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THE EFFECT OF NITROGENOUS FERTILIZER VALUE AND ITS SPLITTING DURING THE GROWTH PERIOD ON MORPHOLOGICAL TRAITS AND ESSENCE RATE OF *Maticaria chamomilla* L.

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Abstract

In order to examine the effect of nitrogenous fertilizer value and its splitting during the growth period on morphological traits and essence rate of Maticaria chamomilla L. in spring cultivation in Tabriz, Iran, a factorial, random whole-block experiment was conducted in triplicates during cultivating year 2009-2010 in Research and Promotive Farm of Basmenj Agriculture Research Center. The treatments in this experiment include three rates of nitrogenous fertilizer 50, 100 and 150 kg/ha along with control one and fertilizing time in four three-phase splitting (b1) 100 percent at cultivation phase, zero at the beginning of flowering, and zero at the middle of flowering, (b2) 50 percent at cultivation phase, 50 percent at the beginning of flowering, and zero at the middle flowering, (b3) 25 percent at cultivation phase, 50 percent at the beginning of flowering, and 25 percent at the middle of flowering, and (b_4) zero at cultivation, 100 percent at the beginning of flowering, and zero at the middle of flowering. In general, the results of experiment indicate that, splitting procedure of nitrogenous fertilizer does not have significant effects on the number of pedicle stem diameter, bush height, number of lateral stems, and tiller number. Regarding the effect of nitrogen consumption level on measured traits in the present research, it was determined that, total traits were affected by different levels of nitrogen (on probability 5%). The review of mutual effect between splitting procedure and different levels of nitrogenous fertilizer on essence rate and essence weight of Matricaria chamomilla L. was meaningful, so that, the highest essence weight was obtained in third treatment and by using 150 kg/ha net nitrogen and also highest rate of essence was related to third treatment with 150kg/ha net nitrogen. Therefore, based on the results of the present research, it appears that the cultivation of Matricaria chamomilla L. along with consumption of 150 kg/ha net nitrogen is suitable in climatic conditions of Tabriz through splitting procedure including 25 percent at cultivation, 50 percent at the beginning of flowering and 25 percent at the middle of flowering. It is expected that the maximum yield of Matricaria chamomilla L. is obtained under conditions of Tabriz along with consumption of nitrogenous fertilize lower than 150 kg/ha.

Key words: *essence, Matricaria chamomilla L, nitrogenous fertilizer, splitting procedure.*

INTRODUCTION

Administration of synthetic chemical drugs for human diseases has been the source of several adverse effects. In some cases, these effects confine drug use or even eliminate some drugs. From the other side, high adaption of herbal drugs with human body has brought pharmaceutical plants to the focus of attention again. As a result, it is apparently indispensable to renew cultivation of these plants and to investigate about breeding and better management of these plants. In this regard, determination the optimum fertilizer dose for the maximum yield and active substances is a major problem. Chamomile is among the most important pharmaceutical plants recognized so far (Naderidarbaghshahi et al., 2012). The German chamomile (*Matricaria chamomilla* L.) is primarily grown for its essential oil. Belonging to the family *Asteraceae*, chamomile is a famous medicinal plant usually mentioned as the ‘‘star among medicinal species’’. As a medicinal plant, this species is currently highly favored and broadly used in traditional medicine. It has been established that this plant possesses multi-therapeutic, cosmetic, and nutritional values (Singh et al., 2011).

As a familiar traditional drug, chamomile is nominated by several names, such as Baboonig, Babuna, Babuna camornile, Babunj, Camomilla, pinheads, scented mayweed, English chamomile, German chamomile, Hungarian chamomile, Roman chamomile, Flos chamomile, Single chamomile, and sweet false chamomile, suggesting its ubiquitous application (Singh et al., 2011).

Chamomile essential oil contains almost 40 different compounds among which the most important ones are chamanzulene, sesquiterpenes, bisabolo oxide A, b-farenzn, and bisabolo oxide B (Ghaedi Jeshni et al., 2017). Chamomile was originally endemic in central Asia and Mediterranean regions.

