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Original Article

Evaluation of Essential Oil Yield, Morphological and Phenological Traits in Some Populations of Two Chamomile Species (*Matricaria recutita* and *M. aurea*)

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Abstract

Evaluation of essential oil yield, morphological and phenological traits of seven populations of two Chamomile species (*Matricaria aurea* and *M. recutita*), were carried out using Randomized Completely Blocks Design (RCBD) in three replications in Alborz research station in Karaj, Iran during 2011-2012. Data were collected for 12 morphological and phenological traits. Analysis of variance showed significance difference (P ≤%1) between populations for all of traits. Also, the effect of year and year x population interaction effect were significant (P≤%1) for all of traits. Results showed *Matricaria recutita* hah higher values for all of traits except shoot fresh and dry weight. Mean comparison showed that two populations of Esphahan and Hamadan from *Matricaria recutita* and one population Gachsaran of *Matricaria aurea* had high shoot yield and essential oil yield than other populations. Result of simple correlation analysis showed that essential oil percentage was positively correlated with plant height, flower number, shoot dry weight and essential oil yield and negatively correlated with time of flowering and maturity date and GDD (Growth Degree Days), suggesting that early maturity plants had higher essential oil content. Results of stepwise regression analysis for essential oil content as dependant variables and other traits as independent variables showed significant effects of maturity date, flower number, plant height, canopy diameter length and flowering date in essential oil content.

Key Words: Chamomile, *Matricaria recutita, M. aurea*, Essential oil

Introduction

The Chamomile plant of the genus of Matricaria is related to Compositae family. According to Beremer and Humpheries [1], seven species were identified for genus of Matericaria. *Matricaria recutita* L. is growing in Eurasia area but *Matericaria aurea* (Loefl) Sch. Bip.annual plant is endemic of Europe but also it is distributed in other parts of the world. Both species recorded in Flore of Iranica as non-endemic species of Iran. *M. aurea* has provenance in north of country (Golastan), west (Lorestan, Charmohal) South (Khozestan and Fars) . *Matricaria recutita* L. has provenance in center of country (Tehran), west (lorestan), and south (Andimesk, Shoshtar and Izeh). The situation of *M.recutita* in Iran is as lower Risk Plant [2] but *Matricaria recutita* species is as Data deficit plant [3].

These plants are annual plant which is growing as wild type in field, gardens, unfertile land and shading area. Consumption of the chamomile plant documented in pharmacopeias of 26 countries [4]. 120 of compounds were identified from Matricaria genus. This plant is diploid which have 20=2x=18 Chromosome [5,6]. Genetic variation of different species of Chamomile genus with provenance of Iran and Europe were studied for morphological and molecular marker and result showed that maximum essential oil percentage obtained with

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high economical yield and high number flower. Also it was found no relationships between Genetic variation and geographical distribution [7].

13 populations of German chamomile with provenance of center and north of Italy including: 9 central population and two North Italian variety, Eslovaky variety of Bona, Italian variety of SYN1 compared for agronomical and quality traits: fresh weight, flower yield and essential oil properties. Result showed that agronomical traits and quality of essential oil of wild type chamomile were similar or better than Bona Eslovaky variety [8].

20 populations of German chamomile and 5 European populations were compared for morphological traits and result showed that there was significant variation for biological and economical yield, flower number/plant and essential oil percentage but phenological traits showed lower variation [9]. By a research, flower traits and essential oil yield of some populations of two species of *Matricaria recutita* and *M. aurea* were studied and result showed that essential oil% of *Matricaria recutita* were 2.85%, 0.68%, 2.35% for populations of Bosher, Khozestan and Fars, respectively. Also the value of essential oil content as 0.63% obtained for *Matricaria aurea* [10].

