Studies on the effect of Selenium and organic residues on Chamomile (*Matricaria chamomilla L.*) plants

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Abstract: A field experiment was carried out at El –Kassasin region Ismailia Governorate over two growing seasons (2007-2008 and 2008-2009) to study the effect of foliar spray of Selenium at the rates of (0, 4,6and8 ppm) and organic material (sheep manure) at three rates (0,10and 20m^3 per feddan) on the morphological growth, essential oil and some chemical composition of Chamomile (*Matricaria chamomilla L.*) plants .Results pointed out that using different rates of organic residue or selenium increased fresh and dry weight of herbs and inflorescences compared with the control treatment in both seasons**.** Also,all treatments tended to increase essential oil , nitrogen, phosphorus and potassium content and uptake as compared with the control treatments**.** The highest value in N, P and K content and uptake was noticed when applied selenium at a rate of 30g with organic residue.Thus,the applications may be recommended for increasing the growth,essential oil and chemical constituents of chamomile (*Matricaria chamomilla*) plant.

[Azza, A.M. Mazher, Sahar, M. Zaghloul and Yassen, A.A. Studies on the effect of Selenium and organic residues on Chamomile (*Matricaria chamomilla L.*) plants. New York Science Journal 2010;3(12):56-63]. (ISSN: 1554-0200).

Keywords: Medicinal plant – heavy metal - sheep manure

1. Introduction

Chamomile (*Matricaria chamomilla L.*) is a member of the family Asteraceae. It is an annual herbaceous plant that flowers from May to August. The original area of distribution was southern and eastern Europe and the Near East. From there, the chamomile has spread through most of Europe and has extended further to Iran, Afghanistan, Pakistan, India, Egypt and East Africa (Reichling and Beiderbeck, 1991). Chamomile is one of the important herbal medicines as it is used for the treatment of many diseases inflammations of the skin, as well as the mucous membranes as well as to bacterial infection of the oral cavity and the gums and diseases of the respiratory tract. Internally, Chamomile extracts and infusions are applied to inflammatory diseases and spasms of the gastrointestinal tract (Carle and Isaac, 1985, Simpson, 2001, McKay and Blumberg 2006 and Koch *et al* 2008

Selenium (Se) is one of the most interesting microelements. It seems that it is not essential for plant growth, although it replaces sulfur in the amino acids. On the other hand, it is important element in human and animal nutrition. In the case of its pronounced deficiency, as well as in the case of its higher concentrations, various diseases in humans and animals often occur (Adriano, 1986 , Wachowicz *et al*. 2001 and Fordyce, 2005) . Foliar application of selenium was shown to be several times more efficient than application in fertilizers Aspila (2005) but riskier as Se uptake by the crop depends on spraying conditions. Curtin *et al.* (2006) also showed that foliar spray gave a high recovery. However, Lyons *et al.* (2004) found that foliar application to be less efficient than application to soil at planting. Selenium supplementation to plants enhance the production and quality of edible plant products, by increasing antioxidant activity of the plants, as shown in tea leaves Xu *et al* (2003) and in rice Xu and Hu (2004). Spraying plants with selenium (Se) solution may enrich the utilizable plant parts with Se compounds in concentrations of nutritional importance (Germ *et al*., 2007, Ozbolt *et al*., 2008and Smrkolj *et al*., 2006).

It is suggested that interaction with general minerals is one of more important factors due to which trace elements affect the plant's metabolism. Presence of heavy metals may induce deficiency of macronutrients and micronutrients necessary for a proper course of principal life processes (Baranowska-Morek 2003and Barbara Hawrylak-Nowak (2008)). Interaction between selenium and a given element depends on quantitative proportions and it may also cause synergistic effects (Pyrzynska 2000). Selenium like heavy metals can modify uptake and accumulation of minerals which are important for metabolism (Kopsell *et al.* 2000, Pazurkiewicz-Kocot *et al*. 2003). Moreover, positive influence of selenium on changes in the activity and permeability

of the cellular membrane has been found, and this may be one of the earliest symptoms of the influence of selenium on plants (Kinraide 2003).

