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# CULTIVATION OF *STERNBERGIA FISCHERIANA* (HERBERT) RUPR., AND A STUDY ON ITS MORPHOLOGICAL CHARACTERISTICS

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**Abstract**

Bulbs of *Sternbergia fischeriana* collected from the village Taşlıca of the province of Marmaris in the first weeks of March, April and May 1998 were planted after separating them into 4 groups based on size with three replications each at the experimental farms of the Department of Field Crops, Faculty of the Agriculture, University of Ankara, Turkey during 1998-2000. Percentage of emerging plants, percentage of flowering plants, percentage of plants setting fruits, number of leaves per plant and the plant height showed a range of 60.00- 96.67 %, 0-13.69 %, 0-7.50 %, 2.36-3.86 % and 12.61-17.69 cm during 1999 and 60.00-100.00 %, 33.60-96.97 %, 5.90-42.60 %, 5.00-11.33 and 15.14-19.23 cm during 2000, respectively.

## Introduction

Turkey is rich in flora and has about 9000 seed plant species, of which nearly 3000 or 30% are endemic in nature (Ekim, 1992). About 600 geophytic plant species having bulbs, tubers and rhizomes are found in Turkey (Davis, 1984-1988; Baytop & Mathew, 1984).

The bulbs and tubers of *Galanthus elwesii, Galanthus ikariae, Anemone blanda, Leucojum aestivum, Cyclomen spp. Fritillaria imperialis, Firitillaria persica, Lilium candidum and Stenbergia lutea etc.*, have been exported from Turkey for a long time (Arslan, 2000). However, a few cultural studies have been carried out pertaining to these and available information is poor.

The genus *Sternbergia* belonging to the family *Amaryllidaceae* is divided into seven species, of which 6 are found in Turkish flora (Ünal *et al.*, 1997; Yüzbaşıoğlu *et al.*, 1997). Genus *Sternbergia* Waldst. & Kit., belongs to Mediterranean region and extends to the North Persia, Caucasus and the mountains of Central Asia in the East and to Hungary and Romania in the north (Davis 1984-1988). Various species of the genus are cultivated for their beautiful golden yellow and white (*S. candida*) flowers. Their cultivation has even spread to some countries, where it is not native (Ünal *et al.*, 1997).

Cytological studies show that *Sternbergia* has a chromosome number of 2n=20 (Ünal, 1997); however, morphological and adaptation studies have yet to be carried out. Therefore, the research studies were carried out to examine the adaptations and some of the morphologic characteristics of *S. fischeriana.*

*Sternbergia fischeriana* was described by an English researcher Herbert under the name of *Oporanthus fisherianus* for the first time in 1837 but was changed to *S. fischeriana* during 1868 by a German researcher Ruprecht (Davis, 1984-88). The plant is widely available in Anatolia, Caucasus, Iraq, Iran and Kashmir with main concentration in the south and south-western Anatolia at Hatay, Adana, Içel, Konya and Muğla and some areas with elevation of 1500 meters above sea level. The species is generally found growing on or near rocks, stones and thickets in nature (Baytop & Mathew 1984).

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*S. fischeriana* is a bulbous plant that opens yellow flowers during spring, which greatly aids in its marketing. However, to materialize this effectively, it is needed to grow and culture it under economical conditions. The present study aims to take some morphological characteristics of the plant for adaptation.

Export of bulbous plants is partially met by collecting them from wild and partially by their cultivation. *Sternbergia lutea*, which flowers during autumn is being exported by some firms after taking it into cultivation. Annual export of this species has a range of 800,000-1,000,000 (Anon., 1999). Similarly, *S. fischeriana* has also an export potential.

## Materials and Methods

The study was carried out during 1998-2000 at the experimental farms of the Department of Field Crops, Faculty of Agriculture, University of Ankara, Ankara, Turkey. The bulbs of *Sternbergia fischeriana* was collected in wild from the village Taşlıca of the province of Marmaris from highly rocky area with an elevation of 100 meters from sea level (Fig. 1a) and distance of 500 meters from the sea shore with limited availability. Positive efforts are needed to conserve its germplasm. This could be done by optimizing time of sowing and knowing size of bulb through easy adaptation techniques. This aim was achieved by taking plant out of Mediterranean climate to the continental climate of the province of Ankara, with altitude of 850 m above sea level, as first step.

