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Full Length Research Paper

Some Morphological and Agronomical Characteristics of Genus of Turkey: *Tchihatchewia isatidea* Boiss

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ABSTRACT

This research was done at the experimental fields of Cumra High Educational College, Konya, Turkey, in 2008-2010 years. In this study, seeds of *Tchihatchewia isatidea*, which is endemic as genus, collected from various regions of Turkey. Adaptation trial was done with four replications and some morphological observations were recorded, after germination tests resulted positive. The aim of this study was to improve a new ornamental, dyeing and aromatic plant with long flowering period. According to the results; observed characters changed between 26- 44 cm in plant height; 11- 52.7 cm in canopy diameter; 45- 163 leaves per plant; 6- 120 in branch number; 10.45- 35.86 mm in leaf width; 47.65- 152.74 mm in leaf length; 194- 1091 in capsule number per plant; 8- 26 g in capsule yield per plant; 532- 576 days to flowering; 13-30 days to flowering period; 5.1-10.5 g in 1000 seed weight; 5.1-17.4 g in seed yield per plant and 561- 1875 kg in seed yield per hectare.

Keywords: *Tchihatchewia isatidea*, ornamental plant, morphological characteristics, agronomical characteristics, yield components.

INTRODUCTION

Turkey is among rich countries in flora because of both having different climatic conditions and placed along a point of intersection of three floristic regions (Atalay, 1994; Arslan et al., 2002). Turkey has about 11000 seed plant species, of which nearly 3000 (approx. 30 %) are endemic in nature (Ekim, 1992).

The Turkish flora is rich from the point of view wild, medicinal, aromatical and ornamental plants which constitute an important part of the biological diversity of this country. Many tuberous or bulbous, woody biennial and perennial ornamental plants are present on the turkish flora. The lots of important geophyte species belong to the families Liliaceae, Iridaceae and Amaryllidaceae (Arslan et al. 1998a, b). Also, there are some species belonging to the other families having showy and sweet-scented flowers. One of these families is the family Brassicaceae (Cruciferae). There are some species such as *Alyssum, Aethionema,* Cheiranthus genus, which could put important agricultural and ornamental species in Turkey (Budak et al. 2011; Yilmaz and Yilmaz, 2009; Özen et al. 1998). Also, another taxon *Tchihatchewia* (Syn: *Neotchihatchewia*) is a monotypic genus and a Turkish endemic, and belongs to the Brassicaceae family (Mutlu and Dönmez, 2003).

Tchihatchewia isatidea Boiss. is a biennial herb. Its stem has up to 40 cm long bearing 3-5 mm width, patent, simple, bifurcate, rarely dendroid hollow hairs. Basal leaves are up to 120 mm in length and 20 mm in width, distinctly petiolate and oblanceolate to spathulate in shape. The stem leaves are up to 60 mm in length and 12 mm in width, sessile or shortly petiolate and lanceolate in shape. Both of them are similar to each other by irregularly acute lobes and dentate margin. The inflorescence of this species is paniculate or lower branched corymbose and flowers are showy and fragrant. Sepals and petals are 4 and petals are red-violet in color. Fruits are up to 25 mm in length and 5 mm in width, obovate to narrowly elliptic, widely elliptic to orbicular in

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shape and appearence with wings, pendulous, indehiscent. Fruits have 1 or 2 seeds, which are nonmucilaginous (Davis, 1965; Mutlu and Dönmez, 2003).

The distribution area of the genus ranges from east of central Anatolia to the border of Iran. The species grows on eroded hills and slopes. This taxon is assessed as "vulnerable" threat category in Turkey (Ekim et al., 2000). It is very important that such species should be cultivated and propagated using alternative methods. Because, this species can grow on the arid conditions and soils; does not want any specific soil property. In the last 10 years, alternative and economically important plants and products were searched and supported from government in Turkey. Therefore, this species can be a good alternative ornamental plant to the ornamental plant producers in central and transition regions.

Around Sivas (east of central Anatolia) areas, flowers of this plant are used as a dye (Baytop, 1994). Other uses as medicinal plant are known (Cakilcioglu et al., 2011; Altundag and Ozturk, 2011; Khatun et al., 2012). However, don't exist previous data of morphological or agronomic studies about this species. Therefore, there were not any literatures cited for this species. Due to the showy inflorescence which has attractive flower color and interesting indumentum, the plant could be useful as a garden ornamental (Mutlu and Dönmez, 2003).

