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PREFLOWERING GROWTH OF GLADIOLUS IN RESPONSE TO STAGGERED PLANTING

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Abstract

The experiment was conducted at the Agriculture Research Farm, Department of Horticulture, NWFP Agricultural University, Peshawar, during the year 2003-05 with the objectives to introduce and explore the possibility of producing a high valued crop for the development of an emerging floriculture industry and to expend the employment opportunities in Pakistan. The corms of eight cultivars viz., Deciso, Hong Kong, Jessica, Jester Ruffled, Madonna, Peters Pears, Rose Supreme and White Friendship were planted on 1st November, 1st December and 1st January of 2003-04 and 2004-05. Plant emergence (sprouting) was earlier in 1st year (2003-04) as compared to 2nd year (2004-05). Cultivar White Friendship proved earlier in sprouting (26.0 days), spike emergence (97.8 days), first floret opening (111.3 days) and full spike opening (127.7 days). Cultivars Hong Kong, Deciso and Jester Ruffled were found late and took maximum 58.8, 56.0 and 53.3 days respectively, for plant emergence. Cultivars Jessica and Hong Kong resulted in maximum (1.9) and minimum (0.7) number of plants corm^{-1} respectively. Cultivar Rose Supreme was found the tallest with a maximum plant height of 137.5 cm while White Friendship was noted as the shortest stature cultivar with an average height of 86.6 cm. A delay in planting date (1st Nov., 1st Dec. and 1st Jan.) resulted in earlier spike emergence (130.3, 129.0 and 121.9 days), earlier first floret opening (146.2, 142.3 and 134.1 days), earlier full spike opening (161.2, 154.7 and 146.1 days) and decreased number of plants (1.4, 1.2 and 1.0) corm^{-1}. Cultivar White Friendship planted on 1st November resulted in earlier sprouting (8.7 days), spike emergence (87.5 days) and earlier first floret opening (106.2 days). Cultivar Jessica planted on 1st January in 1st year (2003-04) was earlier in first floret and full spike opening. However, Jessica when planted on 1st November of 1st year (2003-04) resulted in more number of plants (2.5) mother corm^{-1}. Rose Supreme planted on 1st November of 2nd year (2004-05) produced the tallest plants (154.3 cm).

Introduction

The present research work is aimed to explore the possibility of producing a high valued crop, to expand the employment opportunities in the area and to contribute to the development of an emerging floriculture industry in Pakistan in general and Peshawar in particular. Bulbous crops are the ones that can meet the criteria, as two parts i.e., bulbs as well as flowers, are used for the commercial purposes. Both these plant products are very important economically, and thus bulbous plants can be used as an effective substitute for the conventional crops. In Peshawar, the price of a single corm is Rs. 10-18 whereas the price of a single spike of gladiolus is in the range of Rs. 50 to Rs. 150 depending on the quality and season. On the other side, large amounts of labor are needed for the production of bulbous plants and thus will expand the employment opportunities. Besides, both the fresh flowers and the bulbs will be exported to other countries. This export will definitely add to the economy of the country as some of the countries have boosted their economy through the export of cut flowers. Production of quality flowers, depends on several factors, is an essential step towards the success of floriculture business. Hence, introduction, investigation and standardization of production factors of exotic cultivars of gladiolus in Peshawar are the dire needs of the time. Besides, the flower quality and spike length of Gladiolus can be improved by adopting proper package of cultural practices like, timely planting, proper planting distances between rows and plants, weeding and proper irrigation (Lehri *et al*., 2011).

Gladioli are principally native to South Africa, with some species found in the wild in southern Europe and the Near East. This plant is used to a limited extent for landscape effect; their chief value is for cut flowers. Their wide range of colors, sizes and flower types make them particularly useful for flower arrangements. These are spectacular flowers for exhibition in flower shows and are specialty for many amateur growers. As a cut flower, the people adore it for its beautiful flowers, lengthy spikes and more vase life. The gardeners love to have gladiolus in their gardens as the people always appreciate it when it is growing in the gardens. These important points enforce the growers to produce year-round gladiolus to satisfy the demands of the customers. The yield and flower quality depends on strong and vigorous preflowering growth. The preflowering growth of gladiolus cultivars and its availability round the year depends on planting times (Leena *et al.*, 1993) and it is also observed that several cultivars sprout earlier with earlier plantation and *vice versa* (Arora & Sandhu, 1987, Hong *et al*., 1989, Zubair *et al*., 2005-06) as well as their plant heights (Dod *et al*., 1989) and other parameters are influenced (Ahmad *et al*., 2011) by different with planting dates. It is therefore needed to introduce several genotypes of gladiolus in Peshawar and to investigate and standardize a suitable planting date for attaining an optimum preflowering growth which is a prerequisite for the production of standard cut flowers, corms and landscape plants.

Materials and Methods

The corms of 8 cultivars Deciso, Hong Kong, Jessica, Jester Ruffled, Madonna, Peters Pears, Rose Supreme and White Friendship were planted on 1st November, 1st December and 1st January of 2003-04 and 2004-05. The farmyard manure was mixed in the field @ four loaded tractor trolleys ha^{-1}. Nitrogen, phosphorus and potassium were added to the field @ 100 kg each ha^{-1}. Phosphorus and potassium were applied before plantation of the corms. Nitrogen was applied in split doses, half of the dose was applied before three leaf stage and the remaining dose was

applied at the six-leaf stage (spike emergence stage). Urea, Superphosphate and sulphate of potash were used for nitrogen, phosphorus and potash respectively. All the cultural practices (irrigation, weeding and spraying of insecticides) were performed uniformly. The soil was analyzed for physico-chemical properties and the following information was noted. Sand = 17.12%, silt = 54%, clay = 28.88%, pH = 8.32, EC = 0.334 mmhos per cm, N = 100% deficient, P = 27% deficient and 73% marginal, K = 50% marginal and 50% adequate.

