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ORIGINAL ARTICLE

Effects of Sowing Date and Planting Density on Quantity and Quality Features in Thyme (*Thymus vulgaris* L.)

[1]Payam Moaveni, [2]Hossein Aliabadi Farahani and [2]Kasra Maroufi

[1]*Islamic Azad University, Shahr-e-Qods Branch, Tehran, Iran.*
[2]*Member of Young Researchers Club, Islamic Azad University, Shahr-e-Qods Branch, Tehran, Iran.*

Payam Moaveni, Hossein Aliabadi Farahani and Kasra Maroufi**;** Effects of sowing date and planting density on quantity and quality features in thyme (*Thymus vulgaris* L.)

ABSTRACT

This study was conducted as split plot field experiment in a randomized complete block design with four replications for one year planting in 2010-2011 at Islamic Azad University Shahr-e-Qods Branch, Tehran, Iran. The main factors were the sowing dates (20 April, 5 May, 10 May and 15 May) and sub factors were the planting densities (10, 30, 50 and 70 plants/m^2). Our results showed that sowing date (SD) and planting density (PD) significantly affected total biomass, fresh weight, branches numbers and plant height. The highest total biomass, fresh weight, branches numbers and plant height were achieved under the 10 plants/m^2 planting density and 20 April sowing date. It was thus concluded that sowing date and planting density are the main factors influencing the quantity and quality features in thyme. Our findings may give applicable advice to commercial farmers and agricultural researchers for management of planting density strategy and for estimate of sowing date carefully for increase of quantity and quality features in medicinal and aromatic plants farming. And is better that such studies be further validated by conducting them for two or more years.

Key words: Sowing date, planting density, essential oil and thyme.

Introduction

Thyme (*Thymus vulgaris* L.) is a perennial Labiatae of the Mediterranean region, which has been used for centuries as spice, home remedy, drug, perfume and insectiside. In Medicine, it is used as antispasmolytic, antibacterial, antifungal, secrotolytic, expectorant, antiseptic, anthelmintic and antitusive as reported by other authors [7]. Thymol and carvacrol constituted the main phenolic compound of Thyme oil. The major nonphenolic compounds were linalool and p-cymene [22]. Thyme oil with high thymol content strongly inhibited the bacterial growth. Also, thymol has the higher activity against fungi, followed by carvacrol and geraniol, but linalool, terpineol and thujone exhibited the least effect [8]. The market demand for thyme is rather high, yearly estimates running at about 500 tonnes in USA and 1000 tonnes in Europe. Owing to a general popularity of the use of natural substances instead of synthetic compounds, an increase in that demand is predictable [22]. The yield of plant material, the essential oil content and quantitative composition of T. vulgaris can be influenced by harvest time, ecological and climatical conditions [10,23]. It has been reported that a fairly tight correlation exists between the soil type and the chemotypic structure of the thyme population growing on it. Where the soil type varies, distinct differences among chemotypes can be found over a few metres. To optimize yield of commercial essential oil, most growers use high planting densities with over 6 to 10 plants/m^2 for annual crops but not for biennial crops [16]. High plant density may increase relative humidity within the canopy and

Corresponding Author
Kasra Maroufi, Member of Young Researchers Club, Islamic Azad University, Shahr-e-Qods Branch, Tehran, Iran.
Email: kasramaroufi@yahoo.com

increase the duration of leaf wetness by reducing air movement and sun light penetration [9,27]. Thus, plant density could have significant impact on plant disease incidence [9]. Several studies have been conducted on the effect of plant density on essential oil in medicinal plants [24,21,26,29]. The relationship between essential oil and sowing date has not been established. Early planting increases the total length of time that the plant is in the field and exposed to the environment and also, it is associated with increased incidences of several diseases [8]. Thus, early planting increases the probability of unfavorable consequences, including the quality of the essential oil. Several studies have been conducted on the effect of sowing date on essential oil in medicinal plants [13,29]. The objectives of this study were to describe relationships between sowing date and planting density on essential oil yield and determine the optimum sowing date and planting density for thyme essential oil at Iran.

