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Full Length Research Paper

Effects of different planting dates on improving yield of *Fritillaria imperialis* L. and *Fritillaria persica* L. bulbs damaged by small narcissus fly (*Eumerus strigatus* Fallen)

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***Fritillaria imperialis* and *F. persica* were planted during April 2003 and May 2004 growing seasons on the basis of split block design with three replications to investigate the effects of planting dates on various plant parameters and extent of recovery by planting 25% damaged bulbs. The results showed significant effects of planting dates on plant height, number of bulbs per plant and infected bulb ratio. A comparison of the two species showed that *F. persica* gave more bulblets than *F. imperialis*. A general comparison of the two species also showed that damaged bulbs of *F. imperialis* produced lesser yield compared to *F. persica.* Furthermore, both species gave more number of bulblets from early and mid September plantings compared to early and mid October plantings. The most suitable date of planting was determined as September 1st and 15th.**

Key words: *Fritillaria persica, F. imperialis*, planting time, agronomic properties, small narcissus fly.

INTRODUCTION

The genus *Fritillaria* belongs to the subclass, Monocotyledonae family *Liliaceae*. The genus includes about 100 species native from the temperate climatic zones of the Northern Hemisphere (Ekim et al., 1992). Most of the species come from Europe and Asia (Le nard and De Hertogh, 1993) including Southeast Anatolia, Turkey (Arslan, 1999). There are more than 688 species of bulbous monocotyledons found in Turkey of which 244 are endemic (Davis, 1965-1985). *Fritillaria persica* is native to Syria, Lebanon, Iraq, Iran, Jordon Cyprus and Southern Turkey (Bryan, 1989; Arslan, 1999; Tubives, 2007) and *Fritillaria imperialis* is found in Iran, Northern Iraq, Afganistan, Pakistan and Kashmir (Tubives, 2007). Commercial collection and trade represents the principle threat to individual species. Collecting these plants from nature creates a big pressure on wild populations; therefore their collection from wild is illegal under Turkish law. Ministry of Agriculture and Rural Affairs have collectively promoted programs to encourage propagation and cultivation of bulbs in rural areas from time to time to reduce pressures on wild populations of plants. This programme has largely been accepted by village communities and act as valuable source of income to them. Since 1992, *Fritillaria* species, especially *F. persica* and *F. imperialis*, are cultivated in Siverek (Southeast Anatolia) under state control for export purpose (Arslan, 1999).

Small narcissus fly, *Eumerus strigatus* Fallen is serious pest of cultivated flower bulbs of the families *Liliaceae* and *Amaryllidaceae,* in temperate and Mediterranean climates (Avidov and Harpaz, 1969; Akbulut, 1990; Toros, 1992). *Fritillaria* bulbs are usually planted during late summer or early winter and are harvested early in the following summer (Le Nard and De Hertogh, 1993). In spring, the maggots migrate toward the soil surface and pupate. The first generation of flies emerges in April and May. These flies live about 3 weeks. The second generation emerges in midsummer, and a small third generation

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Table 1. Means of temperature, humidity and precipitation at the site of experimentation for long years and 2003-05.

	Months	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.
L. term	Temp.	24.4	17.3	9.2	4.2	2.8	3.5	8.1	13.3	19.3	26.7	31.7	30.5
	Humidity	30	47	61	75	73	69	64	63	52	31	21	23
	Precipitation	5.2	28.8	43.9	81.5	58.8	67.6	74.8	56.5	38.7	9.4	1.0	0.2
		2003				**2004**							
2003-04	Temp.	25.0	19.0	8.80	4.0	3.3	2.7	9.6	12.8	18.0	26.4	31.1	30.0
	Humidity	21.0	40.0	67.7	76.1	82	80	54	50	54	23	12	14
	Precipitation	0.3	33.3	62.5	87.9	84.6	93.4	1.5	54.9	97.5	16.0	0.0	0.0
		2004				**2005**							
2004-05	Temp.	25.0	18.2	8.2	1.4	2.3	3.0	8.4	14.1	19.6	25.8	32.4	31.8
	Humidity	19	41	69	60	66	62	53	52	44	25	11	20
	Precipitation	0.0	0.7	123.1	4.7	58.7	46.8	58.4	36.8	26.5	33.1	0.0	0.0

