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Comparing the Morphology, Shoot and Essential Oil Yield of the Accession of Two Perennial Savory Species

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ABSTRACT

In this experiment, six accessions of Satureja bakhtiarica and S. spicigera from Yazd, Esfehan and Gilan provinces, Iran, were collected and cultivated in the form of a randomized complete block design with three replications. At flowering stage, the following traits were measured: canopy diameter, plant height, total number of branches, number of flowering branches, fresh and dry yield, and essential oil percentage and yield. At the flowering stage, plants were harvested and dried under shadow, and the essential oil was produced by hydrodistillation using a Clevenger in 2 hours. Analysis of variance indicated the two species varied in their shoot dry yield. There were significant differences in plant height (P≤0.01) and number of main branches, canopy diameter, essential oil percentage and yield (P≤0.05) of the different accessions. Mean comparison of the species showed that the accession Yazd 18 had the highest plant height (45.78 cm). Regarding the number of main branches, Yazd 18, Yazd 19, Gilan 32 and Gilan 35 were in a same group and Gilan 29 and Esfehan 26 were in another group. Shoot dry yield was the highest (903 kg/ha) in Gilan 35. The essential oil yield was the highest in Gilan 29, Gilan 32 and Gilan 35 (8.30, 8.57 at 8.02 kg/ha, respectively). Results also indicated that dry yield was significantly correlated to essential oil yield.

Keyword: essential oil, habitat, *Savory bakhtiarica, S. spicigera*.

INTRODUCTION

Mentha family has 200 genus and 3300 species which usually contain essential oil [1, 5]. In Iran, savory has 15 herbaceous annual and perennial species which nine of them are only found in Iran: *S. intermedia, S. khuzistanica, S. isophylla, S. bakhtiarica, S. rechingeri, S. sahendica, S. atropatana, S. edmondi and S. kallarica* [9]. Savory can be herbaceous or woody, annual, biennial or perennial plant, with various needs and ecological requirements [7].

Shoots of this plant are used to cure infectious diseases and respiratory and urinary systems [2]. Alcoholic extract of *S. khuzistanica* inhibits both gram-negative and gram-positive bacteria and *Candida albicans* and *Aspergillus niger* fungi [4]. Carvacrol content in cultivated and wild savory at pre flowering and full flowering stages was 48.6%, 62.3% and 20%, 25.8% respectively. This indicates that ecological conditions affect plant carvacrol content [8]. In another experiment, shoot of *S. bakhtiarica* and *S. khuzistanica* was harvested from natural habitat at pre flowering and full flowering stages and dried. The essential oil was produced by hydrodistillation. Their results showed that the essential oil of *S. bakhtiarica* at both stage and *S. khuzistanica* at pre flowering stage had noticeable antimicrobial features [3].

Finally, this experiment was conducted to study the variation in morphology, yield and essential oil of different savory accessions from two species.

MATERIALS AND METHODS

This experiment was conducted in Homan Absard Research Station, located 65 km east of Tehran (35° 40´ N, 52° 5´ E, 1960 m above the sea level). Homand research station is a plain area with 4% grade, brown alluvial soil and ph of 7.7. The soil type at the upper soil layer is loam, and at the lower soil layers contains calcareous layers. The area is classified as cold climates with mean annual of 333mm.

Six accessions from *Satureja bakhtiarica* and *S. spicigera*, from the natural habitats of Yazd, Esfehan and Gilan provinces in Iran, were collected and cultivated. The experimental design was one-way nested in the form of a randomized complete block design with three replications, and 25 plants / plot. Plots were 5 × 5 m and plants were planted with 1 × 1 m intervals.

In mid may 2011, transplants were moved from the greenhouse to the prepared field. At the flowering stage, plants were evaluated for traits such as canopy diameter, plant height, flower length, corolla length, flower diameter and sepal length. Five plants from each plot were harvested at flowering for measurement of shoot yield and essential oil. The essential oil was produced by hydrodistillation using a Clevenger in 2 hours. Data were analyzed using SPSS and means were compared by Duncan's multiple test.

RESULTS

Analysis of variance showed the significant variation in shoot dry yield between the two species ($P \leq 0.01$). There was also significant differences in plant height ($P \leq 0.01$) and number of main branches, canopy diameter, essential oil percentage and yield ($P \leq 0.05$) (Table 1).

Mean comparison indicated that plant height was the highest in Yazd 18 accession (45.78 cm) and the lowest in Gilan 35 (20.72 cm). Regarding plant height, Yazd 18, Yazd 19, Gilan 29 and Gilan 32 were in the first group and Gilan 35 and Esfehan 26 were in the second group (Table 2). Yazd 18, Yazd 19, Gilan 32 and Gilan 35 had the same number of main branches, in one group, and Gilan 29 and Esfehan 26 were in the second group; the highest number of main branches was related to Yazd 19 (7.89). Canopy diameter was significantly the same between the species; however, it was the highest in Gilan 32 (70.94 cm). Mean comparison of shoot fresh yield indicated that Gilan 35 had the highest value (2533 kg/ha). Shoot dry yield was also the highest (903 kg/ha) in Gilan 35.

About the essential oil percentage, Esfehan 26, Gilan 29 and Gilan 32 had the highest content (1.2, 1.39 and 1.62% respectively). Essential oil yield was the highest in Gilan 29, Gilan 35 (8.30, 8.57 and 8.02 kg/ha respectively).

Determining the correlation of the measured traits showed that plant height had significantly positive correlation with canopy diameter and negative correlation with the number of lateral branches, fresh yield and dry yield (Table 3). There was significantly positive correlation between the total branches and flowering branches. Fresh yield was significantly correlated to dry yield, and dry yield was also correlated to essential oil yield.

