

Effect of foliar fertilization with some trace elements on chemical constituents of *Ruta graveolens* L

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Abstract

A field experiment was conducted to study the effect of foliar fertilization with some trace elements (Fe, Mn and Zn) on chemical constituents of *Ruta graveolens* L. plants either alone or in combination of them at concentration of (50 and 100 ppm) on Horticulture experimental farm, Fac. of Agric., Omar El- Mokhtar Univ. El- baida Libya, during 2013/ 2014 and 2014/ 2015. The results indicated that all foliar application treatments caused significant gradual increase in the herb content from Nitrogen, phosphorus, potassium, Iron, zinc, manganese, essential oil and alkaloids percentage as compared with control treatments.

The best treatments was foliar spraying of plants with combination of trace elements (Fe+ Zn +Mn) at concentration (100 ppm) which recorded the highest significant values (2.90, 3.09%) for N, (1.73,1.82%) for P, (5.28,5.30%)for K, (2911.33, 2915.33 ppm.) for Fe, (298.33,299.66ppm)for Mn,(992.33 ,993ppm) for Zn, (0.071,0.075%) for essential oil and (0.042, 0.044%) for alkaloids compared with other treatments included in this study during the two successive seasons respectively.

Key words: *Ruta graveolens* L., Trace elements, foliar spraying, essential oil, alkaloids percentage.

Introduction:

Medicinal and aromatic plants are known to be used by 80% of global population for their medicinaltherapeutic effects as estimated by (WHO, 2008).

Many of these plants synthesize substances that are useful to the maintenance of health in humans, animals and plants. These include aromatic substances, most of which are phenols or their oxygen - substituted derivatives such as tannins. Others contain alkaloids, glycosides, saponins and many secondary metabolites (Lai, 2004).

Rue (*Ruta graveolens* L.) is one of these plants which are native to the Mediterranean region and cultivated in many parts of the world including Libya. Rue's application in herbal therapy was to promote menstruation (Steenkamp, 2003), relieve symptoms of hangover (Chavez, et al., 2003), as contraceptive (Browner, 1985), it is also applied externally as poultice against rheumatic pain (Atta, and Alkofahi A., 1998). Rue's flavonoid content possesses antibacterial activity (Alzoreky and Nakahara, 2003), and antifungal activity (Oliva et al., 2003) moreover (Chiu and Fung, 1997) indicated that rue plants contained cardiovascular active substances that have direct effect on the cardiovascular system, also (Pathak et al., 2003) propose that Ruta in combination with $Ca_3(PO_4)$ could be used for effective treatment of brain cancer particularly glioma. The intensive publications on iron (Fe), manganese (Mn) and zinc (Zn) reflect the important roles of these elements in plant growth and yield of aromatic and medicinal plants. The main functions of Iron (Fe) concern growth, respiration, chlorophyll synthesis and photosynthesis. Manganese (Mn) is considered essential elements for tryptophan as precursor to form indoles (Hopkins, 1995; Marschner, 1995).

Since, the foliar application of plant nutrient is an additional channel to nutrition, as well as, regulating root uptake, thus the changing in level of mineral in above ground organs are not so much attributable to foliar absorption, but rather to the effect of latter on the uptake of nutrients by root system. Several researchers reported the beneficial effect of foliar fertilization with trace elements on chemical constituents of medicinal plants, (El-Sherbeny et al., 2002) on *Cymbopogon citratus* L. plants, (Naguib et al., 2007) and (El-Khateeb, 1994) on *Ruta graveolens* L. plants, (Preety et al., 2000) on *Mentha spicata* L. plants. (Matter and El-Yazal, 2002) on *Ambrosia maritime* L. plants. (Misra and Bansal, 1992) and (Faroogi and Misra, 1983) on *Mentha arvensis* L. (Tarraf et al., 1994) and (Kassem, 2002) on *Rosmarinus officinalis* L., (Abd El-salam, 1999) on *Foeniculum vulgare* Mill., (Swaefy, 2002) on *Trachyspermum ammi* L.

This paper aimed to study the effect of foliar nutrition with some trace elements (Fe, Zn, and Mn) alone or as combination of them on chemical constituents of *Ruta graveolens* L. Plants.

Materials and methods:

A field experiments was carried out at the experimental farm of horticulture department-faculty of Agriculture, Omar El-Mokhtar university in El- Beida- Libya during the two successive seasons of 2014/2015 and 2015/2016, seedlings were sown on 1st of Marsh in rows, The distance between rows was 50 cm and 50 cm between plants in complete randomized block design containing 9 treatments with three replicates, each replicate contain 4 plants. All other agricultural practices were done as needed.

The fertilization treatments included the following:

The plants were sprayed three times (the first one was applied after 40 days from sowing, the second one was applied after 21 days from the first spray the third one was applied after 21 days from the second spray) with an aqueous solution of trace elements, using 0.5 m/1 bio-film as a wetting agent.

