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The effect of vermicompost and spraying with humic acid and fertilizer on quantitative and qualitative characteristics of rosemary

Niloufar Jalayerinia[1], Seyed Mohsen Nabavi Kalat[2], Reza Sadr abadi Haghighi[3]

1 Msc in Agroecology, Islamic Azad University of Mashhad, Iran
2 Assistant Professor, Phd of ecology, College of Agriculture Islamic Azad University of Mashhad, Iran
3 Assistant Professor, Phd of ecology, College of Agriculture Islamic Azad University of Mashhad, Iran

E-mail : jalayerinia-n@mashhad.ir

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Abstract

Rosemary (*Rosmarinus officinalis* L.) is an evergreen woody aromatic herb with a characteristic aroma and lavender-like leaves. This research was conducted to evaluate the effect of vermicompost and foliar application of humic acid and complete fertilizer on quantitative and qualitative characteristics of rosemary in the first and second harvest. This study was laid out in factorial experiment with randomized completely design (RCD) with three replications in greenhouse condition. Treatments included vermicompost (0, 4, 8 and 12 weight percentage of pot soil) and foliar application in four levels (no spray, sprayed with fertilizer, foliar application of human acid, foliar spray with fertilizer and humid acid), respectively. The characteristics such as plant height, the number of branches, leaves and flowers per plant, fresh and dry weight of shoots and essential oil content were measured. The results showed that different levels of vermicompost on the first and second harvest was significant. In addition, all traits were significantly affected by different levels in both harvest. With increasing vermicompost level all quantitative and qualitative traits increased significantly. The highest values for all traits in both first and second harvest obtained in combination of humic acid and complete fertilizer.

Key words : Rosemary, vermicompost, humic acid, fertilizer, quantitative and qualitative characteristics

INTRODUCTION

Rosemary (*Rosmarinus officinalis* L.) is an evergreen woody aromatic herb with a characteristic aroma and lavender-like leaves. The plant is native to the Mediterranean region where it grows wild along with the sea coast. Rosemary is cultivated on a large scale in Spain, Italy, France, Algeria, and Portugal for its essential oil. Morocco, one of the world's leading producers of rosemary oil, is second only to Spain and Tunisia in terms of volume of production [1]. The leaves of rosemary are also used for culinary purpose and are reported to possess antioxidant properties. Rosemary is also used in food products, for example to control Salemonella infection in meat [2]. Rosemary oil is obtained by steam or hydro distillation of twigs and leaves and is used extensively in the food, flavor, and fragrance industries and in aromatherapy. The crop normally responds to the application of fertilizer. Integrated supply of nutrients to plants through planned combinations of organic sources is becoming an increasingly important aspect of environmentally sound agriculture[3].Humic acid is an organic acid without environmental destructive effects that is applied for increasing germination rate and growth [4]. Vermicomposts are products of anon thermophilic bio-degradation of organic materials through interactions between earthworms and microorganisms. They provide many benefits to agricultural soil, including increased ability to retain moisture, better nutrient-holding capacity, better soil structure and higher levels of microbial activity. The process of vermicomposting tends to result in higher levels of plant availability of most nutrients than does the conventional composting process. Meantime, vermicompost stimulates further plant growth even when the plants are already receiving optimal nutrition [5]. No research has been reported on the influence of vermicompost and conjoint application of vermicompost and organic fertilizers on yield and quality of rosemary oil. Keeping this in view, the present experiment was conducted to study the effect of vermicompost, humic acid and complete fertilizer on growth, yields and oil quality of rosemary.

MATERIAL AND METHODS

A field experiment was conducted during 2014–2015 in the research greenhouse of Azad university of Mashhad, Iran, to study the effect of vermicompost, humic acid and complete fertilizer on growth, yield and quality of essential oil of rosemary crop. This study was laid out in factorial experiment with randomized completely design (RCD) with three replications in greenhouse condition. Treatments included vermicompost (0, 4, 8 and 12 weight percentage of pot soil) and foliar application in four levels (no spray, sprayed with fertilizer, foliar application of human acid, foliar spray with fertilizer and humid acid), respectively. UNIGOL was used as complete fertilizer and Hiumixin was applied as humic acid source. The chemical characterization of vermicompost and pot soil has been shown in (Table 1). The rooted cuttings of rosemary plants were obtained from Natural Resource Park of Mashhad and were kept under greenhouse condition at 24ºC. Standard irrigation was applied.

