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EFFECT OF BIO-, ORGANIC-, AND CHEMICAL FERTILIZATION ON DILL, CORIANDER AND PARSLEY

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The present study was carried out in two successive seasons (1999-2000 and 2000-2001) to investigate the effects of bio-, organic-, and chemical fertilization on *Anethum graveolens* L., *Coriandrum sativum* L., and *Petroselinum sativum* Mill. N, P, and K were added at the rate of 100+100+50 kg/feddan. It was added as one fourth or half of this quantity/feddan. While organic manure, as Farm Yard Manure, was used as $10m^3$/feddan. The used bio-fertilizers were *Bacillus megatherium* (P.D.B.), *Azospirillum lipoferum* and *Azotobacter chroococcum.* Almost all the applied treatments enhanced the plant growth of the three species in terms of plant height, fresh and dry weight**s**, leaf area, and leaf/shoot ratio. However, the treatment with $10m^3$ of FYM plus bio-fertilizers proved to be the best one in this regard. With respect to the effects of the applied treatments on the chemical composition of the herb, the same treatment was superior in increasing the chlorophyll (a and b), vitamin C, N, P, and K contents of dill and coriander plants. On the other hand, parsley in some cases responded to the applied treatments in a different way.

Keywords: dill, coriander, parsley, Umbelliferae, herb, fertilization.

INTRODUCTION

Bio- and organic fertilizers proved to be efficient and safe for production of healthy food, and avoiding the hazards of chemical fertilizers. The last decade witnessed increasing demand for the organically grown crops, specially medicinal and aromatic plants; ITC Report (1999). Several studies have been carried out to investigate the effects of fertilization regimes on seed production of these plants. However, there is a lack of information regarding the green herb produced under such fertilization regimes, especially the organic and bio-fertilization.

The present study has been carried out to investigate the impact of bio-, organic-, and chemical fertilization on the growth, herb production and chemical composition of *Anethum graveolens*, *Coriandrum sativum* and *Petroselinum sativum*

MATERIALS AND METHODS

Two field experiments were carried out in a clay soil in the Experimental Farm of the Faculty of Agriculture at Kafr El-Sheikh, Tanta University during 1999/2000-2000/2001 seasons to study the effect of some organic manure, bio- and chemical fertilizers applications on the growth and

productivity of *Anethum graveolens* L., *Coriandrum sativum* L. and *Petroselinum sativum* Mill).

The seeds were sown on November 10th and November 5th in the two seasons, respectively. They were sown at 10cm distance on rows of 60cm in between, in plots of $3m^2$ each.

The physiochemical properties of the soil were investigated according to the methods of Hesse (1971), and the results were as follows:

Mechanical properties: sand (12.4%), silt (26.8%), clay (60.9%), the soil had a clay texture.

Chemical analysis: pH (0.8), EC (ds/n) 2.1, organic matter (2.1%), total N(0.8%), total P(6.0 ppm) exchangeable K (0.9 g/100g soil).

Cations (meq/l): Na(15.1), K (1.5) , Ca (3.3) and Mg (1.5).

Anions; (meq/l): HCO3 (4.9), SO4 (2.3), Cl (14.2).

Organic manure (FYM) was added at the rate of $10m^3$/feddan and applied through the soil preparation before planting.

The used chemical fertilizer mixture consisted of ammonium sulphate (20.5% N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) at the rate of 100, 100 and 50 kg/fed., respectively.

The NPK dose was divided in two halves, the first one was added one month after sowing, while the second half was applied one month later.

The used bacterial biofertilizers; (*Bacillus megatherium* (P.D.B.), *Azospirillum lipoferum* and *Azotobacter chroococcum*) were provided from the National Research Center. They were added as soil dressing one month after sowing and that was the date of addition of NPK fertilizers. Application of NPK fertilization was done in the previous day and then immediately followed by irrigation. In the next day the biofertilizers were added as soil dressing.

The conducted treatments were as follows:

Control: No fertilizers were added.