Analysis of variance for the measured traits

SOV	df	Mean Squares (MS)									
		Plant height	Number of main branches	Number of lateral branches	Number of total branches	Number of flowering branches	Canopy diameter	Shoot fresh yield	Shoot dry yield	Essential oil percentage	Essential oil yield
Species	1	97.16ns	0.49ns	0.49ns	29.01ns	9.83ns	8.87ns	3416498ns	706464**	0.42*	133**
Rep	2	64.67	6.92	12.00	727.80	170.10	175.45	150380	21541	0.01	2.01
Accession in species	4	392.7**	15.31*	9.96ns	602.76ns	76.08ns	1034*	1397910ns	73756ns	0.158*	2.09ns
Error	10	66.22	4.29	6.41	239.65	51.16	263.51	530104	65548	0.06	3.16
CV (%)	-	20.76	38.22	28.83	39.50	37.89	36.69	34.96	35.30	19.59	31.84

ns, nonsignificant; *, significant at P≤0.05; **, significant at P≤0.01.

Table 2. Variation of the measured traits in the studied accessions

Species	Accession	Plant height (cm)	Number of main branches	Number of lateral branches	Number of total branches	Number of flowering branches	Canopy diameter (cm)	Shoot fresh yield (kg/ha)	Shoot dry yield (kg/ha)	Essential oil percentage (%)	Essential oil yield (kg/ha)
S. bakhtiarica	Yazd18	45.78a	4.67ab	6.44a	27.78a	16.67a	44.11ab	918b	301b	1.07bc	3.64b
	Yazd19	44.81a	7.89a	8.70a	57.77a	22.74a	55.11ab	470b	192b	0.88c	1.54b
	Esf26	33.98ab	3.20b	10.75a	28.23a	15.00a	35.63b	668b	283b	1.20abc	3.40b
S. spicigera	Gilan29	40.15a	3.52b	8.85a	29.30a	13.26a	35.48b	1477ab	573ab	1.39ab	8.30a
	Gilan32	49.76a	7.74a	7.56a	49.65a	24.75a	70.94a	660b	508ab	1.62a	8.57a
	Gilan35	20.72b	5.50ab	10.38a	42.44a	20.83a	24.22b	2533a	903a	1.06bc	8.02a
Mean	*S. bakhtiarica*	41.52	5.25	8.63	37.92	18.14a	44.95	685	265	1.05	2.86
Mean	*S. spicigera*	36.88	5.58	8.93	40.46	19.61a	43.55	1557	661	1.36	8.30

Means in a column followed by the same letter are not significantly different at P≤0.01.

Table 3. the correlation of the measured traits

	Plant height	Number of main branches	Number of lateral branches	Number of total branches	Number of flowering branches	Canopy diameter	Shoot fresh yield	Shoot dry yield	Essential oil percentage	Essential oil yield
Plant height	1									
Number of main branches	0.39ns	1								
Number of lateral branches	-0.79*	-0.34ns	1							
Number of total branches	0.19ns	0.94**	-0.05ns	1						
Number of flowering branches	0.20ns	0.95**	-0.19ns	0.90**	1					
Canopy diameter	0.85*	0.76*	-0.61ns	0.56ns	0.64ns	1				
Shoot fresh yield	-0.81*	-0.27ns	0.39ns	-0.17ns	-0.13ns	-0.73ns	1			
Shoot dry yield	-0.67ns	-0.09ns	0.31ns	-0.04ns	0.08ns	-0.46ns	0.93**	1		
Essential oil percentage	0.33ns	-0.04ns	-0.19ns	-0.15ns	0.03ns	0.40ns	-0.09ns	0.24ns	1	
Essential oil yield	-0.22ns	-0.06ns	0.04ns	-0.09ns	0.06ns	-0.07ns	0.59ns	0.83*	0.073ns	1

ns, nonsignificant; *, significant at P≤0.05; **, significant at P≤0.01.

DISCUSSION

Analysis of variance showed that there was no significant difference in plant height, the number of main branches and lateral branches of *Satureja bakhtiarica* and *S. spicigera*, indicating that the both species are compatible with the new conditions, because accessions had been collected from different habitats, and cultivated in new environmental conditions. Mean comparison showed that Gilan 35 had the lowest plant height while Gilan 29 had the lowest number of main branches.

In other savory species it was observed that plant height reduced in field conditions compared with the habitat conditions. This reduction may be attributed to the new conditions, which may alleviate in following years. So the results of the first year cannot be used in breeding programs and selection of species or accessions. Non significant differences in the number of main and lateral branches under same environmental conditions can be attributed to the same growth potential of both species, because of their close genetic relationships.

Shoot dry yield, which is one of the most important factors in savory, was significantly different between the species and accessions. Shoot dry yield was 661 kg/ha in *S. spicigera* and 265 kg/ha in *S. bakhtiarica*.

Higher number of branches in savory is not considered as a directly favorable trait because stems usually contain the lowest essential oil percentage and increase the cost of production; however, it can increase the essential oil yield indirectly through increasing the number and yield of leaves. Results of this experiment showed that the highest essential oil percentage was achieved in Gilan 29 and Gilan 32. As the ecological conditions were the same for all accessions, the variation in the essential oil percentage must be related to the genetic factors. Genetic flexibility of medicinal plants populations mainly depends on the environmental condition of their growth area. This flexibility makes the populations more adaptable to the habitat [6].

The negative correlation of plant height with lateral branches and dry and fresh yield represents that the effect of the number of lateral branches on yield is more than plant height. Maybe, the main reason of the negative effect of plant height on yield is the negative correlation of plant height with the number of tillers and lateral branches.

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