Materials and methods

This study was carried out in Islamic Azad University, Shahr-e-Qods Branch, Tehran, Iran during 2010-2011. The field experiment was carried out in a split plot, randomized complete block design with four replications in an area of 1800 m^2. The main factor was sowing date (20 April, 5 May, 10 May and 15 May) and the sub factor was planting density (10, 30, 50 and 70 plants/m^2). Nitrogen fertilizer was added twice; first, 50 kg ha^{-1} urea at the stem elongation stage and 50 kg ha-1 urea at the beginning of flowering stage. Also 50 kg ha-1 potash (K_2O) and phosphorus (triple super phosphate) fertilizers were applied at cultivation time respectively. At the maturity, we collected 10 plants from each plot randomly for determination of plant features and selected 100 g flowering shoot dry matter for determination of essential oil percentage by Clevenger. Finally, essential oil yield was determined using the formula by Aliabadi Farahani *et al*. [3]:

Essential oil yield = Essential oil percentage × Flowering shoot

Data were subjected to analysis of variance (ANOVA) using Statistical Analysis System (Spss) computer software at $P < 0.05$.

Results and discasion

It can be resulted that planting date significantly decreased biomass, ($P \leq 0.01$) (Table 1). In such that the highest dry matter is due SD1 (914.1 kg/ha) and the lowest amount related to SD4 (417.3 kg/ha) (Table 2). Production of total dry matter is due SD3 and SD4 (729.28 and 723.4) (Table 2). Highest fresh weight, branches numbers and plant height were achieved under SD1 in first and second cut (Table 1, 2). Also, fresh weight, branches numbers and plant height increasing by increased planting density in first cut (Table 1). But in second cut decreased fresh weight, branches numbers and plant by increasing planting density (Table 2). The highest essential oil yield were achieved under SD1 and PD1 during second cut (Table 3).

In a study, the effects of planting time and plant density on flower yield and active substance of chamomile (*Matricaria chamomilla* L.) were investigated. The treatments were three planting times (5, 15 and 25 March) and three plant densities (50 × 20, 50 × 30 and 50 × 40 cm). The results showed that, highest number of flower per plant, fresh flower per plant, dried flower per plant, fresh flower yield, dried flower yield, essential oil yield, chamazulene percentage and chamazulene yield were obtained by the first planting time (5 March). Also, the highest number of flower, fresh flower per plant and dried flower per plant were obtained by the lowest plant density (50 × 40 cm). The highest fresh flower yield, dried flower yield, essential oil yield and chamazulene yield were obtained by the highest plant density (50 × 20 cm). So, according to the results of this investigation, the *highest* yield was obtained by the earliest sowing and the highest plant density [20]. Also, the highest root yield was achieved by optimal plant density (8 plants/m^2), because photosynthesis increases by development of leaves areas and increases essential oil yield. The plant density of red chicory (*Cichorium intybus* L. var. *foliosum* Hegi) was studied at a field in Linares, south central Chile. Four and five plants/m^2 were established, using a single or a double planting line/row. The distance between rows was 0.60 m. The treatments were 60000, 80000, 130000 and 170000 plants/ha. The average total fresh weight/plant, the marketable fresh weight/plant and head size were higher at the lower plant density. The total yield was higher at the treatment with 4 plants/m^2 and a double planting line/row. The highest marketable and export quality yield was obtained with the treatment 4 plants/m^2, single planting line/row. The lowest marketable yield was observed in the highest plant density treatment. The critical plant density was 0.2 m with a single row [11]. High plant density increased essential oil yield of sweet annie [24] and cumin [21]. On the other hand, if plant density is too high, there is decrease in the availability of resources per plant in the period of flowering stem production. This may lead to a marked fall in yield per plant that is not offset by the increase in the number of plants. High plant density may increase relative humidity within the canopy and increase the duration of leaf wetness by reducing air movement and sun light penetration.

Table 1: Mean comparison of main sowing date and different planting density in first cut.