Source: State Meteorology Institute (Diyarbakir, Turkey).

emerges in late summer (Doane, 1983). Newly hatched dirty white or brownish larvae infest the bulb through the neck region of the bulb and feed on the inner tissue of the bulb reducing it rapidly to a rotting mass. The larval and pupal stages take 20-30 days and 7-12 days respectively at 21-23^{o}C. It is considered to be a secondary pest of bulbs and infestation usually follows damage by other agents such as fungi, nematodes, slugs and other insects (Speight et al., 1998). Some narcissus flies have two generations a year (Brosh and Hadar, 1979). Adult flies of the autumn generation are active during October and November, and those of the spring generation during April and May (Ben-Yakir et al., 1997).

During summer dormancy the infested bulbs deteriorate in to a slimy black mush (the excrement) writhing with larvae, resulting in total loss of difficult to recover bulbs. The main objective of the study was to investigate the effects of different planting dates on some agronomic characteristics of *F. imperialis* and *F. persica*, and determine recovery of damage by small narcissus fly (*Eumerus strigatus* Fallen)

MATERIALS AND METHODS

Field studies were conducted under Diyarbakır ecological conditions at the Department of Field Crops, Faculty of Agriculture (latitude 37^{o} 53' N and longitude 40^{o} 16' E, 680 m above sea level), Dicle University during 2003-04 and 2004-05 growing seasons using bulbs of *F. imperialis* L. and *F. persica* L. obtained from local producers in Karacadag region that lies between Sanliurfa, Diyarbakir and Adiyaman provinces of Turkey. Care was taken to select the bulbs that were damaged with small narcissus fly to the extent of 25%.

The planting material was submerged in water at 39^{o}C for 40 min (Baker, 1993) before planting to kill narcissus fly. Care was taken to avoid overheating and damage to the bulbs during heat treatment.

Monthly mean temperatures, relative humidity and total precipitation under Diyarbakir ecological conditions during the experimental years (Table 1), showed that total precipitation of the first growing season was higher than the average of long-term means. Whereas, total precipitation of the second growing season was lower than the average of long-term means.

Experimental fields were watered before planting. Planting was done with row spacing of 60 cm and plant spacing of 20 cm. The experimental design was a split plot with three replications for each experimental year with four plantings done on September 1st and 15th, October 1st and 15th, respectively with 48 bulbs in each plot. Plots size was kept 5.4 m^{2} (1.8 x 3 m) in each of the experiment.

Planted bulbs had diameter of 17 to 19 mm and were hand planted at a depth of 5 cm in the soil. The plots were weeded as and when required. The plots were harvested manually on 5th June, 2004 for the first year and 18 May, 2005 for the second year.

Plant height (cm), plant stem diameter (mm), bulblets number per plant, number of bulblets per plot, bulb circumference (cm), number of flowers and infected bulb ratio with small narcissus fly per plot were investigated in the study. Infected bulb ratio (%) per plot was determined by counting infected bulbs per plot separately.

The percentage data were converted to arcsine values to homogenise the variances and analysis was performed using ANOVA followed by Duncan's multiple range test at significance level of 5% (Snedecor and Cocharn, 1967). Data obtained in the study were analysed statistically, using MSTAT-C (Michigan State University) computer program, and means were grouped, using LSD test or t test at 0.05 level of significance.

RESULTS AND DISCUSSIONS

It is not possible to compare the effects on agronomic characteristics of healthy and damaged bulbs; however it was very encouraging to note that narcissus fly damaged bulbs were not difficult to recover once they were heat treated. Plant height of *Fritillaria* species is very important, because it affects flower length and blooming. The results showed that two genotypes varied significantly ($p<0.05$, Table 2). *F. persica* was considerably taller compared to *F. imperalis*. The results further showed that both planting years and planting dates significantly affected ($P<0.05$) plant height of both species (Table 2). Early and mid October plantings had negative effects on plant height as the planted bulbs in both species had less time to grow compared to early planted bulbs in both species. Apparently, more precipitations

Table 2. Effects of different planting times on growth parameters of *F. persica* and *F. imperialis* during 2003-04 and 2004-05 growing season.

