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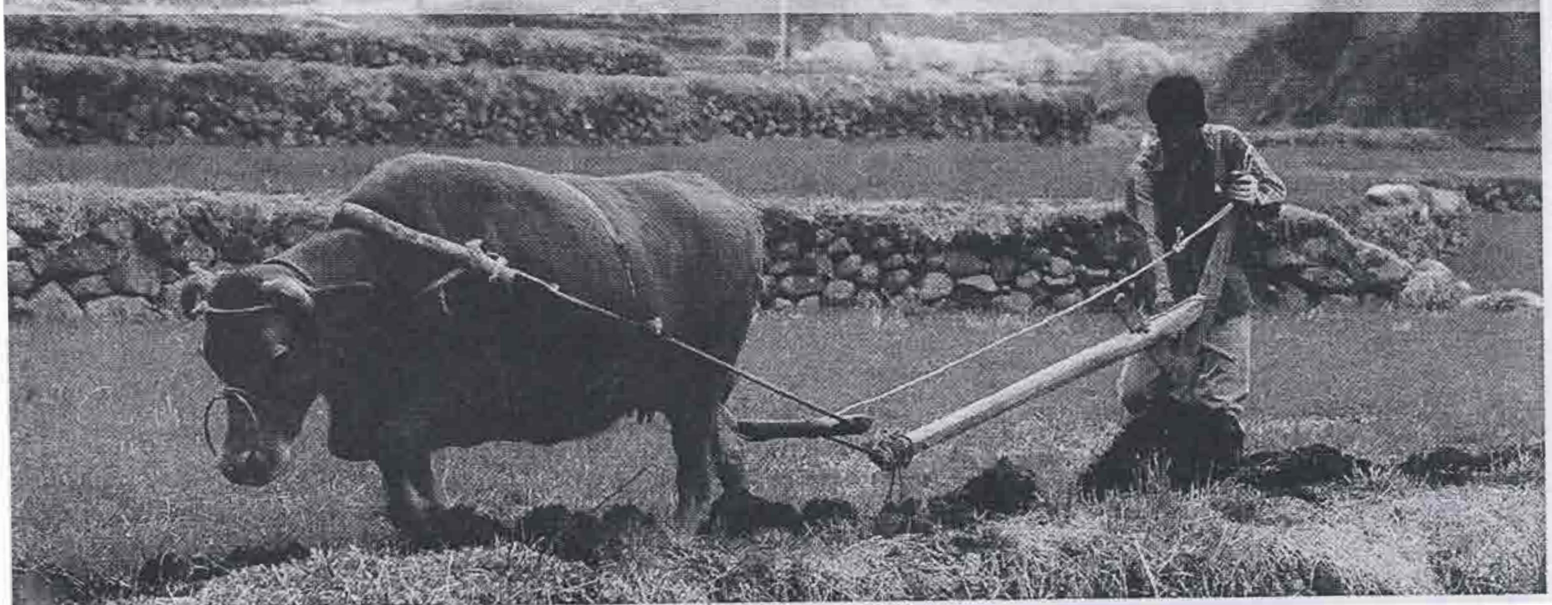

Evaluation of domestication possibility of *Thymus transcaspicus* Klokov under low input cropping system

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Keywords: Irrigation interval, Manure; Khorasan thyme; phytochemical characteristics

Abstract

In order to evaluate the possibilities of cultivation of Khorasan thyme (Thymus transcaspicus), an experiment was conducted in the years 2006 and 2007 under field conditions at the Research Station of the Faculty of Agriculture, Ferdowsi University of Mashhad, Iran. Irrigation intervals (2, 3 and 4 weeks as main plots) and cattle manure (10, 20 and 30 t ha-1 as subplots) were employed within a split-plot design with three replications. Plant biomass and its components as proportion of leaf, stem and flowers and also essential oil percentage and yield were measured at final harvest. Phenological cycles were recorded during the two years of the experiment. Results indicated that increasing application of organic manure beyond 10 t ha-1did not show any significant effect on plant biomass. Increasing irrigation intervals in the second year of trial, significantly reduced plant biomass. This was also true for stem, leaf and flower content in dry matter. Essential oil content and yield in response to organic manure and irrigation showed no particular trend. Phenological cycles were completed in 192 days equivalent to 3300 degree-days in 2006 and 172 days equivalent to 3050 degree-days in 2007. The constituents of essential oil were 25 components which was 43.1% of the total essential content with thymol as the main constituent.