Organic material, such as sheep and chicken manure, improves soil physical properties (structure and aggregation) and soil chemical properties (decrease soil pH, increase cation exchange capacity and enhance most nutrients) that are important for plant growth (Snyman *et al.*, 1998).. Marculescu *et al.* (2002) revealed that the soil, with its content in macro and micro elements enhanced by the use of organic fertilizers, plays an essential role in the plants growing and development, in the biosynthesis of organic substances, also it can be noted that the vegetative mass is rich and the amount of essential oil is high in *Chrysanthemum balsamita L.* plant when using organic fertilizer. Khalid et *al.* (2006b) reported that organic farming increased the vegetative growth, essential oil and mineral content of *Calendula officinalis L*. (marigold) plants. Yassen and Khalid (2009) indicated that all treatments of onion plants (*Allium cepa L*.) with different mixture of farmyard and chicken manure improved the vegetative growth characters, essential oil, some of the main constituents of essential oil and N,P and K contents.

Therefore the present investigation aimed to study the response of Chamomile (*Chamomilla recutita L. Rauschert*) for foliar spray of Selenium and organic material on the morphological growth, essential oil and some chemical composition.

2. Material and Methods

A field experiment was carried out at El – Kassasin region Ismailia Governorate over two growing seasons (2007-2008 and 2008-2009) to study the effect of foliar spray of Selenium and organic material on the vegetative growth, inflorescences yield and oil percentage and chemical composition chamomile plants. Prior to any practices, a composite soil sample was taken from the soil surface (0-30 cm) of the experimental site, air dried, sieved by 2 mm sieve and analyzed (Table 1). The physical and chemical properties of soil were determined according to Chapman and Pratt (1961) and Cottenie *et al* (1982)

Table (1) Some characteristics of the experimental site in two seasons

	Physical properties				Chemical properties						
	Sand	Silt	Clay	Texture	pH	EC dSm^{-1}	$CaCO_3$	OM	N	P	K
	%						%		ppm		
1st season	86.3	8.8	4.8	sandy	8.5	1.3	1.9	0.3	22	9	44
2nd season	88.6	7.9	3.4	sandy	8.3	1.1	2.3	0.5	29	12	56

Chamomile (*Matricaria chamomilla L.*) seeds were kindly provided by the Department of Medicinal and Aromatic Plants, Ministry of Agriculture, Egypt**.**

Seeds were sown on the nursery at October the 1th in two seasons of 2007and2008. Uniform seedlings of about10cm.length were transplanted on November the 1th. The treatments were arranged in randomized complete block design at four replications. The experimental plot was $10.5m^2$ (3.5m long and 3 m in width) with six ridges, 30 cm apart.

Recommended dose of phosphorus fertilizer as superphosphate (15.5% P_2O_5) was fully added to the soil during seed preparation at 50 kg P_2O_5 / feddan and Potassium fertilizer at 50kg K_2O feddan incorporated with soil before sowing.

The organic residue (sheep manure) mixed with 0-20cm soil surface layer before transplanted at the rates of 0, 10 and $20m^3$ per feddan. The analytical data of sheep manure was shown in Table (2) foliar spray of selenium at four rate (0,4,6and 8 ppm) .Four sprays at 3 weeks intervals were used. The first was after 45 days of cultivation

Table (2) Some chemical analysis of sheep manure under study.

	C	N	C/N	OM	P	K
	%				Ppm	
1st season	25.47	2.15	11.47	43.80	23	132
2nd season	25.90	2.22	11.66	44.45	26	148

The experimental treatments can be described as follows:

1- Control
2- Sheep manure at a rate of 10m^3 /feddan.
3- Sheep manure at a rate of 20m^3 /feddan
4- 4 ppm of Se.
5- Sheep manure at a rate of 10m^3 /feddan + 4 ppm of Se.
6- Sheep manure at a rate of 20m^3 /feddan + 4 ppm of Se.
7- 6 ppm of Se.
8- Sheep manure at a rate of 10m^3 /feddan + 6 ppm of Se.
9- Sheep manure at a rate of 20m^3 /feddan + 6 ppm of Se.
10- 8 ppm of Se.
11- Sheep manure at a rate of 10m^3 /feddan+ 8 ppm of Se.
12- Sheep manure at a rate of 20m^3 /feddan + 8 ppm of Se.

