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Effect of organic and chemical fertilizers on Amount of Essence, biological yield and harvest index of *Matricaria chamomile*

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ABSTRACT

To evaluate the effect of chemical, manure and mixed fertilizers on quantitative and morphological traits of German chamomile (Matricaria chamomile), an experiment was carried out at the field experiment of Hariri scientific foundation, Babol, iran in two seasons. A factorial experiment based on randomized complete blocks design (RCBD) with three replications was followed in the study. Results represented that quantitative and morphological traits was significantly affected by different fertilizer treatments and ecotypes. Utilization of mixed fertilizer, manure and chemical fertilizers in spring planting increased 64.27%, 47.84% and 38.33% on plant height in compare with control. Maximum of plant height and amount of essence was obtained by Isfahan ecotype. in spring planting and 50% flowering stage, utilization of manure and chemical fertilizer has similar effects on flower dry weight and application of mixed, manure and chemical fertilizers increased 325%, 189% and 104.6% on flower dry weight in compare with control. in fall and spring planting , the highest and lowest biological yield was obtained by application of mixed fertilizer and non-application of fertilizer treatments and there wasn't significant difference between utilization of chemical and manure fertilizers on biological yield. In spring planting, utilization of mixed fertilizer, manure and chemical fertilizers increased 18.99%, 18, 20% and 10.35% on harvest index in compare with control. In fall planting, utilization of mixed fertilizer, manure and chemical fertilizers increased 25.85%, 18.26% and 13.47% on harvest index in compare with control.

Keywords: herbal medicine plant, Matricaria chamomile, essence yield, manure fertilizers, chemical fertilizers.

INTRODUCTION

Chamomile (*Matricaria chamomilla* L.), family *Asteraceae*, a native of Europe is cultivated extensively in Hungary, Germany, Russia and Yugoslavia. The main useable part of chamomile is its flowers.German chamomile is an annual herb with erect, light-green, smooth and multi-branched stems. The entire plant is downy and greyish green in colour. Chamomile is a creeping, herbaceous perennial reaching a height of about 30 cm. The aromatic plant is characterized by downy stems with a yellow disc. Medicinal value of this plant is for active substances, mainly accumulated in the flowers [1, 2]. McKay and Blumberg [3] reported that Chamomile flowers are used in alternative medicine. Chamomile has medicinal properties such as anti-inflammatory [4], antispasmodic, antiseptic and

therapeutic use [5] and anti-microbial [6]. Several applications of dry powder for medicinal effect such as fevers, sore throats, the aches and pains due to cold, flu and allergies. Herbal and essential oil crops grown on natural soils yield products that are of high quality and in demand globally. Producers are advised to have the soil analyzed at a laboratory to check for mineral deficiencies and excesses, organic status and carbon ratios. Soil analysis will guide the producer in correcting the nutritional status of the soil. The world market currently has German chamomile drug of various origin and therapeutically values. In the 1970s, plant material was evaluated by the content of essential oil and the content of chamazulene [7]. 25 German chamomile ecotypes have been compared by Mahdikhani et al. [8] with using morphological traits. The results indicated high phenotypic variation for the traits biological yield, dry flower yield number of flower plant-1 and essence percent Also, biological yield and number of flower were introduced as the most effective traits on flower yield and essence percent. Zeinali et al. [9] evaluated the German chamomile genotypes and found that plant height, flower diameter and Number of flower plant have the least, while dry and fresh flower yield the most variation. D' Andrea [10] investigated the genetic correlation between flower yield and essence components with the different morphological attributes in two harvesting times. The traits number of flower, flower weight and number of flowering sub-branches as the most important dry flower yield components in German chamomile have been determined by Letchamo [11] and Jamshidi [12]. In the other research, Pirkhezri et al [13] reported the significant and positive relationship of the traits, number of flower, fresh flower yield, 100 flower weight, days to flowering and plant height with essence percent. The aims of this research were assessment of relationships between dry flower yield and essence percent with the other morphological traits and nutritional condition.