The material was collected giving interval of one month each during first week of March, April and May 1998. The bulbs collected each time were divided into 4 groups (4cm and above, 3.5-4.00 cm, 3.0-3.5 cm and 2.5-3.0 cm) based on bulb size. Each group was planted immediately after collection with 3 replications containing 10 bulbs each using split plot design. Row to row distance of 30 cm, plant to plant distance of 20 cm and plant depth of 15 cm was maintained during the experiments.

No development was observed from bulbs planted during March, April and May 1998 till the end of year. Observation continued during 1999 starting from the first month. During 1999 and 2000 characteristics such as percentage of emerging plants, percentage of flowering, fruit setting, number of leaves per plant and plant height were recorded and analysed further. Significance was determined by analysis of variance (ANOVA) and the differences between the means were compared by Duncan's multiple range test using an MSTAT-C computer program (Michigan State University). Data given in percentages were subjected to arcsine ($\sqrt{X}$) transformation (Snedecor & Cochran, 1967) before statistical analysis.

## Results and Discussion

All of under observation parameters were subjected to analysis of variance along with bulb size, collection period and their interaction, which were found to be significant.

**Emergence:** During 1999, the maximum emergence percentage (96.67 %) was observed from the collection period of April with bulbs having more than 4 cm size and from bulbs having 3.0-3.4 cm and 2.5-3.0 cm in May collection (Table 1). Minimum emergence percentage (60.00%) was observed from May collection with bulbs having more than 4 cm size. No significant difference was observed from March and April collections as far as the bulb size is concerned. Groups I and II of April and groups III and IV of May collections had the highest values. Mean of groups showed the maximum value of 92. 22% from group III with 3.0- 3.4 cm bulb size; whereas mean of collection periods showed highest ratio of 91.67 % from the bulbs collected in April.

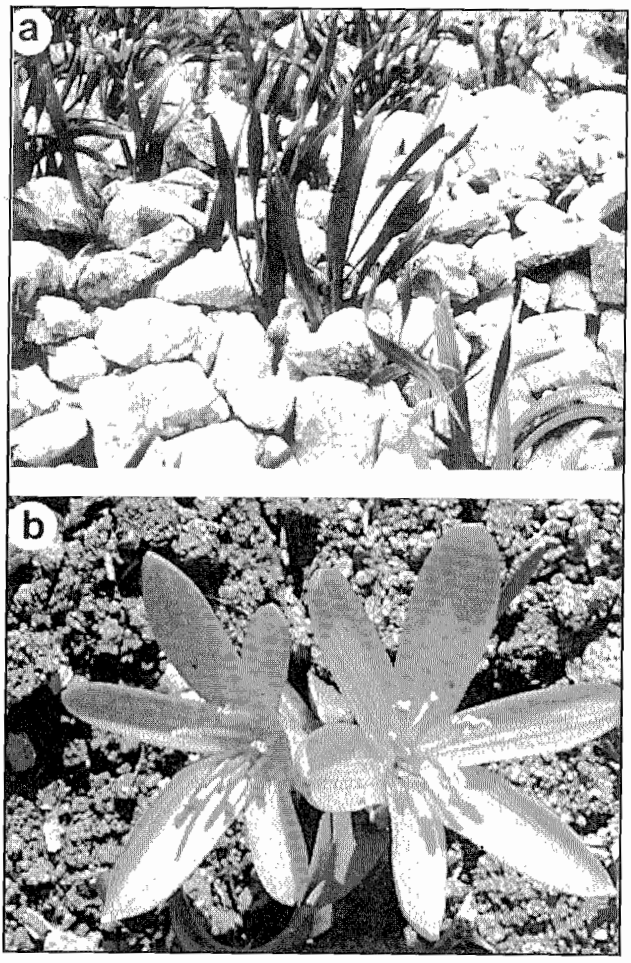


Fig. 1. *Stenbergia fischeriana* growing in wild (a) and cultivated (b) *S. fischeriana* experimental trials.

During the year 2000, maximum emergence (100%) was observed from April collection with bulbs larger than 4 cm. The lowest recorded value (60%) again fell in the same group of May collection. No statistical difference was recorded between March and April collections. Analysing bulb groups from inside groups II, III and IV, no significant difference was found among the groups. Moreover, the values for group I entered into same column during March and April. The highest mean value (96.67%) was observed during April and the highest mean value (94.45%) was observed in group IV for the emergence percentage.