This plant is also widely spread across Iran, from West to East and from North to the center of the country. With a direct stem, its height is in the range of 30-80 cm depending on the climatic conditions. The flower a diameter also ranges from 0.6 to 1.6 cm and rarely reaches 2.2 cm. The flowers are hermaphrodite with a self-pollinated plant (Bernath, 2000). The most important compounds affecting the biological activity of chamomile include flavonoids, luteolin, apigenin, patuletin, quercetin, and the ingredients of essential oil such as α-bisabolol and its oxides and azulenes (Kawthar et al., 2017).

Chamomile possesses bacteriostatic, antimicrobial, antiseptic, anti-inflammatory, deodorant, carminative, sedative, and spasmolytic effects. It can treat sleep problems. These effects are mostly due to its essential oils (Kawthar et al., 2017). Flowers of chamomile have been extensively used by Greek, Indian, and Middle Eastern physicians (Omidbeigi, 2005; Letchamo et al., 2006). In 1993, Letchamo showed that increasing nitrogenous fertilizer concentration increased flower yield and the amount and percentage of active substances. He reported that the increase in nitrogen and phosphorus dose increased the essence but more potassium concentration had the reverse outcome. environmental factors such as temperature, moisture, nutrients, genetic factors and also the interactions between two types of factors can affect dry matter buildup by chamomile (Salamon and Abou-zied, 2006; Vildova et al., 2006). Poor nutrient content is the characteristic of sandy soils, negatively influencing the growth and yield of medicinal and aromatic plants including chamomile (Kawthar et al., 2017). Optimal growth and development of plants necessitates a variety of nutrients. Nitrogen has most remarkable effect on the quantitative and qualitative plant productivity (Maleki et al., 2014). Numerous researches have reported the significant effects of this element on the yield and other traits of different medicinal plants such as pot marigold (*Calendula officinalis*) and German chamomile (*Matricaria chamomilla* L.) (Rahmati et al., 2009; Ameri et al., 2007). Meawad and colleagues (1984) reported the positive effect of nitrogen, potassium, and some growth regulators on the yield of chamomile flowers (Meawad et al., 1984). Considering the potential importance of German chamomile among pharmaceutical plants of the world (and Iran), the present investigation was conducted to examine the effects of nitrogenous fertilizer value and its splitting on quantitative and qualitative traits of German chamomile, to evaluate the effect of different concentrations of nitrogenous fertilizers on this plant's traits, and to study the interactions between experimental treatments and different quantitative and qualitative traits of German chamomile.

MATERIALS AND METHODS

The present study was conducted on Research and Promotive Farm of Basmenj Agriculture Research Center located on kilometer 15 of Tabriz-Ahar Road in East Azarbaijan Province at the longitude of 46 degrees and 2 minutes and latitude of 37 degrees and 58 minutes. The physicochemical properties of soil are summarized in Table 1. The experiment was carried out in the form of factorial completely randomized blocks with two factors.

Table 1. Mechanical and chemical analysis of cultivated soil

Depth	$EC\times10^3$	pH	O.C%	Clay%	Silt%	Sand%	Soil texture	N%
0-30	1.53	8.1	0.62	20	34	46	Silty	0.02

The field preparation operation was done at the beginning of 2010. The operation included field selection, running the soil tests, early plowing, and finally, leveling and plotting for transplanting. During the field preparation operation, seedling planting was done with 1100 pots in the form of paper cups. The pots were planted on April 24, 2010 in nursery. Noticing the ideal temperature and humidity conditions in greenhouse, the bushes were transferred to the field on May 19, 2010 after reaching six-leaf stage and the approximate height of 8 cm. The row spacing was 30 cm at field with margins of 25 cm and the space between bushes was 10 cm in rows. The first stage of fertilization was manual before the first field irrigation. The next stages of fertilization splitting were also manual. The strain studied in the present work was German chamomile, which was an imported strain purchased from Pakanbazr, Isfahan, Iran. The fertilizer treatments used included nitrogen fertilizer at four levels of 50, 100, and 150 Kg per hectare along with control and fertilization period in four three-stage splits (b_1) 100% at cultivation and beginning of zero flowering and middles of zero flowering, (b_2) 50% at cultivation, 50% at be3ginning of flowering and middles of zero flowering, (b_3) 25% at cultivation, 50% at beginning of flowering, and 25% at middles of flowering, (b_4) zero at cultivation, 100% at beginning of flowering, and zero at middles of flowering. There were 12 treatment combinations with controls at each replicate with total sum of 39 experimental units for all replicates. Noting that chamomile flowers maturate gradually, each time the flowers maturated, they were harvested and the number of flowers in each harvest was recorded. The sampling was conducted on morphologic, phonologic, and physiological traits of the plant. So that subjecting the margins, five plants were selected from the middle of each plot to randomly measure the height and other morphologic traits. The traits examined in this experiment included the height of plant at flowering time, the number of lateral stalks at each plant, the number of leaves at each plant, the total number of flowers, wet weight of flower, dry weight of flowers, essence percentage of flowers, and essence rate of flowers. To measure the flower essence, the harvested flowers were dried at 70°C for 48 hours and immediately weighed after leaving the oven and 30 g of dried flower was set aside for essence extraction. Essence extraction was performed on Laboratory of Agricultural and Natural Resources Research Center of Tabriz using water distillation method by Clevenger apparatus for two hours (Baydar and Baydar, 2005). To measure the essence, 25 g of dried flowers was ground. Then, 600 ml water and 10 g sodium chloride were added for complete essence extraction and the apparatus temperature was set initially at 100°C and then at 70°C. The essence phase was readily separated from salt-water phase through addition of diethylether (the solvent for chamomile essence).