MATERIALS AND METHODS

This experiment was carried out in 2008-2009 at the field experiment of Hariri scientific foundation, Babol, Iran in two seasons. The pH of soil field experiment was 7.4 with silt loam texture, physical and chemical properties of soil in experimental field were presented in (table 1). Experiment was conducted in factorial within a randomized complete block design with three replications. Fertilizer treatments in 4 levels included: non-application fertilizers, chemical fertilizers (utilization of 100 kg/ha urea + 100 kg/ha ammonium phosphate fertilizers), manure fertilizers (15 ton/ha) and mixed fertilizers (combination of 50 kg/ha urea + 50 kg/ha ammonium phosphate + 7.5 ton/ha manure fertilizers) together with 3 level of ecotype (Zabol, Isfahan and Tehran) was conducted in this experiment. Seeds were sown in 3 to 4 m length rows in each plot. Distances about 0.3 and 0.1 m were considered between rows and within rows, respectively. Irrigation was performed every three days until plantlet establishment and every six days after this stage. Weed control was conducted during growing season. All operations were done regularly during the growing season. Sampling was conducted in 50% flowering stage and 100% flowering stage. Morphological characteristics including plant height, flower dry weight, biological yield, harvest index, amount of essence were determined. The flowers were gradually harvested and weighted for determination of fresh flower yield. The individual plant samples of each population were conditioned in plastic bags and transported to the laboratory under refrigeration. Samples (~200 g) were air dried at room temperature (20 to 25ºC) and preserved in a refrigerated chamber (10ºC) until extraction. Each sample used in this survey was deposited in the laboratory of Hariri scientific foundation; the air-dried samples (100 g) were subjected to water distillation for 2 h using a Clevenger-type apparatus. The oil obtained was separated from water and dried over anhydrous Na2SO4. This essence was weighted for measuring the essence percent. Data analysis was done by using SAS. The ANOVA test was used to determine significant ($p \leq 0.01$ or $p \leq 0.05$) treatment effect and Duncan Multiple Range Test to determine significant difference between individual means.

RESULTS AND DISCUSSION

Plant height

Results represented that plant height was significantly affected by different fertilizer treatments and years (fall and spring planting) however different ecotypes and interaction between treatments hadn't significant effect on this morphological trait (table 2). Means comparison (table 3) indicated that in spring planting, utilization of manure and mixed fertilizers had similar effects on plant height and the highest and lowest plant height was gained by application of mixed fertilizers and non-application of fertilizer treatments. Utilization of mixed fertilizer, manure and chemical fertilizers in spring planting increased 64.27%, 47.84% and 38.33% on plant height in compare with control. Means comparison (table 3) showed that however there wasn't significant difference between application of chemical and mixed fertilizer treatments on plant height in fall planting but maximum and the lowest plant height was obtained by application of chemical fertilizers and non-application of fertilizer treatments. Utilization of mixed

fertilizer, manure and chemical fertilizers in fall planting increased 60.9%, 38% and 65.54% on plant height in compare with control (table 3). However effect of different ecotype on plant height wasn't significant but in spring planting, maximum of plant height was obtained by Isfahan ecotype and there wasn't significant difference between Tehran and Zabol ecotypes on plant height (table 4). In fall planting, the highest and lowest plant height was gained by Isfahan and Tehran ecotypes (table 4).