The fresh and dry weights of herb / plant at full flowering stage were determined .Also, the fresh and dry weight of inflorescences/ plant. The following chemical analyses on herb were determined nitrogen, phosphorus, and potassium according to the method described by Cottenie *et al* (1982). Collected data was subjected to statistical analysis of variance according to Snedecor and Cochran (1980)

In inflorescences, the essential oil was determined apparatus according to the method described by the British Pharmacopoeia (1963) by using Clavenger (1928) apparatus for determination of essential oil lighter than water. Essential oil yield was determined by multiplying essential oil percentage x average of fresh inflorescences yield /plant.

3. Results and Discussion

Morphological growth:

The different comparison in Table (3), generally, clarified that fresh and dry weight of herbs and inflorescences of chamomile plants was significantly stimulated as a result of application of different rates(10 m^3 and 20m^3) of organic residue (sheep manure) treatments ,compared with the control treatment in both seasons . The highest value was noticed with the high level of organic residue (sheep manure). Similar result was obtained by Khalid et *al.* 2006b and Yassen and Khalid 2009.

Data presented in Table (3) demonstrated that application with selenium at all levels gave an increase in fresh and dry weight in herbs and inflorescences in both seasons as compared with the untreated treatment .These results were reported by Germ *et al*., 2007,Ožbolt *et al*., 2008and Smrkolj *et al*., 2006.

Concerning the influence of the different rates of selenium on fresh and dry weight of herbs and inflorescences results showed that increasing rate of selenium decreased fresh and dry weight in herbs and inflorescences in both seasons .The results achieved by Hartikainen *et al.* (2000)confirmed the fact that selenium interaction with plants depends on its concentration. At lower rates, selenium stimulated growth of ryegrass seedlings, while at high doses it acted as pro-oxidant reducing yields and inducing metabolic disturbances Also, Barbara Hawrylak-Nowak (2008) revealed that disturbances of growth and reduction of plant's biomass at the presence of high selenium concentrations in the nutrient solution may have resulted from the disturbance of mineral balance of plants, namely accumulation of large amounts of phosphorus in shoot tissues on maize.

The interaction between Se and organic residue gave a slight increase in fresh and dry weight in herbs and inflorescences as compared with Se or sheep manure as a sole. This increase may be due to the important role of organic matter on inducing vital process in plants.

Chemical composition

-Essential oil percentage and oil yield / plant:

Data in Figs. (1&2) indicate that organic residue (sheep manure) at 10m^3 and 20 m^3 increased essential oil percentage as comparing to the control in both season .This results are in harmony by Khalid *et al.* (2006b) on *Calendula officinalis L* and Yassen and Khalid (2009)on (*Allium cepa L.*). They found that organic farming increased essential oil.

As far the interaction between foliar spray of selenium and sheep manure on oil percentage the result showed that increasing oil percentage as compared with foliar spray of selenium alone in both season. The highest value was noticed when applied 6 ppm Se with sheep manure followed by 4 ppm Se and 8 ppm Se .

The same trend was noticed with oil yield mg / plant.

