

Influence of Biofertilizers on Flower Yield and Essential Oil of Chamomile (*Matricaria chamomile* L.)

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Abstract—The main objective of this study was to determine the effects of vermicompost and amino acids on the qualitative and quantitative yield of chamomile. The experiment was conducted during the growing season of 2010 at the Alborz Medical Research Center. The Treatment groups consisted of vermicompost (0, 5, 10, 15 and 20 tons/ha) and the sprays of amino acids (budding stage, flowering stage, and budding + flowering stage). The experimental design was a factorial experiment based on Randomized Complete Block Design (RCBD) with three replications. The present results have shown that the highest plant height, flower head diameter, fresh and dry flower yield and significant essential oil content were obtained by using 20-ton vermicompost per hectare. Effects of amino acids were similar to those seen in vermicompost treatment and all measured traits were seen to be significant after the spray of amino acids at the budding + flowering stage).

Keywords—Vermicompost, amino acids, chamomile, yield

I. INTRODUCTION

CHAMOMILE (*Matricaria chamomilla* L.) is an annual plant belonging to the Asteraceae family [31]. Its height varies from 20 to 60 cm, depending on the location and the soil. The root system in this plant is short but quite widespread [2]. Chamomile may be considered as an economic substitute of the field crops, irrigated with fresh water since it has adaptability to a wide range of soil and climatic conditions. Nowadays, chamomile is among the widely used medicinal plants throughout the world [9].

Many medical properties of chamomile are attributed to its essential oil. Therefore, the improvement of oil quality and quantity is among the major objectives in chamomile breeding programs [35]. Over 120 components have been identified in chamomile essential oil, while α -bisabolol, chamazulene, α - and β -bisabolol oxides, farnesene and α -bisabolonoxide A are the most important ones [27]. Chamomile is known to be anti-inflammatory, anti-spasmodic, anti-bacterial, antiseptic and antispasmodic [15].

Chamomile is an herb and native to Iran [28] and Europe that grows as a wild plant [27]. Chamomile is naturally

widespread in west, northwest and south of Iran and its consumption has a long history in Iranian folklore medicine [28].

Its consumption as a folklore medicine has a long history. Medicinal importance of this species is also on the rise and at present, seven pharmaceutical products have been manufactured from chamomile in Iran under the license of the Ministry of Health. Its cultivation has been increased steadily in recent years [9].

The form, structure and morphological characteristics of chamomile plants, their essential oil content and quality are affected by genetic background, ecological and agronomical conditions [31]. In this respect, the management of nutritional aspects of chamomile is very important in agro-ecosystems [18].

Sustainability of agricultural systems has become an important issue throughout the world. Many of the sustainability issues are related to the quality and time-dependent changes of the soil [20]. It is well known that intensive cultivation has led to a rapid decline in organic matter and nutrient levels besides affecting the physical properties of soil. Conversely, the management practices with organic materials influence agricultural sustainability by improving physical, chemical and biological properties of soils [30].

The use of organic amendments has long been recognized as an effective means of improving the structure and fertility of the soil [14], increasing the microbial diversity, activity and population, improving the moisture-holding capacity of soils and crop yield [16].

Vermicompost contains most nutrients in plant-available forms such as nitrates, phosphates, and exchangeable calcium and soluble potassium [12]. Vermicompost has large particulate surface area that provides many microsites for the microbial activity and strong retention of nutrients. It is rich in microbial population and diversity, particularly fungi, bacteria and actinomycetes [12]. It contains plant growth regulators and other growth-influencing materials produced by microorganisms [6]. Krishnamoorthy and Vajrabhiah (1986) reported the production of cytokinins and auxins in organic wastes that were produced by earthworms [22]. Vermicompost also contains large amounts of humic substances and some of the effects of these substances on plant growth have been shown to be very similar to those of soil-applied plant growth regulators or hormones [24].

As a result, most nutrients are easily available such as; nitrates, phosphates, and exchangeable calcium and soluble

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potassium [12], which are responsible for increased plant growth and crop yield. Vermicompost has been shown to increase the dry weight, [11] and nitrogen uptake efficiency of plants [34]. The beneficial effects of vermicompost have been observed in horticultural [4, 5, 17] and agronomic crops [26, 29].

However, most research on the use of vermicompost has been on the horticultural crops and a few workers have reported on the use and effects of vermicompost on the field crops and medicinal plants.

Studies have proved that amino acids can directly or indirectly influence the physiological activities in the growth and development of plants. According to several studies, the foliar application of amino acids causes an enhancement in plant growth and fruit yield while the maintenance of protein component is also regulated in cucumber [13], garlic [7], potato [21] and sweet pepper [19].

The main objective of this study was to assess the effects of vermicompost and amino acids on the flower yield and essential oil content of chamomile.