The solution of diethylether and essence was put into 45°C hot water bath to evaporate diethylether (Ghasemi Dehkordi et al., 1375). The data was analyzed by MSTATC and SPSS software and the mean values were compared through Duncan's test at probability level of 5%. The Figures were plotted by Microsoft Excel.

RESULTS AND DISCUSSIONS

Based on the results acquired from table of variance analysis (Table 2), the effect of nitrogenous fertilizer and its significant interactions with number of flowers, wet weight of flowers, dry weight of flowers, essence percentage, and essence weight were calculated at probability levels 1% and 5%. The effect of nitrogenous fertilizer content was also significant at probability level 1% on different flower traits such as number of flowers, wet weight of flowers, dry weight of flowers, plant height, number of stalks, diameter of stalks, number of tillers, number of minor stalks, essence weight, and essence percentage, indicating the effect of different fertilizer concentrations on making significant differences in the extent of the traits mentioned. However, the effect of nitrogenous fertilizer content was insignificant on the number of days until budding and 100% and 50% flowering rates. The interaction of nitrogenous fertilizer content on the splitting of nitrogenous fertilizer also indicated that the number of flowers and essence percentage were under the effect on the interactions between the two factors examined, showing that different nitrogenous fertilizer contents in different splitting periods produced different extents of significant traits, i.e. during examination of effectiveness on significant traits, the two factors examined did not act independently. As a standard criterion, the coefficient of variation also shows the effect of environmental factors on different traits, so that the highest coefficient of variation is related to dry weight of flowers and the lowest one is for essence percentage.

The effect of nitrogenous fertilizer content and its splitting procedure and the interactions between these two factors on the number of German chamomile flowers was significant at probability level 0.01 (Table 2). Through comparison of mean value, it was determined that regarding the number of harvested flowers, the content of 150 Kg nitrogenous fertilizer at all four splitting stages had significant differences with other nitrogenous fertilizer contents and controls, and showed the maximum number of harvested chamomile flowers (Figure 1). As well, the content of 150 Kg nitrogenous fertilizer as 50% splitting at cultivation stage, 50% at the beginning of flowering, and 0% at the middles of flowering produced the maximum number of harvested chamomile flowers.

While the minimum number of chamomile flowers was related to the treatment with splitting as 0% at cultivation, 100% at the beginning of flowering, and 0% the middles of flowering (Figure 1).

The effect of nitrogenous fertilizer content and its splitting procedure on the wet weight of chamomile flowers was significant at probability level 1% (Table 2). The results of comparison of average total wet weight between different spitting procedures shows that there is a significant difference between different splitting procedures in terms of this trait. So that when 100% nitrogenous fertilizer was introduced to the plants at the beginning of flowering, the highest wet weight of flowers was produced.

