Determination of yield and yield components in wild thyme (*Thymbra spicata* L. var. *spicata*) as influenced by development stages

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ABSTRACT: *Thymbra spicata* var. *spicata*, which grows wildly in the flora of Turkey, is known as thyme. A field trial was conducted to determine suitable harvesting time and cutting height for *Thymbra*, therefore plants in the trial were harvested at two cutting heights in various stages of development in the course of the growing season (pre-flowering, full-flowering and post-flowering). It was determined that the time of harvesting had a significant effect on herbage yields, oil percentage and oil yield. The highest drug leaf yield (3.107 t/ha) was obtained in the full-flowering stage with 10 cm cutting length, essential oil percentage ranged from 1.58 to 2.33%, the highest essential oil yield (70.7 l/ha) was obtained at the full-flowering stage with 10 cm cutting length. As a result of this study, harvesting in the full-flowering stage with 10 cm cutting height was the best treatment in respect of the yield of dry matter and oil for thyme (*Thymbra spicata*) cultivation.

Keywords: *Thymbra spicata* var. *spicata*; harvest time; cutting height; essential oil

Thymbra spicata is naturally found as wild in Thracian, Aegean, Mediterranean coastal and Southeast Anatolia areas (Davis 1982). In Southeast Anatolia, *T. spicata* var. *spicata* is known as "Sater" or "Zater" (Baytop 1984). *Thymbra* (*Labiatae*) is represented in Turkey by four taxa belonging to two species (*T. spicata* var. *spicata* and *T. spicata* var. *intricate*) (Davis 1982).

The essential oil of *T. spicata* is dominated by carvacrol (Başer 2002) but there are reports on the occurrence of thymol-rich chemotypes, which is in agreement with the reported finding of Israeli researchers that thymol-rich chemotypes are also possible (Tümen et al. 1994). Carvacrol has an anti-inflammatory activity in the human body. *Thymbra spicata* is also used widely in traditional medicine such as antiseptic, tonic, stimulant, treating diabetes, stomach-ache, common cold, anthelminthic, headache, toothache, mouth ulcer and is extensively used as a spice (Baytop 1984).

One of the most important characteristics of oil accumulation is its dependence on the developmental stage/phase of the plant (art/organ, tissue and the cells). Weather parameters such as atmospheric temperature and rainfall have been reported to influence oil content and composition in several aromatic plants (Sangwan et al. 2001). In the previous work, related to *Labiatae* essential oil plants, different harvest dates are required in order to obtain the highest yields and the highest levels of essential oil (Basker, Putievsky 1978).

The purpose of the present study is to determine the optimum harvesting stage and cutting height of *T. spicata* var. *spicata* to obtain maximum herb and essential oil yield.

MATERIAL AND METHOD

The experiments were conducted in the experimental area and greenhouses of Field Crops Department of Agricultural Faculty, Dicle University in Diyarbakır. *T. spicata* L. var. *spicata* is a perennial plant. The flowers are hermaphrodite (both male and female organs) and are pollinated by insects, especially by bees.

The experimental area has typical climatic conditions (latitude 37°53´N and longitude 40°16´E). This climatic type is characterized by cold and mild winters, by dry and hot summers. Monthly mean temperatures, relative humidity and total rainfalls in Diyarbakır ecological conditions during the experimental years are presented in Table 1. As shown in Table 1, total rainfalls of the first year were lower than long-term data, total rainfalls of the second year

Table 1. Temperature, rainfall and relative humidity data during three years in Diyarbakır ecological conditions

Months	Long-term			2001			2002			2003		
	Temp. (°C)	Rain (mm)	Hum. (%)	Temp. (°C)	Rain (mm)	Hum. (%)	Temp. (°C)	Rain (mm)	Hum. (%)	Temp. (°C)	Rain (mm)	Hum. (%)
January	1.6	73.5	76	4.0	14.9	67	0.7	31.2	77.0	4.0	68.4	78
February	3.6	67.1	72	5.0	72.4	66	5.6	46.1	58.0	2.5	151.8	76
March	8.1	67.9	65	11.4	126.1	69	9.4	73.0	64.0	6.5	80.7	64
April	13.8	70.5	63	14.3	54.0	64	12.2	65.0	69.0	13.4	80.6	66
May	19.3	42.1	56	16.7	86.9	60	17.9	34.9	48.0	20.4	5.4	45
June	25.9	7.0	37	26.7	0.0	26	26.3	1.3	29.0	26.4	26.9	25
July	31.0	0.7	27	31.6	0.0	22	31.0	0.0	19.0	31.7	0.0	14
August	30.3	0.5	27	30.2	0.0	25	29.8	0.0	22.0	31.5	0.3	15
September	24.8	2.7	32	24.7	0.0	27	25.0	5.5	27.0	25.0	0.9	21
October	17.0	31.1	48	16.3	67.0	51	18.6	15.7	41.9	19.0	33.3	40
November	9.6	54.0	67	7.0	52.3	61	10.2	36.6	55.3	9.0	62.5	68
December	4.1	71.5	67	5.1	131.7	82	4.0	74.4	71.0	4.0	87.9	76
Totally		490.0		193.0	605.5		190.7	383.6		193.4	598.7	

were higher than long-term data while rainfalls were high especially in June (Reports of Meteorological Institute of Diyarbakır).

