

Full Length Research Paper

# Minimum leaf width as an indicator of *Colchicum speciosum* Steven (*Liliaceae*) suitable for collection

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In the present study, statistical analyses were conducted of the leaf width and corm diameter of *Colchicum speciosum*, in order to be able to determine whether it is suitable for harvesting, without uprooting the plant. *C. speciosum* samples (n = 213) were collected randomly from the Hamsiköy district in the Eastern Black Sea Region of Turkey. The leaf width and corm diameter of each plant was measured. Data of 180 plants were used in correlation and regression analyses, and data of 33 plants were used as a control group. The correlation between leaf width and corm diameter was found to be 0.864. A determination model created using leaf width and corm diameter showed a determination coefficient ( $R^2$ ) of 0.778, and standard error ( $S_y$ ) 0.128. A paired t-test was conducted using Control data in order to test the validity of the regression model. The results indicated that there was no significant difference between the corm diameter obtained through measurements and the estimated corm diameter obtained using the created model at a reliability level of 95% ( $p < 0.05$ ). According to the regression model created, the minimum leaf width was estimated as 73 mm in a *C. speciosum* plant with a minimum ripe corm diameter of 25 mm.

**Key words:** *Colchicum speciosum*, corm diameter, leaf width, modeling.

## INTRODUCTION

Due to increased demand for natural medicinal products, *Colchicum* and other medicinal plants have come under threat. It has therefore become necessary to cultivate many medicinal plant species, in order to meet the demand for natural medicinal products (Poutaraud and Champay, 1995).

The lack of knowledge regarding the potential implications of the plants being collected in increasing numbers raises a serious concern (Fuller, 1991). In Turkey, excessive collection of some plants together with their roots, tubers or bulbs harms the habitat and species diversity.

It is therefore increasingly important to ensure sustainable usage and preservation of plants, and to a method for identifying bulbous and tuberous plants of appropriate size for collection prior to uprooting. The genus *Colchicum* belongs to the family *Liliaceae* and includes 100 species worldwide (Wendelbo and Stuart, 1985). *Colchicum* is represented by 46 species in Turkey. (Persson, 2007). *Colchicum speciosum* is a perennial herbaceous species which, within Turkey, is native to the Eastern

Black Sea Region. Leafing and fruit formation occur in spring (histerantus), and flowering occurs in autumn; the underground stem base forms a corm that acts as a vegetative reproductive structure and is also harvested (Brickell, 1984). The corm, leaf, seed and flowers of the *Colchicum* genus contain the alkaloid colchicine (Al-Fayyad et al., 2002). Colchicine is known as a specific medication for gout, Familial Mediterranean Fever (FMF) and Behçet's syndrome. Furthermore, the plant is used in genetic studies, various disorders and as an anticancer agent (Trease and Evans, 1983; Poutaraud and Champay, 1995; Pırıldar, 2006; Alali et al., 2004; Souri et al., 2008). *C. speciosum* is one of the most important indigenous economic plants of Turkey and is the only *Colchicum* species exported from Turkey (Baytop, 1999). The *Colchicum* genus has not yet been cultivated and its biology being different, so trade continues to rely on collection of the plants from their nature habitat (Poutaraud and Champay, 1995). Buyers also pay much higher premiums for plants collected from nature compared to those which are cultivated (WWF, 2006).

Previous studies concluded that leaf width was an indicator of tuber size (Nault and Gagnon, 1988; AVRDC, 2001). Furthermore, the width of the largest leaf is accep-