Treatment	Total biomass kg /ha	Fresh weight gr /Plant	Branches number	Plant height (cm)
Sd1	914.1a	64.1ab	26.1a	27.4a
Sd2	813.0b	68.2a	23.2a	26.3a
Sd3	88.28c	44.5c	18.4b	15.2b
Sd4	417.3d	30.3d	17.1b	14.4c
Pd1	683.2b	48.9c	24.1a	15.0b
Pd2	696.7b	39.8d	22.1a	16.7b
Pd3	729.28a	64.2a	22.3a	24.3a
Pd4	723.4a	51.3b	13.3b	27.3a

Means within the same column and rows and factors followed by same letter are not significantly difference ($P: < 0.05$).

Table 2: Mean comparison of main sowing date and different planting density in second cut.

Treatment	Total biomass kg /ha	Fresh weight gr /Plant	Branches number	Plant height (cm)
Sd1	1005.2a	74.2a	33.4a	35.3a
Sd2	879.1b	70.1a	35.1	33.4a
Sd3	799.2c	59.2b	24.2b	32.1a
Sd4	605.4d	40.3c	15.6c	37a
Pd1	943.3a	73.4a	29.9a	41.5a
Pd2	864.1ab	63.2ab	27.3a	38.2ab
Pd3	840.2ab	58.6c	27.8a	28.4c
Pd4	641.3c	48.6d	23.3ab	30.2bc

Means within the same column and rows and factors followed by same letter are not significantly difference ($P:< 0.05$).

Table 3: Effect of different sowing date and planting density on the main constituents of essential oil % of thyme during second cut.

	Sd1	Sd2	Sd3	Sd4	Pd1	Pd2	Pd3	Pd4
Linalool	4.8	4.6	3.3	3.1	4.3	4.01	3.9	3.5
Terpinol	2.7	2.4	1.7	1.6	2.3	2.2	2	1.9
Thymol	53.1	50.2	43.2	40.1	54	51.1	41.4	40.1
carvacrol	1.3	1.1	0.8	0.4	1.09	1.01	0.6	0.4

The plant increased its shoot for increase of assimilation matters by increase of refulgence absorb for compensation of low density in this condition. Therefore, there was increased root length under planting density of 12 plants/m^2. Two experiments were conducted in Southern Italy with two cultivars of chicory, such as ‘Cicoria da foglie’ (leaf chicory) and "Cicoria di Galatina" ("asparagus chicory") grown at three plant densities (11.1, 5.6 and 3.7 plants/m^2). At maturity, the aerial part of the plant was excised. With the closest spacing during the second year a high seed yield, stems per plant and germination percentage were noticed. Leaving the plants *in situ* resulted in a faster germination, while the excised plants showed a decrease in seed yield, seed per plant, thousand seed weight, plant height and number of stems per plant [6]. Sowing date is very important factor for increasing grain yield which is closely related to the growth duration. The environment during seed development is a major determinant of seed quality, particularly seed vigour [14]. Greven *et al*. [19] suggested that a lower air temperature during seed maturation increases the duration of seed growth, which enabled seeds to be better organised at the cellular level. Adam *et al*. [1] demonstrated the effect that time of sowing can have on soybean seed quality, when they found that hotter environmental conditions were associated with lower quality of harvested seeds. Ahmed and Haque [2] studied the effect of sowing date (November 1, November 20, December 10 and December 30) on the yield of black cumin (*Nigella sativa*) in Bangladesh, they found that early sowing (November 1) was the best for higher seed yield of black cumin. Shortening of the growing cycle decreased the amount of radiation intercepted during the growing season and thus total dry weight of plant [4]. With delayed sowing, development is accelerated because the crops encounter higher temperatures during the vegetative growth [15]. Ehteramian [17] reported that delayed sowing date was better because of the occurrence, resulting to lack sudden winter chilling. Delayed sowing date decreases seed weight and the number of umbrella per plant. El-Gengai and Abdallah [18] and Bianco *et al.* [6] reported significant effect of sowing date and plant density on seed yield of fennel (*Foeniculum vulgar* Mill.). In other studies [5,12,25,28] showed that plant population had significant effect on yield components. Under optimum plant density, plants show efficient use of available water, light and nutrient while under high plant density, and have a higher competition among plants.

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