The soil of the experimental area is classified as clay loam, with 1.67% organic matter, pH 7.2 and low in total nitrogen, medium in available phosphorus and high in potash in Diyarbakır.

In this research, the seeds of wild-growing *T. spicata* were collected in the Dicle district of Diyarbakır province and sown in a greenhouse in January and *Thymbra* seedlings were grown to around 10–15 cm height, then they were transferred to the field in rows 30 × 30 cm apart at the beginning of April. Field trials were designed as a split block design with three replications. Harvesting times and cutting heights were considered as main and subplots, respectively. During the vegetation period, plots were fertilized with farm manure (20 t/ha). Plants were weeded and irrigated when needed.

Three different harvest frequencies were examined during two years in order to study ontogenetic variation in plants that were harvested in pre-flowering time, full-flowering time and post-flowering time. The investigation used two cutting heights, 10 and 15 cm, designated low and high, respectively, above the soil. Harvesting was done with a handheld cutter with both cutting heights used at each harvest.

All plant materials were immediately weighed and dried at room temperature. All data were subjected to the analyses of variance according to a split plot design.

The isolation of the essential oils from 20 g of dry herb plants was done by hydro-distillation for 2 h using a Clevenger type apparatus. The essential oil percentage was measured by the volumetric method (Wichtl 1971).

RESULT AND DISCUSSION

The influence of harvesting times and cutting heights on plant height, fresh, dry and drug leaf yield, essential oil percentage and essential oil yield is summarized in Tables 2 and 3.

Statistically significant differences were observed for plant height, fresh herb yield, dry herb yield, drug leaf yield, essential oil percentage and essential oil yield in *T. spicata*.

It is shown in Table 2 that plant height values were affected by harvesting times and years. The highest plant height was observed at post flowering in the second year. The lowest plant height was obtained at post flowering in the first year. Plant height means in the first year were lower than in the second year. It might result from development of roots, compact soil and adaptation to the environment of the plant (Tansi, Ozguven 1995).

The cutting height × harvesting time interaction revealed that 10 cm cutting height × full flowering and pre-flowering was significantly best for fresh herb yield compared to 15 cm cutting height treatment combinations. Higher yield obtained in lower cutting height might have resulted from the branching structure of *Thymbra*. Similar results were observed for dry herb yield. The highest yield was obtained from full flowering with low cutting. As the other, yields were significantly higher with the low cut as compared with the high cut (Zutic et al. 2003). The interaction of harvesting times × cutting

Table 2. Effect of harvesting time and cutting height on plant height, fresh and dry herbage yield of *T. spicata* var. *spicata*

Harvesting time/ Cutting height		Plant height (cm)			Fresh herbage yield (t/ha)			Dry herbage yield (t/ha)		
		2001–2002	2002–2003	Mean	2001–2002	2002–2003	Mean	2001–2002	2002–2003	Mean
Pre-flowering	10	33.86	37.87	35.86	15.25	15.09	15.17 a	3.95	3.92	3.93 a
	15	32.76	36.97	34.86	12.99	13.21	13.09 b	3.24	3.55	3.39 b
Mean		33.31 c	37.42 b	35.36	14.12	14.15	14.13	3.60 a	3.73	3.66
Full-flowering	10	33.40	37.17	35.28	15.09	16.98	16.04 a	3.88	4.29	4.09 a
	15	33.73	38.73	36.23	12.17	13.93	13.05 b	3.09	3.58	3.34 b
Mean		33.56 c	37.95 b	35.75	13.63	15.46	14.54	3.49 a	3.93	3.71
Post-flowering	10	32.06	40.57	36.31	8.50	12.65	10.57 c	1.89	3.49	2.69 c
	15	31.86	41.90	36.88	7.79	12.52	10.16 c	1.83	3.49	2.66 c
Mean		31.96 c	41.23 a	36.60	8.15	12.58	10.36	1.86 b	3.49	2.67
Mean (years)		32.95	38.86		11.97	14.06		2.98	3.72	
LSD (0.05)		Years: 1.340; Year × harvest time: 2.321			Years: 1.767; Cutting height × harvest time: 1.90			Years: 0.6228; Harvest time × cutting height: 0.26		

*Means followed by the same letter are not significantly different according to LSD at 0.05 level

height was statistically significant for drug yield. The highest drug yield was observed at full flowering with low cutting height. Badi et al. (2004) reported that maximum yield of dry and fresh herbage, yield and content of *Thymus vulgaris* L. oil were obtained at the beginning of blooming stage. Ozguven and Tansi (1998) stated that the highest drug yields were obtained from lowland conditions during the post-flowering stage. It was also determined that environmental conditions significantly influenced the harvesting times.