Table 1: Chemical characterization of pot soil and used vermicompost

	EC ($ds.m^{-1}$)	pH	Organic Carbon (%)	P (ppm)	K (ppm)	N (%)
Soil	1.2	7.85	0.3	28.55	450	0.062
Vermicompost	10	8.7	22	5000	9492	1.47

Table 2: Analysis of variance for the effect of vermicompost and foliar application on some characteristics of rosemary (first harvest)

Mean Square								
Source of variation	Degree of freedom	Plant height	the number of branches	Branches height	The number of leaf per plant	The number of flower per plant	Shoot fresh weight	Shoot dry weight
Vermicompost (A)	3	80.6**	1.4^{ns}	2.0^{ns}	1401.2**	1.4^{ns}	990.4**	250.8**
Foliar application (B)	3	484.6**	28.2**	24.1**	19015.4**	38.0**	15698.1**	3975.3**
A×B	9	18.5**	2.8^{ns}	10.3**	281.4*	3.4**	265.7^{ns}	65.9^{ns}
Error	32	5.7	1.4	2.9	126.0	1.0	235.3	60.1
CV (%)		12.5	23.6	37.3	7.2	39.4	21.6	21.6

ns, * and ** are non-significant, significant at p=0.05 and p=0.01 respectively

Two harvests of rosemary were taken: The first one before shoot pruning and after three months. Foliar application of humic acid and complete fertilizer was done in two stages. The first stage before flowering and the second one after 20% of flowering. After each harvest, the characteristics such as plant height, the number of branches, leaves and flowers per plant, fresh and dry weight of shoots and essential oil content were measured. The obtained data were analyzed by SAS program. Data means were compared by Duncan's Multiple Range Test at P=0.05. The EXCEL Microsoft word was used for drawing of diagram.

RESULTS

The results of analysis variances of rosemary in first harvest (Table 2) revealed that vermicompost had significant effect on plant height, the number of leaf per plant, shoot fresh weight and shoot dry weight at ($p\leq0.01$), while it had no significant effect on the number of branches, the branch height and the number of flower. In case of foliar application in the first harvest data from (Table 2) showed that this factor had significant effect on all studied traits at($p\leq0.01$), while the interaction effect of vermicompost and foliar application had significant effect on plant height, branch height and the number of flower at ($p\leq0.01$) and it had significant effect on the number of leaf per plant at ($p\leq0.05$), while it had no significant effect on the number of branch and shoot fresh and dry weight.

In the second harvest the results of analysis variances (Table 4) showed that vermicompost had significant effect on plant height, the number of leaf per plant, shoot fresh and dry weight and essence percentage at ($p\leq0.01$), while it had no significant effect on the number of branches, the branch height and the number of flower. Regarding foliar application, (Table 2) showed that this factor had significant effect on all experimental traits at ($p\leq0.01$), although the interaction effect of vermicompost and foliar application had significant effect on plant height, branch height, the number of leaf and shoot fresh weight at ($p\leq0.01$) and it had significant effect on the number of flower per plant and shoot dry weight at ($p\leq0.05$), while it had no significant effect on the essence percentage of rosemary. For the first and second harvest with increasing vermicompost level up to 12 (percentage of weight) plant height increased significantly. Regarding interaction effect of vermicompost and foliar application, data presented in (Table 3 and 5) revealed that the highest plant height was observed with application of vermicompost at 8 and 12 level (percentage of weight) and foliar application of humic acid in combination of complete fertilizer. The highest number of branch obtained in foliar application of combined humic acid and complete fertilizer and application of complete fertilizer alone in first and second harvest (Table 3 and 5). [6] with study on mint (*Mentha arvensis*) reported that with application of vermicompost the number of branches per plant increased significantly. Vermicompost is considered to enhance vegetative growth of plants because of early growth of seedling. Early establishment of seedling was found to be better in vermicompost amended soils [7].In case of branch height in the first and second harvest (Table 3 and 5), information on interaction effect of vermicompost and foliar application showed that the highest branch height was seen the plant were treated with 4% weight of vermicompost along with combined humic acid and complete fertilizer.