The aim of this study is to determine the morphological characters and investigate if this plant adapt to the Konya (central Anatolia) conditions and being an alternative product to the farmers, which grow and produce outside ornamental plants in this region.

MATERIALS AND METHODS

Plant material

In this study, at first the seeds of *Tchihatchewia isatidea* Boiss. which may be an economically important ornamental plant, were collected on the natural flora. It was determined till now that this species grows in the following provinces; Giresun, Gümüşhane, Sivas, Elazığ, Erzurum, Tunceli and Malatya of Turkey. The seed materials were collected from these provinces.

The material collection trips were done two times in a season for the collection of the plants on the natural flora. The first trip was at the beginning of flowering in May/June and the second one was at the maturing of seeds in August 2008-2010. In the first trip, the plants localities were determined and herbarium samples were taken. But, these samples were stored only at the department of Field Crops, at the Faculty of Agriculture, Ankara University, and were not given to another official herbarium. In the second trip, enough seeds were collected. A part of these seeds were seperated for field experimental trials at the University of Selcuk, Cumra High Educational College and the other part was for trials at the laboratories of the Central Research Institute for Field Crops in Ankara.

Field Studies

The collected seeds were sown in greenhouse at first. The healthy seedlings were transferred to the field at various densities like 30x15, 30x20, 30x30, 40x20, 40x30, 40x40, 50x20, 50x30 and 50x40 cm.

The experiment was set up with 4 replications randomly complete block design and there was a plot of locality in each block (Gürbüz et al. 1995). The planting was done as 5 rows in a plot and 10 plants in a row.

During the experiment, morphological and agricultural measurements were done from seedling planting till fruit matures (capsules). Especially, the shape, color, bigness and the type of hairy of the cauline leaves were investigated carefully. Besides these characters, branching features, the flowering date and flowering duration were determined. Also, plant height, leaf width, leaf length and canopy diameter were measured at rosette stage; fruit bigness and thousand seed weight were measured at flowering stage.

After setting up the experiment completely, eradication of weeds and irrigation operations were done regularly. An additional fertilization was not made, because the mineral materials consumption of the plant was not known enough.

All data were obtained from 10 plant samples at each plant density treatment. Significance of the data was determined by analysis of variance and the differences between the means were compared by Least Significant Difference (LSD) test using an MSTAT-C computer program (Michigan State University).

RESULTS

The data obtained from the experimental field studies are represented in following tables. All measured and observed characters are showed in different plant density and locations. It was defined that the best growing regions for this species were Sivas, Erzincan and environments. According to this study, this taxon has not any germination problem. During this study, the seeds were sown a lot of time at the greenhouse and field conditions. The germination rate was approximately 90%. But, this taxon should sow in the autumn on the field, because vernalization is needed to the plants. The germination begins in early spring and the plants stay in the first year at the form of rosette.

The plant height values were represented in table 1 as follows.

As seen in table 1, the maximum plant height value was obtained from location Erzurum as 44 cm with 50x40

Table 1. Plant height (cm) mean values obtained from various plant density and locations

	Plant density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD**
	50x20	41 abc*	37 c-j	41 abc	36.5 c-j	30 m-r	30 m-r	35.6 ± 1.898
	50x30	39.5 a-e	34 g-n	38.5 b-f	37.5 c-h	32.4 i-p	33 h-o	35.8 ± 1.908
	50x40	44 a	34 g-n	36 d-k	39.7 a-e	34 g-n	38 c-g	37.5 ± 1.999
Plant height (cm)	40x20	38 c-g	34.5 f-k	37 c-i	28 pqr	29 o-r	29 o-r	32.6 ± 1.738
	40x30	43 ab	31.5 k-q	35 e-k	30 m-r	34 g-n	32 j-p	34.2 ± 1.823
LSD %5: 1.371	40x40	43 ab	30 m-r	37c-i	34.2 f-m	28.7 o-r	35 e-k	34.5 ± 1.839
	30x15	36 d-k	29 o-r	34 g-n	28 pqr	26.5 r	27qr	30 ± 1.599
LSD %1: 5.244	30x20	38 c-g	28 pqr	34 g-n	28.5 o-r	29.2 n-r	26 r	30.7 ± 1.636
	30x30	40 a-d	30 m-r	33 h-o	28 pqr	26.5 r	36 d-k	32.1 ± 1.711
	Mean ± SD	40.2 ± 2.143	31.8 ± 1.695	36.1 ± 1.924	32.2 ± 1.716	30 ± 1.599	31.7 ± 1.690	