Flower dry weight

(Table 2) indicated that utilization of different fertilizers and years (fall and spring planting) had significant effects on flower dry weight in different flowering stages however effect of different ecotype on flower dry weight wasn't significant . In 50% flowering stage, interaction between year and fertilizer treatment was significant (table 2). Means comparison (table 3) indicated that in spring planting, the highest and lowest flower dry weight was obtained by application of mixed fertilizer and non-application of fertilizer treatments. in spring planting and 50% flowering stage, utilization of manure and chemical fertilizer has similar effects on flower dry weight and application of mixed, manure and chemical fertilizers increased 325%, 189% and 104.6% on flower dry weight in compare with control (table 3). However in spring planting and 100% flowering stage, there wasn't significant difference between application of mixed and manure fertilizers on flower dry weight but the highest and lowest flower dry weight was obtained by application of mixed fertilizer and non-application of fertilizer treatments (table 3). Means comparison (table 3) indicated that utilization of mixed, manure and chemical fertilizers increased 135%, 114% and 82.9% on flower dry weight in compare with control in spring planting and 100% flowering stage. In fall planting, application of manure and chemical fertilizers had similar effects on flower dry weight in different flowering stages. Maximum and the lowest flower dry weight were gained by application of mixed fertilizer and non-application of fertilizer treatments. In fall planting and 50% flowering stage, utilization of mixed, manure and chemical fertilizers increased 238%, 175% and 138% on flower dry weight in compare with control however in 100% flowering stage, application of mixed, manure and chemical fertilizer increased 76.49%, 10% and 5.96% on flower dry weight in compare with control (table 3). Means comparison indicated that different ecotypes hadn't significant effect on flower dry weight but in spring planting and 50% flowering stage, the highest and lowest flower dry weight was obtained by Zabol and Isfahan ecotypes however there wasn't significant difference between Tehran and Zabol ecotypes on flower dry weight (table 4). In fall planting and 50% flowering stage, there wasn't significant difference between different ecotypes on flower dry weight but in 100% flowering stage, Zabol and Tehran ecotypes had similar flower dry weight and the highest and lowest flower dry weight was obtained by Tehran and Isfahan ecotypes (table 4).

Biological yield

Results indicated that biological yield was significantly affected by application of different fertilizer treatments and year (fall and spring planting) and different ecotypes and interaction between treatments wasn't significant (table 2). Means comparison (table 3) indicated that in fall and spring planting, the highest and lowest biological yield was obtained by application of mixed fertilizer and non-application of fertilizer treatments and there wasn't significant difference between utilization of chemical and manure fertilizers on biological yield. In spring planting, application of mixed, manure and chemical fertilizers increased 188.6%, 119, 40% and 115.47% on biological yield in compare with control however in fall planting, utilization of mixed fertilizer, manure and chemical fertilizers increased 145.4%, 87.19% and 78.56% on biological yield in compare with control (table 3). Means comparison (table 4) represented that in fall and spring planting, the highest and lowest biological yield was obtained by Zabol and Isfahan ecotypes however in fall planting, there wasn't significant difference between Tehran and Zabol ecotypes on biological yield.

Harvest index

(Table 2) indicated that harvest index was significantly affected by different years (fall and spring planting), different fertilizers and ecotypes. Interaction between years and fertilizer and year and ecotype had significant effect on harvest index however interaction between ecotype and fertilizer wasn't significant. Means comparison (table 3) represented that application of manure and mixed fertilizers had similar effects on harvest index and the highest and lowest harvest index was gained by utilization of mixed fertilizer and non-application of fertilizer treatments. In spring planting, utilization of mixed fertilizer, manure and chemical fertilizers increased 18.99%, 18, 20% and 10.35% on harvest index in compare with control. In fall planting, utilization of mixed fertilizer, manure and chemical fertilizers increased 25.85%, 18.26% and 13.47% on harvest index in compare with control (table 3). Means comparison (table 4) showed that in spring planting, there wasn't significant difference between Zabol and Tehran ecotypes on harvest index and maximum of harvest index was obtained by Isfahan ecotype. In fall planting,

the highest and lowest harvest index was obtained by Zabol and Isfahan ecotypes however there wasn't significant difference between Tehran and Zabol ecotypes on harvest index (table 4).

Amount of Essence

Results showed that amount of Essence were significantly affected by different ecotype, fertilizers treatments and year (fall and spring planting) however interaction between treatments on amount of essence wasn't significant (table 2). Means comparison (table 3) showed that however maximum and the lowest of this trait was obtained by mixed fertilizer and non-application of fertilizer treatments but in fall planting, application of manure and chemical fertilizers had similar effect on amount of essence. In spring planting, utilization of mixed fertilizer, manure and chemical fertilizers increased 84.27%, 57.90% and 29.43% on amount of essence in compare with control (table 3). In fall planting, application of mixed fertilizer, manure and chemical fertilizers increased 82.42%, 51.59% and 30.74% on amount of essence in compare with control (table 3). Result indicated that in fall and spring planting, maximum amount of essence was obtained by Isfahan ecotype and there wasn't significant difference between Tehran and Zabol ecotypes on amount of essence (table 4).