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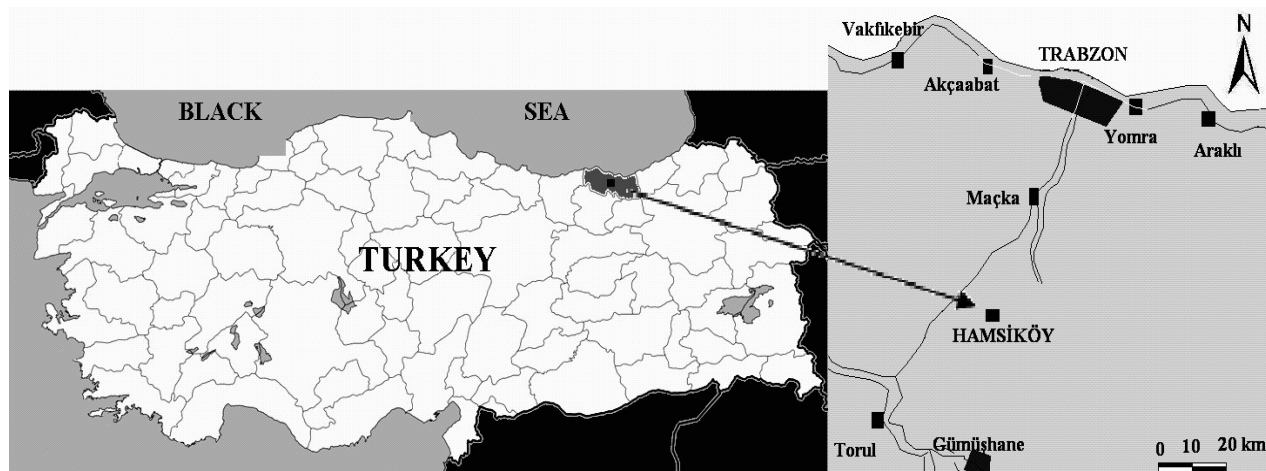


Figure 1. Location of study area.

ted as an estimator of plant size (Cain and Damman, 1997).

The present study aimed to establish whether samples of *C. speciosum* were of suitable size for harvesting, based on leaf width and corm diameter. This method, in turn, may help to reduce indiscriminate plant collection.

## MATERIALS AND METHODS

The study area is located in the Hamsiköy district of Trabzon province, in the Eastern Black Sea Region of Turkey. It is between latitudes 40°38' - 40°45' north and longitudes 39°24' - 39°34' east (Figure 1). *Colchicum speciosum* is distributed from 1100 m to 2000 m in the study area. Furthermore, the plant is tendency to cluster. So, in case of disappearance on each altitude groups, it was composed three altitude groups (300 metric). The study used 213 *C. speciosum* plants collected from the district. 60 plants each were collected from three different altitude groups (1100-1400 m, 1400 - 1700 m, 1700 - 2000 m) in the district, 180 plants in total. Additionally, 33 plants were collected to be used as control data. As fruit formation occurred in only 100 out of the 180 study plants, the seed weights were measured only on these. The corm diameter and leaf width was measured on each plant. Data relating to the plants used in the analyses and the control group are summarized in Table 1 (Figure 1).

A relationship was sought between leaf width and corm diameter with the aim of determining whether or not the *C. speciosum* plant can be appropriately harvest, instead of collected indiscriminately. To this end, correlation analysis was conducted to determine the strength and direction of the relationship between the variables, and regression analysis was conducted to identify the mathematical expression of the correlation between the dependent and independent variables. SPSS 13.0 statistical software was used for the correlation and regression analyses. The minimum harvestable corm diameter of a ripe *C. speciosum* plant was assumed as 25 mm (Brickell, 1984). The validity of the resulting regression equation was evaluated via a paired t test using the control data (Table 1).

## RESULTS AND DISCUSSIONS

A high degree of correlation was found between leaf width-corm diameters. The correlation coefficients (R) are

0.864 (\*\*\*). The seed weight measured in those plants which fruited (n = 100) did not indicate a significant relationship with any of the other parameters. A model was created, according to the regression analysis, between leaf width (Lw) and corm diameter (Cd), as below (Figure 2).

$$y = b_0 * (t^{b_1}), \text{ from here} \\ Cd = 0.936 * (Lw^{0.767}) \quad (1)$$

[ $R^2 = 0.778$ ,  $S_y = 0.128$ ,  $b_0 = 0.936$  (\*\*\*),  $b_1 = 0.767$  (\*\*\*)] (Figure 2).