Table (3) Effect of sheep manure and foliar spray of selenium on vegetative growth in herbs and inflorescences of chamomile plants in both seasons

treatments		herbs				inflorescences			
		Fresh weight		Dry weight		Fresh weight		Dry weight	
		g/plant							
Se	Sheep manure	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	0	97.44	107.20	26.11	26.80	35.22	38.50	8.16	9.71
	$10m^3$	179.12	185.14	35.11	37.68	56.11	60.67	14.71	15.91
	$20m^3$	196.00	208.07	39.99	40.65	66.33	71.60	15.51	17.76
4ppm	0	128.71	136.11	31.20	33.15	70.92	71.32	15.31	16.78
	$10m^3$	227.80	234.61	40.88	42.44	97.66	101.22	19.62	21.22
	$20m^3$	238.63	250.00	48.30	51.36	109.33	113.17	23.17	25.66
6ppm	0	178.36	188.59	38.92	41.17	89.61	94.07	22.34	21.78
	$10m^3$	263.16	271.06	54.22	56.32	118.00	125.79	28.62	28.90
	$20m^3$	294.51	302.18	68.71	68.89	127.41	135.46	30.19	33.01
8ppm	0	155.75	169.00	34.16	35.63	77.67	83.21	16.83	17.79
	$10m^3$	244.11	250.03	44.27	48.71	107.63	115.39	22.56	25.77
	$20m^3$	262.33	268.79	55.13	58.54	122.51	127.00	25.90	28.38
LSD 0.05									
Se		8.05	10.13	3.73	2.21	4.55	7.67	0.88	0.97
Sh.M		6.67	8.81	2.11	1.57	3.11	5.53	0.65	0.71
Se x Sh.M		10.25	12.61	5.12	3.10	6.53	10.12	1.07	1.14

Se: selenium Sh.M:Sheep manure

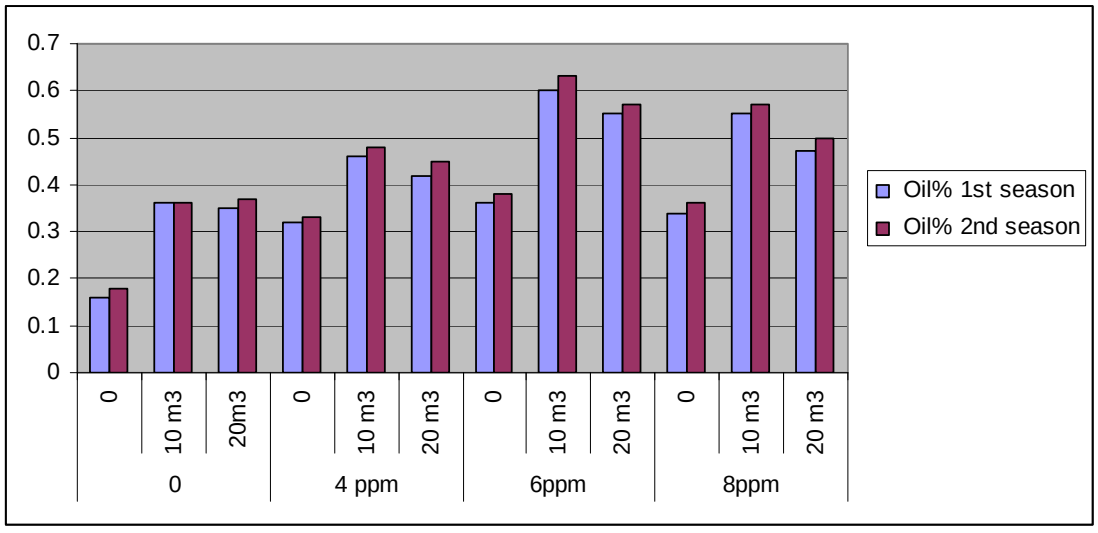

Fig .(1) Effect of foliar spray of selenium and sheep manure on oil percentage (%) of chamomile plants in both seasons

