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Short Communication

Investigation of variations of the essential oil content and morphological values in yarrow (*Achillea santolina*) from Iran

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In order to evaluate the beneficial treatments of ten *Achillea santolina* accessions, some yield characters were investigated. This experiment was carried out using a randomized complete block design with three replications. The factor studied included yarrow genotypes that were collected at the initial stage of flowering. The analysis of variance genotypes showed that all treatments except the leaf length were significant at different levels (5 or 1% levels). Plant height was significant ($p \leq 0.01$) of two genotypes of As6 and As8 which had the highest mean. Genotype As9 had the highest means in leaf width; plant wet weight, plant dry weight, and plant width and plant length. Two genotypes As3 and As1 which were gathered from Lorestan and Kurdistan provinces, respectively owned the highest mean of essential oil content (0.2 and 0.19%, respectively). Considering the amount of essential oil in each genotype from each province, we can say that this feature varied with location with western Iran having the highest. This study provides basic information for effective conservation and introduction of some particular traits of these accessions breeding programs.

Key words: *Achillea santolina*, essential oil content, morphological.

INTRODUCTION

Yarrow is one of the youngest evolutionary genera of the *Asteracea* family, which is present throughout the world. More than one hundred species have been recognized in this genus (Goli et al., 2008). Genus *Achillea* is well-known medicinal plants, widely used in folk medicine against gastrointestinal disorders such as lack of appetite. These plants are native to Europe and western Asia but are also found in Australia, New Zealand and North America. *Achillea* species grows in the wild in different regions of Iran (Rechinger, 1963). In common practice, systematic inferences and taxonomic relationships are initially based on the analysis of morphological traits, multivariate morphometric studies are considered to be effective to resole taxonomic uncertainty (Cook and Ladiges, 1991) and determine taxa within species complexes (Wahid et al., 2006; Passioura and Ash, 1993). The diversity of medicinal and aromatic plant species and varieties is important from both scientific and practical points of view. In the 21st century, attention is focused on the cultivation and preservation of medicinal and aromatic plants and on the evaluation of their quality (Bimbiraitė et al., 2008). Medicinal plants are composed of a community of plants that may differ in phenotypic plasticity, adaptation to grazing, and therefore, in persistence within the medicinal and aromatic plants community (Abbaszadeh et al., 2009a). However, there are limited reports on the morphological variation relationships of *Achillea* species. Rahimmalek et al. (2009a) studied inter and intra genetic diversity of *Achillea* species using amplified fragment length polymorphism; (AFLP) markers, one of the species which

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Abbreviations: AFLP, Amplified fragment length polymorphism; **ANOVA,** analysis of variance; **SAS,** statistical analysis system.

Table 1. List of the *A. santolina* accessions included in this study.

Genotype	Province	City
As1	Markazi	ARAK
As2	Markazi	ARAK
As3	Lorestan	Aligodarz
As4	Gilan	Rodsar
As5	Markazi	Tafresh
As6	Ardabil	Ardabil
As7	Lorestan	Zaghe
As8	Kordestan	Sanandaj
As9	Zanjan	Zanjan
As10	Golestan	Gorgan

Table 2. Analysis of variance for the morphological traits and essential oil content of ten A.santolina accessions from Iran.

Source of variation	df	Plant height (cm)	Plant length (cm)	Plant width (cm)	Leaf width (cm)	Leaf length (cm)***	Plant wet weight (gr)***	Plant dry weight (gr)	Essential oil (%)
Replication	2	6.51	3.9	29.23	0.0003	0.05	0.36	0.06	0.0001
Genotype	9	17.3*	51**	44.38**	0.002**	0.06	29.81**	0.52**	0.002**
Error	18	5.63	7.8	5.56	0.0007	0.04	5.77	0.52	0.0002
CV (%)	-	21.37	24.03	21.77	22.65	20.37	33.5	29.66	10.33

** and * indicates significance at 1% and 5% levels, respectively. ***per each plant (mean of ten plants).

had been studied was *Achillea santolina.* In addition Rahimmalek et al (2009b) obtained torty-three compounds of this plant. To our knowledge, the assessment of morphological variation of Iranian *A. santolina* has never been studied, despite the fact that a general understanding of morphological variation is crucial for a successful protection of biodiversity of this species. It will provide the basic information for effective conservation and introduction of some particular traits of these accessions for breeding programs.