*Mean values followed by the different letters are significant at the 0.05 level
** Standard deviation

Table 2. Canopy diameter (cm) mean values obtained from various plant density and locations

	Plant density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD
	50x20	20 n-q*	29 i	29 i	44 de	49 bc	21 nop	31.9 ± 2.230
	50x30	14 stu	24 k-n	34 h	45.5 cd	27.2 ijk	24 k-n	28.1 ± 1.964
	50x40	28 ij	36 gh	35 h	41.3 ef	28 ij	27 ijk	32.5 ± 2.272
Canopy diameter (cm)	40x20	14 stu	25 j-m	30 i	13 tu	50.2 ab	27 ijk	26.5 ± 1.852
	40x30	21 m-p	15 rst	39 fg	35 h	18 pqr	19 opq	24.6 ± 1.720
LSD %5: 3.321	40x40	22 l-o	35 h	28.5 ij	40.2 ef	47.5 bc	25 j-m	33 ± 2.307
	30x15	25 j-m	15 rst	41 ef	26 i-l	52.7 a	30 i	31.5 ± 2.202
LSD %1: 4.444	30x20	18 pqr	11 u	18 pqr	33.5 h	50 ab	13 tu	23.9 ± 1.671
	30x30	12 tu	17 qrs	20 opq	23 l-o	46.8 bcd	28 ij	24.4 ± 1.706
	Mean ± SD	19.4 ± 1.356	22.9 ± 1.601	30.4 ± 2.125	33.5 ± 2.342	41 ± 2.866	23.8 ± 1.664	

*Mean values followed by the different letters are significant at the 0.05 level

cm plant density. This was followed by location Erzurum as 43 cm with 40x30 cm and 40x40 cm plant densities, respectively. The difference among these plant densities was insignificant statistically by 5% level. The minimum plant height value was obtained from location Malatya as 26 cm with 30x20 cm plant density.

The canopy diameter values were represented in table 2.

The highest canopy diameter value was measured by location Tunceli as 52.7 cm with 30x15 cm plant density. This was followed by location Tunceli as 50.2 cm and 50 cm with plant densities 40x20 cm and 30x20 cm, respectively. These mean values were in same group statistically. The lowest canopy diameter value was measured by location Erzincan as 11 cm with 30x20 cm plant density.

Leaf number values were represented in table 3.

The highest leaf number value was observed from location Gumushane as 182 with 40x30 cm plant density. The smallest one was the location Malatya as 20 with 30x15 cm plant density. This character is important concerning to produce more branches and more flowers of the plants.

Branch number values were represented in table 4.

The highest branch number value was observed from location Tunceli as 120 with 50x20 cm plant density. This was followed by locations Tunceli and Sivas as 115 and 114; with 40x20 cm and 50x20 cm plant density, respectively. The smallest one was the location Malatya as 7 with 30x15 cm plant density. Also, branch number is very important in forming more flowers in the ornamental plants.

The branch number value means were represented as a graphical figure 1 as follows.

The capsule number values represented in table 5.

The highest capsule number value was counted on the location Sivas as 1091 with 50x20 cm plant density. This value was followed by the values from the locations

Table 3. Leaf number mean values obtained from various plant density and locations