Table 1. Physical and chemical features of soil test

OC (%)	EC (dS/m)	pH	Oc (%)	K (ppm)	P (ppm)	texture	sand (%)	silt (%)	clay (%)
0.84	1	7.4	0.07	257	14.7	Silt-loam	53	44	3

Table 2. Analysis of variance for measured traits in German chamomile (*Matricaria chamomile*)

S.O.V	DF	Plant height	Flower dry weight Flowering stage (%)		Biological yield	Harvest index	Amount of essence
			50	100			
Year (y)	1	225.78**	2373.03**	195.55**	2245.5**	477.55*	94.41**
Replication (r)	4	118.39**	37.91*	63.57**	336.22**	519.55**	187.45**
Fertilizer (f)	3	388.14**	367.15**	283.96**	1981.46**	250.14*	339.52**
Ecotype (e)	2	16.04^{ns}	14.25^{ns}	19.21^{ns}	80.01^{ns}	297.4*	36.54*
E × f	6	5.81^{ns}	2.703^{ns}	2.68^{ns}	10.03^{ns}	58.55^{ns}	13.08^{ns}
Y × f	3	15.07^{ns}	91.15**	23.61^{ns}	36.24^{ns}	456.11**	1.37^{ns}
Y × E	2	2.01^{ns}	9.14^{ns}	18.42^{ns}	32.03^{ns}	359.03**	0.07^{ns}
Y × E × F	6	0.85^{ns}	2.60^{ns}	1.39^{ns}	2.91^{ns}	53.93^{ns}	0.27^{ns}
Error	44	13.69	13.16	9.33	40.24	81.96	9.08

*ns= Non significant, ** = p < 0.01 and * = p < 0.05*

Table 3. Means comparison of effects of different fertilizer treatments on morphological and quantitative traits of German chamomile (*Matricaria chamomile*)

Year	Fertilizer treatment	plant height (cm)	Flower dry weight (gr/plant) Flowering stage (%)		Biological yield (gr/plant)	Harvest index (%)	Amount of essence (%)
			50	100			
Spring planting (y1)	Non-application	15.34c	1.72c	6.97c	11.70c	66.81b	11.38d
	chemical	21.22b	3.52bc	12.75b	25.21b	73.71ab	14.73c
	manure	22.68ab	4.98b	14.93a	25.67b	78.97a	17.97b
	mixed	25.20a	7.38a	16.43a	33.77a	79.50a	20.97a
Fall planting (y2)	Non-application	17.47c	6.68c	8.55c	19.83c	60.84c	13.14c
	chemical	28.92a	15.90b	9.06b	35.41b	69.04b	17.18b
	manure	24.11b	18.37b	9.47b	37.12b	71.95ab	19.92b
	mixed	28.11a	22.58a	15.09a	48.67a	76.57a	23.97a

Table 4. Means comparison of effects of different ecotypes on morphological and quantitative traits of German chamomile (*Matricaria chamomile*)

Year	ecotype	Plant height (cm)	Flower dry weight (gr/plant) Flowering stage (%)		Biological yield (gr/plant)	Harvest index (%)	Amount of essence (%)
			50	100			
Spring planting (y1)	isfahan	24a	2.10b	12.61b	17.68c	84.25a	21a
	tehran	18.33b	5.31a	10.95b	24.06b	70.75b	14.82b
	zaboi	21b	5.79a	14.75a	30.52a	69.26b	12.97b
Fall planting (y2)	isfahan	28.08a	14.15a	6.48b	30.92b	64.70b	22.57a
	tehran	21.24c	16.93a	11.47a	38.26a	71.47a	17.75b
	Zabol	24.64b	16.57a	10.47a	36.60a	72.64a	15.34b

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