F_1: Organic manure application (FYM + biofertilizer)

F_2: $N_1P_1K_1$ (1/4 the amount of NPK application + biofertilizer)

F_3: $N_2P_2K_2$ (1/2 the amount of NPK application + biofertilizer)

The experimental design was a complete randomized block design with three replicates (plots). The mean values of the treatments were compared by Duncan's Multiple Range test according to Snedecor and Cochran (1980).

The following data were recorded at harvest time:

1. Plant height (cm).
2. Fresh and dry weights of the aerial parts (g/plant)
3. Leaf area (cm^2) of the fifth leaf from top for coriander and parsley.
4. Leaf /shoot ratio for coriander and parsley.
5. Respiration rate (mg CO_2/kg herb/h).

These data were recorded before harvest time on January 5th and 16th in the two seasons respectively for coriander, January 5th and 25th in the two seasons, respectively for dill, and January 5th and February 4th in the two seasons, respectively, for parsley.

For determination of the respiration rate (R.R.), 100g fresh sherb was placed in a desiccator connected to a tube containing 25 ml of 1.0 N KOH. Air free of CO_2 was drown into the desiccator through the KOH for one hour, then KOH

was titrated with 1.0 N HCl using thymol blue indicator. CO_2 production was calculated as mg CO_2/kg herb/h.
Chlorophyll (a and b) content (mg/g fresh weight) was determined in fresh leaves samples of the fifth leaf from top at harvest time, using the method describe by Moran (1982). N, P, and K contents (%) in herb of the three plants were determined at harvest time. Total nitrogen was determined using the microkjeladhl method according to Black (1983). Phosphorus was determined colorimetrically using the method described by Jackson (1967) and potassium was estimated using flame photometer method according to Richards (1954). Vitamin C content was determined according to the methods of A.O.A.C., 1965.

RESULTS AND DISCUSSION

I - Effects of the fertilization treatments on plant growth:
Anethum graveolens:

Data on growth parameters and respiration rate as affected by the applied fertilization treatments are summarized in Table (1). It could be noticed from that data all the applied treatments increased the plant height, and both the fresh and dry weights of dill plant. The F_1 treatment proved to be the most effective one in this regard. In the first season, it gave the values of 28.00cm, 95.46g and 6.79g, respectively, compared with 21.00cm, 83.27g and 2.64g, respectively for the untreated plants. The F_2 and F_3 treatments gave lower values with no significant difference between them. The same took place in the second season.

Regarding the respiration rate, in the first season, the least respiration rate was recorded due to the F_2 treatment (19.35mg Co_2/kg/h), while in the second season it was due to the F_1 treatment (22.83mg Co_2/kg/h). No data were recorded on the leaf area and leaf/shoot ratio due to the very tynee leaves of dill.

Coriandrum sativum:

All the applied treatments increased the plant height, however F_2 only showed significant difference (32.00cm) but not F_1 27.67cm) or F_3 (29.00cm). The same treatment (F_2) also, gave the highest effect on the leaf area (2.77cm^2). Regarding the fresh and dry weights and the leaf/shoot ratio, the F_1 treatment, the recorded values were 117.00g, 8.25g, and 46.50, respectively. That means that this treatment was superior in this regard, although all the treatments used gave variable degrees of effect.
The least respiration rate was recorded as a result of the F_3 treatment (29.92CO_2/kg/h) followed by F_2 and F_1, in all cases the values were higher than the control treatment.

Table 1: Effect of fertilization treatments on vegetative growth and respiration rate of *Anethum graveolens*, *Coriandrum sativum* and *Petroselinum sativum* in the 1999/2000 and 2000/2001 seasons.

