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Full Length Research Paper

A study on the growth and development of some *Gladiolus* (*Gladiolus* L.) varieties planted in different time under the ecological conditions of Erzurum

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This study was carried out to determine the effect of plantation time (10, 20 and 30 June) on plant growth and floret quality of four commercial varieties of *Gladiolus* (White Prosperity, Amsterdam, Nova Lux and Victor Borge), planted in open field under ecological conditions of Erzurum by comparing varieties for their sprouting time, spiking time, stem length, the number of florets and harvesting time. As the result of the study, 20 June was found to be the most suitable plantation time when considered sprouting and spiking time and White Prosperity is the best varieties. The largest length belongs to White Prosperity, while the lowest is Nova Lux and plantation time did not affect plant length significantly ($p < 0.01$). White Prosperity is the best variety for floret number and harvesting time (84.24 days) when June 10 is considered to be the best plantation time.

Key words: Erzurum, *Gladiolus* varieties, plantation time.

INTRODUCTION

Flowers not only offer aesthetical beauties, but also have become a commercial object. Flower production is a branch of agricultural cultivation today in several countries and can contribute to national economies providing millions of dollars (Bulut, 1994).

Turkey inhabits many distinctive ornamental plant groups due to its location at the cross-section point of Mediterranean, Europe to Siberia and Iran to Turan phyto-geographical regions and different climatic conditions prevalent in its region, which cause natural floristic richness, biological diversity and various habitat characteristics which cannot be seen in many countries. Flower cultivation, which has a large natural potential in Turkey, is gradually gaining importance and become a profitable agricultural and commercial branch.

Cut flower cultivation is a subdivision of ornamental plant production having the largest part either in production or economic value. Cut flower production involves the processes, where fresh or dried flowers or their parts are used in buckles and arrangements in its original or coloured forms. Activities such as growing, picking, procession, classification, storing and marketing of flowers are included in cut flower production process (Anonymous, 2000).

Nearly 50 countries produce cut flower. Turkey is among the most important countries having the largest potential for cut flower growing with its climatic and geographical characteristics. The largest cut flower growing centres are the cities of Yalova, Izmir and Antalya in the country. Above the half of the area rest for ornamental plants in the country is divided for cut flower production. Two third of more than 9500 ha area divided for cut flower production is in green house. Twelve percent of green house area is covered with glass and the rest is plastic. Thirty percent of cut flower production in Turkey is cultivated under open condition (Anonymous, 2009a). It is estimated that, Turkey shares 0.7% of all ornamental plant growing amount in the world (Anonymous, 2009b).

Clove is the most commonly grown cut flower species in Turkey (in an area of 4111 da), followed by *Gladiolus* (1354 da) and rose (786 da). In Turkey, under undercover and open cultivation of *Gladiolus* is common in and around the cities of Istanbul, Yalova, Bursa and Izmir. The reason for the higher cultivation percentage of *Gladiolus* is that, this species is grown for exportation. *Gladiolus* has a considerably high marketing rate with the production of bulb (corm, cormel and cralen), in addition

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Table 1. Cut-flower consumption rate in Erzurum.

Species	Rate (%)
Clove	47
Rose	29
Gladiolus	11
Gerbera	10
Other	2

to cut flower (Anonymous, 2009a).

Total of 9 *Gladiolus* species are grown in various regions of Turkey, 4 of which are endemic to the country (Üzen, 1999). It was found in related studies that, *Gladiolus* atroviolaceus Boiss grows naturally in Serçeme Valley, Kuzgun dam and its surrounding, Narman-Oltu and Şenkaya provinces (Irmak, 2008).

The province of Erzurum is the centre of East Anatolia Region geographically. Erzurum and its surroundings shelter unique and diverse vegetation cover due to the elevation up to 3000 m, soil structure and different ecological characteristics. Demand for cut-flower is high in the city of Erzurum which is a university city. Yearly cut-flower consumption of Erzurum city is given in Table 1 (Bulut et al., 2007).

The aim of this study, which may be seen as baseline for such studies for Erzurum, is to determine that *Gladiolus* can be grown in this region of the country. With this aim, different *Gladiolus* species were planted in open filed in different plantation periods and the most suitable species and flower yield and quality of these species were investigated. In the light of data obtained, *Gladiolus* varieties can be proposed and extended and new production areas can be opened for growers. As a result, this attempt can contribute to the diversity of agricultural crops and economic development of the area.

MATERIALS AND METHODS

The study was conducted in open field in Application and Research Farm of Agriculture Faculty of Atatürk University between June and October in 2004. Victor Borge (red), White Prosperity (white), Nova Lux (yellow) and Amsterdam (white) cultivable varieties of *Gladiolus* grandiflorus species having commercial value were used in the study. Sixteen corms, which were obtained from Ataturk Garden Culture Institution with a perimeter of 10 to 12 cm, were used in each repetition (totally 576 corms).

