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Effect of Organic Manure on Growth, Production and Active Ingredients in Dragonhead (*Dracocephalum moldavica* L.)

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ABSTRACT

Two field experiments were carried out during two successive seasons to study the response of *Dracocephalum moldavica* L. to different levels of two organic fertilizers (compost and farmyard manure FYM) at 240, 480 and 720 kg N/ha. Compost levels had more pronounced effect on growth characters than those obtained as a result of using farmyard fertilizer. The maximum mean values of growth characters were obtained from fertilization with compost at 240 kg N/ha. Moreover, essential oil percentage and yield were greatly influenced by the application of organic fertilizers. The highest values of essential oil (%) were recorded from applying FYM at 240 kg N/ha in the 1st season and compost at 480 or 720 kg N/ha in the second one. Compost at 240 kg N/ha gave the highest mean values of essential oil yield (ml/plant or L/ha). The concentration of N, P and K (%) in different plant tissues showed a remarkable increase with different levels of organic fertilizers. Compost levels were effective on total carbohydrate content (%) compared with FYM levels. The lowest levels of both fertilizers produced the maximum accumulation of total soluble sugars in different organs of plants. Generally photosynthetic pigments were not significantly affected by application of different levels of compost or FYM.

Keywords: compost, farmyard, essential oil yield
Abbreviations: Chl, chlorophyll; **FYM**, farmyard manure

INTRODUCTION

The Moldavian dragonhead (*Dracocephalum moldavica* L., Family Lamiaceae), is an annual plant native to Central Asia and naturalized in Eastern and Central Europe where it is widely used in folk medicine as an antiseptic and stimulant as well as for gastro-intestinal problems, cardiac inadequacy and as a sedative (Budantsev and Shavarda 1987; Kakasy *et al*. 2002). Moldavian dragonhead has two major antioxidant constituents, rosmaric acid and apigenin, discovered by Povilaityte *et al*. (2001).

Dragonhead plants have branching, woody stems form erect and compact bushes or gray green leaves and long, leafy spikes of violet blue flowers resembling salvias and catmints.

Compost fertilizer is safe for human health and the environment. Compost supplementations supply the soil with different plant nutrients, mainly nitrogen in addition to a break down to its mineral matter. Compost can be used to improve soil structure, making soil easier to be cultivated and encouraging the root system to develop (Allison 1973). Several investigators revealed that applied organic compost fertilizers to the soil caused marked promotion to different growth characters and chemical constituents of various medicinal and aromatic plants such as Khalil and El-Sherbeny (2003), on three *Mentha* spp., El-Sherbeny *et al*. (2005) on *Siderites montana* and Hussein *et al*. (2006) on *D. moldavica*.

Farmyard manure (FYM) is an organic fertilizer which is applied as a natural source of nutrients to plants substituting chemical fertilizer; FYM also improves soil health by increasing soil organic matter and promoting beneficial organisms. Aly (2002) studied the effect of three levels (6, 12 and 18 t/fed) of FYM or in combination with various rates of NPK (60, 40 and 20%) on fennel (*Foeniculum vulgare* L.) plants, 18 t/fed FYM as an alternative to mineral fertilizer produced high values of seed production, chemical constituents, macro- and micronutrients and essential oils. The same author (Aly 2003) studied the influence of FYM alone or combined with NPK on *Coriandrum sativum* and reported that the use of FYM at 60 t/fed combined with 60% of recommended NPK produced the highest growth, oil seed yield and highest quality of fruit chemical constituents. However, Corrêa Júnior *et al.* (1999) reported that organic fertilizers such as FYM or green manure (plant cocktail) and inorganic fertilizers such as urea or ammonium sulphate had no significant effect on the yield of the heads flowering and the essential oil content of *Chamomilla recutita*.

Rao (2001) found that application of FYM at 15 t/ha per year to *Cymbopogon martinii* increased the total biomass yield by 10.7% and total essential oil yield by 10.3% over control (no application of FYM).

Recently, dragonhead plants have been cultivated under Egyptian conditions so it is necessary to study the suitable agricultural conditions such as cultivars, sowing date and density as well as organic fertilization to obtain the highest plant production with the highest active constituents.

MATERIALS AND METHODS

Two field experiments were carried out at The Experimental Farm of the National Research Centre at Shalakan, Kalubia Governorate in 2003/2004 and 2004/2005 (from November 17th until 30th May) to study the response of *D. moldavica* plant to different levels of two organic fertilizer types (compost and farmyard).