The concentration and source of elements were as follows:

- . Control plant was sprayed with distilled water.
- . Iron at 50 or 100 ppm as a foliar spray of the chelated Fe-EDTA (Fe 6%).
- . Zinc at 50 or 100 ppm as a foliar spray of the chelated Zn- EDTA (Zn 14%)
- . Manganese at 50 or 100 ppm as a foliar spray of the chelated Mn- EDTA (Mn 14%)
- . Iron(50 ppm) + Zinc (50ppm) + Manganese (50% ppm).
- . Iron (100 ppm) + Zinc (100 ppm) + Manganese (100 ppm).

Statistical analysis: The complete randomized block design was used in the experiments (9 treatments) with 3 replicates. Each replicate contained 4 plants the statistical analysis was carried out according to Costat statistical Software. L. S. D. test was used to compare the means of treatment.

Harvesting: Harvesting was carried out at flowering stage on 15th august in the first and second seasons.

Nitrogen, phosphorus and potassium elements were determined in the acid digested solution, which was prepared according to (Hach et al., 1985). The results were calculated from a standard curve made on ammonium sulfate. Nitrogen content was determined by modified micro kjeldahl method as described by (A.O.A.C, 1970). For phosphorus determination, the ammonium molybdate method according to (Murphy and Riley, 1962) was used. As for potassium, Iron, Manganese it was estimated using atomic absorption apparatus according to (Cottenie et al., 1982). Samples of fresh herb of each treatment were subjected separately for hydrodistillation for three hours in order to extract and determine the percentage of essential oil, according to (Guenther, 1961). and the total alkaloids estimated according to (Djilani et al., 2006).

Results and discussion

Data in table (1) revealed that spraying *Ruta graveolens* L. Plants with (Fe, Zn and Mn) either alone or in combination at level (50,100 ppm.) Caused significant gradual increase in the content of herb from macro- elements (N, P and K) as compared with control treatment, which give the least values (1.85, 1.91%) for Nitrogen, (0.88, 0.89%) for phosphorus and (4.61, 4.70%) for potassium during the two successive seasons respectively.

The results showed that spraying plants with combination of (Fe + Zn + Mn) at level of 100 ppm. gave the highest significant values, which recorded (2.90, 3.09%) for the Nitrogen content of the herb, (1.73, 1.82%) for phosphorus content of the herb and (5.28, 5.30 %) for potassium content of the herb during the two successive seasons of study respectively as compared with other treatments on the study. the results are in agreement with those obtained by (El-Ghdan, 1994) on *Mentha viridis* L., (Naguib et al., 2007) on *Ruta graveolens* L. and (Mansour, 2007) on *Salvia fruticosa* Mill.

Table 1: Effect of spraying some trace elements on potassium, phosphorus and nitrogen percentage in herb of *Ruta graveolens* L. plants

% K		% P		% N		Treatments
1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season	
46.1	47.0	08.8	08.89	18.5	19.1	control
51.4	51.0	09.5	09.5	22.9	23.3	Fe 50 ppm
51.7	51.9	11.7	11.7	23.6	23.9	Fe 100 ppm
46.3	46.5	12.3	12.25	24.2	24.49	Zn 50 ppm
46.7	46.8	12.6	12.6	25.1	25.54	Zn 100 ppm

g		e		e		
4		1		2		Mn 50 pp m
·	4.	·	1.	·	2.	
7	81	3	39	5	64	
2	f	7	d	8	d	
f		d		d		
5		1		2		Mn 100 pp m
·	5.	·	1.	·	2.	
0	08	4	44	6	75	
0	e	4	c	6	c	
e		c		c		
5		1		2		Mix 50 pp m
·	5.	·	1.	·	2.	
2	28	5	58	7	86	
3	b	6	b	4	b	
b		b		b		
5		1		2		Mix 100 pp m
·	5.	·	1.	·	3.	
2	30	7	82	9	09	
8	a	3	a	0	a	
a		a		a		

*Means within column having different letters are significantly different according to LSD at $P \leq 0.05$.

Iron, manganese and potassium content of the herb:

Data in table (2) revealed that spraying *Ruta graveolens* L. plants with (Fe, Zn and Mn) either alone or in combination at level (50 and 100 ppm) caused significant gradual increase in the content of herb from (Fe, Mn and Zn) as compared with control treatment, which give the least accumulation values (2127.66, 2125.61 ppm.) for Iron, (738.33, 743.33 ppm.) for Zinc, while the least accumulation value for Manganese was obtained from spraying the plant with (50 ppm) Fe, which recorded (161.66, 162.66 ppm.) during the two successive seasons of study respectively.