	Density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD
	50x20	102 l*	82 m	108 jkl	114 ij	155 c	110 jk	111.9 ± 5.024
	50x30	45 uv	136 ef	85 m	138 de	145 d	52 stu	100 ± 4.490
	50x40	57 rs	130 fg	103 kl	163 b	65 pq	70 op	98 ± 4.400
Leaf number	40x20	83 m	133 ef	145 d	38 v	113 ij	87 m	99.8 ± 4.481
	40x30	57 rs	55 rst	182 a	110 jk	52 stu	57 rs	85.4 ± 3.835
LSD %5: 6.939	40x40	74 no	53 rst	111 j	123 gh	123 gh	48 tu	88.6 ± 3.978
	30x15	103 kl	45uv	138 de	65 pq	120 hi	20 w	81.8 ± 3.673
LSD %1: 9.285	30x20	101 l	80 mn	60 qr	140 de	140 de	125 gh	107.6 ± 4.831
	30x30	137 ef	50 stu	45 uv	120 hi	120 hi	67 opq	89.8 ± 4.032
	Mean	84.2 ± 3.781	84.9 ± 3.812	108.5 ± 4.872	112.3 ± 5.042	114.8 ± 5.155	70.5 ± 3.166	

*Mean values followed by the different letters are significant at the 0.05 level

Table 4. Branch number mean values obtained from various plant density and locations

	Plant density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD
	50x20	42 m-p*	71 fg	47 klm	114 ab	120 a	32 st	70.8 ± 3.724
	50x30	26 tu	47 klm	76 ef	64 hi	80 e	6 x	49.8 ± 2.620
	50x40	68 gh	58 j	51 k	112 b	34 rs	43 l-p	60.5 ± 3.182
Branch number	40x20	35 qrs	72 fg	94 d	18 w	115 ab	43 l-p	62.7 ± 3.298
	40x30	65 hi	40 n-r	103 c	45 l-o	19 vw	36 p-s	51.1 ± 2.688
LSD %5: 5.73	40x40	52 k	41 m-q	41 m-q	96 d	109 b	32 st	61.8 ± 3.251
	30x15	59 ij	49 kl	76 ef	25 uv	110 b	7 x	54.3 ± 2.856
LSD %1: 7.668	30x20	76 ef	25 uv	44 l-o	110 b	98 cd	43 l-o	65.9 ± 3.466
	30x30	67 gh	26 tu	38 o-s	38 o-s	115 ab	40 n-r	54 ± 2.840
	Mean ± SD	54.3 ± 2.856	47.6 ± 2.504	63.2 ± 3.324	68.8 ± 3.619	88.9 ± 4.676	31.1 ± 1.636	

*Mean values followed by the different letters are significant at the 0.05 level

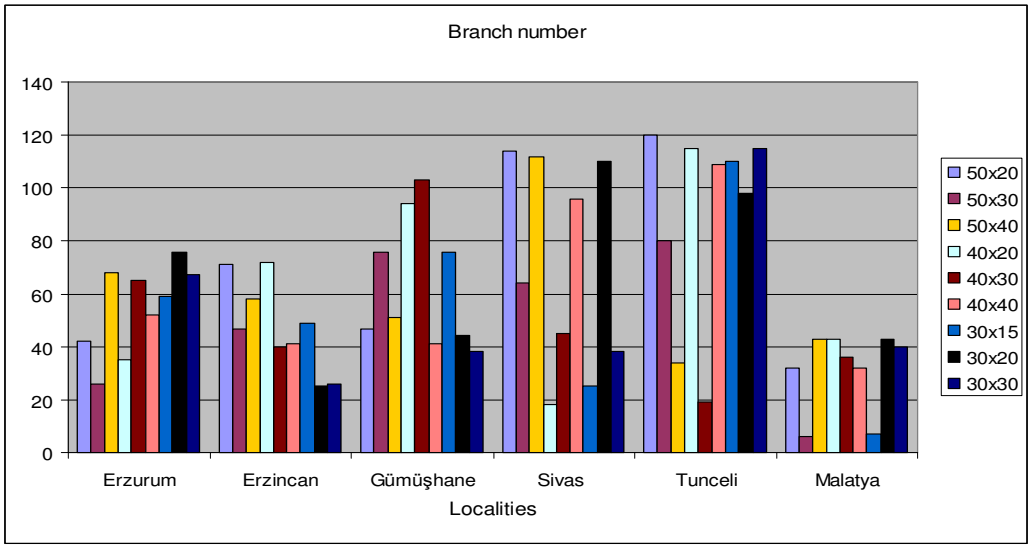

Figure 1. Branch number mean values obtained from various plant density and locations

Table 5. Capsule (fruit) number per plant mean values obtained from various plant density and locations

