigments showed enhanced response to nitrogen and magnesium application.

Key words: *Trachyspermum ammi* L., volatile oil, Thymol, fertilization, nitrogen, magnesium

INTRODUCTION

A jowan fruit (Trachyspermum ammi L) (Carum copticum. Benth and Hook) Fam. Apiaceace (Umbelliferae). is native to Egypt. It is cultivated around the Mediterranean Sea and in south West Asia extending from Iraq to India. In India the essential oil,and the separated thymol is used as medicine, particularly for cholera. Although it grows also in Afghanistan and Egypt, ajowan is produced chiefly in India. Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy. Nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis. Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops. Nitrogen often comes from fertilizer application and from the air (legumes get their N from the atmosphere, water or rainfall contributes very little nitrogen). Few soils have enough natural N available to maintain adequate plants quality and recuperative capacity throughout the growing season. Nitrogen shortages can lead to very slow growth, yellowing (chlorosis) of the leaves, infestation and increased incidence of some diseases. However, over fertilizing with N can lead to excessive shoot and leaf growth, reduced root growth, low plant carbohydrate (food) reserves and increased susceptibility to environmental stresses and some diseases, because it is a mobile nutrient, excess nitrogen can leach through the soil and into the ground water. From there, it is carried to drinking water sources in the form of nitrates, and into lakes and streams where it reduced water quality for aquatic wildlife. Magnesium is an important part of chlorophyll, a critical plant pigment important in photosynthesis. It is important in the production of ATP through its role as an enzyme cofactor. Magnesium deficiency can result in intervenes chlorosis.Magnesium shortage Leaves pale in center, with dead areas close to midrib. Oldest leaves worst affected. Early leaf fall. To correct, apply fertilizer containing magnesium[1-4].

Many investigators confirmed the role of these elements on growth and yield of many plants, Swaefy[5] on *Trachyspermum ammi* L.

As the plants in sandy soil mostly suffer from deficiency of nitrogen and magnesium, this work was conducted aiming to investigate the effect of nitrogen and magnesium on the productivity of *Trachyspermum ammi* L. plants in sandy soil at El-Maghara location, Middle Sinai

MATERIALS AND METHODS

A field experiment was carried out at El-Maghara Research Station Desert Research Center at 100 km South El-Arish City in the Middle of Sinai during the two successive seasons of 2003/2004 and 2004/2005, Seeds were sown on 15 th November directly in rows. The distance between rows was 75 cm and 50 cm between hills. In complete randomized block design containing 6 treatments with three replicates, after two

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Table 1: The chemical properties of Poultry manure.

		Soluble cations meq/L.				Soluble anions meq/L			
pH	E.C mmhos	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
6.96	4.96	6.38	3.47	18.20	20.00	-	1.50	26.48	20.59
Humidity		Ash	O.M	N%		P%		K%	
55%		6%	40%	1.92%		0.88%		1.17%	

Table 2: The chemical properties of soil in ppm (water extract 1:2.5).

		Soluble cations mg/L				Soluble anions mg/L			
pH	E.C mmhos	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
7.70	3.20	114.1	36.77	440	12	0	34.07	728.7	34.07
Total dissolved solids (TDS), mg/L		TOC,%		Total nitrogen, %		Phosphate, µg/L			
1716		12.61		0.42		85.5			

Table 3: Water analysis of the irrigation water

pH	E.C mmhos	Soluble cations mg/L		Soluble anions mg/L					
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
7.5	4.20	188.40	79.79	560	6	0	238.48	923.02	580
Total dissolved solids (TDS), mg/L		TOC,%		Nitrate, mg/L		Phosphate, µg/L			
2456		N.D		N.D		N.D			

** analyzed in the Desert Research Center laboratories

weeks from germination the plants were thinned at two plants per hill.Drip irrigation system was used in this experiment with drippers (4.0 l/h) in the whole period of both seasons for only one hour every two days.

Fertilization treatments: The fertilization treatments included the following:

- Nitrogen: at the rates of 300or 450 kg per feddan of ammonium sulphate (20.5 % N) as N source.
- Magnesium at the rate of 25or 50 kg per feddan of magnesium sulfate (20 % MgO) as Mg source.
- Phosphorus at the rate of 200 kg /feddan calcium super phosphate (16 % P_2O_5) as P source.
- Potassium at the rate of 100 kg per feddan of potassium sulfate (48 % K_2O) as K source.