According to first altitude group (1100 - 1400 m), a model was created between leaf width and corm diameter, as below (Figure 3).

$$y = b_0 * (t^{b_1}), \text{ from here} \\ Cd = 1.331 * (Lw^{0.683}) [R^2 = 0.632] \text{ (Figure 3).} \quad (2)$$

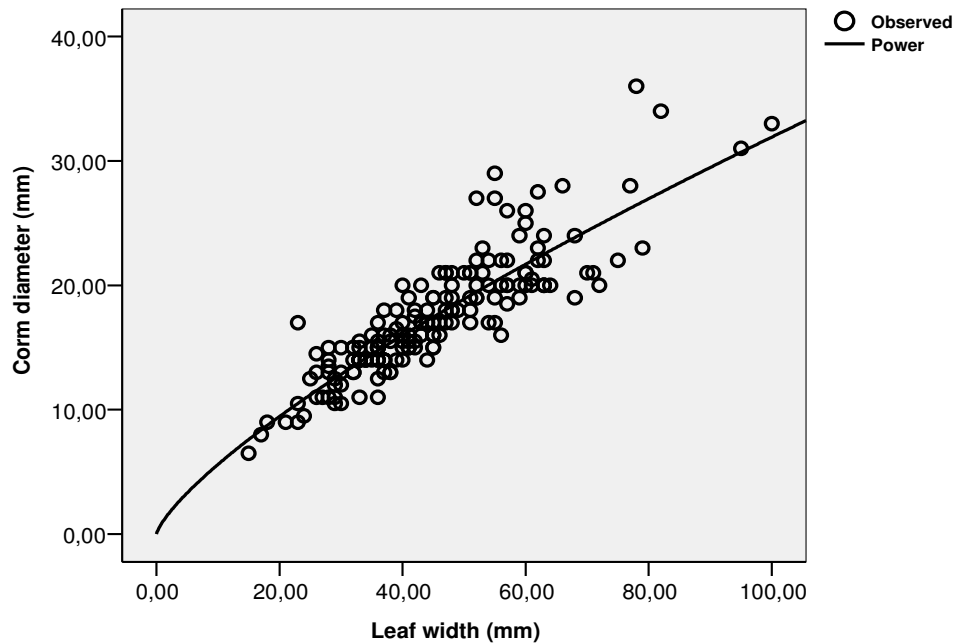
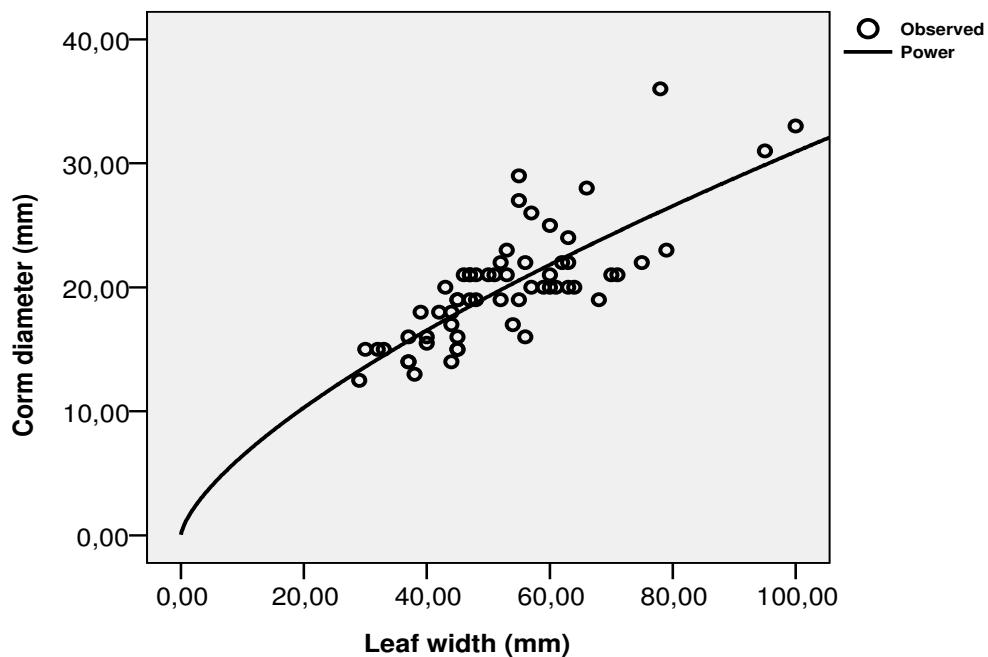
According to second and third altitude groups (1400 - 1700 m, 1700 - 2000 m), a model was created between leaf width and corm diameter, as below (Figure 4).