	Plant density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD
Capsule number per plant LSD %5: 65.75 LSD %1: 87.99	50x20	474 mno*	850 cd	424 opq	1091 a	1069 a	279 st	697.7 ± 39.769
	50x30	260 stu	684 fgh	1062 a	390 pqr	444 nop	218 tu	509.6 ± 29.047
	50x40	685 fgh	630 hij	419 opq	1070 a	377 pqr	672 fgh	642.2 ± 36.605
	40x20	535 klm	920 bc	777 e	202 tu	870 cd	510 lmn	635.5 ± 36.224
	40x30	594 ijk	248 stu	950 b	320 rs	203 tu	418 opq	455.4 ± 25.958
	40x40	599 ijk	467 mno	417 opq	586 jk	663 ghi	386 pqr	519.5 ± 29.612
	30x15	422 opq	800 de	800 de	221 tu	808 de	220 tu	545.1 ± 31.071
	30x20	740 ef	194 u	353 qr	736 efg	550 kl	549 kl	520.4 ± 29.663
	30x30	655 hij	250 stu	257 stu	272 st	917 bc	500 lmn	475.1 ± 27.081
	Mean ± SD	551.4 ± 31.430	560.2 ± 31.931	606.5 ± 34.571	543 ± 30.951	655.6 ± 37.369	416.9 ± 23.763	

*Mean values followed by the different letters are significant at the 0.05 level

Table 6. Capsule (fruit) yield per plant (g) mean values obtained from various plant density and locations

	Plant density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD
Capsule yield per plant (g) LSD %5: 3.5 LSD %1: 4.683	50x20	10 fg*	22 b	10 fg	22 b	16 cde	9 g	14.5 ± 1.766
	50x30	8 g	14 c-f	22 b	10 fg	14 c-f	10 fg	13 ± 1.583
	50x40	20 b	10 fg	10 fg	26 a	14 c-f	14 c-f	15.7 ± 1.912
	40x20	14 c-f	22 b	14 c-f	8 g	22 b	12 d-g	15.4 ± 1.876
	40x30	12 d-g	9 g	22 b	9 g	8 g	18 bc	13 ± 1.583
	40x40	14 c-f	11 d-g	8 g	10 fg	14 c-f	12 d-g	11.5 ± 1.401
	30x15	10 fg	20 b	18 bc	9 g	14 c-f	8 g	13.3 ± 1.620
	30x20	14 c-f	8 g	9 g	15 cd	10 fg	10 fg	11 ± 1.340
	30x30	12 d-g	9 g	8 g	8 g	18 bc	14 c-f	11.5 ± 1.401
	Mean ± SD	12.7 ± 1.547	13.9 ± 1.693	13.5 ± 1.644	13 ± 1.583	14.2 ± 1.730	11.9 ± 1.449	

*Mean values followed by the different letters are significant at the 0.05 level

Sivas as 1070, Tunceli as 1069 and Gumushane as 1062 with 50x40 cm, 50x20 cm and 50x30 cm, respectively. These values are in same group statistically. The smallest capsule number was counted on the location Erzincan as 194 mm with 30x20 cm plant density.

The capsule yield per plant values were represented in table 6.

The highest capsule yield value was measured on the location Sivas as 26 g with 50x40 cm plant density. The smallest capsule yield values were measured on a lot of locations as 8 and 9 g with various plant densities. These smallest values were obtained on all locations approximately and in same groups statistically.

The days to flowering values were represented in table 7.

The maximum days to flowering were 576 on the locations Erzincan and Gumushane with 50x20 cm plant density. These values were followed by the locations Gumushane, Sivas and Malatya as 574 days with 50x40 cm plant density. The shortest days to flowering were 532 days on all locations except Erzurum and Sivas with various plant densities. All of them were in same statisticall group. This character is very important for an ornamental plant. Especially, it is preferred that the days to flowering of an ornamental plant is short after planted. Because of the days to flowering of this biannual plant were very long, this duration should be shorten via various breeding methods.

The days to flowering period values were represented in table 8.

The maximum number of days to flowering duration were 30 days on the location Sivas with 50x40 cm plant density. The shortest days to flowering duration were 13 days on the locations Tunceli and Gumushane with 50x40 cm and 50x30 cm plant densities. The most important character observed was days to flowering duration for an ornamental plant nominee. In this study counted days to flowering period was not so short, but this period may lengthened with a convenient breeding program.