Fertilization with calcium super phosphate, magnesium sulfate and poultry manure at 10 m3/fed. was conducted immediately before planting in each season in only one dose. As for nitrogen and potassium fertilizers they were applied in five equal doses in the both seasons.The first was added 30 days from appearance of the real leaves then every two weeks.

From December to 15 April, the plants were monthly sprayed with suitable concentration of an aqueous solution of trace elements, using 0.5 ml/l Bio-film as a wetting agent.

The treatments were conducted as follows:

1. poultry manure only) control (F1).
2. 300 kg ammonium sulphate (20.5 % N)+ 0 kg magnesium sulfate/ fed(F2)
3. 300 kg ammonium sulphate (20.5 % N)+ 25 kg magnesium sulfate/ fed (F3)
4. 300 kg ammonium sulphate (20.5 % N)+ 50 kg magnesium sulfate/ fed. (F4)
5. 450 kg ammonium sulphate (20.5 % N)+ 25 kg magnesium sulfate/ fed. (F5)
6. 450 kg ammonium sulphate (20.5 % N)+ 50 kg magnesium sulfate/ fed. (F6)

The analysis of poultry manure, soil and water is shown in Table1,2,3

The plants were harvested at 15th May in both seasons and The following data were recorded:

A. Vegetative Growth Characters:

1. Plant height (cm).
2. Number of branches per plant.
3. fresh and dry weights per plant (g/ plant).

B. Yield Components:

1. Number of umbels per plant
2. Fruits yield per plant (gm/ plant)

C Essential Oil: oil percentage of the fruits was conducted according to British Pharmacopoeia[6].

GC/ Mass analysis of volatile oil of each treatment was performed with specification of the apparatus used according to Robert Adams[7].

D Chemical Analysis:

1. Photosynthentic pigments were extracted by pure acetone according to Fadeel[8].
2. Elements Determination:

Nitrogen content was determined by modified micro kjeldahl method as described by A.O.A.C.[9].

For phosphorus determination, the ammonium molybdate method according to Murphy and Riley [10]. As for potassium and magnesium it was estimated using atomic absorption apparatus according to Cottenie *et al.* [11].

3- Total carbohydrates percentages in the herb at beginning of flowering stage were determined according to Herbert *et al.*[12].

2-3- Statistical Analysis: The complete randomized block design was used in the experiments (6 treatments) with 3 replicates. Every replicate contained 10 hills. The statistical analysis was carried out according to Costat Statistical Software[13]. L.S.D.test was used to compare the means of treatments.

RESULTS AND DISCUSSIONS

Vegetative Characters: Data in Table (4) indicated that all fertilization treatments resulted in significant increase for plant height, number of branches, fresh and dry weight of plant. The highest values of those parameters were obtained with application of ammonium sulphate at 450 kg/ fed. plus magnesium sulphate at 25 kg/fed. Increasing magnesium sulphate to 50 kg/ fed. with the same rate of nitrogen fertilization 450 kg/ fed. was not largely effective, since it resulted insignificant increase for most vegetative parameters. On the contrary raising magnesium fertilization rate to 50 kg/fed. was effective when combined with the low rate of nitrogen fertilization 300 kg/ fed., but did not surpass the treatment of 450 kg/ fed. nitrogen fertilization plus 25 kg/fed. Magnesium fertilization.

Flowering and Yield Characters:

Number of Umbels and Fruit Yield: Data in Table (5) show that the number of umbels and fruit yield/plant resulted in significant increase as nitrogen fertilization applied at 300 kg/fed. plus 25 or 50 kg magnesium fertilization, but increasing magnesium fertilization to 50 kg/fed. with the same rate of nitrogen resulted in more increase in umbels number and fruit yield, this increase reached 34.4 & 36.2 and 130.6 & 124.2% for umbels number and fruit yield/plant, respectively for the two seasons.

Increasing nitrogen fertilization rate to 450 kg/fed. plus magnesium at 25 kg/fed. increased umbels number by 33.0 & 28.5 % than application of the same rate of magnesium combined with 300 kg/fed. nitrogen fertilization

The increase of fruit yield as magnesium fertilization rate increased to 50 kg/fed. combined with 300 kg/fed. nitrogen fertilization were 130.6 & 124.2%, where increasing nitrogen fertilization rate to 450 kg/fed. combined with 25 kg/fed. magnesium sulphate increased the fruit yield by 149.2 and 149.5% during the two seasons, respectively. However increasing magnesium fertilization rate to 50 kg/fed. combined with 450 kg/fed. nitrogen fertilization was not significantly effective in obtaining more increase in fruit yield. So the effective treatment for obtaining high yield of fruits was 450 kg/fed. nitrogen fertilization plus 25 kg/fed. magnesium fertilization.