Comparing two years, the highest and the lowest emergence percentage values were recorded from April and May collections, respectively. Comparing bulb size, the least emergence was observed from bulbs having diameter of more than 4 cm during both years. The highest emergence was noted when the bulb size had range of 3.0-3.4 cm and 2.5-2.9 cm during 1999 and 2000, respectively. Lower emergence from larger bulbs may

be attributed to age factor. The present studies showed that the younger bulbs have more adaptation potential compared to larger bulbs (Table 1). Similarly, Sarıhan & Arslan (1998), found higher emergence percentage among earlier harvested bulbs of *Galanthus elwessii.*

**Table 1. Mean values pertaining to emergence percentage and Duncan groups.**

| Groups based on bulb size | Emergence percentage in 1999 | | | | Emergence percentage in 2000 | | | |
|---|---|---|---|---|---|---|---|---|
| | Collection period of bulbs | | | | Collection period of bulbs | | | |
| | March | April | May | Means | March | April | May | Means |
| I. More than 4 cm | 86.67a[1] | 96.67a | 60.00b | 81.11 | 73.63ab | 100.0a | 60.00b | 77.88 |
| II. 3.5-3.9 cm | 86.67a | 93.33a | 80.00ab | 86.67 | 86.67ab | 96.67a | 86.67ab | 90.00 |
| III. 3.0-3.4 cm | 90.00a | 90.00a | 96.67a | 92.22 | 96.67a | 93.33a | 93.33a | 94.44 |
| IV. 2.5-2.9 cm | 73.33ab | 86.67a | 96.67a | 85.56 | 96.67a | 96.67a | 90.00ab | 94.45 |
| Means | 84.17 | 91.67 | 83.33 | | 88.41 | 96.67 | 82.50 | |

LSD (Int.1999) 21.90, LSD (Int. 2000) 23.09
Each value is the mean of 3 replications each with 10 explants
Years were analysed separately
[1] Values within a column followed by different letters are significantly different at the 0.05 level.

**Table 2. Mean values pertaining to flowering percentage and Duncan groups.**

| Groups based on Bulb size | Flowering percentage in 1999 | | | | Flowering percentage in 2000 | | | |
|---|---|---|---|---|---|---|---|---|
| | Collection period of bulbs | | | | Collection period of bulbs | | | |
| | March | April | May | Means | March | April | May | Means |
| I. More than 4 cm | 11.80 | 10.37 | 13.69 | 11.95 | 62.67bcd[1] | 53.90bcd | 85.57abcd | 67.38 |
| II. 3.5-3.9 cm | 10.83 | 7.04 | 11.11 | 9.66 | 73.30abcd | 61.83bcd | 96.97a | 77.37 |
| III. 3.0-3.4 cm | - | 3.70 | 10.00 | 4.57 | 47.97cd | 51.30cd | 95.57a | 64.95 |
| IV. 2.5-2.9 cm | - | 3.70 | 10.74 | 4.81 | 33.60d | 42.97cd | 89.10a | 55.22 |
| Means | 5.66 | 6.20 | 11.39 | - | 54.39 | 52.50 | 91.80 | |

LSD (int.2000): 25.18
Each value is the mean of 3 replications each with 10 explants
Years were analysed separately
[1] Values within a column followed by different letters are significantly different at the 0.05 level.

**Flowering percentage:** The flowering percentage was very low during 1999 (Table 2). No flowering was observed from the material collected during March in groups III and IV, therefore the values were not put to statistical analysis. Comparing collection months, the maximum value (11.39%) was observed during May. Falling in descending order from group I to IV, the highest value among groups was noted down from bulbs larger than 4 cm in size.

However during the year 2000, the interaction among groups was significant and the highest value (96.97%) was recorded from May collection and bulb group II of 3.5-3.9 cm and the lowest value (33.60%) was noted down from March and bulb group IV of 2.5-

2.9 cm. Means of months showed the highest flowering percentage of 91.80% from May collection; however, lower values obtained during March and April were very close. The highest flowering percentage of 77.37% was obtained from bulbs in the range of 3.5-3.9 cm diameter followed by group I (67.38%), group III (64.95%) and group IV (55.22%).