Studied parameters	Fertilization treatments							
	First season	Second season						
	Control	F_1	F_2	F_3	Control	F_1	F_2	F_3
Anethum graveolens								
Plant height (cm)	21.00c	28.00a	25.00b	25.33b	26.33b	30.33a	27.33b	28.00ab
Herb fresh weight (g)	83.27c	95.46a	86.49b	85.59b	92.27c	97.22a	95.63b	94.79b
Herb dry weight (g)	2.64c	6.79a	4.93b	4.84b	4.88c	7.36a	6.96b	6.64b
Respiration rate (mg CO_2/kg/h)	39.73b	22.43c	19.35d	63.92a	28.87c	22.83d	62.33a	38.25b
Coriandrum sativum								
Plant height (cm)	27.33b	27.67b	32.00a	29.00b	27.83b	30.33b	35.67a	30.50b
Leaf area (cm^2)	2.30b	2.54ab	2.77a	2.32b	3.80b	4.39ab	4.77a	4.57a
Leaf :shoot ratio	40.50c	46.50a	42.50b	42.27bc	50.18b	55.00a	53.64a	53.94a
Herb fresh weight (g)	40.58d	117.00a	74.69c	101.00b	61.29c	143.13a	82.94b	150.50a
Herb dry weight (g)	4.21d	8.25a	5.60c	6.52b	5.62d	8.82b	6.47c	10.29a
Respiration rate (mg CO_2/kg/h)	31.53bc	53.68a	32.03b	29.92c	30.94b	50.16a	31.08b	27.87c
Petroselinum sativum								
Plant height (cm)	17.00c	20.33a	19.00b	19.33b	19.33c	23.67a	20.00bc	21.00b
Leaf area (cm^2)	2.98c	5.81a	4.67b	4.62b	5.91c	8.16a	6.95b	7.79a
Leaf :shoot ratio	46.80b	53.38a	52.32a	53.30a	54.00b	57.00a	56.00a	54.00b
Herb fresh weight (g)	34.41d	54.70a	44.15b	35.90c	38.04c	60.75a	47.07b	39.28c
Herb dry weight (g)	3.65c	5.79a	4.84b	3.84c	3.82d	6.09a	5.24b	4.46c
Respiration rate (mg CO_2/kg/h)	49.37b	61.05a	15.04d	44.54c	45.83c	83.88a	49.99b	49.83b

Note: Means having the same letter in the column are not significantly different at 5% level according to Duncan's Multiple Range Test.

Control: Zero treatment, F_1 :Organic manure + biofertilizer, F_2: $N_1P_1K_1$ (1/4 dose/fed) + biofertilizer,

F_3: $N_2P_2K_2$ (1/2 dose/fed) + biofertilizer.

Petroselinum sativum:

It is obvious from data in the same Table (1), that F_1 treatment was the most effective one in increasing the plant height (20.33 and 23.67cm) and leaf area (5.81 and 8.16cm^2) in both seasons, respectively, although the other treatments also gave considerable effects.

Regarding to the leaf/shoot ratio, the plant fresh and dry weights, the F_1 treatment continued to be the most effective one (53.38, 54.70g, and 5.79g in the first season, and 57.00, 60.75g and 6.09g in the second season, respectively), followed by F_2 then F_3, without significant difference between the last two. That was true in both seasons. Also, the highest respiration rate was recorded due to the F1 treatment (61.05mgCO2/kg).

It could be concluded that almost all the applied treatments improved the growth parameters of the three species under investigation, in terms of plant height, fresh and dry weights, leaf area and leaf/shoot ratio. Similar results were reported by Hussien (1991) on coriander and dill, Mallanguda *et al*. (1995) on coriander, Hammam (1996) and Gomaa and Abo-Aly (2001) on

anise, El-Sawy (1998) and Nofal *et al*. (2001) on *Ammi visnaga*, and Kandeel *et al*. (2001) on fennel.

The F_1 treatment (10m^3 of organic manure + biofertilizer) was the best treatment in this regard. The superiority of organic manure + bio-fertilizers than the other treatments may be due to the increase in available amounts of N and P from the organic fertilizer. Also, microbiological processes can change the unavailable forms of nutrients into available ones that can be easily assimilated by plants; Salem (1986), Subb Rao (1981) and Alaa El-Din (1982).