Treatment	Plant height (cm)		Plant stem diameter (mm)		Number of flowers per plant		Number of bulblets per plot		Bulb circumference (cm)		Number of bulblets per plant		Ratio (%) of unrecovered bulbs	
Genotypes	**2003-04**	**2004-05**	**2003-04**	**2004-05**	**2003-04**	**2004-05**	**2003-04**	**2004-05**	**2003-04**	**2004-05**	**2003-04**	**2004-05**	**2003-04**	**2004-05**
F. persica	45.36a[1]A[2]	31.22aB	1.04A	0.62B	32.29aA	20.19aB	49.92aA	34.83aB	24.00A	17.91B	2.67A	1.67B	4.68b	4.34b
F. imperialis	40.89aA	27.43bB	1.08A	0.64B	14.88a	14.03b	37.50bA	7.91bB	22.87A	18.09B	2.37A	1.17B	64.75aA	40.62aB
Planting times														
September 1	49.17 a[3]A[4]	31.93 aB	1.13A	0.67B	23.65 aA	14.67 cdB	42.83 bcA	30.33 aB	25.32A	18.05B	3.12A	1.30B	38.19 aA	18.75 cB
September 15	45.56 aA	30.67 aB	1.07A	0.70B	19.35 bA	12.58 deB	43.50 bA	19.83 bB	23.11A	19.30B	2.58A	1.91B	27.77 bA	11.80 cB
October 1	40.39 bA	27.77 bB	1.04A	0.63B	16.48 cA	11.70 efB	36.17 cdA	18.17 bB	22.64A	17.47B	2.27A	1.50B	37.49 aA	27.43 bB
October 15	37.39 bA	27.24 bB	1.01A	0.52B	14.87 cdA	9.50 fB	52.33 aA	17.17 bB	22.68A	17.16B	2.13A	1.00B	35.41 abA	31.94 abB

[1]Means followed by the different small letters in a column are significantly different using t test (P<0.05).
[2]Means followed by the different Capital letters in a row are significantly different (P<0.05) using t test
[3]Means followed by the different small letters in a column are significantly different using LSD test (P<0.05).
[4]Means followed by the different Capital letters in a row are significantly different (P<0.05) using t test.

during 2003-2004 (Table 1) also contributed to the taller plants of both species. No precipitation during September, low precipitation in October and a very high precipitation in November in 2004-2005 (double compared to the precipitation of November 2003-2004) and lower precipitation thereafter had negative effect on the growth and development especially plant height. Plant height of both species (with in each species) from September 1st and 15th plantings was significantly different from the plant height of both species from October 1st and 15th plantings.

Plant stem diameter is important character for plants bearing wind and others unfavourable environmental conditions. Remarkable differences were not found in the stem diameter of two species. Significantly thick stemmed plants were obtained from the first year planted bulbs compared to the 2nd year planted bulbs. It seemed that the planting dates did not affect the stem diameter statistically; however, seasonal variations had significant effect on the stem diameter. This showed that stem diameter increased parallel to the precipitation; with more stem diameter during 2003-2004 compared to 2004-2005.

Fritillaria has multiflowered inflorescence that has high potential in cut flower industry. Flowering in *Fritillaria* bulbs was affected by bulb diameter and environmental conditions. Both *Fritillaria*'s flowered earlier during 2003-2004 compared to 2004-2005. Late blooming resulted in reduced flowering during 2nd year. Late planting also affected flowering of both species negatively.

The results further showed that environmental conditions had significant effect on the flowering behaviour of *F. persica* and no effect on the flowering behaviour of *F. imperials*. This shows that besides genetic behaviour of the two, environmental conditions and morphology of flowering in both species also affected the number of flowers per plant. In general, more flowers were recorded from earlier plantings compared to late plantings during both years. Ozel and Erden (2005) reported and *F. imperialis* bears 4.5 and *F. persica* bears 42.0 flowers; which shows a high compatibility with our results for *F. imperialis*. Whereas, number of flowers per plant for *F. persica* does not show a compatibility with our results. Our results are in agreement with Arslan (1999), who reported 20 to 25 flowers per *F. persica* plant.