Table 2. Analysis of variance of physiological traits

Sources Change	df			Average of Squares					
		Time Budding	Time of 50% Flowering	Time of 100% Flowering	Number of Flower	Fresh weight flowers	Dry weight flowers	Stem height	Number of Stem
Block	2	4.92	6.33	1.92	76.86	2.86	3.02	12.75	2.86
Divide	3	11.59^{ns}	7.78^{ns}	5.26^{ns}	4390.84^{**}	25.11^{**}	22.02^{**}	35.97^{ns}	0.843^{ns}
Amount Consumptin	3	0.26^{ns}	4.44^{ns}	4.59^{ns}	141706.69^{**}	579.52^{**}	688.77^{**}	434.23^{ns}	8.69^{**}
Divide× Amount Consumptin	9	6.37^{ns}	3.94^{ns}	5.48^{ns}	1065.62^{**}	2.52^{ns}	1.22^{ns}	18.36^{ns}	2.39^{ns}
E(b)	18	2.55	2.85	1.91	86.52	1.48	1.22	7.35	0.704
CV(%)	-	18.46	20.26	14.23	14.12	16.21	19.32	16.14	18.10

** refer to non-significant and significant at the statistical level of 0.05 and 0.01, respectively.

Continue Table 2. Analysis of variance of physiological traits

Sources Change	df	Average of Squares				
		Diameter Stem	Number Paw	Number of Branches	Percent Essential oil	Weight Essential oil
Block	2	0.001	0.255	13.083	0.00003	5.36
Divide	3	0.00005^{ns}	0.114^{ns}	1.40^{ns}	0.001^{**}	23.84^{ns}
Amount Consumptin	3	0.049^{**}	12.39^{**}	978.25^{**}	0.021^{**}	1904.11^{**}
Divide× Amount Consumptin	9	0.0001^{ns}	0.555^{ns}	4.54^{ns}	0.001^{**}	22.812^{ns}
E(b)	18	0.0001	0.323	2.49	0.0001	5.91
CV(%)	-	10.11	17.16	10.41	9.52	17.12

ns, *, and ** refer to non-significant and significant at the statistical level of 0.05 and 0.01, respectively.

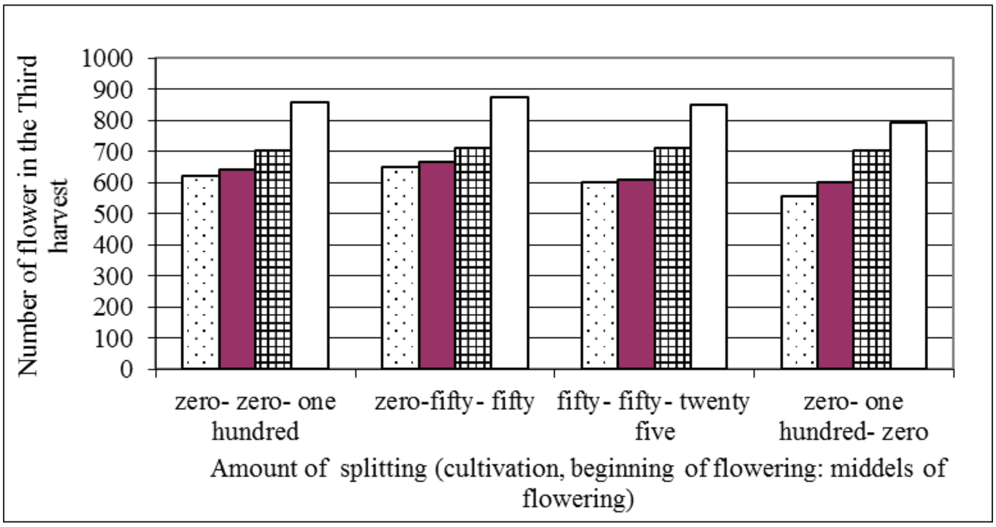

Figure 1. The effect of nitrogenous fertilizer content and its splitting procedure during growth period on the number of flowers

However, when 100% nitrogenous fertilizer was introduced to the plants at cultivation, the lowest wet weight of flowers (73 g) was produced. Noticing, the maximum wet weight of flowers also resulted from consumption of 150 kg in hectare of nitrogenous fertilizer.

The effect of nitrogenous fertilizer content and its splitting procedure on the dry weight of chamomile flowers was significant at probability level 0.01. Noticing, the highest rate of dry weight of flowers resulted when 100% nitrogenous fertilizer was applied at the beginning of flowering and the lowest rate was related to application of 150 kg nitrogenous fertilizer, which was the highest rate in comparison with other treatment and control levels. In general, during the present investigation, it was observed that consumption of above 50 kg per hectare of nitrogenous fertilizer had significant effects on the number of flowers and consequently, dry and wet weights of German chamomile flowers and an almost increasing trend is detectable in the number of flowers, wet weight, and dry weight.