Regarding the respiration rate, F_2 was almost the most effective one in decreasing this process followed by F_1. These results are in agreement with those of Harridy and Amara (1998) on roselle and El-Naggar (1998) on tuberose.

II - Effect of the fertilization treatments on the chemical composition of the herb:

1- Anethum graveolens:

Data in Table (2) reveal that all the applied treatments increased the content of both chlorophylls (a and b) in the fresh herb of dill. The F_1 treatment was the best one in this regard, it gave 1.81 and 0.44 mg/g in the first season and 1.97 and 0.50mg/g fresh weight in the second season, respectively.

The same treatment resulted in the highest vitamin C content in the herb followed by F_2 then F_3 with significant difference between the last two treatments. The recorded values were 41.81, 38.93 and 37.31mg/100ml juice, respectively in the first season, while 44.00, 37.50 and 34.50, respectively in the second season.

Regarding to the effect of the applied treatments on the nitrogen content of the herb, only F_1 (4.53%) and F_3 (4.40%) treatments gave significant increase, while F_2 caused a reduction in N content of the herb (3.53%) compared to the control (4.13%) in the first season. The same trend took place in the second season.

In case of phosphorus, the F_1 (1.10%) and F_2 (1.10%) treatments were the most effective ones in increasing the content of this element in the herb, with no significant difference between them, followed by F_3 (0.96%). That was true in both seasons. The three treatments gave the same effect in the same sequence on the potassium content of the herb.

2- Coriandrum sativum:

It could be noticed from data in Table (2), that the highest content of chlorophylls (a and b) was obtained from the F_1 treatment; 2.00 and 0.58mg/g fresh weight in the first season and 2.01 and 0.58mg/g fresh weight in the second season, respectively, while the F_3 treatment did not differ significantly from the control treatment.

All the applied treatments increased the vitamin C content in the herb, but F_1 (56.64mg/100ml juice) and F_3 were the best ones, with no significant difference between them. That applies on the results of both seasons.

Although the applied treatments slightly increased the N content of the herb, however the differences were not significant, but it is worth to mention that F_1 was the best one in this regard (4.40%), compared with 4.07%) for the untreated plants.

All the applied treatments increased the P content of the herb, but F_2 (0.68%) was the highest and F_3 (0.44%) was the least effective with significant differences between them.

Regarding the K content of the herb, all the treatments used showed positive effect but F_1 was the best (4.68%), followed by F_3 (4.46%) then F_2, with variable degrees of significance in the two seasons.

Table 2: Effect of fertilization treatments on the chemical composition of the herb of *Anethum graveolens*, *Coriandrum sativum* and *Petroselinum sativum* in the 1999/2000 and 2000/2001 seasons.

Studied parameters	Fertilization treatments							
	First season				Second season			
	Control	F_1	F_2	F_3	Control	F_1	F_2	F_3
Anethum graveolens								
Chlorophyll a (mg/g F.W.)	1.54c	1.81a	1.70b	1.66b	1.68b	1.97a	1.78b	1.69b
Chlorophyll b (mg/g F.W.)	0.39b	0.44a	0.40b	0.40b	0.41b	0.50a	0.43b	0.43b
Vitamin C (mg/100 ml juice)	35.59d	41.81a	38.93b	37.31c	34.25c	44.00a	37.50b	34.50c
N (% of D.W.)	4.13b	4.53b	3.53c	4.40ab	4.20b	4.73a	3.67c	4.67a
P (% of D.W.)	0.84c	1.10a	1.10a	0.96b	0.89b	1.07a	1.07a	0.92b
K (% of D.W.)	2.88d	3.82a	3.48b	3.19c	2.82c	3.78a	3.49ab	3.18b
Coriandrum sativum								
Chlorophyll a (mg/g F.W.)	1.58c	2.00a	1.89b	1.58c	1.61c	2.01a	1.84b	1.64c
Chlorophyll b (mg/g F.W.)	0.42c	0.58a	0.54b	0.42c	0.42b	0.58a	0.54a	0.40b
Vitamin C (mg/100 ml juice)	35.20c	56.64a	42.18b	56.64a	32.80c	60.48a	43.66b	60.48a
N (% of D.W.)	4.07a	4.40a	4.27a	4.03a	4.20a	4.60a	4.47a	4.53a
P (% of D.W.)	0.40d	0.63b	0.68a	0.44c	0.46c	0.66b	0.70a	0.48c
K (% of D.W.)	3.43c	4.68a	3.68d	4.46b	3.34c	4.54a	3.62b	4.42a
Petroselinum sativum								
Chlorophyll a (mg/g F.W.)	2.18a	1.41c	1.61b	1.62b	2.29a	1.74d	1.78c	1.82b
Chlorophyll b (mg/g F.W.)	0.58a	0.31d	0.39c	0.47b	0.58a	0.50b	0.44c	0.43d
Vitamin C (mg/100 ml juice)	116.80 b	137.07 a	104.80 c	80.80d	112.80 b	141.20 a	111.80 b	89.60c
N (% of D.W.)	3.40b	4.20a	3.80ab	3.53b	4.03a	4.67a	4.20a	4.13a
P (% of D.W.)	0.67a	0.69ab	0.65b	0.68a	0.68ab	0.70a	0.64b	0.69a
K (% of D.W.)	3.34d	3.48c	3.57b	3.81a	3.31c	3.42b	3.49b	3.77a