$$y = b_0 * (t^{b_1}), \text{ from here} \\ Cd = 0.974 * (Lw^{0.756}) [R^2 = 0.810] \text{ (Figure 4).} \quad (3)$$

Leaf width, corm diameter exhibited statistically significant differences between the groups, according to the altitude of the collection site. For all three groups 1100 - 1400 m, 1400 - 1700 m, 1700 - 2000 m),  $p = 0.000$ . Leaf width and corm diameter average values were higher in the lowest altitude group (1100 - 1400 m) compared to the other two altitude groups. However, the second (1400 - 1700 m) and third (1700 - 2000 m) altitude groups emerged as similar to each other. The results are significant at a confidence level of 95% (Table 2). In the study area, according to all regression models (in all altitude groups) created, the minimum leaf width was estimated 73 mm in a *Colchicum speciosum* plant (with a minimum

**Table 1.** Summary statistics for fitting and control data sets.

Data	N	Leaf width (mm)			Corm diameter (mm)		
		Range	Mean	SD	Range	Mean	SD
Fitting	180	15 - 100	44.94	14.35	6.5 - 36	17.41	4.82
Control	33	26 - 100	46.36	14.88	10.5 - 33	17.76	4.73

**Figure 2.** Regression model between leaf width and corm diameter (all data).**Figure 3.** Regression model between leaf width and corm diameter (1. altitude group: 1100-1400 m).

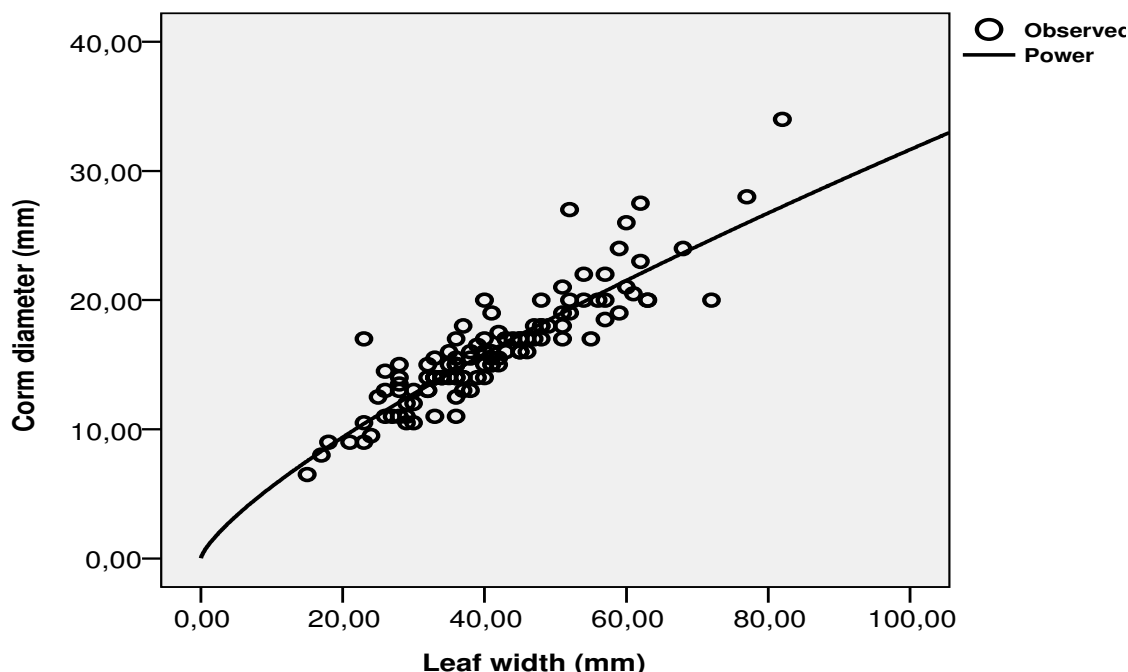


Figure 4. Regression model between leaf width and corm diameter (II. and III. altitude groups: 1400 - 2000 m).