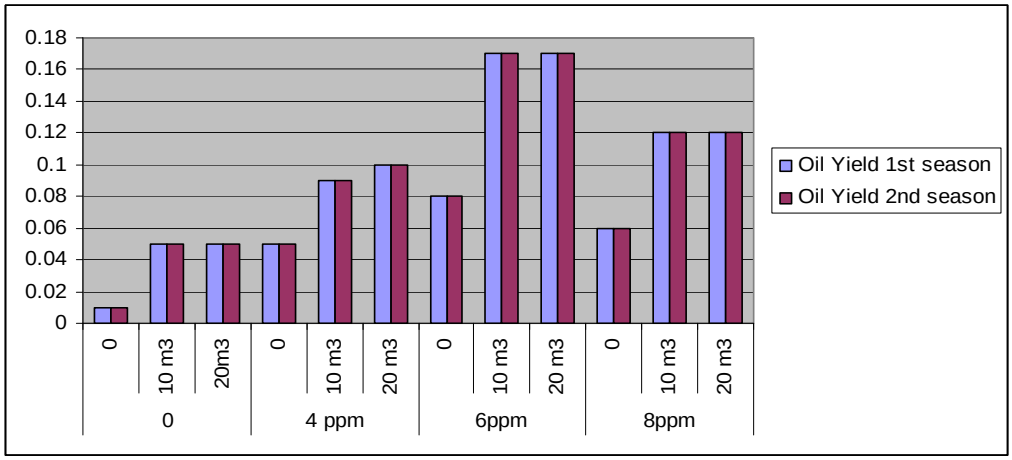

Fig. (2) Effect of foliar spray of selenium and sheep manure on oil yield mg / plant of chamomile plants in both seasons

Nutrient content:

Data presented in Tables (4&5) reported that the effect of sheep manure and selenium on N content and uptake on Chamomile plants .All treatments tended to increase nitrogen ,phosphorus and potassium content and uptake as compared with the control treatments in both seasons . Data also, found that applied of sheep manure at a rate of (10 m^3) without selenium gave significant increase in nitrogen content and uptake in both seasons. The N concentration increased when added sheep manure (10 m^3) and spray selenium fertilizer (4,6and 8 ppm) 39%, 34% and 21% respectively in the first season and 44%, 31% and 37% respectively in the second season.

Data in Tables (4&5) clarified that application of sheep manure at a rate of (10m^3) with selenium at the rate of 6 ppm gave high significant increase in N content followed by sheep manure at the rate of (10m^3) with selenium at the rate of 8 ppm in both seasons . These results are in agreement with Mahendra Singh (1979) who found that N concentration decreased with increasing Se application.

Whereas application of sheep manure at a rate of (20m^3) with selenium at the rate of 6 ppm gave high significant increase N uptake followed by application sheep manure at the rate of (20m^3) with selenium at the rate of 8 ppm. The increase in N uptake my be due to accumulation of dry matter production.

Cocerning P concentration and uptake in Chamomile treated with cheep manure and spray selenium fertilizers data showed that sheep manure at a rate of (20m^3) increased P content and uptake as compared sheep manure at a rate of (10m^3) and control. Regarding the interaction between sheep manure and foliar spray selenium fertilizer data showed that the increase of P content and uptake as compared with sheep manure alone.

Phosphorus in dry matter manifested an increasing content and uptake tendency along with an increase in the selenium concentration. These results are inagreement with Mikkelsen *et al.* (1989) and Barbara Hawrylak-Nowak (2008).who observed that phosphorus content increased in plants cultivated at the presence of selenium.

With regard to K concentration in plant the pronounced increase in K was observed with sheep manure at a rate of (10 and 20m^3) as compared with the control treatment. The interaction between sheep manure and spray selenium with fertilizer data in Table (4) revealed that significant increase in K concentration in both seasons

Positive effects of selenium on potassium accumulation were also noticed by Pazurkiewicz-Kocot et al. (2003), who found that the content of potassium in maize leaves significantly increased when introducing 10 µmol Se dm into the medium, but a contrary dependence was recorded in roots. Kopsell *et al.* (2000) observed that the potassium level in cabbage leaves increased linearly along as the selenium concentration in the medium rose.