The experimental soil was analyzed according to Jackson (1985) to reveal that the texture of soil was clay loamy with EC (0.68-0.89 m.mohs/cm), pH (8.12-8.05), available N (0.12-0.14%), P (2.11-3.05 mg/100 g), exchangeable K (20.5-23.4 mg/100 g).

Compost fertilizer, produced by Green Valley for Organic Products to Co., S.A.E (chemical analysis is shown in **Table 1**), and

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Table 1 Some physical and chemical properties of the organic compost.

Characters	pH	EC (m.mohs)	Total (N %)	Organic matter (%)	Ash (%)	C/N ratio	P (%)	K (%)
(%)	7.50	4.5	0.6	38.45	22	19.8	0.5:0.75	1.75:1.25

Table 2 Some physical and chemical properties of the farmyard manure.

Characters	pH	EC (m.mohs)	Total (N %)	Organic matter (%)	Ash (%)	C/N ratio	P (%)	K (%)
(%)	7.85	5.23	0.3	33.5	46.50	18.45	0.56	0.51

Table 3 Vegetative growth characters of dragonhead plants as affect by compost and FYM fertilization during 2003/2004 – 2004/2005 seasons.

Dry weight (g/m^2)				Fresh weight (g/m^2)				Number of branches/plant	Plant height (cm)	Treatments
Whole plant	Roots	Stems	Leaves	Whole plant	Roots	Stems	Leaves			
First season										
45.95	5.5	20.1	20.35	113.5	10.85	49.85	52.79	22.1	63.15	Cont.
119.7	13.5	50.6	55.55	272.4	22.8	112.5	137.1	26.05	77.00	Comp.240
102.9	12.25	44.8	45.9	229.2	21.55	99.6	108.1	23.3	71.95	Comp.480
96.55	10.9	41.3	44.35	217.2	19.5	93.75	103.9	22.2	69.35	Comp.720
100.7	13.65	38.6	48.45	222.6	22.05	90.1	110.4	24.75	73.10	FYM.240
68.6	7.15	26.7	34.75	175.1	12.65	75.8	86.68	20.65	66.80	FYM.480
61.2	6.6	27.25	27.35	156.4	11.7	72.25	72.45	20.3	64.60	FYM.720
8.56	2.56	4.57	4.30	27.6	3.42	10.1	12.0	1.11	2.51	LSD at 5%
Second season										
51.90	5.700	22.70	23.50	135.5	12.30	60.70	62.5	20.25	64.15	Cont.
130.7	14.05	54.95	61.70	292.7	22.95	121.7	148.1	26.35	81.55	Comp.240
108.8	12.45	47.50	48.80	252.4	21.55	112.6	118.3	24.00	76.55	Comp.480
103.2	11.35	45.35	46.45	239.4	20.00	105.9	113. 5	22.25	70.75	Comp.720
99.5	12.95	39.10	47.45	222.8	20.30	92.25	110.3	24.65	73.8	FYM.240
82.05	8.55	33.35	40.15	185.2	13.50	82.65	89.05	22.70	71.4	FYM.480
72.50	7.1	32.25	33.15	183.9	13.45	92.60	77.85	21.45	67.8	FYM.720
8.21	3.53	4.10	5.11	26	4.97	12.1	15.3	0.93	1.44	LSD at 5%

farmyard manure (FYM; physical and chemical properties are shown in **Table 2**) were used. Organic fertilizers (compost or FYM) were added at three levels (240, 480, 720 kg N/ha) during soil preparation before sowing. The seeds were sown for all treatments at November 17th.

D. moldavica seeds were obtained from the conservator Jardin Botanique De-Nancy, France. The seeds were sown directly in the field in a plot of 32 m^2 (4 × 8), including 12 rows with three replicates and inter-plant spacing of 40 cm. The levels of both organic fertilizer levels used were 240, 480, 720 kg N/ha along with the control treatment.

At the full flowering stage (30th May) in both seasons, four plants were chosen randomly from each replicate and the following characters were recorded: plant height (cm), number of branches/plant, fresh weight of herbage (g/plant) and dry weight of herbage (g/plant). Samples of fresh herb from each treatment were separately subjected to water distillation for 2 hrs according to the A.O.A.C. (1990) to determine essential oil percentage. The essential oil yield (ml/plant) was calculated for each replicate.