The aim of this experiment, was to evaluation of essential oil yield, morphological and phenological traits of seven populations of two Chamomile species (*Matricaria recutita* and *M. aurea*) for identification of high yield populations and relationships between yield and agronomic traits

Materials and Methods

In this research, 6 populations *M. recutita* and one population *M. aurea*, with different provenance (Table 2) provided from the Natural resource gene bank of Research Institute of Forest and Rangelands. Seeds were sown in Jify pot in March of 2010. Then, after seed emergence, seedlings were transferred into field in Alborz research station in Karaj city on 2011. The experiment layout was Randomized Completely Blocks Design (RCBD) with three replications. Each unit of experiment consists of six rows with 50 cm distance between rows and 40 cm between plants within rows. Data were collected for morphological and phenological traits including: length and width of canopy diameter, plant height, number of flower, shoot fresh and dry weight, growth degree days (GDD), essential oil percentage and essential oil yield and plant height. Date of flowering and maturity were recorded as number of days was from date of cultivation till first flower emergence per plant. Growth degree days were recorded using Frank *et al* [11] formula as follows :

$$GDD = \frac{Tmin + Tmax}{2} - Tb$$

GDD= Growth degree days

Tmax = Maximum daily temperature

Tmin = Minimum daily temperature

Tbase = is the base temperature

For extraction and measuring of essential oil, the samples of plants were collected in flowering time then 80 g of each sample were measured. Measuring of essential oil was performed by Celvenger Instrument on the base of Hungarian plant pharmacopoeia letter [12]. For calculation of essential oil percent, 5 g of each sample was dried in oven 50°C for 24 h then reweighed and moisture % was calculated.

Percent and yield of essential oil were calculated by following calculation Siddiqui *et al*., [13]):

$$\text{Essential oil content } \% = \frac{\text{Essential oil weight g}}{\text{Shoot dry matter g}} \times 100$$

The collected data were analyzed and mean comparisons were made using Duncan method. Phenotypic correlation was determined between traits and stepwise regression analysis was used for essential oil% content as dependant variables and other traits as independent variables using MINITAB 16.

Results

Analysis of variance and means comparisons

Matricaria aurea had one population originated from Gachsaran in south of Iran and *Matricaria* recutita had 6 populations Najafabad 1, 2, Chelgard, Sarband, Hamadan and Esfahan (Table 2). Results of analysis of variance showed that there were significance differences between years and populations for all of traits (P≤%1). Also the population by year interaction effect was significant for all of traits (P≤%1) (Table 2).

Results showed *M. recutita* hah higher mean values for all of traits except shoot fresh and dry weight. *M. aurea* with average values of 441g per plant had higher shoot dry weight yield than that for *M. recutita* ranged from 127 to 447 g per plant. Similarly, *M. aurea* with average values of 0.21%

had higher essential oil percentage than *Matricaria recutita* with range of (0.10-0.16%).

Mean comparison for populations showed that populations of Esfahan and Sarband with average values of 59.39 and 56.76 cm had higher canopy diameter length, respectively. The maximum value of canopy diameter width was obtained for Esfahan population. as 47.77. The minimum values of canopy diameter width were 25.68 and 25 cm for Hamadan and Najfabad populations, respectively (Table 2). For Plant height, populations of Esfhan, Chelgard and Sarband with average values of 48.66, 47.61 and 42 cm had higher plant height, respectively. The lower Plant height value of 32 cm was related to Hamadan population (Table 2). Maximum number of flower per plant with average values of 241 and 203 were obtained for Esfhan and Sarband populations, in contrast, the lower flower number with average values of 52 was obtained for Hamadan population (Table 2).

For phenological traits, results showed populations of Sarband and Chelgard with 137 and 130 days till flowering, 165, 162 days till maturity, respectively were considered as late population. The Hamadan with average values of 54 and 56 days had lower time of flowering and maturity (Table 2).

For Fresh and dry weight of shoot, the populations of Esfahan and Hamadan with average values of 9863 and 6302 g fresh weight and 4477 and 2607 g dry weight had higher production than other populations (Table 2).

For essential oil content and essential oil yield, the populations Esfahan and Hamadan with average values of 0.17 and 0.13% oil contents and essential oil yield with average values of 9 and 3 g/ha, had higher than other populations (Table 2). The lower essential oil content with average values of 0.11and 0.10% and essential oil yield with average values 2.31 and 1.63 g/ha were obtained for Sarband and Chelgard, respectively (Table 2).

For the GDD of flowering date, Sarband and Chelgard with 2514 °C and 2367 °C had higher GDD values than other populations. The lower GDD values of flowering with average values of 847°C was obtained for Najafabad1 (Table 2).