II. MATERIALS AND METHODS

A. Field experiments

The present study was conducted during the growing season of 2010 at the Alborz Medical Research Center of Research Institute of Forests and Rangelands (Latitude: 35° 38' N; Longitude: 51° E; Altitude: 1321m). The soil of the experimental region was loamy with pH 7.36.

The experimental design was a factorial study, based on Randomized Complete Block Design (RCBD) with three replications. Treatments consisted of vermicompost with five concentration levels (V1 = zero, V2 = 5, V3 = 10, V4 = 15 and V5 = 20 ton ha⁻¹) and amino acid spraying at three levels (spraying at the F1 = budding stage, F2 = at flowering stage, and F3 = at budding + flowering stage).

The vermicompost was prepared from cow dung by employing epigeic species of *Eisenia foetida*. Vermicompost was applied and incorporated to the top 10 cm layer of soil in experimental beds. At the end of March and before the planting time (14th of April), the field was ploughed and harrowed thoroughly up to the depth of 30 cm and leveled. Each experimental plot was 4 m long and 3 m wide with the total area of 12 m². Chamomile seeds (Esfahan ecotype: a diploid ecotype belonging to chemotype A (prevailing content of α (-)-bisabolol oxide A with a high content of chamazulene) were obtained from the Research Center of Medicinal Plants, Isfahan, Iran. Sowing was done manually, and three weeks after sowing, the seedlings were thinned up to 33.3-plant m⁻² (30 × 10 cm distances). The experimental plots were irrigated weekly and the weeds were controlled manually. All necessary cultural practices and plant protection measures were followed uniformly for all the plots during the entire period of experimentation.

B. Measurements

Data of the plant height (cm), fresh and dry flower yield (kg ha⁻¹), and essential oil content were recorded from each treatment. Measurements and samplings were done on the inner eight rows in each plot, discarding 50 cm from both ends to avoid edge effects. Twenty plants were randomly selected for measuring the traits.

At the beginning of the flowering period, plant height was measured for each plot using a ruler (± 0.1 cm) from the base to the tip of plant. Dry weight of the flowers was calculated in each plot after drying the flowers at room temperature (25° C for 120 h) using a digital balance (Sartorius B310S) (± 0.01 g) [8]. To determine the amount of essential oil, a sample of 100 g of flowers was mixed with 500 ml of tap water in a flask and the water was distilled for 3 h using a Clevenger-type apparatus. The oil content was measured by following the protocol of Letchamo and Marquard (1993), based on ml oil per 100 g dry matter of flower [23].

C. Statistical analysis

Data were subjected to statistical analysis using ANOVA, a statistical package available from SAS. Means comparisons were done by Duncan multiple range tests at 5% level.

III. RESULTS AND DISCUSSION

The results have indicated that all measured traits were significantly affected by using vermicompost and the spray of amino acids. Interactions were significant only for the dried flower yield.

After the application of Vermicompost, the Chamomile plant height was increased significantly. Regression analysis showed that by increasing the vermicompost amount from V1 to V5, the plant height increased linearly. The highest plant height (41.8 cm) was recorded by using 20-ton vermicompost per hectare. Azizi et al. (2009) has indicated that vermicompost shows a positive effect on chamomile height [8]. Studies on the field crops also had the same results [6].

Mean comparison showed significant differences between various levels of fosnutren spraying. Foliar application of fosnutren at F3, caused the plant to reach the highest height (38.7 cm). Many studies have reported that the foliar application of amino acids causes enhanced plant growth [7, 19].

Amino acids are the fundamental ingredients of the process of protein synthesis because of their nitrogen content. The importance of nitrogen or amino acids came from their increased application for the biosynthesis of a large variety of non-nitrogenous materials *i.e.* pigments, vitamins, coenzymes, purine and pyrimidine bases [19]. Vermicompost had positive effects on the fresh and dry flower yield of chamomile. Plants grown in the plots, treated with V5, had significantly greater flower yield ($P \leq 0.05$). As shown in Figures 1 and 2, by increasing the vermicompost amounts, the flower yield increased nonlinearly. The highest fresh and dry flower yields (3335.7 and 653.8 kg/ha, respectively) were recorded by using V5 treatment (Figure 1). Vermicompost has been shown to increase chamomile flower yield [8].

Studies on the field crops have also shown that the vermicompost has a positive influence on flower yield by improving the biological activities in soil and the absorption of mineral elements [6, 29]. The high flower yield of chamomile under V5 might be due to higher number of flowers per plant and an increased flower head diameter (Table 1). This finding is in accordance with the previous observations on the *Fragaria ananasa* and *Foeniculum vulgare* [3, 10].

Mean Comparison showed significant differences between various levels of fosnutren spraying. Foliar application of amino acids at F3 phase (Budding + Flowering stage) caused the greatest fresh and dry flower yield (Table 1). Significant differences in flower yield were also recorded for the plants sprayed with fosnutren at the budding (F1) and flowering stage (F2).