Meteorological values in the area and study period were obtained Meteorology Institution and are given in Table 2 (Anonymous, 2004). Analysis of soil types in the study area was carried out in the laboratory of Soil Department of Agricultural, Faculty of Ataturk University. When physical and chemical data of soil samples were considered, it was determined that soil is close to neutral, normal in lime content, with good porosity, since it contains sand at a percentage of nearly 60 and sufficient in macro nutrients.

Predetermined experiment field was ploughed at a depth of 25 to 30 cm and made ready for plantation. After that, each plots of 1 m^2, were prepared and 16 corms were planted in each plot. Corms were placed in plots on their tablets and they were pressed slightly into soil form their uppermost parts until reaching a depth of 6 to 7 cm by leaving a distance and interval of 15 cm between each corm and line (Fernandes et al., 1974; Altan and Altan, 1997; Fodor, 1978). Before June, no plantation activity was performed due to unsuitable weather and soil conditions. Corms were planted on six different dates; 10^{th}, 20^{th} and 30^{th} days of June and July. However, plants planted in July could not be harvested due to short vegetation period. Therefore, data was obtained from June only.

Four different *Gladiolus* varieties were used in the experiment by choosing time and type to be factors and the experiment was laid down in completely randomized block factorial design with three replications (Yildiz and Bircan, 1991).

Data was subjected to variance analysis and means of variation sources found to be statistically significant were compared using Duncan multiple comparison test. Corms were dipped for 30 min in a water solution at 46°C containing Captan (2%) and Benomyl (1%) in order to protect them from fungi before plantation (Altan and Altan, 1997).

Required maintenance conditions were met during experiment period and plants were applied after they had 3^{rd} and 4^{th} leaves 50 g/m^2 fertilizer containing N, P and K in the rate of 15% once 30 days (Amen, 1985; Gürsan, 1993).

Parameters such as shooting and spiking time (day), the number of flower candles (item/spike), length of flower stem (cm) and harvesting time were observed and measured (Disperati, 1982; Hussain et al., 2002; Akin, 2001; Kumar et al., 2002; Gupta et al., 2002): Sprouting time (day) is the period extending from the plantation of corms to appearance of plant peaks on the ground; spiking time (day) is the period from the plantation of corms to appearance of spikes; the number of florets (item/spike) is the total number of flower candles on a spike; plant length (cm) is the distance from ground level to the last candle; harvesting (cutting) time is the period from the plantation of corms to appearance of the lowest candle.

RESULTS

Results obtained from the observations and measurements of parameters belonging to four different *Gladiolus* types are thus explained.

Shooting time

Table 3 represents the results of Duncan multiple comparison test belonging to shooting time of four different types. It can be seen that, the earliest shooting type is White Prosperity with 12.36 days, while the latest is Victor Borge. A statistically significant difference is not seen between Amsterdam, Victor Borge and Nova Lux, while the difference between White Prosperity and others was found to be statistically significant.

Effect of plantation time on the shooting time of *Gladiolus* types is represented in Table 4 using Duncan multiple comparison test. As can be seen in the table, 30^{th} and 10^{th} of June are in the same statistical group, 20^{th} of June is in different group. 20 June was found to be the most suitable plantation time among three dates (12.41 days).

Table 2. Monthly values of some meteorological parameters in 2004.

Months	Rainfall (mm)	Mean temperature (°C)	Minimum temperature (°C)	Maximum temperature (°C)	Relative humidity (%)	Wind direction and velocity (m/s)
June	40.7	14.5	5.8	22	52.7	WSW 9.5
July	2.4	17.9	7.7	26.3	41.9	NE 9.1
August	1.3	19.6	8.6	28.4	41.1	ENE 8.5
September	6	13.8	3.9	23.5	40.9	ENE 9.4
October	27.4	7.9	-0.1	17.2	59.2	SSW 2.2
November	88	-1	-6.8	6	71.9	WSW 1.7
December	8.2	-14.1	-20.5	-7.4	77.1	SSW 0.8

Table 3. Mean shooting time of different *Gladiolus* types (day).

Type	Mean
White Prosperity	12.36 b
Amsterdam	16.09 a
Victor Borge	18.85 a
Nova Lux	18.36 a

Means signed by different letters are statistically different (P < 0.01). LSD 01: 3.095.

Table 4. Effect of plantation time on shooting periods of *Gladiolus* types.

Date	Means
10 June	17.79 a
20 June	12.41 b
30 June	19.05 a

Means signed by different letters are statistically different (P < 0.01). LSD 0.1: 2.680.