During the first year (1999) of planting, flowering ratio was very poor with the range of 3.70-13.69%, whereas during the second year (2000) a significant increase in flowering was quite evident with range of 33.60% to 96.67% (Fig. 1b). The best results were obtained from the collection month of May during both the years. Comparing groups, the best results were recorded in groups I and II. These results signify that bulb size and age contributes effectively to flowering. Arslan *et al.*, (1998) observed increase in flowering after first year in *Galanthus elwesii.* Sarıhan & Arslan (1998) found that only mature bulbs flower during first year and there was no flowering if harvested earlier. Dilbirliği & Arslan (1998) recorded that the increased flowering percentage was directly proportional to increase in bulb size.

**Fruit setting:** Poor flowering during 1999 considerably affected fruit setting (Table 3). A comparison of Table 2 and Table 3 shows that majority of flowers did not set fruit in 1999. The mean fruit setting value for March collection was 3.64% and that for May is 2.39%. A comparison among groups (1999) shows fruit setting in first 3 groups only.

**Table 3. Mean values pertaining to fruit setting and Duncan groups.**

| Groups based on Bulb size | Fruit setting percentage in 1999 | | | | Fruit setting percentage in 2000 | | | |
|---|---|---|---|---|---|---|---|---|
| | Collection period of bulbs | | | | Collection period of bulbs | | | |
| | March | April | May | Means | March | April | May | Means |
| I. More than 4 cm | 7.04 | - | 4.76 | 3.93 | 32.62ab[1] | 11.00bcd | 30.00ab | 25,74 |
| II. 3.5-3.9 cm | 7.50 | - | 3.70 | 3.73 | 26.73ab | 21.63abc | 42.62a | 30,32 |
| III. 3.0-3.4 cm | - | - | 3.33 | 1.11 | 13.57bcd | 12.60bcd | 41.57a | 22,58 |
| IV. 2.5-2.9 cm | - | - | - | - | 5.90cd | 6.07d | 36.67ab | 16,21 |
| Means | 3.64 | - | 2.39 | | 20.61 | 12.83 | 37.71 | |

LSD (int 2000) 16,27

Each value is the mean of 3 replications each with 10 explants

Years were analysed separately

[1] Values within a column followed by different letters are significantly different at the 0.05 level.

During 2000 fruit setting had range of 5.90-42.60% (Table 3), the highest value was recorded for May collection in group II and the lowest value was noted down in group IV for March collection. Analyzing bulb collection period, the highest value was obtained for May and the lowest for April. Comparison among groups show the highest value for group II and the lowest value for group IV.

A comparison of two years show that fruit setting was at lower level during 1999 with significant increase during 2000, showing effect of bulb collecting period and bulb size on fruit setting. Increase in bulb size had positive effects on fruit setting. For each of the two years, plants falling in group I and II had the highest fruit set. Generally fruit setting corresponded with flowering ratio but the fruit setting was considerably lower.

**Number of leaves:** As is evident from Table 4, the number of leaves per plant had a range of 2.36-3.86 during 1999. Maximum number of leaves per plant was recorded from May collection and bulbs of group II, whereas, the minimum number of leaves per plant was noted down from March collection and plants in group IV. An analysis of collection months showed maximum number of leaves per plant for the months of March and May. Similarly, a comparison among groups showed number of leaves per plant from group I to IV fall in descending order.

**Table 4. Mean values pertaining to number of leaves per plant and Duncan groups.**

| Groups based on Bulb size | Number of leaves per plant in 1999 | | | | Number of leaves per plant in 2000 | | | |
|---|---|---|---|---|---|---|---|---|
| | Collection period of bulbs | | | | Collection period of bulbs | | | |
| | March | April | May | Means | March | April | May | Means |
| I. More than 4 cm | 3.79ab[1] | 3.44ab | 3.80ab | 3.68 | 11.33a | 8.22b | 7.00bcd | 8.85 |
| II. 3.5-3.9 cm | 3.76ab | 2.96cd | 3.86a | 3.53 | 10.22a | 7.22bc | 6.67bcd | 8.04 |
| III. 3.0-3.4 cm | 2.59de | 2.50de | 3.34bc | 2.81 | 6.44bcd | 5.45cd | 6.22bcd | 6.04 |
| IV. 2.5-2.9 cm | 2,36e | 2.65de | 2.86d | 2.62 | 5.00d | 5.00d | 5.45cd | 5.15 |
| Means | 3.13 | 2.89 | 3.46 | - | 8.25 | 6.47 | 6.34 | |

LSD (int.1999): 0,441, LSD (int.2000): 1,922

Each value is the mean of 3 replications each with 10 explants

Years were analysed separately

[1] Values within a column followed by different letters are significantly different at the 0.05 level.