The results showed that spraying plants with combination of (Fe+ Zn + Mn) at level of 100 ppm. gave the highest accumulation values of Iron, Manganese and Zinc which recorded (2911.33, 2915.33 ppm.) for herb Fe content, (298.33, 299.66 ppm) for herb Mn content and (992.33, 993) for herb Zn content during the two successive seasons of study respectively as compared with other treatments included in this study. The results are in agreement with those obtained by (El-Ghdban, 1994) on *Mentha viridis* L., (Naguib et al., 2007) on *Ruta graveolens* L.

and (Mansour, 2007) on *Salviafruticose*, Mill.(Misra and Bansal, 1992) on *Mentha arvensis* L., (Tarraf et al., 1994) on *Rosmarinus officinalis* L.The improvement in micronutrient and macronutrient uptake by micronutrient application (Fe,Mn andZn) would be explained by their role on improving roots that lead to greater absorbing surface of roots,consequently increasing nutrient uptake and improves transportation of the nutrients from the soils to plant organs via the roots (Najjar, 1985).

Table 2: Effect of spraying some trace elements on zinc, manganese, iron(ppm) content in herb of *Ruta graveolens* L.

Zn ppm		Mn ppm		Fe ppm		Treatments
1 st	2 nd	1 st	2 nd	1 st	2 nd	
73.33	74.33	18.1	18.3	21.6	21.1	control
73.33	77.33	16.6	16.6	26.0	26.0	
75.6	75.7	19.2	19.5	27.3	25.3	Fe 100 ppm
75.6	75.7	19.2	19.5	27.3	25.3	

h				3 c		
8 0 7 .1. 6 6 d	81 1. 66 d	1 8 8 g	18 9. 66 g	2 4 4 8 f	24 49 .2 2 f	Zn 50 pp m
8 3 1 .3 3 3 c	83 5 c	1 9 5 .6 6 6 e	19 7. 33 e	2 3 2 7 h	23 29 .3 3 h	Zn 100 pp m
7 8 3 .6 6 6 f	79 0. 66 f	2 1 6 .6 6 6 d	21 9. 66 d	2 4 8 9 .6 6 6 e	24 90 .6 6 e	Mn 50 pp m
7 9 5 .3 3 3 e	79 9 e	2 3 8 .6 6 6 c	23 9. 23 c	2 4 4 0 .6 6 6 g	24 43 .3 3 g	Mn 100 pp m
9 3 1 .3 3 3 b	93 7 b	2 6 4 b	26 7 b	2 8 1 5 b	28 30 .3 3 b	Mix 50 pp m

9		2		2		Mix 100 pp m
9		9		9		
2	99	8	29	1	29	
.	3	.	9.	1	15	
3	a	3	66	.	.3	
3		3	a	3	3	
a		a		3	a	

*Means within column having different letters are significantly different according to LSD at $P \leq 0.05$.

Oil and alkaloids percentage in the herb:

Data in table (3) revealed that *Ruta graveolens* L. plant responded well to spraying with (Fe, Mn and Zn) either alone or in combination of them. All treatments showed significant increment in oil and alkaloids percentage as compared to control, which gave the least significant values (0.040, 0.041%) for oil percentage in the herb and (0.019, 0.020 %) for total alkaloids content in the herb.

The results showed that spraying plants with combination of (Fe+ Zn + Mn) at level of 100 ppm. gave the highest significant values of oil percentage content which recorded (0.071, 0.075 %) and (0.042, 0.044 %) for herb total alkaloids content during the two successive seasons of study respectively as compared with other treatments included in the study. the results are in agreement with those obtained by (Abd El- salam, 1999) on *Foeniculum vulgare* Mill., (El-Ghdban, 1994) on *Menthaviridis* L. (Kassem, 2002) on *Rosmarinus officinalis* L.

The improvement in oil and alkaloid yield by trace elements application (Fe, Zn and Mn) either alone or in combination of them, could be explained by their role in a wide variety of metabolic and physiological processes as well as cellular functions within the plants. Iron is necessary for chlorophyll synthesis and it is a constituent of some enzymes which controlled the respiratory mechanism such as cytochrome oxidase. Zinc is directly involved in the synthesis of plant hormone auxin. Manganese has a function in chloroplast as a part of electron transfer reactions and electron transport system. In addition, they play an essential role in improving yield and quality (Barker and Pilbeam, 2007; Hansch and Mendel, 2009).

Table 3: Effect of foliar spraying with some trace elements on essential oil and total alkaloid percentage of *Ruta graveolens* L. plants

Alkaloids %		Essential oil %		Treatment s
1 st seaso n	2 nd seaso n	1 st seaso n	2 nd seaso n	
0.019 g	0.020 g	0.040 g	0.041 g*	control
0.025	0.026 d	0.048	0.047 f	Fe 50 ppm

d		f		
0.026 c	0.028 c	0.063 c	0.062 c	Fe 100 ppm
0.022 f	0.022 f	0.048 f	0.048 f	Zn 50 ppm
0.024 e	0.025 e	0.051 d	0.053 d	Zn 100 ppm
0.022 f	0.023 f	0.050 e	0.050 e	Mn 50 ppm
0.023 e	0.024 e	0.051 d	0.052 d	Mn 100 ppm
0.032 b	0.034 b	0.064 b	0.066 b	Mix 50 ppm
0.042 a	0.044 a	0.071 a	0.075 a	Mix 100 ppm

*Means within column having different letters are significantly different according to LSD at $P \leq 0.05$.

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