In terms of the number of leaf per plant, interaction effect of these two factors showed that the highest number of leaf was observed in treatment of vermicompost in 4, 8 and 12% weight with foliar application of humic acid and complete fertilizer, while there was no significant difference between them (Table 3 and 5).

In this study from the first and second harvest information, the highest number of flower was seen with foliar application of complete fertilizer and combined treatment of humic acid and complete fertilizer (Table 3 and 5).

Interaction effect of vermicompost and different foliar application in the second harvest showed that the highest shoot fresh and dry weight was observed in plants were treated with 4, 8 and 12% weight of vermicompost along with combined acid

Table 3: Mean comparisons of interaction effect of vermicompost and foliar application on some characteristics of rosemary (first harvest)

Vermicompost (weight percentage)	Foliar application	Plant height (cm)	Number of branch	Branch height (cm)	The number of leaf per plant	The number of flower	Shoot fresh weight (gr)	Shoot dry weight
0	No spray	9.6f	1.6e	5.33bc	112.6d	0.6def	32.7g	16.5g
	Humic acid	12.2ef	3.6de	5.33bc	123.0cd	1.3cdef	43.4fg	21.9fg
	Complete fertilizer	19.3cd	5.3bcd	5.67abc	137.6c	2.0cde	66.4def	23.6def
	Humic acid & complete fertilizer	24.6ab	8.0a	3.33cd	183.0b	5.0a	95.7bc	48.3bc
4	No spray	12.0ef	4.0cd	3.0cd	114.3d	0.3ef	31.3g	15.9g
	Humic acid	17.0d	4.3cd	4.0cd	130.6cd	2.3bcd	51.3efg	25.8efg
	Complete fertilizer	16.3de	6.3abc	3.67cd	176.6b	4.0ab	81.8cd	41.4cd
	Humic acid & complete fertilizer	25.6ab	6.0abcd	8.67a	205.0a	5.0a	110.2ab	55.7ab
8	No spray	10.0f	3.6de	1.33d	123.0cd	0.2f	43.4fg	21.9fg
	Humic acid	22.3bc	4.6cd	3.0cd	128.6cd	2.0bc	45.9fg	23.4fg
	Complete fertilizer	21.6bc	6.3abc	3.33cd	179.3b	5.0a	75.8cde	38.0cde
	Humic acid & complete fertilizer	27.6a	6.3abc	8.33ab	219.0a	3.0bc	131.3a	66.1a
12	No spray	12.6ef	4.0cd	4.33cd	130.6cd	0.6def	50.7efg	25.6efg
	Humic acid	25.0ab	5.0bcd	3.67cd	122cd	0.3ef	42.6fg	21.7fg
	Complete fertilizer	23.0bc	7.3ab	4.00cd	177.3b	4.0ab	95.7bc	48.3bc
	Humic acid & complete fertilizer	28.3a	5.6abcd	6.33abc	214.6a	4.0ab	135.3a	68.1a

*Values within a column followed by the same letters are not significantly different ($p<0.05$, means±SE). Significant at the 0.01 probability level.

humic and complete fertilizer, while there were no significant differences between these three treatments statistically (Table 3 and 5).

Essence percentage trait was studied in the second harvest. Based on the information of (Table 5), the highest essence percentage obtained in all treatments of vermicompost with foliar application of combined humic acid and complete fertilizer.

DISCUSSION

The results of this study indicated that using vermicompost and foliar application of humic acid and complete fertilizer had significant positive effect on quantitative and qualitative of rosemary characteristics. Similarly, positive effects of using vermicompost and organic fertilizers have been reported by many researchers. These findings show the important role of organic

Table 4: Analysis of variance for the effect of vermicompost and foliar application on some characteristics of rosemary (secondharvest)