Note: Means having the same letter in the column are not significantly different at 5% level according to Duncan's Multiple Range Test.

Control: Zero treatment, F_1 :Organic manure + biofertilizer, F_2: $N_1P_1K_1$ (1/4 dose/fed) + biofertilizer, F_3: $N_2P_2K_2$ (1/2 dose/fed) + biofertilizer.

3- Petroselinum sativum:

It is obvious that the applied treatments negatively affected the chlorophyll (a and b) content of this herb, the least reduction was due to F3

treatment. In the first season this treatment gave the values of 1.62 and 0.47mg/g fresh weight for chlorophylls (a and b), respectively, compared with 2.18 and 0.58mg/g fresh weight, respectively for the untreated plants.

Regarding the vitamin C content, only F_1 was able to increase it (137.07mg/g fresh weight) with significant difference over the control (116.80mg/g fresh weight). However, the other two treatments F_2 and F_3 decreased the vitamin C content of the herb, they gave the values of 104.80 and 80.80mg/g fresh weight, respectively in the first season. The results followed the same trend in the second season.

Although all the applied treatments improved the total nitrogen content of the herb, only F_1 (4.20%) showed significant difference in the first season, while in the second season the applied treatments did not differ significantly from the control.

Regarding the effect of the applied treatments on the phosphorus content of the herb, it could be noticed that they failed to improve it, moreover, the F_2 treatment reduced it in the two seasons.

The applied treatments positively affected the K content in the herb, F_3 (3.81%) was the best one followed by F_2 then F_1 with significant differences between them, compared with 3.345 for the control. That was true in both seasons.

With respect to the chemical composition, it is evident that all the applied treatments increased the chlorophyll content. Similar results were achieved by Hammam (1996) and Gomaa and Abo-Aly (2001) on anise. The F_1 treatment was the best one in this regard in case of dill and coriander, however that was reversed in case of parsley. The increase in chlorophyll (a and b) content by using organic manure and bio-fertilizer may be due to availability of Mg element from organic fertilizer. Also, microbiological activity may change the unavailable forms of nutrients into available ones in absence of chemical fertilization, Subb Rao (1981).

The F_1 treatment proved to be the best treatment in increasing the vitamin C content although the other treatments gave slight effects. This positive effect may be due to the increment of biological processes, helping in solubilization of mineral nutrients, synthesis of vitamins, amino acids, auxins and gibberellins, which stimulate growth as well as the vitamins content of the plant juice (Sprenat, 1990).