Relationships between yield and agronomic traits

Result of simple correlation analysis showed that essential oil percentage was positively correlated with plant height, flower number, shoot dry weight and essential oil yield and negatively correlated with time of flowering and maturity date and GDD, suggesting that early maturity plants had higher essential oil content (Table 3).

Shoot dry matter yield was positively correlated with canopy diameter, plant height, flower number, Essential oil content and Essential oil yield were negatively correlated with date of flowering and maturity. There was strong correlation between flowering and maturity date. Both traits was negatively correlated with canopy diameter, plant height, flower number, shoot fresh and dry weight. Indicating early populations had higher production (Table 3).

Results of stepwise regression analysis for essential oil percentage as dependant variables and other traits as independent variables showed significant effects of maturity date, flower number, plant height, canopy diameter length and flowering date in essential oil content (Table 4). The final model with R square=80.34 explained most of variation. There was a good agreement between the results of correlation and regression analysis (Table 4).

Discussion

With regard of result which obtained for *Matricaria recutita*, for economic traits including: length and width of canopy diameter, shoot yield, essential oil percentage and oil yield it was concluded that Esfhan population had higher values for these traits. This result was coordinated with result of Azizi [14], who compared four variety of *M. chamomile*. Also high value of essential oil yield in *M. recutita*, and low value *Matricaria aurea* were in agreement with result of (Pirkhezri *et al*.,[15]; Mann & Staba [16]. They concluded that essential oil yield would be controlled by both genetical and environmental factors. Therefore selection of superior populations would be useful for increasing and improvement of traits in next breeding programs.

Also with regards of GDD, population of Najafabad1 had lower value of GDD compare with other populations like Sarband and Chelgard which they had high value of GDD. Therefore population of Najafabad1 goes to flowere sooner than other populations. This result was in agreement with result of Alizadeh, *et al.*, [17] and Rojas-Arechiaga, [18], Ghani dehkardi *et al*., [19] Jalali *et al.*, [10] who reported effect of temperature on development of phenological stage in some species of Anthemis genus.

Table 1 Summary of analysis of variance and the mean square of the significant traits of German Chamomile *M. recutita* and *M. aurea* populations over two years in Karaj, Iran

SOV	DF	MS										
		Length of Canopy Diameter	Width of Canopy Diameter	Plant Height	Flower Number Per Plant	Date of Flowering	Date of Maturity	Shoot Fresh Eight	Dry Shoot Weight	Essential Oil Content%	Essential Oil Yield	*GDD of Flowering
Year	1	7638**	3648**	13333**	296558**	33171**	58855**	3765440**	1231361**	3.51**	2.976**	22141730**
Error 1	4	12.85	0.80	22.71	203.11	55.37	73.91	95231	18303	0.007	0.023	4105
Population	6	414**	460**	313**	35154**	10702**	15837**	1836162**	939010**	0.40**	1.671**	2983367**
Year* Population	6	646**	321**	1609**	48382**	6214**	12274**	23201	17733	0.007	0.090	8267883**
Error 2	24	35.2	24.3	45.5	1256	41	41	36362	17331	0.03	0.037	117506

*, **= Means of squares are significant at 5%, 1%, respectively.

*GDD: Growth Degree Days

Table 2 Comparison of the seven populations of German chamomile, *M. recutita* and *M. aurea* based on the means of two years in Karaj

Species	Populat-ions	Origin	Length of Canopy Diameter (cm)	Width of Canopy Diameter (cm)	Plant Height (cm)	Flower Per Plant	Date of Flowering (days)	Date of Maturity (days)	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Essential Oil Content%	Essential Oil Yield	GDD of Flowering (°C)
M. aurea	15262	Gachsaran	14.26 e	9.130 f	8.48 d	54.92 d	28.23 d	45.67 d	866.7 a	441.0 a	0.210 a	0.80	338.0 d
	1136	Najafabad 2	42.85 cd	31.80 c	35.92 bc	88.39 c	35.02 d	52.13 d	400.5 b	211.8 bc	0.120 bc	2.06 c	1052.0 bc
	1137	Najafabad 1	41.50 d	25.00 d	33.75 bc	85.00 c	58.76 c	70.16 c					847.2 c
M. recutita	8528	Chelgard	49.748 cb	36.70 bc	47.61 a	186.17 b	129.75 a	161.83 a	265.5 c	165.5 cd	0.113 bc	2.31 b	2367.5 a
	8617	Sarband	56.762 ab	39.71 b	41.99 ab	202.6 ab	137.33 a	165.33 a	243.3 c	127.1 d	0.101 c	1.63 b	2514.5 a
	14324	Hamadan	39.787 d	25.68 d	31.74 c	53.63 c	53.55 c	56.10 d	571.0 a	260.8 b	0.130 b	2.70 b	1233.9 bc
	23879	Esfahan	59.388 a	47.77 a	48.66 a	240.67 a	88.28 b	99.16 b	630.1 a	447.6 a	0.166 a	8.70 a	1326.3 b