Mean Square									
Source of variation	Degree of freedom	Plant height	the number of branches	Branches height	The number of leaf per plant	The number of flower per plant	Shoot fresh weight	Shoot dry weight	Essence percentage
Vermicompost (A)	3	38.2^{**}	3.8^{ns}	3.3^{ns}	1586.2^{**}	0.4^{ns}	1561.9^{**}	280.9^{**}	0.06^{**}
Foliar application (B)	3	478.3^{**}	26.7^{**}	78.2^{**}	24234.4^{**}	53.1^{**}	24061^{**}	6523^{**}	0.9^{**}
A×B	9	16.6^{**}	3.5^{ns}	6.7^{**}	376.9^{**}	2.9^{*}	376.4^{**}	89.4^{*}	0.02^{ns}
Error	32	2.7	2.0	2.0	114.7	1.2	114.1	34.2	0.009
CV (%)		39.4	24.8	16.9	6.0	36.6	14.1	14.9	15.7

ns, * and ** are non-significant, significant at p=0.05 and p=0.01 respectively

Table 5: Mean comparisons of interaction effect of vermicompost and foliar application on some characteristics of rosemary (second harvest)

Vermicompost (weight percentage)	Foliar application	Plant height (cm)	Number of branch	Branch height (cm)	The number of leaf per plant	The number of flower	Shoot fresh weight (gr)	Shoot dry weight	Essence percentage
0	No spray	11.6f	2.6f	6.0ef	129.3de	0.6ef	29.3ef	15.1de	0.2f
	Humic acid	12.6f	3.0f	8.0cde	143.6cdc	0.6ef	44.6cdef	24.4cd	0.4dc
	Complete fertilizer	18.6dc	7.0abcd	9.0bcd	160.6c	5.6a	60.5c	32.3c	0.7bc
	Humic acid & complete fertilizer	26.2b	7.3abc	9.0bcd	202.7ab	4.6ab	102.4b	56.9b	0.8ab
4	No spray	12.0f	4.3def	6.0ef	128.6e	1.0def	28.3ef	12.7e	0.1f
	Humic acid	17.0e	4.0ef	7.3cde	148.3cdc	1.6cdef	48.3cdef	24.9cd	0.4dc
	Complete fertilizer	17.3e	7.6ab	9.0bcd	194.0b	4.6ab	93.9b	49.4b	0.6cd
	Humic acid & complete fertilizer	31.0a	6.6abcdc	13.6a	238.0a	5.6a	127.9a	71.4a	0.9a
8	No spray	12.0f	6.0abcde	4.0f	131.0de	0.0f	31.3def	15.7de	0.2f
	Humic acid	20.0cde	4.6cdef	6.7dc	151.3c	3.0bcd	50.8cd	25.8cd	0.4c
	Complete fertilizer	20.0cde	6.3abcde	8.0cde	198.6b	4.6ab	98.0b	51.1b	0.6cd
	Humic acid & complete fertilizer	29.0ab	8.3a	13.6a	251.0a	5.6a	150.3a	75.2a	0.9a
12	No spray	16.6e	5.0bcdef	7.3cde	149.0cd	2.3cde	48.8cde	25.1cd	0.4de
	Humic acid	21.0cd	6.0abcde	7.6cde	143.6cde	1.3cdef	44.5cdef	22.7cde	0.6c
	Complete fertilizer	22.3c	7.0abcd	9.6bc	199.0b	3.3bc	98.8b	51.5b	0.6c
	Humic acid & complete fertilizer	26.3b	6.0abcde	11.0b	243.3a	5.0ab	143.8a	72.0a	0.9a

**Values within a column followed by the same letters are not significantly different (p<0.05, means±SE). Significant at the 0.01 probability level

fertilizers toward decreasing chemical fertilizers and sustainable agriculture. [8] reported that application of 10 ton/ha could increase the number of flower, plant height, 1000 seed weight, biological yield and essence percentage in fennl (*Foeniculum vulgare* Mill.).[9] in the study on the effects of different organic fertilizers on the growth of lilies (*Lilium longiflorum*) showed that vermicompost increased the plant height, shoot fresh and dry weight and chlorophyll content in this plant. In another study on French basil, it has been reported that application of 10 ton/ha vermicompost enhanced growth characteristics of this plant because of improving water holding capacity and increasing microorganisms activity [10]Chemical and physical properties of humic acid causes accumulation of nitrogen by plants which increase growth regulator hormones and microorganisms activities result in plant growth and biomass production [11-12].Humic acid as an organic acid without environmental destructive effects improves the physical, chemical and biological soil structure and due to having hormones compounds has positive effects on quantitative and qualitative plant indicators [4].

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