Forty eight (48) bulbs (83.000 bulbs per hectare) were planted in each plot. Increased number of bulblets per plot is the most desired characteristic for the farmers. Increased number of bulblets even from the damaged bulbs showed that their production is economical; however, *F. persica* is more productive compared to *F. imperialis* in term of new bulb formation. The results (Table 2) showed that *F. persica* and *F. imperialis* inducted 49.92 and 37.50 bulbs per plot during 2003-2004, respectively. During second year (2004-2005), bulb yield of both decreased such that *F. persica* and *F. imperialis* inducted 34.83 and 7.91 bulbs per plot, respectively. The highest numbers of 52.33 bulblets per plot were

obtained from 15th October planting during first year. However, reduced precipitation during 2nd year had negative implications on number of bulbs per plant. The highest number of 30.33 bulbs per plot was observed from September 1st planting. No effect of dates was recorded on number of bulbs per plot on all other dates.

In addition, pest damage also affected new bulb formation, because some of the main bulbs were damaged resulting in a rotting mass under soil. Our results are compatible with Ozel and Erden (2005) who reported that *F. persica* produces considerably higher bulblets compared to *F. imperialis*.

Fritillaria species can be vegetatively propagated by offsets, bulb cuttings, bulb scaling or tissue culture. About three years are necessary to obtain commercial sized bulbs. *Fritillaria* are also propagated by seeds. It takes five to six years to obtain saleable bulbs from seed (Ekim et al., 1992). In addition, the minimum size of a flowering bulb should be about 16 cm for *F. persica* and 18 cm for *F. imperialis* (Arslan, 1999; Le Nard and De Hertogh, 1993). The bulb circumference ranged between 17 to 18 cm during first and 2nd year. Large bulbs size is desirable commercially. The largest bulbs were obtained from the first planting (September 1st) followed closely by those obtained from the second planting (September 15th). Late planting (October and 15th) resulted in marked decrease in bulb circumference.

The results showed that both species produced higher number of bulbs during first year of experimentation. This showed that both species were considerably affected by the environmental conditions especially precipitation. Poor precipitation resulted in supply of less soil moisture resulting in reduced nutrient needed for growth and multiplication of the bulbs.

Apparently, the damaged bulbs of *F. persica* had lesser effect compared to the damaged bulbs of *F. imperialis,* which showed lesser yield due to lesser recovery during 2003-2004; however, recovery level increased during 2004-2005. Combined effects showed that the highest ratio of unrecovered bulbs was recorded during 2003-2004 (38.19%) from September 1st planting, while this ratio reduced to 11.80% during second year from September 15th planting (Table 2). These results also emphasize that yield reduction due to non recovery of damaged bulbs is directly related to the higher humidity and precipitation. A comparison of two years showed that September 15th is more desirable planting date if the idea is to increase yield from damaged bulbs. No earlier study reports economic recovery of planting from damaged bulbs and their effect on agronomic characteristics of plants.

In earlier studies made with narcissus fly *Narcissus tazetta*, Ben-Yakir et al. (1997) reported 32% damage. Brosh and Hadar (1979) stated that some narcissus flies have two generations a year. Adult flies of the autumn generation are active during October and November, and those of the spring generation during April and May (Ben-Yakir et al., 1997). In this study, bulbs were planted on four different dates in September and October. Therefore, pest activation, especially in larva stage may have started at the beginning of winter, and accelerated through spring and harvest date. Ben-Yakir et al. (1997) emphasise that to increase yield and reduce pest damage application of pesticides (imidacloprid, isazofos and aldicarb) during February – April growth period has positive results.

This study confirmed that economically important *Fritillaria* species could be cultivated in large area and the damaged bulbs could also be used for cultivation, if proper cares are taken with mid September plantings for more yield. It may also be suggested that *Fritillaria* species could be planted on 1st September for comparatively higher bulb induction per plant.

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