The effect of nitrogenous fertilizer content was statistically meaningful on stalk height at probability level 1%. In comparison of average stalk height with consumption of 150 kg of nitrogenous fertilizer, the maximum stalk height resulted. The results of the present study have revealed that through application of below 75 kg per hectare of nitrogen, the sufficient concentration of this element is available to reach the maximum height of German chamomile plant and higher amounts of nitrogen had no effects on plant height. In other words, limitations in genetic potential of this plant inhibits higher rates of plant height at the above contents of nitrogenous fertilizer. The interactions between consumption rate and the procedure of splitting the nitrogenous fertilizer was also significant for stalk height. The effect of nitrogenous fertilizer content was statistically meaningful on the number of major stalks at probability level 1%. Noticing, application of 150 kg nitrogenous fertilizer dramatically increased the number of major stalks in chamomile plants. The stalk diameter was affected by application of nitrogenous fertilizer, but the effect of splitting the nitrogenous fertilizer and their interaction on stalk diameter was not significant. Noticing, through application of 150 kg nitrogenous fertilizer, the highest stalk diameter was approached, which could be attributed to increased growth of vegetative cells. The effect of application of nitrogenous fertilizer was statistically meaningful on the number of tillers per plant. Increasing nitrogenous fertilizer concentration above 50 kg caused a significant increase in the number of tillers per plant, so that the highest number of tillers was related to 150 kg per hectare of nitrogenous fertilizer. The effect of different values of nitrogenous fertilizer on the number minor stalks was significant at probability level 1%. Comparison of different values of nitrogen showed that the minimum number of minor stalks belonged to levels 50 and 100 kg fertilizer per hectare, which were 66.1 and 66.8, respectively. The maximum number of minor stalks (82.1) was related to fertilizer levels 150 kg. In the results gained from fertilizer levels 100 and 50 Kg per hectare along with 0 Kg of nitrogenous fertilizer, decreased number of minor stalks was observed, whose reason is not clearly understood; however, it seems that other parameters such as environmental parameters could involve in this case. The effect of consumption rate, splitting procedure of nitrogenous fertilizer, and its interaction on essence percentage was statistically significant in chamomile plant. Based on Figure 2, when at cultivation, of 100% specific fertilizer content of treatment 150 kg per hectare given to the plants, 58% essence was produced, which included the highest essence value in comparison with two fertilizer contents of 50 and 100 Kg per hectare applied on neither growth stages. When 100 kg nitrogenous fertilizer was completely given to the plant, the resultant essence percentage rate was at the same statistical level as the conditions under which the nitrogenous fertilizer was not applied at cultivation stage. The effect of consumption rate on essence weight in chamomile plant was statistically significant at probability level 1%. The highest essence weight was generated through application of 150 kg nitrogenous fertilizer per hectare.

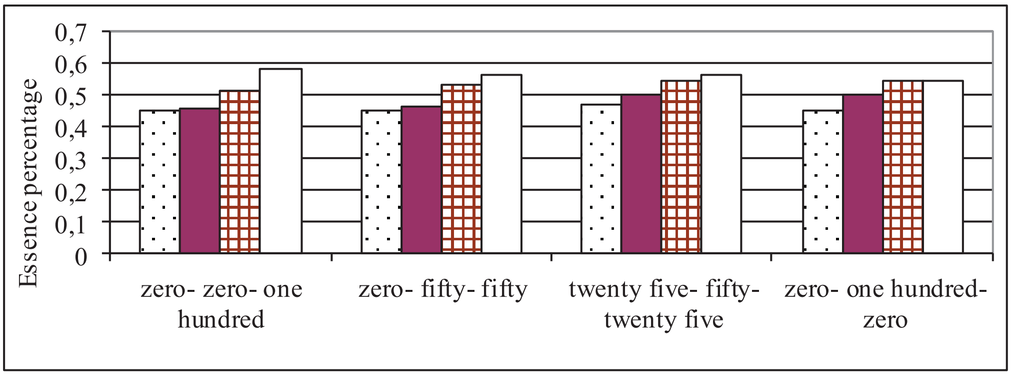

Figure 2. The effect of nitrogenous fertilizer content and its splitting procedure during growth period on essence percentage

