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Effect of harvesting date on percent and yield of essential oil of *Thymus daenesis* (case study: arid and semi-arid region)

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Abstract

One of the most important endemic medicinal species of Iran is *Thymus daenesis*. This plant grows by itself in many places. The aim of this study was determination of the most suitable time for harvesting of aerial part so that we can have maximum percent and yield of essential oil. This study had been done as factorial experiment in complete randomized block design with two factors, 3 times of harvesting(at the beginning of flowering, middle of flowering and end of flowering)and three distances of bushes in row(30, 50 and 70 cm)and 3 replications during one year (2011-2012). Traits under study were wet weight of aerial part, dry weight of aerial part, percent and yield of essential. Results showed that effect of harvesting time was significant for all traits. Means comparison of dry weight of aerial part of pant by Duncan's test showed that the highest value for this trait was obtained at the end of flowering with 125.47 g/m^2.Also, the highest percent and yield of essential oil equal to 2.76% and3.505 g/m^{2}were observed at the end of flowering.

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Introduction

Phenolik compounds are well known as radical scavengers, metal chelators, reducing agents, hydrogen donors, and singlet oxygenchers (Elena *et al.,* 2009; Proestos *et al.,* 2006). Consumption of fruits and vegetables with high content of antioxidative photochemical such as phenolic compounds may reduce the risk of cancer, cardiovascular disease and many other diseases (Robbins and Bean, 2004). Therefore, the interesting naturally occurring antioxidants have increased considerably for use in food and pharmaceutical products (Djeridane *et al.,* 2006). In recent years, there a wide interest in findings natural compounds that could replace synthetic antioxidant such as butylated hydroxytoluence (BHT) and butylated hydroxyanisole (BHA) because of its possible toxicity and due to a suspected action as promoters of carcinogenesis (ÓSoler_Rivas *et al.,* 2000). Thymus daenensis is an ancient herb used medicine by the Greeks, the Egyptian and the Romans. Essential oil of various types of thymus containing high amount of thymol and caracole were reported to possess the highest antioxidant activity (Andrikopoulos *et al.,* 2002).Thymus involve high amount of polyphones .During the last decades many studies have demonstrate that polyphones, which are the most abundant natural antioxidants in our diet, prevent oxidative alterations due to free radicals and other reactive species (ÓSoler_Rivas *et al.,* 2000) and oxidation of low-density lipoproteins (Andrikopoulos *et al.,* 2002). The nutrition community has recognized the importance of dietary polyphones as health promoting agents, based on accumulating literature data that demonstrate the association of polyphones in take with lower risk of coronary heart diseases. In Iran, it is predominantly found in the north of the country. It is used as a food ingredient, as atea, as an herbal drug for its reputed medicinal properties .Thymus oil strengthens the nerves ,aids memory and concentration it the lungs and helps with colds, coughs asthma, laryngitis, sinusitis, whooping cough ,sore throats and tonsillitis. Oxidant of lipids, which occurs during raw material storage, processing, Processes causing rancidity in food products, leading to their deterioration (Donnelly and Robinson, 1995). Oxidative deterioration can result in alteration of organoleptic characteristics, e., taste and aroma, in the finished products, making them unacceptable effects on the human organism (Elena *et al.,* 2009). Evaluation of the total antioxidant capacity of fruits, vegetables, and other plant products nature of photochemical (Benzie, 1996).

Materials and Methods

Torbate Jam is located in longitude and latitude and has an arid and semi-arid climate with annual average of precipitation of 176 mm. This region is in Khorasan-e razavi province. Mean annual temperature is15c. Also, Thymus *daenesis* growing by itself in this region.

This study had been done as factorial experiment in complete randomized block design with two factors, 3 times of harvesting (at the beginning of flowering, middle of flowering and end of flowering)and three distances of bushes in row (30, 50 and 70 cm) and 3 replications during one year (2011-2012) in Islamic Azad University of Torbat-e jam, Iran.

After preparing field of experiment, seeds were planted in special dishes with cocopythe and pythmose instead of soil. Then, they were kept at green house. When seedlings had 2 leaves, they were moved to plastics pot. At the next stage, when the height of the plants became 10 cm, they were moved out of green house for adaptation. Finally, they were moved to prepared field that furrowed and plotted in 2m*2m dimensions. Harvestings were done by cutting and weighting method in three stages (beginning, middle and end of flowering) during 20thmay to 20thjuly.Harvesting samples were moved to the lab to measure fresh weight of aerial parts, then after air drying their dry weight were measured. Finally essential oil of samples was extracted by Kelevenjer. Also, control samples were collected from range land of Torbate Jam.

Results

Effect of harvesting date on percent of essential oil, yield of essential oil, fresh weight and dry weight of aerial parts was significant statistically at 1% level (table 1). Means comparison for fresh weight at different dates of harvesting by Duncan's test at 5% level showed that the highest fresh weight was related to third cut equal to 285.96 g/m² and the lowest one was related to first cut equal to 29.42 g/m². Also, means comparison for fresh weight at different distances on row by Duncan's test at 5% level showed that the highest fresh weight was related to 30 cm equal to 173.6 g/m² and the lowest one was related to 70 cm equal to 131.2 g/m². So, higher biomass production was obtained at higher planting densities but diameter of the branches was lower at higher densities (4 and 5) (Table 2).