Photosynthetic pigments, chlorophyll (Chl) *a*, *b* and total carotenoids were estimated in the fresh leaves according to the A.O.A.C. (1990). Total carbohydrate content (%) and total soluble sugars in dried leaves, stems and roots, were determined according to Dubois *et al*. (1956). Mineral content in the dried leaves, stems and roots, determined including total N, using the modified method of Kjeldahl as described by Horneck and Miller (1998), P and K (%) according to Hucker and Catroux (1980) and Cottenie *et al*. (1982), respectively.

Statistical analysis

All recorded data were subjected to analysis of variance procedures and treatment means were compared using L.S.D at 5% described by Snedecor and Cochran (1980).

RESULTS

Vegetative growth characters

Compost levels had a more pronounced effect on growth characters than those obtained as from farmyard fertilizer as shown in **Table 3**. The maximum mean values of growth characters (plant height, number of branches/plant, fresh and dry weight of different parts/plant) were obtained from application of compost at 240 kg N/ha followed by 480 kg N/ha in most characters or FYM at 240 kg N/ha in the other characters.

Both types of organic fertilizers at various levels promoted different growth characters significantly in both seasons (**Table 3**). Tallest plants were recorded with application of the lower compost level (240 kg N/ha). The increment in plant height as a result of compost or FYM at 240 kg N/ha above the control in both seasons was 21.93 and 15.75% in the 2003/2004 season, and 27.12 and 15.43% in 2004/2005 season, respectively. It is clear that compost fertilizer at the two levels (240 and 480 kg N/ha) significantly increased the number of branches compared with the control in the first season. The lowest level of FYM markedly increased the number of leaves/plant in the first season, while the other two levels resulted in a significant decrease. In the second season all applied FYM amounts insignificantly increased the number of branches. Fresh and dry weights of plant herbage revealed, in general, a significant response in both seasons with various levels applied either from compost or FYM. The lowest level (240 kg N/h) was the most favorable for both organic fertilizers. Compost fertilizer was more effective in improving the different growth parameters than FYM. The increment caused by compost at 240 kg N/ha for the whole plant at the first and second season reached 140 and 116.0% more than the control, while the corresponding increment by FYM reached 90.9 and 64.4% more than the control for both seasons, respectively.

Essential oil content (%) and yield

Data shown in **Table 4** indicates that oil percentage and yield (ml/plant) of dragonhead were significantly influenced by the application of organic fertilizers (compost or FYM). The highest values of essential oil percentage (0.048% for the 1st and 0.067% for 2nd season), were recorded from applying compost at 480 Kg N/ha for the 1st season and compost at 720 Kg N/ha in the second one. However, the positive effect of organic fertilizers may be due to stimulation of the synthesis of the oil through the physiological processes

Table 4 Essential oil content (%) and yield (L/ha) of dragonhead plants as influenced by organic fertilizers during 2003/2004 - 2004/2005 seasons.

Second season			First season			Treatments
Oil yield (L/ha)	Oil yield (ml/plant)	Oil % (v/w)	Oil yield (L/ha)	Oil yield (ml/plant)	Oil % (v/w)	
4.52	0.083	0.029	3.29	0.068	0.032	Cont.
9.91	0.205	0.057	7.92	0.173	0.057	Comp.240
7.68	0.158	0.066	7.92	0.150	0.048	Comp.480
6.45	0.133	0.067	6.17	0.133	0.033	Comp.720
6.03	0.117	0.050	8.45	0.133	0.067	FYM.240
6.24	0.133	0.050	4.83	0.100	0.050	FYM.480
6.72	0.150	0.050	5.01	0.100	0.050	FYM.720
0.90	0.028	0.0033	0.73	0.30	0.013	LSD at 5%

Table 5 Nutrients content of dragonhead plants as affected by compost and FYM fertilization during 2004/2005.

Treatments	N%			P%			K%		
	Leaves	Stems	Roots	Leaves	Stems	Roots	Leaves	Stems	Root
Cont.	2.02	2.04	0.74	0.74	0.89	1.99	2.78	2.78	2.88
Comp.240	2.74	2.54	1.46	1.46	1.19	3.67	4.16	4.16	4.03
Comp.480	2.49	2.37	1.33	1.33	1.58	3.67	3.77	3.77	3.82
Comp.720	2.33	2.34	1.49	1.49	1.34	3.54	3.55	3.55	2.99
FYM.240	2.47	2.42	1.13	1.13	1.12	3.87	4.19	4.19	3.52
FYM.480	2.36	2.56	1.68	1.68	1.10	3.37	3.23	3.23	3.24
FYM.720	2.23	2.25	0.74	0.74	0.89	3.65	3.39	3.39	3.73
LSD at 5%	N.s	0.22	0.12	0.12	0.16	0.44	0.16	0.16	0.46

of biochemical synthesis.