Correlation Coefficient of the Traits Investigated

According to the table of correlation coefficient (3), there was a meaningful and positive correlation between the number of flowers on plants and most of the traits investigated. So that the highest correlation of the number of flowers was with wet and dry weight of flowers, stalk diameter, and essence weight. This indicates that increasing the number of flowers caused an increase in each of the traits mentioned. Also the correlation between wet weight of flowers and dry weight of flowers, stalk diameter, and essence weight had the highest value. The wet weight of flower had also the highest correlation with traits such as stalk diameter and the number of minor stalks. Stalk diameter had the highest correlation with the number of minor stalks, showing that with increasing stalk diameter, the number of minor stalks increased significantly. In examination of the results of analysis of variance, the effect of nitrogenous fertilizer consumption rate was significant at probability level 1% on several traits including the number of flowers, wet weight of flowers, dry weight of flowers, plant height, number of stalks, stalk diameter, number of tillers, number of minor stalks, essence weight, and essence percentage. The*se findings are in accordance with the results of investigations done during 2008 (*Zeynali et al., 2008). Based on the results summarized in Table 2, some researchers also proved that increased nitrogenous fertilizer levels caused higher growth of aerial organs and number of flowers and finally, leads in increased accumulation of dry material (Letchamo et al., 1993; Franz and Kirsch, 1974). Comparison between nitrogenous fertilizer levels was conducted in a study showing that via increasing the nitrogen content up to 225 kg per hectare, there was a significant increase in the number of flowers on each plant (Zeynali et al., 2008). During 1974, it was reported that nitrogen played a key role in the growth and development of German chamomile and its shortage at every stage of growth caused decreased number of flowers on each minor stalk by disrupted material synthesis and as a result, lower yield in chamomile. Generally, strains of chamomile with higher productivity and desired resistance to lodging have the potential of higher yield by increased content of nitrogenous fertilizer (Franz and Kirsch, 1974). Letchamo and coworkers (1993) reported that by increased nitrogen application, the number of flowers increased dramatically in German chamomile (Letchamo et al., 1993). The results presented in Figure 2 and 3 are compatible with the findings of Zeynali et al. (2008). They indicated that the application of nitrogen at the beginning of chamomile flowering caused increased growth of plant's reproductive organs and as a result, its higher wet weight. They also stated that the application of nitrogen at the beginning of flowering caused relatively increased accumulation of dry material in flowers (Zeynali et al., 2008). Letchamo and coworkers (1993) reported that through elevating the nitrogen content, wet weight of flowers increased remarkably in German chamomile (Letchamo et al., 1993). Franz and Kirsch, 1974, and Meawad et al., 1984, also reported similar results. Findings reported through 1974 to 1984 show that by increasing nitrogenous fertilizer up to 150 kg per hectare, the number of flowers increases. Letchamo also reported that the rate of fertilization should be fit to plant genotype. He stated that in some species resistant to wind blow, it was meaningful to apply higher fertilizer values (Letchamo et al., 1993). However in some genotypes, higher levels of nitrogenous fertilizer will not lead in remarkably different number of flowers and this accordant with the results pf the present study (Franz and Kirsch, 1974 Meawad et al.,1984). Some reports have stated the required amount of fertilization as 60 kg of net nitrogen per hectare for autumn chamomile (Uori et al., 2000; Sheibanivaziri, 1998). Fernandez (1993) reported that 80 kg of net nitrogen per hectare was suitable for autumn chamomile (Fernandez et al., 1993). In comparison of average stalk height, the maximum height resulted from 150 kg per hectare of nitrogenous fertilizer. The results of Letchamo (1993) showed that by increased nitrogen application, the stalk height significantly increased in German chamomile (Letchamo et al., 1993). Franz and Kirsch, 1974, and Meawad et al., 1984, also reported similar results. Increasing nitrogenous fertilizer via altering the available soil nitrogen during growth season has great effects on height and usually parallel to its elevation, the plant height increases (Mirshekari et al., 2008). Principally, the reason for increased height as a result of applying nitrogenous fertilizer can be attributed to the synergistic effects of nitrogen on vegetative growth and cell divisions in plant organs, especially the stalks. Indicated that because of applying nitrogen, leaf and stalk weight increased. Consequently, it is expected that the plant produces more photosynthetic material and this sets the stage for stalk elongation (Broujerdi, 2002). In a study on autumn chamomile during 2002, it was concluded that by elevating nitrogen from 0 to 150 kg per hectare, there was an increase in stalk height. The maximum (52.1 cm) and minimum (38.3 cm) stalk height were related to 150 and 0 kg per hectare of net nitrogen, respectively and there was a significant difference among levels of nitrogenous fertilizer (Broujerdi, 2002). Figure 7 shows that application of 150 Kg nitrogenous fertilizer causes a significant increase in the number of major stalks in chamomile, which can be attributed to the synergistic effects of nitrogen on vegetative growth, cell divisions in plant organs, specially the stalk. As a consequence of nitrogen application, the number of leaves and stalks increases. Therefore, it is expected that the plant produces more photosynthetic material and this sets the stage for increased number of major stalks (Broujerdi, 2002). The results of investigations conducted by other researchers reveal that by increased nitrogen application, the number of flowering stalks increases significantly in German chamomile