Oil Percentage and Oil Yield/Plant: Data in Table (5) clear that nitrogen fertilization at 300 kg/fed. plus 25 or 50 kg/fed. magnesium sulphate treatments were not significantly effective in enhancing oil percentage, where the highest rate of nitrogen fertilization 450 kg/fed. plus 25 kg/fed. magnesium fertilization increased it significantly. On the contrary all nitrogen treatments plus magnesium fertilization rates were significantly effective in enhancing oil yield/plant being maximum when 450 kg/fed. nitrogen fertilization plus 25 kg/fed. treatment was applied, this was due to the increase in fruit yield and oil percentage.

Table 4: Effect of nitrogen and magnesium fertilization on plant height, number of branches, fresh and dry weights per plant of *Trachyspermum ammi* L. (ajowan) plants Under Sinai Conditions

	Plant height (cm.)		Number of branches		Fresh weight (gm.)		Dry weight (gm.)	
Treatments	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control F1	50.00	52.50	7.00	7.75	46.25	57.50	9.31	12.07
F2	72.50	71.25	11.75	13.25	67.50	82.50	19.21	22.08
F3	73.75	72.50	13.25	15.00	73.75	81.25	22.36	24.76
F4	91.25	93.75	16.25	17.50	202.50	246.30	30.03	32.89
F5	98.75	101.30	17.25	19.75	222.50	280.00	53.04	55.80
F6	101.30	103.80	18.00	20.50	238.80	277.50	56.11	56.69
L.S.D. at 5%	4.106	3.56	1.12	0.99	13.82	6.26	2.95	1.29

Table 5: Effect of nitrogen and magnesium fertilization on number umbels, fruits yield (gm) /plant, oil percentage and oil yield /plant (ml) of *Trachyspermum ammi* L (ajowan) plants Under Sinai Conditions

	Number of umbels per plant		Fruits yield per plant (gm)		Oil percentage		Oil yield /plant(ml)	
Treatments	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control F1	7.50	9.75	9.31	10.64	5.45	5.42	0.51	0.58
F2	31.75	34.50	20.21	22.01	5.35	5.36	1.08	1.18
F3	37.75	39.50	29.36	30.05	5.37	5.37	1.58	1.62
F4	50.75	57.75	67.72	67.39	5.34	5.34	3.62	3.64
F5	67.50	74.25	73.17	74.99	5.47	5.44	4.01	4.08
F6	70.75	73.50	73.72	76.10	5.21	5.42	3.84	4.13
L.S.D. at 5%	2.72	2.24	5.37	3.99	0.12	0.12	0.31	0.21

Table 6: Effect of nitrogen and magnesium fertilization on oil components of *Trachyspermum ammi* (ajowan) plants under Sinai conditions

Treatments	α - pinene	Y - Terpinene	P - Cymene	Thymol	Others components
Control F1	2.04	19.02	22.11	50.32	6.51
F2	1.98	21.78	22.18	50.21	3.85
F3	1.95	20.56	22.58	50.14	4.77
F4	1.81	20.31	23.32	50.18	4.38
F5	1.83	21.15	23.14	50.07	3.81
F6	1.90	20.23	22.68	50.25	4.94

Table 7: Effect of nitrogen and magnesium fertilization on nitrogen, phosphorus, potassium and magnesium percentage in herb of *Trachyspermum ammi* L (ajowan) plants under Sinai conditions.

	Nitrogen %in herb.)		Phosphorus in herb		Potassium in herb		Tl magnesium in herb	
Treatments	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control F1	0.95	1.02	0.21	0.20	1.12	1.14	0.41	0.45
F2	1.37	1.33	0.25	0.23	2.03	2.06	0.55	0.53
F3	1.40	1.47	0.24	0.31	2.12	2.11	0.64	0.71
F4	1.51	1.52	0.31	0.34	2.22	2.26	0.72	0.74
F5	1.91	1.87	0.30	0.30	2.12	2.15	0.53	0.50
F6	2.55	2.35	0.34	0.34	2.24	2.23	0.75	0.76

Table 8: Effect of nitrogen and magnesium fertilization on chlorophyll A, B, Total Chlorophyll and carotenoids of *Trachyspermum ammi* L (ajowan) plants under Sinai conditions.