Introduction

In order to conserve medicinal and aromatic plants communities on the basis of sustainability, there are different strategies including domestication and cultivation practices as a means to conserve the species within the human domain. For cultivation of medicinal and aromatic plants under field conditions, different management practices are required including method of propagation, time of planting, plant density, nutrient and water requirements and competition with weeds. However, among these practices, nutrient and water requirements, which may interact with plant secondary metabolites, should be dealt with cautiously. It has been noticed that higher amount of available nutrient in the form of mineral fertilizer may reduce the content of these metabolites. Therefore to supply the amount of nutrient needed, organic fertilizers may be more appropriate for this type of plants. Although water is a limiting factor for plant production, a mild water stress has been shown to increase secondary metabolites in medicinal and aromatic plants. Today, production of these metabolites under low input and organic cropping systems has been considered. *Thymus transcaspicus* (Lamiaceae), is native to the North-East of Iran and Turkamanistan and is used widely by the local communities for different purposes such as curing illnesses, spice and condiment. The aim of this study was to evaluate performance of *T. transcaspicus* plants growth and its suitability for domestication under low input and organic cropping systems.

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Materials and methods

This study was conducted in 2006 and 2007 growing seasons at Research Station of Faculty of Agriculture, Ferdowsi University of Mashhad, Iran. Seeds were sown under glasshouse conditions and then the 66-day-old seedlings were transplanted in the field on 10 May 2006 as spring cultivation with 5 seedlings m^{-2} in plots of 4 m^2 on rows 50× 40 cm distances. All treatments were arranged in split-plot design with three replications in which irrigation intervals (2, 3 and 4 weeks Intervals) were allocated in main plots and composted cattle manure (10, 20 and 30 t ha^{-1}) as subplots which was applied three months prior to transplanting. Experimental plots were irrigated up to field capacity (26.5% θ) with1.5 cm of water (675 l) in each irrigation. Phenological observations were carried out in each plot. The field was managed organically, with no application of chemicals including fertilizers and pesticides. At full blooming stage, from 0.5 m^2 area in each plot, plants were cut at a height of 10 cm above soil level and dried under shaded conditions. Dry matter yield and plant parts (leaf, stem and flower) proportions, except at the second harvest in the second year when the flower number was low and ignored, were determined. Essential oils from the dried aerial parts were isolated by hydro-distillation method using a Clevenger-type apparatus and stored for further gas chromatography analysis and gas chromatography-mass spectrometry. Data analysis was made using SAS statistical software (SAS Institute 2002) and means were compared by Duncan's Multiple Range test at $P < 0.05$.

Results

Crop development: Our observations showed that the total duration of plant growth and development from transplanting to maturity was 192 days equivalent to 3300 GDD in 2006. However, in 2007, up to the second cut when the growth was initiated, from the established plants of first year, it lasted 172 days equivalent to 3050 GDD. Established plants of the second year showed longer reproductive growth duration, from early flowering to the end of plant life-cycle, both in days and GDD measures, compared to the first year plants.

Plant biomass: Increasing the amount of applied organic manure more than 10 t ha^{-1} showed a negative effect on biomass production in the first year and similar results obtained in the second year (Table 1). Plant biomass was higher in the second year of the experiment particularly at the first cut. Increasing the irrigation intervals showed no significant ($P>0.05$) effect on plant biomass in the first year and the first cut of the second year, except the second cut of the year 2007. In this cut, with increasing the irrigation intervals, the plant biomass was reduced (Table 1). In general, higher irrigation intervals resulted in lower plant biomass, although not significant; but the negative impact of longer irrigation intervals was more than the negative impact of higher amounts of manure. It is expected that with increasing plant irrigation intervals, the proportion of stem in total dry matter increases and accordingly the proportion of leaves and flowers decrease. This type of effect has been reported for forage and rangeland crops; however, we did not realize such an effect on medicinal and aromatic plant like Khorasan thyme (Figure 1).

Oil production: Essential oil yield was not affected by cattle manure nor irrigation intervals (Table 1). Increasing irrigation interval from 2–3 weeks decreased the oil percentage; however, a further increase of irrigation interval from 3–4 weeks increased the oil content. Decreasing the irrigation interval from 4 and 3 to 2 weeks showed the highest positive interaction of the two treatments on foliage biomass in both years). At the second cut of 2007, increasing the applied manure more than 10 t ha^{-1} increased the production of biomass as the irrigation intervals decreased. At the first cut of both years, the oil percentage and total oil production increased as the irrigation interval increased from 2–4 weeks across all manure levels. This result was not consistent for the second cut of year 2007. Thymol (43.1%) and carvacrol (8.7%) were the main constituents of the essential oil in Khorasan thyme.

Table 1. Interactive effects of irrigation interval and manure on herbage biomass and oil production of *T. transcaspicus* in two years of experiment (2006–2007).