Concerning the effect of organic fertilizer levels on essential oil yield (ml/ plant or L/ha), it was generally found that the maximum mean values of oil yield were obtained as a result of applying compost at 240 kg N/ha during both seasons.

Chemical constituents

1. Nutrient content

Data presented in **Table 5** clearly reveals that the percentages of N, P and K were affected by different organic fertilizer treatments compared with the untreated plants.

This effect varied with the type and rate of fertilizer, and plant organ. The concentration of N, P and K recorded a remarkable increase with different levels of organic fertilizers (compost or FYM) treatments compared with some exceptions obtained as a result of fertilizer treatments on P content (%) in roots.

The maximum mean values of N content were observed as a result of using compost at 240 kg N/ha for both leaves and roots, while farmyard at 480 kg N/ha resulted in the greatest increase in N (%) for stems.

Concerning the effect of organic fertilizers on P content (%), it was found that FYM at 240 kg N/ha and compost at 480 kg N/ha gave the highest P content (%) in the leaves and stems, respectively. On the other hand, fertilizer treatments had a negative effect on P content for roots.

In the case of K content (%), a significant increase in its content as a result of different levels of organic fertilizer were obtained with FYM at 480 kg N/ha, the treatment which gave the highest mean P content (%) for leaves. Application of compost at 240 kg N/ha resulted in the highest mean P content (%) for stems and roots tissue.

2. Total Carbohydrates content (%)

Date presented in **Table 6** shows that compost added to the soil at various levels caused significant accumulation of carbohydrates (%) in the leaves and stems while the opposite trend was true for roots. The highest mean values for carbohydrate contents were obtained with 240 kg N/ha, which reached 19.0 and 25.1% more than the control for leaves and stems, respectively. Similarly, the lowest FYM level (240 kg N/ha) promoted the highest significant increase in carbohydrate content in the leaves and stems, while the two other levels (480 and 729 kg N/ha) showed a general significant increase for all organs. The maximum carbohydrate increment produced by FYM fertilizer reached a 20.4 and 19.3% increase over the control for the leaves and stems, respectively.

3. Total soluble sugar content

As shown in **Table 6**, the application of various levels of compost and FYM significantly improved the accumulation of total soluble sugars in the leaves, stems and roots of dragonhead plants with one exception (720 kg N/ha (in stem)).

The lowest levels of both fertilizers produced the maximum accumulation of TSS in different plant organs, where the increases (above the control) recorded by compost at 240 kg N/ha reached 80.0, 40.4 and 60.7% while these values for FYM reached 61.3, 27.3 and 42.6% over the control treatment for leaves, stems and roots, respectively. From these data it was evident that compost fertilizer was more effective in improving the TSS content (%) in dragonhead plants than FYM fertilizer.

Table 6 Percentage carbohydrate, soluble sugar and pigments of dragonhead plants as affected by compost and FYM fertilization during 2004/2005.

Treatments	Carbohydrate %			Soluble sugar %			Pigments %		
	Leaves	Stems	Roots	Leaves	Stems	Roots	Chl. *a*	Chl. *b*	Carotenoids
Cont.	22.58	20.74	20.85	8.00	9.9	6.1	0.066	0.095	0.085
Comp.240	26.89	25.90	21.07	14.4	13.9	9.8	0.094	0.091	0.113
Comp.480	28.13	24.05	18.89	12.1	13.7	8.0	0.089	0.093	0.113
Comp.720	27.23	23.44	19.18	11.6	12.5	7.6	0.082	0.084	0.099
FYM.240	27.17	24.69	22.78	12.9	12.6	8.7	0.076	0.265	0.101
FYM.480	25.35	22.75	17.36	10.7	13.0	7.9	0.066	0.083	0.095
FYM.720	25.49	25.37	19.98	9.7	10.9	7.5	0.049	0.474	0.080
LSD at 5%	3.0	2.1	2.4	1.1	1.2	0.80	0.03	N.S	0.02

4. Photosynthetic pigments

Data illustrated in **Table 6** shows that Chl *a* and/or *b* contents were not significantly affected by the application of different levels of compost or FYM, with one exception being the lowest level of compost (240 kg N/ha) with Chl *a*. For carotenoids content, significant response was recorded with application compost at different levels. Meanwhile, the carotenoid accumulation at various FYM levels was not significantly different.