Application of F_1 treatment led to higher contents of N in tissues of both dill and coriander. Almost the same has been achieved by Rahman *et al.* (1990) on Coriander, Hammam (1996), on anise, and El-Sawy *et al.* (1998) and Ibrahem (2000) and Nofal *et al.* (2001) on *Ammi visnaga* Gad (2001) and Kandeel *et al.* (2001) on *Foeniculum vulgare*. The increment of N content as a result of application of either organic manure and biofertilizer (F_1) or chemical and biofertilizer (F_3), might be due to excesses of N in root zone coming from analyses of the organic fertilizer, fixed N by bacteria or addition of inorganic N. Also, inoculation with nitrifying bacteria may help in the overall management of N_2 in the rhizosphere, Lang and Elliot, (1997).

All the applied treatments increased the P content of dill and coriander. Menesi (1995) on *Ammi majus,* Hammam (1996) and Gomaa and Abo-Aly (2001) on anise, Reddy *et al.* (1998) on coriander, Ibrahem (2000)

and Gad (2001) on *Foeniculum vulgare*. The increment of P% in plant tissues as a result of these treatments may be due to increasing the available P in the root zone, which turns in P uptake (Burger *et al.,* 1997).

Potassium content in the plant tissues was improved as a result of all the fertilization treatments used, however F1 remained the best on in case of both dill and coriander. Similar results were obtained Menesi (1995) on *Ammi majus,* El-Sawy *et al.* (1998), Ibrahem (2000) and Nofal *et al.* (2001) on *Ammi visnaga,* Gad (2001) on *Foeniculum vulgare* and Gomaa and Abo-Aly (2001) on anise plants.

It could be concluded that fertilization of dill and coriander with $10m^3$/feddan of poultry manure plus bio-fertilizers significantly improved the growth and yield parameters of these two species in comparison with the unfertilized plants or those received mineral fertilization. That treatment not only increased the dry herb yield but also improved its chemical composition in terms of chlorophyll, vitamin C, N, P, and K contents. On the other hand, the third species in this study, i.e., parsely responded to the applied treatments sometimes in another way.

Although $10m^3$ of poultry manure are more expensive than the chemical fertilizers used in this experiment however, the increased herb yield may compensate that difference. Most important in this regard is that the organically grown herbs are preferable for export for higher prices than the conventionally produced herbs. They are also increasingly demanded in the local market.

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تـاثير بعـض معـاملات التسـميد الحيـوى والعضـوى والمعـدنى علـى نباتـات الشـبت والكزبرة والبقدونس

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أجريت هذه الدراسة خلال موسمى نمو متتاليين لدراسة تاثير بعض معاملات التسميد الحيوى والعضوى والمعدنى على نباتات الشبت والكزبرة والبقدونس. حيث تم خلط الأسمدة الأزوتية والفوسفاتية والبوتاسية بمعدل ١٠٠+١٠٠+٥٠ كجم/فدان واستخدمت بمعدلين هما ربع او نصف تلك الكمية للفدان بينما استخدم سماد المزرعة العضوى بمعدل ١٠م^{٣} /فدان اما الأسمدة الحيوية فقد تكونت من انواع البكتريا الآتية:

Bacillus megatherium (P.D.B.), *Azospirillum lipoferum* and *zotobacter chroococcum*

وقد اوضحت النتائج ان معظم المعاملات المستخدمة قد حسنت نمو النباتات الثلاثة متمثلا فى ارتفاع النبات, الوزن الطازج والجاف للنبات, المساحة الورقيةونسبة الأوراق للسيقان. الا ان المعاملة المكونة من ١٠م^{٣} سماد مزرعة مضافا اليه الأسمدة الحيوية كانت هى الأفضل من حيث تاثيرها على تلك القياسات. اما من حيث التركيب الكيميائى للعشب فقد كانت نفس هذه المعاملة هى الأفضل من حيث زيادة محتوى العشب من الكلوروفيلات, فيتامين ج, النتروجين, الفوسفور, البوتاسيوم فى نباتات الشبت والكزبرة. لكن لوحظ ان بنات البقدونس فيسلك فى بعض الحالات سلوكا مخالفا من حيث استجابته لتلك المعاملات.