Maximum percentage of *T. spicata* essential oil was found at full flowering in the first year. The essential oil percentage depends on the plant development stage but not on cutting height. Sangwan et al. (2001) reported that the oil content of geranium usually increased from the onset of flowering to be the highest at full bloom and decreased very rapidly thereafter. Tümen et al (1994) stated that the essential oil of *T. spicata* changed 0.5–3.4% at full flowering. Badi et al. (2004) found out that the highest oil and thymol yields were produced by *Thymus vulgaris* L. harvested at the beginning of flowering. Tansi and Ozguven (1995) also reported that essential oil content and components were significantly affected by climatic, ecological conditions and harvesting dates.

The essential oil yield paralleled the herbage yields. The highest essential oil yield was from plots of plants that were cut low at the full-flowering stages. This is due to high yields of fresh and dry biomass and content of oil in this stage. The trend of essential oil

Table 3. Effect of harvesting time and cutting height on drug leaf yield, essential oil percentage and essential oil yield of *T. spicata* var. *spicata*

Harvesting time/Cutting height		Drug leaf yield (t/ha)			Essential oil percentage (%)			Essential oil yield (l/ha)		
		2001–2002	2002–2003	Mean	2001–2002	2002–2003	Mean	2001–2002	2002–2003	Mean
Pre-flowering	10	2.92	2.90	2.91 a	2.00	1.75	1.87	58.0	50.8	54.3 b
	15	2.37	2.59	2.48 b	1.58	1.82	1.70	37.8	47.3	42.5 c
Mean		2.65	2.75	2.70	1.79 c	1.78 c	1.78	47.9	49.0	48.4
Full-flowering	10	2.80	3.40	3.10 a	2.33	2.20	2.26	66.4	75.0	70.7 a
	15	2.19	2.66	2.43 b	2.25	1.92	2.12	48.7	51.1	49.9 bc
Mean		2.50	3.03	2.76	2.29 a	2.06 b	2.19	57.5	63.0	60.3
Post-flowering	10	1.32	2.51	1.91 c	1.58	1.92	1.75	20.2	48.0	34.1 d
	15	1.30	2.50	1.90 c	1.58	1.85	1.71	20.5	46.0	33.2 d
Mean		1.31	2.51	1.91	1.58 d	1.88 c	1.73	20.3	47.0	33.7
Mean (years)		2.15	2.76		1.88	1.91		41.9	53.0	
LSD (0.05)		Harvest time × cutting height: 0.512			Harvest time: 0.089; Years × harvest time: 0.1263			Harvest time × cutting height: 7.69		

*Means followed by the same letter are not significantly different according to LSD at 0.05 level

production was also similar to that of the herb yields, most likely due to the higher yield of the herb producing a higher yield of essential oil (Zutic et al. 2003).

CONCLUSION

In recent years, thyme has started to be cultivated as a new crop in some regions of Turkey. Therefore, the cultivation of thyme should be studied for making it a successful crop and high economic value. Harvesting time and cutting height had significant effects on herbage yields and essential oil percentages of *T. spicata* var. *spicata*. In the 10 cm cutting height and harvesting at full flowering, we found the highest drug leaf yield (3.107 t/ha) and essential oil yield (70.7 l/ha).

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Vliv vývojových fází a výšky seče na výnos drogy a silice planě rostoucího tymiánu (*Thymbra spicata* L. var. *spicata*)

ABSTRAKT: *Thymbra spicata* var. *spicata* je přirozenou součástí flóry Turecka, která je známa jako tymián. Polní pokusy byly prováděny s cílem zjistit nejvhodnější termín sklizně a výšku seče. Byly sledovány dvě výšky seče ve třech fázích vývoje rostlin (před květem, v plném květu a po odkvětu rostlin). Bylo zjištěno, že termín sklizně má průkazný vliv na výnos natě, obsah a výnos silice. Nejvyššího výnosu drogy (3,107 t/ha) bylo dosaženo ve fázi plného květu při výšce seče l0 cm, obsah silice se pohyboval v rozmezí 1,58–2,33 %.Také nejvyšší výnos silice (70,7 l/ha) byl získán ve fázi plného květu při výšce řezu l0 cm. Práce dokumentuje, že nejvyšších výnosů drogy a silice při pěstování druhu *Thymbra spicata* L. lze dosáhnout sklizní v plném květu při výšce seče l0 cm.

Klíčová slova: *Thymbra spicata* var. *spicata*; termín sklizně; výška seče; silice

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