Table 2. Summary statistics for altitude group data sets.

Altitude Group(m)	Leaf width (mm)			Corm diameter (mm)		
	Range	Mean	SD	Range	Mean	SD
I (1100 - 1400)	29 - 100	53.17	14.29	12.5 - 36	20.13	4.74
II (1400 - 1700)	23 - 82	41.37	13.50	9 - 34	16.17	4.56
III (1700 - 2000)	15 - 68	40.30	11.61	6.5 - 27	15.94	3.99

ripe corm diameter of 25 mm.

Among the altitude groups, the higher growth values observed in the first group compared to the second and third altitude groups, indicates that the number of plants which reach the ripe corm diameter (25 mm) may be greater at the lower altitudes of 1100 - 1400 m. This suggests that harvesting activities will be more intense in the lower altitude areas and, consequently, such areas will require greater sensitivity when establishing the sustainable balance between preservation and usage (Table 2).

Estimated corm diameters obtained from "the regression equation 1" using the actual corm diameter values of the control group displayed no statistically significant variation from those of the experimental group ( $p < 0.05$ ). Many growth models have been created for different genera and species worldwide, whose underground organs are utilized. In previous growth model studies relating to bulbous, tuberous and cormous plants, different parameters were taken into account such as leaf area, leaf length, leaf width, leaf number, flower yield, trunk

length (Lee and Yang, 1997; Rees, 1969; Lancaster et al., 1996). Jean and Sheng (2005) found a high correlation between the leaf area and tuber diameter in gladiolus. In the present study, leaf width was used instead of leaf area, as leaf width is relevant in the determination of both the tuber diameter and the leaf area (Nault and Gagnon, 1988; Çırak et al., 2005; Camas et al., 2005). A high correlation of 0.864 was found between corm diameter and leaf width in the present study. This is in accordance with the findings of AVRCD (2001), which indicated that leaf width exhibited a high correlation ( $R = 0.8$ ) with the plant bulb yield.

Of the parameters used in modeling, the only above-ground organ measured was the leaf. In Turkey, the legal criteria determining the collection of flower bulbs collected from nature is the bulb-tuber-corm size (Resmi Gazete, 2007). Therefore, in deciding whether a plant was suitable to collect, the relationship between leaf width-corm diameters was considered and an equation (1) was used in determining the limit value. In the present study, the equation (1) estimated that, in a *C. speciosum* plant

whose ripe corm diameter was 25 mm, the corresponding minimum leaf width would be 73 mm. As a result, it would be appropriate to harvest *C. speciosum* plants with a leaf width of 73 mm or more.

The non-correlation between collected seed weight and the other relevant parameters suggest that the age of the plant or climatic events such as temperature or rainfall may have an effect on seed weight.

## Conclusions

Bulbous, tuberous or cormous plants are widely used in the field of medicine, and are mostly harvested from the wild. This necessitates preservation measures to ensure the sustainable usage these plants. The plants' bulb, tuber and corm diameters have been specified as criteria in national and international trade. Further research is required to develop species-specific growth models, in order to protect plants which are not suitable to be collected, to prevent the over-collection of plants, and to ensure sustainability of both plant species and their habitat.

With this study, it was emphasized that the leaf width should be taken into consideration for the harvest of *Colchicum speciosum*. In a plant which has a ripe corm of minimum diameter of 25 mm, it was determined that the minimum leaf width would be minimum 73 mm. Brickell (1984) have reported that the *C. speciosum* is widely spreaded in the North and East regions of Turkey. He also reported that the minimum leaf width changes between 55 mm to 95 mm and the minimum ripe corm diameter changes between 25 mm to 40 mm. Although, our research results in the Hamsiköy district showed that the minimum corm diameter is about 25 mm (which also between the values given by Brickell (1984)) and minimum ripe leaf width is about 73 mm (which is also pleased between the values given by Brickell (1984)). This result indicates that a plant with a leaf width smaller than 73 mm has not reached ripe corm diameter. The results suggest that leaf width is a reliable indicator of ripe corm diameter of *C. speciosum*, and; that leaf width may be relevant to policies designed to ensure the sustainable management of *C. speciosum*.

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