(Letchamo et al., 1993). As can be readily seen in Figure 2, the maximum stalk diameter was observed with 150 kg nitrogenous fertilizer per hectare. The reason is behind increased growth of vegetative cells. More than 50 kg increase in nitrogenous fertilizer caused a significant increase in the number of tillers and the highest number of tillers was produced by applying 150 Kg per hectare of nitrogenous fertilizer. Broujerdi (2002) and Fernandez and Krisch (1974) stated that the levels of nitrogenous fertilizer were meaningful on chamomile. Noting this significance, it can be concluded that the increased tiller number along with increased levels of nitrogenous fertilizer is meaningfully different between various genotypes. However, regarding the same strain used during the present study, it seems that environmental parameters have caused these alterations. Some reports of tillering were presented in 1990, which stated branching and tillering after the first harvest (Letchamo, 1990). Letchamo et al. (1993) reported that through increased nitrogen application, the number of tillers was significantly increased in German chamomile (Letchamo et al., 1993). Through comparison of different average nitrogen levels, it is inferred that the least number of minor stalks belongs to 50 and 100 Kg per hectare, with 66.1 and 66.8, respectively. The highest number of minor stalks (82.1) is related to 150 kg. looking at the results, the vegetative growth enhances by increasing nitrogenous fertilizer, which leads in increased branching and number of minor stalks. Franz and Kirsch (1974) also got similar results. In the results of fertilizer levels 100 and 50 kg per hectare along with zero of nitrogenous fertilizer content, we observed a decreased number of minor stalks, whose reason was not clear, but it seems that other factors such as environmental ones have been involved in this case (Franz and Kirsch, 1974). According to the findings of Sheibanivaziri (1997), the nitrogenous fertilization content of 60 kg per hectare yields the best and the highest essence rate in Chamzulene (Sheibanivaziri, 1998). Increasing the nitrogen content over 60 kg per hectare did not lead in significant differences in the essence rate (Bagheri et al., 2003). Investigations of Omidbaigi (2003) indicated that the cultivation time had a key role in essence and chamazulene rate of chamomile flowers, so that the plants cultivated during the spring had higher essence and chamazulene rate than ones cultivated in autumn. He stated that the role of nitrogen along with cultivation date is essential for increasing the essence rate (Omidbaigi, 2003). In some studies, the average essence percentage was reported to be 0.58% in total of treatments and the highest essence rate was reported for the treatment with net nitrogenous fertilizer level of 135 kg per hectare (Madani, 2006). Our results are in accordance with the results reported by Meawad and coworkers (Meawad, 1984). The claimed that increasing the nitrogen content caused higher essence production.

CONCLUSIONS

It could be concluded that the consumption rate of nitrogenous fertilizer had significant effects on all of the traits examined in German chamomile. Also through increasing the rate of nitrogenous fertilizer consumption, the valuse of traits such as number of tillers, number of major and minor stalks,and essence weight increased.

Applying nitrogenous fertilizer with the ratio of 25:50:25 percent led in increased essence percentage and effective traits in chamomile. Also fertilization level of 150 kg per hectare with the pattern of 25% at cultivation: 50% at the beginning of flowering: 25% at the middles of flowering could have the greatest effect on increasing essence percentage and most of the traits examined had positive and meaningful relations with each other.

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