MATERIALS AND METHODS

Ten accessions of *A. santolina* were collected from northwestern, western and central region of Iran (Table 1). Voucher samples were deposited at the Herbarium of Research Institute of Forests and Rangelands Tehran, Iran. This experiment was carried out using a randomized complete block design with three replications. The factor studied included yarrow genotypes that were collected at the initial stage of flowering to determine plant height, leaf width, leaf length, plant wet weight, plant dry weight, essential oil content, plant width and plant length . Dried mature leaves (100 g) of each sample were subjected to hydro-distillation for 5 h using Clevenger-type apparatus to extract essential oils. The essential oil content determined was based on dry matter. The data were subjected to analysis of variance (ANOVA) using statistical analysis system (SAS) computer software (SAS institute Cary, usa 1988) in addition; means were compared using Duncan multiple test series of ANOVA analysis.

RESULTS AND DISCUSSION

The ANOVA genotypes showed that all treatments except the leaf length were significant at different levels (Table 2). Plant height was significant ($p \leq 0.01$) with the two genotypes of As6 and As8 having the highest means. Comparison of the means made it clear that these genotypes have significant differences from others (Table 3).

For the two treatments plant length and width, genotype As9 had the highest mean (19 and 19.66 cm). Genotype As8, by contrast, had the lowest means related to these two treatments. As9 had the highest leaf width in relation to others (0.17 cm) and the difference was significant compared to most others while genotype As8 had the least leaf width. The only treatment that was not significant among *A. santolina* genotypes was the height of the leaf length.

Genotype As9 had the highest means in the two treatments of plant wet weight and dry weight also As8 genotype had the lowest mean for these two treatments. The most important treatment studied in this research was the amount of the essential oil in the dry plant which was significant at ($p \leq 0.01$) among genotypes. Two genotypes As3 and As1 gathered from Lorestan and Kurdistan provinces, respectively had the highest mean of this treatment (0.2 and 0.19%, respectively).

Also, two genotypes As4 and As10 gathered from the

Table 3. Result of means comparison of ten *A. santolina* accessions from Iran.

Accession code	Plant height (cm)	Plant length (cm)	Plant width (cm)	Leaf width (cm)	LEAF length (cm)	Plant wet weight (gr)	Plant dry weight (gr)	Essential oil (%)
As1	9.4 B	13.83 A-C	11.33 BC	0.16 AB	1.06 A	7.06 B	2.73 B	0.19 A
As2	8.66 B	7.33 CD	7.33 DE	0.11 B-D	1.3 A	5.53 BC	1.83 BC	0.15 C
As3	10.06 B	12.33 B-D	10 BC	0.12 A-D	0.86 A	8.1 AB	2.6 B	0.2 A
As4	9.76 B	15.66 AB	13.33 B	0.11 BD	1.26 A	8.8 AB	2.7 B	0.11 D
As5	10.5 B	10.66 B-D	7.66 C	0.08 D	0.9 A	2.5 C	1.06 C	0.19 AB
As6	16 A	14 A-C	13 B	0.13 A-C	1.2 A	9.27 AB	2.7 B	0.15 C
As7	10.56 B	9 C-E	10.66 BC	0.109 CD	1.2 A	8.8 AB	3.06 AB	0.13 CD
As8	15 A	5.33 E	7C	0.09 CD	1.06 A	1.6 C	0.91 C	0.16 BC
As9	10.66 B	19 A	19.66 A	0.17 A	0.9 A	11.9 A	4.1 A	0.13 CD
As10	10.4 B	8.66 C-E	8.33 C	0.086 CD	1.17 A	8.16 AB	2.63 B	0.11 D

Means within the same column and factor, followed by the same letter are not significantly different ($P < 0.01$).

north of Iran had the least amount of essential oil in the dry plant. Considering the amount of essential oil in each genotype from each province, we can say that this feature is varied in different areas and the amount of essential oil in the north of Iran compared to other parts of Iran, is less, while western parts of Iran have more amount of essential oil than the northern parts. Usually there is a significant geographical variation in certain morphological characteristics of plants (Andersson, 1991; 1995; Widen and Schiemann, 2003; Barrera and Walter, 2006). Therefore, the selection of *A. santolina* accessions that perform well over a wide range of environments can increase yields of essential oils.

Medicinal plants are composed of a community of plants that may differ in phenotypic plasticity, adaptation to grazing. An analysis of species population dynamics over time can provide a basis for understanding temporal trends of botanical composition and dry matter production within the fields of medicinal plants (Abbaszadeh et al., 2009b).

Perennial medicinal plants, which are often harvested as mixed species in the field, are composed of tillers, each constituting an independent plant growth unit. Field management can modify tiller morphology, developmental growth and tiller dynamics over time. Short harvesting height regimes, plants tiller density increased and tiller weight/size decreased. Individual tiller size may change in a compensatory manner, usually described by the "self-thinning" law, until plants reach their physiological potential under the applied management and environmental conditions.

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