Table 5. Mean spiking time of different *Gladiolus* types (day).

Type	Mean
White Prosperity	77.59 b
Amsterdam	83.72 a
Victor Borge	78.41 b
Nova Lux	85.20 a

Means signed by different letters are statistically different (P < 0.01). LSD 0.1: 4.885.

Table 6. Effect of plantation time on spiking periods of *Gladiolus* types.

Time	Mean
10 June	82.79 a
20 June	80.24 a
30 June	82.79 a

Means signed by different letters are statistically different (P < 0.01).

Table 7. Means of floret numbers.

Type	Mean
White Prosperity	14.10 a
Amsterdam	13.27 ab
Victor Borge	11.20 b
Nova Lux	12.20 ab

Means signed by different letters are statistically different (P < 0.01). LSD 0.1: 2.018.

Spiking time

Table 5 represents the results of Duncan multiple comparison test belonging to spiking time of four different types. When considered the results, it can be seen that, the earliest spiking type is White Prosperity (77.59 days) followed by Victor Borge (78.41 days). These two types are in the statistically same group (P < 0.01). The latest spiking type was found to be Nova Lux.

Effect of plantation time on the spiking time of *Gladiolus* types is represented in Table 6 using Duncan multiple comparison test. It can be seen that, different plantation times do not affect significantly the spiking time and all three plantation times are in the same statistical group.

The number of florets

Table 7 represents the results of Duncan multiple comparison test belonging to floret number of four different types. As it can be seen from the table, there is no statistically significant difference

Table 8. Effect of plantation time on the floret number of *Gladiolus* types.

Time	Means
10 June	11.41 a
20 June	13.04 ab
30 June	13.63 b

Means signed by different letters are statistically different (P < 0.01). LSD 0.1: 1.748.

Table 9. Means of stem lengths.

Type	Means
White Prosperity	87.44 a
Amsterdam	77.95 a
Victor Borge	73.17 b
Nova Lux	71.71 b

Means signed by different letters are statistically different (P < 0.01). LSD 0.1:6.675.

Table 10. Effect of plantation time on the stem length of *Gladiolus* types.

Time	Means
10 June	75.56 a
20 June	78.09 a
30 June	79.04 a

Means signed by different letters are statistically different (P < 0.01).

Table 11. Means of harvesting time.

Type	Mean
White Prosperity	82.24 b
Amsterdam	93.47 a
Victor Borge	84.60 b
Nova Lüx	94.30 a

Means signed by different letters are statistically different (P < 0.01). LSD 0.1: 7.935.

between White Prosperity, Amsterdam and Nova Lux however the difference between these three types and Victor Borge is statistically significant. .

Effect of plantation time on floret number of *Gladiolus* types is represented in Table 8 using Duncan multiple comparison test. It can be seen that, the most suitable plantation time when considered the floret number is 10 June, while no statistically significant difference was found between 20 and 30 June.

Stem length

Table 9 represents the results of Duncan multiple comparison test belonging to stem length of four different types. As it can be seen from the table, the highest mean of length belongs to White Prosperity (87.44 cm) followed by Amsterdam (77.95 cm). While these two types are in the same statistical group, Victor Borge (73.17 cm) and Nova Lüx (71.71 cm) are in different group due to lower means.

Effect of plantation time on stem length of *Gladiolus* types is represented in Table 10 using Duncan multiple comparison test. It can be seen that, no statistically significant difference was found between the dates for stem lengths.

Table 12. Effect of plantation time on harvesting time of *Gladiolus* types.

Time	Mean
10 June	90.81 a
20 June	89.21 a
30 June	85.94 a

Means signed by different letters are statistically different (P < 0.01).

Harvesting time

Table 11 represents the results of Duncan multiple comparison test belonging to harvesting time of four different types. As it can be seen from the table, the earliest harvested type is White Prosperity (82.24 days) followed by Victor Borge. While these two types are in the same statistical group, Nova Lüx and Amsterdam are in a different group. The latest harvested type is Nova Lux with 94.30 days.

Effect of plantation time on harvesting time is represented in Table 12 using Duncan multiple comparison test. It can be seen that, no statistically significant difference was found between the dates for harvesting time.

DISCUSSION AND CONCLUSION

Results and suggestions given are derived from the study carried out to determine the effect of different plantation time of White Prosperity, Amsterdam, Nova Lux and Victor Borge, cultural types of *Gladiolus*, on floret yield and quality under ecological conditions of Erzurum.

Effect of variety and time on sprouting period was found to be very significant. White Prosperity had the shortest shooting time (12.36 days), while Victor Borge was the latest shooting type with 18.85 days (Table 2). 20 June was found to be the most suitable plantation time for shooting. The earliest shooting type is White Prosperity which is 6 days after plantation.