Data in Tables (4&5) illustrated that application of selenium increased Se content and uptake in herb compared with organic residue (10and 20m^3) and control treatments. These results are inagreement with Ducsay and lozek (2006)

It is noticeable that the increase of applied Se doses influenced its higher accumulation in plants which is inagreement with Adriano 1986 on chamomile plants .Data also, revealed that

application of Se with high organic residue gave a decrease in Se content and uptake.

Table (4) Effect of sheep manure and foliar spray of selenium fertilizer on N, P and K content on herbs of chamomile plants in both seasons.

		Herbs							
treatments		N%		P %		K%		Se (ppm)	
Se	Sheep manure	1st season	2nd Season	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	0	0.97	0.96	0.31	0.32	1.52	1.66	0.14	0.15
	$10m^3$	1.4	1.37	0.33	0.36	2	2.12	1.22	1.55
	$20m^3$	1.32	1.31	0.39	0.37	2.23	2.35	1.84	2.16
4ppm	0	1.06	1.05	0.37	0.34	1.74	1.9	5.53	5.98
	$10m^3$	1.5	1.44	0.39	0.41	2.34	2.62	8.58	9.1
	$20m^3$	1.36	1.33	0.41	0.46	2.59	2.71	7.92	8.11
6ppm	0	1.24	1.28	0.34	0.35	1.84	1.91	7.44	7.76
	$10m^3$	1.55	1.62	0.44	0.46	2.53	2.66	10.33	11.64
	$20m^3$	1.44	1.5	0.44	0.45	2.67	2.71	9.67	11.09
8ppm	0	1.21	1.19	0.36	0.37	1.99	1.82	9.91	9.32
	$10m^3$	1.49	1.41	0.5	0.52	2.47	2.39	11.11	11.91
	$20m^3$	1.3	1.35	0.52	0.49	2.37	2.55	10.46	10.66
LSD									
Se		0.05	0.06	0.03	0.03	0.08	0.09	0.1	0.17
Sh.M		0.04	0.05	0.02	0.27	0.07	0.48	0.25	0.36
Se x Sh.M		0.09	0.1	0.05	0.53	0.14	0.16	0.63	0.71

Se: selenium Sh.M.: sheep manure

Table (5) Effect of Sheep manure and foliar spray of selenium fertilizers on N, P and K uptake (mg/ plant) on herb of Chamomile in both seasons.

		Herbs							
Treatments		N (mg/plant)		P (mg/plant)		K(mg/plant)		Se (mg/plant)	
Se	Sheep manure	1st season	2nd Season	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	0	259.96	250.66	83.08	83.55	407.36	433.43	3.75	3.92
	$10m^3$	486.07	442.37	124.34	126.4	753.6	744.3	45.97	54.42
	$20m^3$	536.58	423.87	158.54	147.96	906.5	939.77	74.79	86.38
4ppm	0	351.39	327.6	122.66	106.08	578.81	592.8	183.32	186.58
	$10m^3$	636.6	588.67	165.52	167.61	993.1	1071.06	364.14	372.01
	$20m^3$	698.5	642.39	210.58	222.16	1330.22	1308.93	406.77	391.71
6ppm	0	510.51	498.18	139.98	136.22	757.53	743.37	306.31	297.74
	$10m^3$	872.96	878.36	247.81	249.41	1424.9	1442.25	581.79	631.12
	$20m^3$	992.02	1030.65	303.12	309.2	1839.36	1862.04	666.17	761.99
8ppm	0	399.06	406.5	128.27	126,39	709.04	621.71	353.09	318.37
	$10m^3$	725.78	624.21	243.55	230.2	1203.14	1058.05	541.17	527.26
	$20m^3$	761.02	744.26	304.41	270.14	1387.4	1405.82	612.33	587.69
LSD									
Se		15.11	18.12	9.61	10.61	27.31	31.75	9.15	10.13
Sh.M		12.12	15.37	7.31	7.35	21.12	22.31	7.09	7.63
Se x Sh.M		22.35	25.61	13.63	14.65	36.86	39.47	14.11	15.09

Se: selenium Sh.M :Sheep manure

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