	Chlorophyll a (mg / g)		Chlorophyll b (mg / g)		Total Chlorophyll (mg / g)		Total carotenoids (m (mg / g)	
Treatments	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control F1	0.92	1.01	1.08	1.21	2.00	2.22	0.643	0.640
F2	2.17	2.13	1.21	1.30	3.38	3.43	0.667	0.671
F3	2.44	2.57	1.64	1.76	4.08	4.33	0.683	0.687
F4	2.71	2.79	1.81	1.78	4.52	4.57	0.721	0.733
F5	2.39	2.27	1.19	1.24	3.58	3.51	0.710	0.715
F6	2.95	2.85	1.81	1.79	4.76	4.64	0.800	0.825

Oil Constituents: Data in Table (6) show that the highest component percentage was thymol followed decently by ρ-cymene, γ-terpinene and ∂-pinene. The applied treatments i.e. nitrogen fertilization plus magnesium fertilization appeared to not largely affect the percentages of those components.

Total Nitrogen, Phosphorus, Potassium Percentages in the Leaves: Data in Table (7) show that all applied nitrogen plus magnesium fertilization rates resulted in increase for total nitrogen, phosphorus, potassium and magnesium percentages in the leaves. The higher nitrogen and magnesium fertilization rates, the higher percentages of those elements in the leaves.

Pigments Content in the Leaves: Data in Table (8) indicate an increase in chlorophyll a, b, total chlorophyll and total carbenoides in the leaves due to all nitrogen and magnesium fertilization.

Discussion: The results of the present work on *Trachsprmum ammi* L. at El-Magara region, middle Sinai in sandy soil indicated that, nitrogen fertilization with ammonium sulphate at 450 kg/fed. plus 25 kg/fed. magnesium sulphate was effective in enhancing the vegetative growth characters, i.e. plant height, number of branches, fresh and dry weight of plant.

This was reflected on enhancing number of umbels, fruit and oil yield/plant. The chemical analysis indicated parallel increase in pigments content in the leaves besides total nitrogen, phosphorus, potassium and magnesium contents. The above mentioned findings are in harmony with Meawad and El-Deeb [14] on anise plant, Abou El-Fadl [15] and Othman[16] on fennel plant,, Helal [17] and Mathur *et al.* [18] on coriander plant. The enhanced growth and yield could be attributed to the need of nitrogen and magnesium fertilization in sandy soil, since it consider poor soil of such minerals due to its high mobility and loss for instance, nitrogen losses through several processes, the loss of nitrogen can be sizable, Leaching is a major problem in humid regions and sandy soils. Because of its negative charge, the NO_3^- ions is not held by negatively charged soil particles and so remain in soil solution and can be leach easily in sandy soils, moreover sandy soils is poor in clay particles which can held the NH_4^+ ions, in addition to the conversion of NH_4^+ to NO_3^- ions by nitrification process. For all these causes sandy soils can be consider poor for its content of nitrogen, and nitrogen fertilization must apply to obtain good yield.

Magnesium exists in the soil in forms much like calcium. It is held by soil particles, and this exchangeable fraction is in equilibrium with the magnesium in the soil. A large percentage of total soil magnesium is in relatively unavailable forms. The unavailable or slowly available magnesium is in minerals as mica and dolomite and is released only as these minerals weather by the action of soil water which contains carbonic acid. Magnesium in the soil is depleted more quickly than either calcium or potassium, and sandy soils are more likely to be deficient in magnesium than finer-texured soils with greater cation exchange capacity[19].

The enhanced growth and yield of *Trachsprmum ammi* L. plant in the present work could be attributed to the importance of both nitrogen and magnesium as they participate in chlorophyll building. So, the pigments content in leaves were enhanced, this may reflect in more photosynthesis, moreover magnesium functions in the chloroplasts as an enzyme activator which facilities a wide diversity of reactions, especially in the transfer of energy [19-21], also nitrogen is important for amino acid building and protein synthesis in addition to nucleic acids and enzymes, these all metabolites are needed for plant growth and development [22].

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