Means with the same letter are not significantly different ($\rho<0.05$)

Table 3 Correlation between oil yield, morphological and phenological traits evaluated over 2 years (2011-2012).

Traits	Canopy diameter length	Canopy diameter width	Plant height	Flower no/ plant	Flowering date	Maturity date	Shoot fresh weight	Shoot dry weight	Essential oil %	Essential oil yield
Canopy width	0.97**		-	-	-	-	-	-	-	-
Plant Height	0.95**	0.92**		-	-	-	-	-	-	-
Flower No/plant	0.93**	0.92**	0.94**	-	-	-	-	-	-	-
Flowering date	-0.24	-0.18	-0.38*	-0.27	-	-	-	-	-	-
Maturity date	-0.31*	-0.24	-0.43**	-0.32*	0.99**	-	-	-	-	-
Fresh Weight	0.58**	0.60**	0.54**	0.42*	-0.43**	-0.50**	-	-	-	-
Dry Weight	0.63**	0.70**	0.58**	0.53**	-0.31**	-0.38**	0.93**		-	-
Essential oil %	0.26	0.22	0.37*	0.41*	-0.74**	-0.76**	0.29	0.34*	-	-
Essential oil yield	0.65**	0.70**	0.62**	0.59**	-0.39*	-0.46**	0.91**	0.98**	0.50**	-
GDD Flowering	0.32*	0.33*	0.24	0.32*	0.67**	0.63**	-0.34*	-0.26	-0.43**	-0.26

*, **= Coefficients of correlation are significant at 5%, 1%, respectively.

Table 4 Results of stepwise regression analysis for essential oil% content as dependant variables and other traits as independent variables

Equation components	Stepwise regression				
	Step1	Step2	Step3	Step4	Step5
Constant	17.87	16.69	20.36	22.01	23.15
Maturity date	-0.045	-0.041	-0.051	-0.048	-0.136**
Flower number per plant	-	0.006	0.038	0.042	0.044**
Plant Height	-	-	-0.194	-0.124	-0.100*
Canopy diameter length	-	-	-	-0.110	-0.172*
Flowering date	-	-	-	-	0.112*
R square	58.20	61.28	74.60	77.10	80.34

*, **= Coefficients of regressions are significant at 5%, 1%, respectively.

A positive and significance correlation between essential oil yield with canopy diameter and dry shoot yield was similar with the result of Golparvar and Ghasemi pirbaloti [20] for German chamomile (Matricaria). Similarly, Pirkhezri *et al.*, [15] reported that there were positive correlation between essential oil percentage and number of flowers per plant, fresh yield of shoot flower and plant height but there were negative correlation with phenological traits

Also The same result reported by Dadkhah and *et al.*,[21] that number of flower was an important component of plant biomass yield. With regard of stepwise regression analysis, it was proved that high positive effects of maturity date, flower number, plant height, canopy diameter length and flowering date in essential oil content.

Conclusion

Regarding result of this research work, some points were concluded: 1) there were significant variation for population of *Matricaria recutita* and *M. aurea* for morphological and phenological traits and essential oil yield, also it proved that population of Esfahan belong to *Matricaria recutita* had higher values of canopy diameter, shoot yield, and essential oil yield, 2) Regarding of GDD, population of Najafabad1 goes to flowere sooner than other populations, 3) high positive correlation was found between essential oil yield with dry matter yield and morphological traits but it had negative correlation with maturity date.

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