Sprouting time of *Gladiolus* in the present study is

similar to that in other studies. Tamberg and Chirva (1980) stated in their study using 18 types in different climatic conditions that, shooting time varied from 14 to 22 days. Kabacaoğlu (1988) reported in a study where effects of different plantation time on *Gladiolus* varieties that, all the studied types had 18 day shooting period. In various studies in India and Austria, shooting time changed from 2 to 26 days (Powell, 1990; Hocking, 2002).

In the study, it was found that in the late plantation, shooting time of plant is also late due to reduced light and temperature. Altan and Altan (1997) stated that, reduction in shooting time with increasing sun light intensity can be seen in *Gladiolus*. In the present study, 20 June was determined to be the most suitable time for sunlight. The reason for early shooting in the plantation on 20 June may be that soil and air temperature and light intensity are optimum for shooting time.

Since White Prosperity is an early variety, it spiked early. Plantation time had no effect on spiking statistically but best results were found in the plantation on 20 June. It was observed that, temperature had significant effects on spiking of *Gladiolus* types as well as the characteristics of type itself. In spite of early spiking at lower temperatures, reduction was seen in the length of plant and spike. With Nova Lux type, which is a late type, early spiking and reduction in flower quality are seen in 30 June plantation. Lower temperature may accelerate generative growth in *Gladiolus* (Wilfret, 1980).

In terms of spiking, Düzalan (1994) reported spiking on 97.13 days in a study in Tekirdağ, Turkey in open field using White Prosperity, which is 77.59 days in Erzurum. The reason for early spiking in Erzurum is temperature difference between day and night and more suitable thermal environment.

Effect of plantation time on floret number is statistically significant. The most suitable plantation time for floret number is 30 June, which is relatively cool period and may cause shortening of stem and spiking. It is not surprising that the tallest plants, White Prosperity and Amsterdam have the largest number of florets.

In an experimental study in Tekirdağ, Turkey using cultural types of *Gladiolus* in pods floret number of White Prosperity type varied between 11.00 to 14.65 (Ata, 1992) which is similar to present study (14.10).

In different parts of Turkey (İzmir, Isparta, Van, Tekirdağ) and the world (Italy, France, India) *Gladiolus* studies have been conducted and results of present study are similar to them where the number of florets changes from 7 to 15 (Contor et al., 2000; Kabacaoğlu, 1988; Akin, 2001; Kurun, 1988; Türkoğlu, 1995; Düzaalan, 1994; Bujimol and Singh, 2002; Gürcan, 1999; Buschman and Groen, 1989). Plant length was not affected significantly by plant time.

In the present study, among ecological factors temperature was found to be the most effective on plant length. Lower means of plant length in the present study may result from lower temperature and higher elevation of the study area. Higher elevation may inhibit the plant development and therefore, shorter length in the present study compared with western parts of Turkey may be caused by elevation. Lower temperatures may accelerate generative development in types causing early spiking and shortening of plant and spike length. Gürsan (1993) found in a study where the effect of environmental factors on the plant development of *Gladiolus* that, plant length varied between 77 and 113 cm.

There is no statistical effect of plantation time on harvesting time; however, the earliest harvesting took place in the plantation in 30 June. White Prosperity type was found to give more yield and quality florets than other types (shooting and spiking time, stem length, floret number and harvesting time). Aşkin et al. (1991) also found in their studies carried out in Van province in open field that, Victor Borge and White Prosperity types showed more yield than Applause and Nova Lux. In that study, a reduction was seen in the number of floret and flowering rate in the plantation after 11 July due to shortening of day time. In the present study, similar results were found in the yield rate between types and Nova Lux had lower cut flower quality than the others, since this type is a late flowering type and vulnerable to cold climatic features.

It is known that, climatic elements such as temperature and light density and ecological features like soil structure may be effective on the development and yield of *Gladiolus* as well as the quality of type and corm. In Middle Anatolia part of Turkey, the earliest harvested type is Nova Lux (95.96 days; Yazgan et al., 1992), while the same type was harvested the latest under the ecological conditions of Erzurum in 94.30 days. Under the same conditions in a city, Van, time period of harvesting plants is 90 to 99 (Türkoğlu, 1995) the length of this period is 82 to 95 in the present study. Diurnal temperature differences in Erzurum may reach 20°C causing an increase in the quality of *Gladiolus* florets.

Consequently, it can be stated that suitable plantation time for *Gladiolus* may differ according to types used under environmental conditions of Erzurum and the most suitable type was found to be White Prosperity among the experimented types considering climatic characteristics of the study area. It is thought that, if *Gladiolus* cultivation as cut-flower is performed under these conditions quality flowers can be obtained and significant contributions to the economy of the region can be provided.

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