Many studies have reported that foliar application of amino acids caused an increase in the growth and development of plants [7, 19]. Amino acids are the valuable nutrients for plant growth because of their nitrogen content. Analysis of variance showed that vermicompost and fosnutren had significant effects on the essential oil content. Mean Comparison showed significant differences between various levels of vermicompost treatments (Table 1). Total essential oil content varied between 0.34 and 0.49% (Table 1), which was obtained from control (V1) and V5, respectively. Vermicompost is rich in macro and microelements, which are responsible for increased qualitative and quantitative yield of many crops [6, 29].

Azizi et al. (2009) have found the positive influence of vermicompost on the essential oil and chamazulene contents of chamomile [8]. Other studies have indicated the same results on some medicinal plants [10, 18].

There were significant differences in essential oil content between the plants sprayed with various levels of fosnutren treatments. Foliar application of fosnutren at F3 (Budding + Flowering stage) resulted in greatest essential oil content (Table 1).

The present results suggest that not only purely physical and chemical properties of vermicompost stimulate the plant growth but there is also the possibility that its indirect effects, via the inhibition of plant pathogen infection [12], nitrate uptake kinetics [24], effects on beneficial microorganisms and plant growth regulators [34] might override pure nutrient effects. In addition, amino acid spraying on chamomile has stimulating effects on the flower yield and could be substitution for chemical fertilizers.

Clearly, more experimental research, aiming to specifically address vermicompost application and amino acid spraying and their consequences for medicinal plants, seems necessary.

IV. CONCLUSION

In conclusion, the results of current experiment show that vermicompost and amino acids have no detrimental but rather stimulatory effects on the growth, flower yield and essential oil content of chamomile and have thus considerable potential for providing nutritional elements in chamomile production, especially for the sustainable production systems.

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TABLE I
EFFECTS OF VERMICOMPOST AND FOSNUTREN ON SOME TRAITS OF CHAMOMILE
(*MATRICARIA CHAMOMILLA* L.)

Treatments	Height (cm)	Fresh flower yield (Kg/ha)	Dry flower yield (kg/ha)	Essential oil %
Vermicompost				
V1	25.3 d	1800.77 d	352.95 e	0.34 d
V2	31.2 c	2311.23 c	462.42 d	0.37 c
V3	34.1 bc	2733.5 b	535.77 c	0.38 c
V4	37.2 b	3172.54 a	592.63 b	0.43 b
V5	41.8 a	3335.7 a	653.81 a	0.49 a
Fosnutren				
F1	33.2 b	2528.48 b	510.18 b	0.35 b
F2	31.9 b	2315.68 c	493.07 b	0.36 b
F3	38.7 a	2868.09 a	572.15 a	0.39 a

Vermicompost levels: V1, 0 ton/ha (control); V2, 5 ton/ha; V3, 10 ton/ha; V4, 15 ton/ha; V5, 20 ton/ha.

Fosfutren spraying F1, at budding stage; F2, at flowering stage; F3, at budding stage + at flowering stage.

Mean values followed by the same letter are not significantly different at $P \leq 0.05$.

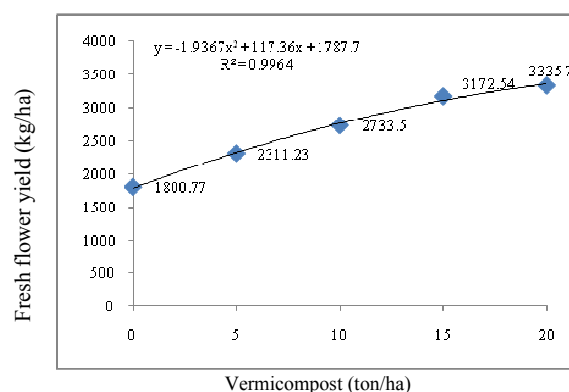


Fig. 1 Effects of vermicompost on fresh flower yield

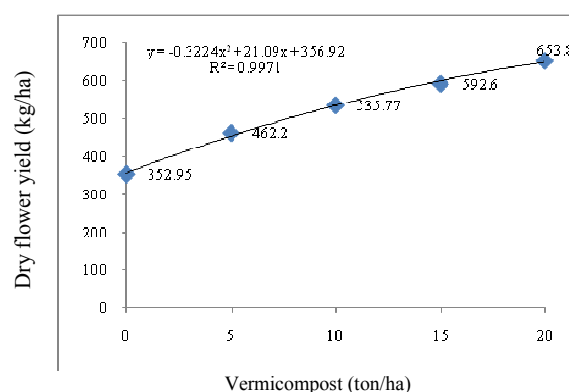


Fig. 2 Effects of vermicompost on dry flower yield

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