DISCUSSION

The promotive effect of compost fertilizer on various growth characters may be due to the role of compost in improving soil structure, encouraging root development and providing plant nutrients. Moreover, compost affects water absorption and retention by soil positively and this reduces erosion and run-off and thereby protects surface water from sedimentation and help to bind agriculture chemicals (Master *et al*. 1998). The observed results were supported by those reported by El-Gendy *et al*. (2001) on *Ocimum basilicum* L., who stated that increasing compost rate (from 15 till 45 m^3/fed., where 1 ha = 2.4 fed.) resulted in a significant increases in growth characters per plant i.e. plant height, number of branches, herb fresh and dry weights where the fresh and dry weight of herb increased with 45 m^3/fed. by 48 and 40% compared with 15 m^3/fed. The same results were obtained by Edris *et al*. (2003) on *Origanum morjorana* L., Khalil *et al.* (2002) on *Tagetes erecta*, Ferreira *et al*. (2004) on *Catharnthus roseus* and El-Sherbeny *et al*. (2005) on *Sideritis montana* L.

Similarly, the improvement of growth parameters of dragonhead plants by applying FYM fertilizer may be due to its effect on improving soil texture by increasing soil organic matter and promoting beneficial organisms. These results are in agreement with those mentioned by many authors, e.g. Aly (2002, 2003) on *Coriandrum sativum* L. and *Foeniculum vulgare*, respectively. In addition, Rao (2001) reported that application of FYM at 15 t/ha/year increased the total biomass yield of *Cymbopogon martinii* plants by 10.7% over the control. Similary, Shirole *et al*. (2005) recorded that application at 10 t/ha to *Bacopa monnieri* significantly increased the dry matter, fresh weight and plant height as compared to the application of 5 and 15 t FYM/ha.

The enhancement of essential oil yield as a result of organic fertilizers may be due to increment of essential oil percentage and/or mass production.

Such finding was obtained by El-Sherbeny *et al*. (2005) on *Sideritis montana*, and Naguib *et al*. (2007) on *Tagets erecta*. They found that essential oil percentage and oil yield/plant was significantly increased by application of compost levels that reached maximum values at the highest levels of application (16.5 tons compost /Ha).

It can be concluded that organic materials play an important role in solubilizing and supplying plants with available forms of nutrients. The variations in the effect of different organic materials could be related to the nature of their chemical composition, their degree of decomposition, and their pH, which affects the availability of the nutrients and consequently their behaviors in soil.

The results we obtained for N, P and K were affected by different organic fertilizers treatments compared with the untreated plants and these findings are in agreement with those published by Herrera *et al*. (1997) who examined the effect of compost (0, 15, 30, 45 or 60% in combination with peat on seedling of *Angelica archaugalica*, *Marrubium vulgare* and Thymus vulgaris grown in multicell flats. He found that the mineral N, P, K, Ca and Mg contents increased with increasing percentage of compost in the media.

Generally, compost affected total carbohydrates content (%) more than FYM levels. However, improvement in vegetative growth characters by application of the two organic fertilizers may have resulted in stimulation of the photosynthesis system, which accumulated more carbohydrate content. Similar results were obtained by El-Sherbeny *et al*. (2005) on *Sideritis montana* where compost at the highest level used (16.5 t/fed.) gave the maximum mean values for total carbohydrate content giving 35.5 and 35.4% during the vegetative and flowering stage, respectively and corresponding to 32.8 and 32.4% for the control during same periods.

The improvement of Chl *a* and carotenoid contents with 100 kg N/fed. were previously revealed by Hussein *et al*. (2006) on dragonhead and Khalil *et al*. (2002) on *Tagetes erecta*. They reported that the stimulation in growth characters resulted in improvement of photosynthetic processes that lead to photosynthesis and food reserve.

CONCLUSION

From the aforementioned results and discussion, it may be concluded that the addition of organic fertilizers, especially compost, had a favorable effect on most growth characters and chemical composition of dragonhead plants.

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