Table 7. Days to flowering mean values obtained from various plant density and locations

	Density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD
Days to flowering (day) LSD %5: 30.16 LSD %1: 40.36	50x20	550 a-g*	576 a	576 a	540 a-g	554 a-g	554 a-g	558.4 ± 3.853
	50x30	560 a-g	566 a-g	569 a-f	571 a-d	570 a-e	563 a-g	566.7 ± 3.910
	50x40	564 a-g	570 a-e	574 ab	574 ab	573 abc	574 ab	571.5 ± 3.943
	40x20	546 a-g	546 a-g	551 a-g	541 a-g	552 a-g	550 a-g	547.7 ± 3.779
	40x30	553 a-g	549 a-g	550 a-g	540 a-g	541 a-g	552 a-g	551.8 ± 3.807
	40x40	553 a-g	541 a-g	550 a-g	550 a-g	547 a-g	545 a-g	547.7 ± 3.779
	30x15	551 a-g	535 d-g	544 a-g	537 c-g	532 g	533 fg	538.5 ± 3.716
	30x20	545 a-g	532 g	534 efg	536 d-g	534 efg	532 g	535.5 ± 3.695
	30x30	548 a-g	539 b-g	534 efg	534 efg	532 g	535 d-g	537 ± 3.705
	Mean	552.3 ± 3.811	553.3 ± 3.818	553.6 ± 3.820	547 ± 3.774	548.3 ± 3.783	548.7 ± 3.786	

*Mean values followed by the different letters are significant at the 0.05 level

Table 8. Days to flowering duration (period) mean values obtained from various plant density and locations

	Plant density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD
Days to flowering duration (day) LSD %5: 4.087 LSD %1: 5.469	50x20	24 c-h*	19 h-m	19 h-m	16 l-o	14 no	14 no	17.8 ± 1.803
	50x30	16 l-o	17 k-o	18 j-n	28 abc	13 o	16 l-o	18 ± 1.823
	50x40	22 d-j	19 h-m	13 o	30 a	13 o	17 k-o	19.1 ± 1.935
	40x20	17 k-o	16 l-o	21 e-k	22 d-j	29 ab	18 j-n	20.6 ± 2.087
	40x30	15 mno	20 g-l	19 h-m	19 h-m	15 mno	15 mno	17.3 ± 1.753
	40x40	18 j-n	26 a-e	20 g-l	22 d-j	27 a-d	25 a-f	23 ± 2.330
	30x15	23 c-h	25 a-f	25 a-f	18 j-n	23 c-h	23 c-h	23 ± 2.330
	30x20	22 d-j	17 k-o	26 a-e	23 c-h	23 c-h	17 k-o	21.5 ± 2.178
	30x30	22 d-j	20 h-m	23 c-h	21 e-k	20 h-m	21 e-k	21.2 ± 2.148
	Mean ± SD	20.1 ± 2.036	20 ± 2.026	20.6 ± 2.087	22.2 ± 2.249	19.8 ± 2.006	18.5 ± 1.874	

*Mean values followed by the different letters are significant at the 0.05 level

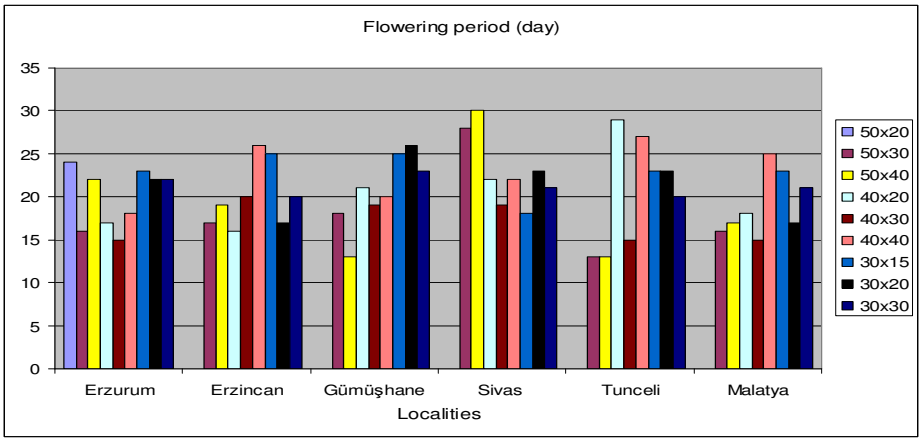

Figure 2. Days to flowering duration mean values

The days to flowering period mean values were represented as a graphical figure 2 as follows.