II (week)	2006			First cut 2007			Second cut 2007		
	M (t ha-1)								
	10	20	30	10	20	30	10	20	30
Dry matter (g m-2)									
2	37.2ab	29.6ab	19.9ab	61.2a	63.9a	57.8a	36.9a	37.6a	38.3a
3	38.9ab	11.8b	19.3ab	51.0a	51.7a	50.4a	27.3ab	19.1ab	34.2ab
4	47.7a	19.6ab	18.5ab	54.6a	46.5a	44.6a	15.1ab	12.4ab	3.5b
Essential oil (%)									
2	2.4a	2.0a	1.6a	0.9ab	1.1ab	1.1ab	0.8a	1.1a	0.9a
3	1.9a	1.9a	2.1a	0.8b	0.9ab	0.9ab	0.7ab	0.7ab	0.7ab
4	2.2a	2.1a	1.9a	1.2a	1.0ab	1.1ab	0.1c	0.36c	0.1c
Essential oil yield (g m-2)									
2	0.6ab	0.6ab	0.3ab	0.5a	0.7a	0.6a	0.8a	0.8a	0.78b
3	0.7ab	0.2b	0.4ab	0.4a	0.4a	0.4a	0.4ab	0.3ab	0.5ab
4	1.2a	0.4ab	0.3ab	0.7a	0.5a	0.5a	0.31ab	0.2ab	0.05b

*Means in each column followed by the same letter are not significantly different (P<0.05), using Duncan's Multiple Range Test. II: Irrigation interval, M: Manure

Discussion

Among various concerns of using fertilizers, including their optimum rate, time and location of application and their interaction with other environment and management factors, our field observation indicated plants loss mostly due to root decay at higher rates of manure application. It may be postulated that the high amount of organic manure in the first year, which is the period of plant establishment with smaller root structure, might have had a negative effect on the plant growth. This has been also reported for other similar plants (Koocheki *et al.* 2004). In another experiment with *Nepeta binaludensis* there was no difference of plant biomass with the application of 10, 20 and 30 t ha^{-1} organic manures (Najafi 2006). Therefore, it appears that this species is not able to tolerate high organic matter in the soil, particularly where irrigation water is limited. Water stress reduced growth and yield of plants and this has been associated with lower photosynthetic rate due to reduced stomatal conductance. There are many reports which confirm the negative effect of water stress on dry biomass production of medicinal and aromatic plants such as *Rosmarinus officinalis* (Delffine *et al.* 2005), and *N. binaludensis* (Najafi 2006). Although essential oil yield was not affected by cattle manure in present study, but this was somehow in

contradiction with some literature in which a positive effect of organic fertilizers on essential oil percentage and yield has been previously reported (Najafi 2006;). Ram *et al.* (2006) reported that increasing water availability reduced essential oil percentage of *Mentha arvensis* but total essential oil yield was increased due to the positive effect of available water on plant biomass, i.e. a dilution effect. It seems that after the first cut, the plants are not able to tolerate any water deficit and increasing irrigation interval more than two weeks would result in biomass reductions, oil percentage and total oil production across all manure levels (Table 1). In general, these results revealed that *T. transcaspicus* has good potential for domestication under low input and organic cropping systems.

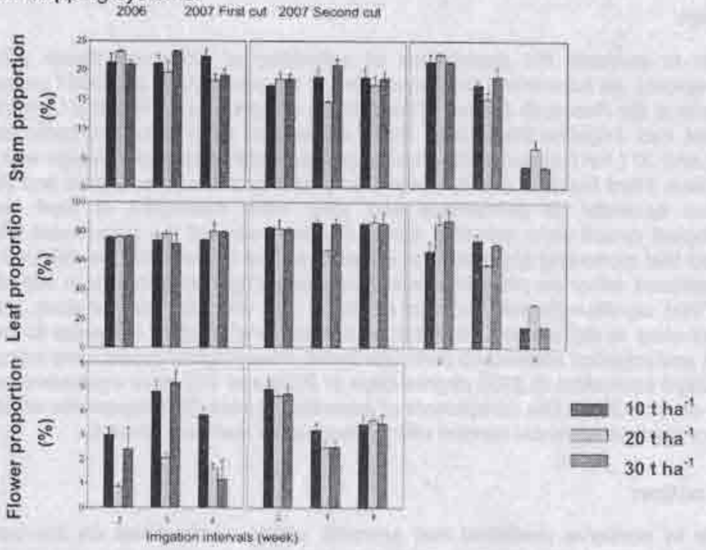

Figure 1. Effects of irrigation intervals and manure on plant part proportion (%) in years 2006 and 2007 (error bars indicate the standard errors).

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