Number of leaves per plant had range of 5.00-11.33 during the year 2000. The maximum and the minimum number of leaves per plant were recorded from March collection and plants with bulb size of more than 4 cm and from March and April collections and plants lying in group IV (2.5-3.9 cm), respectively. Analysis of months show that the maximum number of leaves per plant were noted down from March collection, whereas the comparison among groups show the lowest value (8.15) for plants falling in group IV.

A joint analysis of 1999 and 2000 showed that maximum number of leaf setting occurred from March and May collections during first year and in March during second year of planting. This clearly indicates that earlier collected and planted bulbs had greater number of leaves per plant. The results pertaining to number of leaves per plant correspond for both years, falling in descending order from group I to IV. These results show direct proportion of bulb size to number of leave per plant.

Mathew (1984) observed 4-7 leaves per plant in *Sternbergia fischeriana* however Ekim *et al.*, (1991) noted 4-6 leaves per plant. Number of leaves per plant does not match with the literature cited, it was lower during first year and higher during 2$^{nd}$ year.

**Plant height:** The plant height ranged between 12.04-17.96 cm in 1999 (Table 5). The tallest plant was obtained from May collection and among plants of group IV. However, the shortest plant was also obtained from group IV and April collection. Statistically the results could be subdivided into six groups. No significant difference among plants of group II, III and IV was recorded in May collection. A comparison among months shows that the tallest plant was obtained from May collection with height of 16.56 cm.

**Table 5. Mean values pertaining to plant height and Duncan groups.**

| Groups based on Bulb size | Plant height (cm) in 1999 | | | | Plant height (cm) in 2000 | | | |
|---|---|---|---|---|---|---|---|---|
| | Collection period of bulbs | | | | Collection period of bulbs | | | |
| | March | April | May | Mean | March | April | May | Mean |
| I. More than 4 cm | 15.29bcd | 12.76cf | 14.65cde | 14.23 | 13.14 b | 17.40ab | 16.80ab | 16.45 |
| II. 3.5-3.9 cm | 14.19de | 13.13ef | 16.57abc | 14.63 | 15.33b | 17.76a | 18.00a | 17.03 |
| III. 3.0-3.4 cm | 13.79def | 13.44def | 16.83ab | 14.69 | 17.33ab | 18.82a | 17.48ab | 17.88 |
| IV. 2.5-2.9 cm | 12.61cf | 12.04f | 17.96a | 14.20 | 17.00ab | 19.23a | 17.78a | 18.00 |
| Means | 13.79 | 12.84 | 16.56 | - | 16.20 | 18.30 | 17.52 | - |

LSD (int.1999):1,870 ; LSD (int.2000):2,134

Each value is the mean of 3 replications each with 10 explants

Years were analysed separately

[1] Values within a column followed by different letters are significantly different at the 0.05 level.

The tallest plant was obtained from April collection with plant height of 19.23 cm in group IV and the shortest plant was noted down from March collection with plant height of 15.14 cm in group I during year 2000. Except for the values in group I and II, all other values fell into the same group. Comparison of mean of months shows that the tallest plant (18.30 cm.) was observed from April collection. Similarly, a comparison among group shows the least value (16.45 cm.) and the highest value (18 cm.) for plants fell in group I and IV, respectively. Frank (1986) observed 15-18 cm of plant height in *S. fischeriana*. Our results especially during 2nd year of cultivation correspond to the results cited in literature.

The present studies would suggest that *Sternbergia fischeriana* has a large export potential but is found in limited amount under natural conditions. Also its collection is forbidden for the sake of conservation. The successful cultivation of bulbs collected from village Taşlıca of Mediterranean climatic zone shows the high adaptation capacity of the plant in the continental climatic zone of Ankara (Fig. 1b). A comparison of 2 years shows that mean emergence had a range of 80-90%. These are appropriate values for taking the plant into cultivation. However, some combinations had poor results. Although flowering ratio is higher yet the fruit setting is very poor in this species. This may be due to the climatic effects of the province of Ankara.

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