The thousand seed weight values were represented in table 9.

The highest 1000 seed weight value was 10.5 g on the location Erzincan with 50x20 cm plant density. This value was followed by the locations Sivas and Tunceli as 10.3 g and 10.2 g; with 50x40 cm and 50x20 cm plant densities,

Table 9. 1000 seed weight (g) mean values obtained from various plant density and locations

	Plant density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD
1000 seed weight (g) LSD %5: 1.253 LSD %1: 1.677	50x20	6.1 j-p*	10.5 a	5.7 m-p	6.4 j-p	10.2 a	5.9 k-p	7.5 ± 0.252
	50x30	7.1 e-m	8.3 b-g	6.3 j-p	7.4 c-k	6.4 j-p	5.1 p	6.8 ± 0.229
	50x40	5.3 nop	7.9 b-i	6.8 g-n	10.3 a	7.6 c-j	7.4 c-k	7.6 ± 0.255
	40x20	8.6 b-e	8.8 bcd	5.8 l-p	6.5 i-p	6.9 f-m	6.4 j-p	7.2 ± 0.242
	40x30	6.8 g-n	7.6 c-j	6.1 j-p	7.4 d-k	7.1 e-m	5.2 op	6.7 ± 0.225
	40x40	7.9 b-i	6.5 i-p	7.0 f-m	7.3 d-l	7.5 c-j	7.1 e-m	7.2 ± 0.242
	30x15	9.3 ab	6.6 i-p	5.9 k-p	8.9 bc	8.0 b-i	6.6 i-p	7.6 ± 0.255
	30x20	7.1 e-m	7.3 d-l	6.8 g-n	6.6 i-p	6.9 f-m	7.1 e-m	7 ± 0.235
	30x30	6.9 f-m	8.4 b-f	6.4 j-p	7.0 f-m	6.7 h-o	8.2 b-h	7.3 ± 0.245
	Mean ± SD	7.2 ± 0.242	8 ± 0.269	6.3 ± 0.212	7.5 ± 0.252	7.5 ± 0.252	6.6 ± 0.222	

*Mean values followed by the different letters are significant at the 0.05 level

Table 10. Seed yield per plant (g) mean values obtained from various plant density and locations

	Plant density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD
Seed yield per plant (g) LSD %5: 1.227 LSD %1: 1.642	50x20	6.8 m-p*	16.5 d	6.3 opq	18.1 bc	13.9 ef	5.1 q	11.2 ± 0.715
	50x30	6.0 pq	11.3 gh	17.4 cd	7.9 mn	10.7 g-k	7.7 mno	10.1 ± 0.644
	50x40	13.2 f	7.0 m-p	6.9 m-p	24.0 a	11.4 gh	11.2 gh	12.3 ± 0.785
	40x20	11.1 ghi	17.3 cd	10.2 h-k	5.9 pq	18.5 b	9.8 ijk	12.1 ± 0.772
	40x30	10.3 h-k	6.0 m-p	17.1 cd	5.7 pq	6.0 pq	14.7 e	10.1 ± 0.644
	40x40	9.9 ijk	7.9 mn	6.4 opq	7.1 m-p	11.6 gh	9.3 kl	8.8 ± 0.561
	30x15	8.2 lm	16.7 d	14.9 e	7.0 m-p	10.8 g-j	5.8 pq	10.6 ± 0.676
	30x20	10.8 g-j	5.9 pq	6.7 nop	11.8 g	6.7 nop	7.9 mn	8.3 ± 0.530
	30x30	9.6 jk	6.9 m-p	5.8 pq	6.1 pq	14.2 ef	11.0 g-j	8.9 ± 0.569
	Mean ± SD	9.6 ± 0.613	10.6 ± 0.676	10.1 ± 0.644	10.4 ± 0.664	11.6 ± 0.740	9.2 ± 0.587	

*Mean values followed by the different letters are significant at the 0.05 level

Table 11. Seed yield per hectare (Kg/ha) mean values obtained from various plant density and locations