Table 1. Summary of data analysis.

S.O.V.	D.F.	MS of Traits			
		Yield of Essential oil	Percent of Essential oil	Dried weight of aerial parts	Fresh weight of aerial parts
Block	2	0.974	0.152	1181.3	7988.75
Distance on row (D)	2	1.223 ^{ns}	0.028 ^{ns}	1658.9*	4298.5 ^{ns}
Error a	4	0.269	0.136	280.07	2241.2
Harvesting time (H)	2	26.867**	2.675**	32296.14**	149955.1**
H*D	4	0.28 1 ^{ns}	0.084 ^{ns}	214.51^{ns}	2630.9^{ns}
Error b	12	0.377	0.162	340.58	2120.5
Coefficient of Variation (%)		26.05	16.95	26.05	25.8

**, *and ^{ns} show that there is significant effect at 1% and 5% level and no significant effect, respectively.

Table 2. Means comparison of measured traits.

Main effect	Levels	Yield of Essential oil (g/m²)	Percent of Essential oil	Dried weight of aerial parts (g/m²)	Fresh weight of aerial parts (g/m²)
Distances on row	30	1.741 a	2.32 a	75.02 a	173.6 a
	50	1.316 a	2.36 a	50.29 b	143.3 b
	70	1.453 a	2.43 a	52.93 b	131.2 b
Harvesting time	Beginning of flowering (B)	0.145 c	1.75 b	8.61 c	29.42 c
	Intermediate of flowering (I)	1.132 b	2.60 a	44.16 b	132.73 b
	End of flowering (E)	3.505 a	2.76 a	125.47 a	285.96 a

- Common letters in each column for one of the main effects show there is no significant difference

Means comparison for dried weight at different dates of harvesting by Duncan's test at 5% level showed that the highest dried weight was related to third cut equal to 125.47 g/m² and the lowest one was related to first cut equal to 8.61 g/m². Also, means comparison for dried weight at different distances on row by Duncan's test at 5% level showed that the highest dried weight was related to 30 cm equal to 75.02 g/m² and the lowest one was related to 70 cm equal to 52.93 g/m². So, the highest biomass production will be obtained by harvesting at the end of flowering because its phase of growth is passing from vegetative stage to productive stage (3 and 4) (table 2). Also, Effect of day length, temperature and

light of sun increased by shifting from vegetative stage to productive stage then dry weight of plant will be increased (4).

Radiation use efficiency (RUE) is a major factor on dry matter accumulation. Positive effect of pattern of planting on increase of dry matter accumulation is due to higher absorbance of active photosynthetic radiation and increase of photosynthetic efficiency (5).

Table 3. Comparison of interaction means.

Interaction	Yield of Essential oil (g/m²)	Percent of Essential oil	Dried weight of aerial parts (g/m²)	Fresh weight of aerial parts (g/m²)
30* b	0.214 c	1.57 cd	13.54 d	44.61 d
30* i	1.608 bc	2.57 ab	63.42 c	191.31 bc
30* e	4.214 a	2.83 a	148.1 a	284.91 a
50* b	0.123 c	1.95 bc	6.53 d	24.50 d
50* i	0.885 cd	2.53 ab	34.11 cd	98.72 d
50* e	2.941 a	2.6 ab	110.24 b	306.71 a
70* b	0.110 c	1.73 cd	5.77 d	19.13 d
70* i	0.099 bc	2.70 a	34.95 cd	108.14 cd
70* e	0.902 bc	2.86 a	118.07 ab	266.25 ab
Control	3.361 b	1.10 d	107.13 b	247.69 ab

- Common letters in each column show there is no significant difference

Table 4. Correlation coefficients among measured traits.

Coefficient of correlation	Yield of Essential oil (g/m²)	Percent of Essential oil	Dried weight of aerial parts (g/m²)	Fresh weight of aerial parts (g/m²)
Fresh weight of aerial parts (g/m²)	1			
Dried weight of aerial parts (g/m²)	0.964**	1		
Percent of Essential oil	0.331 ns	0.326 ns	1	
Yield of Essential oil (g/m²)	0.932**	0.990**	0.670**	1

**, * and ns show that there is significant correlation at 1% and 5% level and no significant correlation, respectively.

Means comparison for percent and yield of essential oil at different dates of harvesting by Duncan's test at 5% level showed that the highest percent and yield of essential oil were related to third cut equal to 2.76% and 3.505 g/m². Also, the highestpercent of essential oil at different distances on row was related to 70 cm equal to 2.43% and the highest yield of essential oil at different distances on row was related to 30 cm equal to1.741 g/m² (Table 2). This increase is due to effect of day length, temperature and sun light that they increased by shifting from before flowering stage to after flowering stage. On other hand, rate of shading increased by higher density of planting, then rate of light absorbance by aerial parts of plant will be decreased and percent of essential oil will be decreased but yield of essential oil is highly influenced by biomass production due to higher plant density. Although, percent of essential oil

decreased by higher density but yield of essential oil due to higher biomass production increased per area unit (4, 5 and 6). Totally, the highest biomass production and yield of essential oil was obtained from treatment with 30 cm distance on row and cutting at the end of flowering (Table 3).

Correla\tion coefficients show that there was no significant relation between biomass production and percent of essential oil but yield of essential oil had positive and significant correlation with biomass production and percent of essential oil (table 4).

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