	Density	Erzurum	Erzincan	Gümüşhane	Sivas	Tunceli	Malatya	Mean ± SD
Seed yield (kg/ha) LSD %5: 11.03 LSD %1: 14.76	50x20	773 q-v*	1875 a	716 t-w	1807 ab	1580 efg	580 xy	1222 ± 48.758
	50x30	655 v-y	856 o-s	1318 kl	799 p-u	811 p-u	583 xy	837 ± 33.396
	50x40	750 r-w	998 n	892 n-q	1364 jk	648 v-y	636 wxy	881 ± 35.152
	40x20	1577 efg	1457 g-j	1449 hij	838 p-t	1628 de	1392 ijk	1390 ± 55.461
	40x30	975 no	568 y	1619 def	840 p-t	568 y	1392 ijk	994 ± 39.661
	40x40	703 u-x	561 y	855 o-s	904 nop	824 p-u	1349 jk	866 ± 34.553
	30x15	1671 cde	1617 def	1763 abc	1768 abc	1727 bcd	1465 g-j	1668 ± 66.553
	30x20	1546 e-h	1117 m	1269 kl	1635 de	1269 kl	1496 f-i	1389 ± 55.421
	30x30	1212 lm	871 o-r	732 s-w	770 q-v	1793 abc	1389 ijk	1128 ± 45.007
	Mean ± SD	1096 ± 43.730	1102 ± 43.970	1180 ± 47.082	1192 ± 47.561	1205 ± 42.080	1142 ± 45.566	

*Mean values followed by the different letters are significant at the 0.05 level

respectively. The smallest 1000 seed weight value was 5.1 g on the location Malatya with 50x30 cm plant density. The 1000 seed weight character is important for cultivating a plant species in germination speed and seed vigour. This provides homogeneity on a cultivating area and using less seed while sowing.

The seed yield per plant values were represented in table 10.

The highest seed yield per plant value was 24 g on the location Sivas with 50x40 cm plant density. The lowest seed yield per plant value was 5.1 g on the location Malatya with 50x20 cm plant density. Seed yield per plant shows a cultivating plant species productivity.

The seed yield per hectare values were represented in table 11.

The seed yield per hectare values changed between 561 -1875 kg/ha. The highest one was 1875 kg/ha on the location Erzincan with 50x20 cm plant density and this was followed by the location Sivas as 1807 kg/ha with 50x20 cm plant density. The both value was in same group statistically. The lowest seed yield per hectare value was 561 kg/ha on the location Erzincan with 40x40 cm plant density.

DISCUSSION

This study related to this plant species is the first that involves agronomical and morphological studies. Leaf number and branch number characters are important concerning to produce more branches and more flowers of the plants. The day number to flowering is very important for an ornamental plant. Especially, it is preferred that the days to flowering of an ornamental plant are short after planted. Because of the days to flowering of this biannual plant were very long, this duration should be shorten via various breeding methods. The most important character observed was days to flowering duration for an ornamental plant nominee. In this study counted days to flowering period was not so short, but this period may lengthened with a convenient breeding program.

The 1000 seed weight character is important for cultivating a plant species in germination speed and seed vigour. This provides homogeneity on a cultivating area and using less seed while sowing. Seed yield per plant shows a cultivating plant species productivity.

CONCLUSIONS

As a result, the data obtained showed that this endemic species may be an economically important ornamental plant for Central Anatolia Region of Turkey. Because of this region includes generally arid lands and has rainfall between 300-500 mm. According to the results, this species can grow very good in the Central Anatolia Region (Konya) on the non-irrigated lands and has flowering duration with nice scent and appearance. Especially, it may be cultivated on arid conditions without irrigation. But better agronomic and agricultural traits may be produced with a longlife breeding program or a short program as biotechnological studies.

As seen in tables, the most of the best results of measured/calculated traits such as capsule yield per plant, capsule number, days to flowering duration, canopy diameter and branch number obtained from the locations Sivas and Tunceli. Moreover, it is the best suited plant densities such as 50 cm row distances and 40 or 20 cm distances in rows for the cultivation.

According to these results, for the cultivation and higher yields of this plant, it is suggested that the best suited densities are 50x40 cm and 50x20 cm and the best suited locations are Sivas and Tunceli.

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