The corms were purchased from a reliable nursery situated in Lahore. The corms were planted in a well-prepared field at a depth of 10 cm (Hartmann *et al*., 1981). The corms were planted in a row at a distance of 20 cm while the rows were made at a distance of 60 cm. The experiment was executed on 70.0 m^2 area.

The experiment was laid out as Randomized Complete Block Design (RCBD) with two factors factorial arrangement. The data were analyzed with the general linear model procedures in Anon., (1989-96), and the least significant difference (LSD) test was used for means separation.

The following growth parameters were studied:

1. Days to plants emergence (sprouting) (DE),
2. Days to spike emergence (DSE),
3. Days to first floret opening (DFFO),
4. Days to full spike opening (DFSO),
5. Average number of plants per corm (PLANTS/CORM) and
6. Average plant height (in cm) (Plant height).

Results and Discussion

Before interpreting and discussing the results regarding individual growth parameters, it is important to discuss briefly the environmental conditions prevailed during the project. Maximum and minimum ambient air temperature in Celsius of 1st year (1st November 2003 to 30th June, 2004) and 2nd year (1st November 2004 to 31st August, 2005), soil temperature at a depth of 10 cm at 8.0 AM and 5.0 PM as well as precipitation in millimeters are presented in Figs. 1-6. Maximum temperature in 1st year and 2nd year was decreasing from November (1st planting date) and dropped less than 15^0C in the month of January of 1st year and less than 10^0C in 2nd year. Maximum temperature again was on rise from the first week of February in 1st year while from the last week of February in 2nd year. On the other hand, minimum temperature crossed the point zero and reached -1 in 2nd year. This shows that the weather was colder in 2nd year as compared to 1st year (Fig. 1 and Fig. 4). The soil temperature in 1st year was lower than the soil temperature in 2nd year (Fig. 2 and Fig. 5). During the second year of the experiment, the amount and number of precipitation events were more as compared to the first year (Fig. 3 and Fig. 6).

Days to plant emergence (sprouting): Days to plant emergence of gladiolus cultivars were significantly affected by different years, planting dates, interactions (years X planting dates, years X cultivars, cultivars X planting dates, cultivars X planting dates X years) (Table 1). Comparison of the years showed that sprouting was earlier in 1st year than in 2nd year with average number of 25.9 and 59.5 days in 1st year and 2nd year respectively (Table 2). This might be due to lower soil temperature during first year of experiment as lower temperature encourages the production of growth promoters such as gibberellins and consequently resulted in earlier sprouting. Means for planting dates across years and cultivars showed that earlier plantation (1st November) resulted in earlier sprouting (35.0 days) whereas mid (1st December) and late (1st January) plantations resulted in late sprouting (46.9 and 46.4 days respectively) (Table 2). It shows that the sprouting is closely associated with planting dates. This finding is in conformity with the finding of Young (2005) who reported a significant effect of planting dates on number of days to emergence. Upon the examination of the observed means for each of the eight cultivars across years and planting dates, three groups of cultivars can be identified. The first group of cultivars White Friendship and Rose Supreme sprouted in less than a month, the second group of cultivars Madonna, Peters Pears and Jessica sprouted in between one and one-and-a half month and the third group of cultivars Jester Ruffled, Deciso and Hong Kong sprouted in between one-and-a half and two months (Table 2). This variation among the cultivars regarding sprouting may be due to the different response of various genotypes to environmental conditions. Means for years X planting dates indicated that sprouting of plants delayed with a delay in planting dates in 1st year (2003-04) whereas in 2nd year (2004-05) late planting resulted in earlier sprouting (Table 3). Means of individual years for each of the eight cultivars indicated that in 1st year (2003-04) all cultivars except Hong Kong sprouted in less than a month (Table 3). However in 2nd year (2004-5) only one cultivar White Friendship sprouted in less than a month while rest of the cultivars sprouted in more than a month with the exception of cultivars Deciso and Hong Kong which took almost three months to sprout (Table 3). Cultivars Deciso and Hong Kong took maximum number of 71.9 and 70.4 days respectively to sprout when planted on 1st November whereas minimum numbers of 8.7 days were taken by cultivar White Friendship planted on 1st November (Table 3). According to means for interaction (years X planting dates X cultivars), there was a specific trend that the sprouting of all cultivars except Hong Kong delayed with a delay in planting dates in 1st year (Table 4). In 2nd year, a delay in planting dates caused earliness in cultivars Deciso, Hong Kong and Jester Ruffled whereas 1st November and 1st January of 2nd year, resulted in earlier sprouting of cultivars Peters Pears, Madonna, Jessica and Rose Supreme but 1st December plantation resulted in late sprouting (Table 4). Only a cultivar White Friendship showed consistency in both experimental years i.e., the sprouting delayed with a delay in planting dates. These results are in agreement with those of Arora & Sandhu (1987) who reported that some of the cultivars sprouted earlier and some later when planted on the same date. However, these results are not in conformity with those of Hong *et al*., (1989) who reported that a delay in planting decreased the number of days to sprouting. These variations in the response of cultivars to planting dates is definitely due to the variations in the genotypes and the other possible reason was the tremendous change in the environmental conditions during the two experimental years (Figs. 1-6). These results are in agreement with those of Al-Humaid (2004) who reported that not only the genetic make-up but the environmental conditions are important factors determining the success of gladioli cultivars to grow under the existing field conditions.

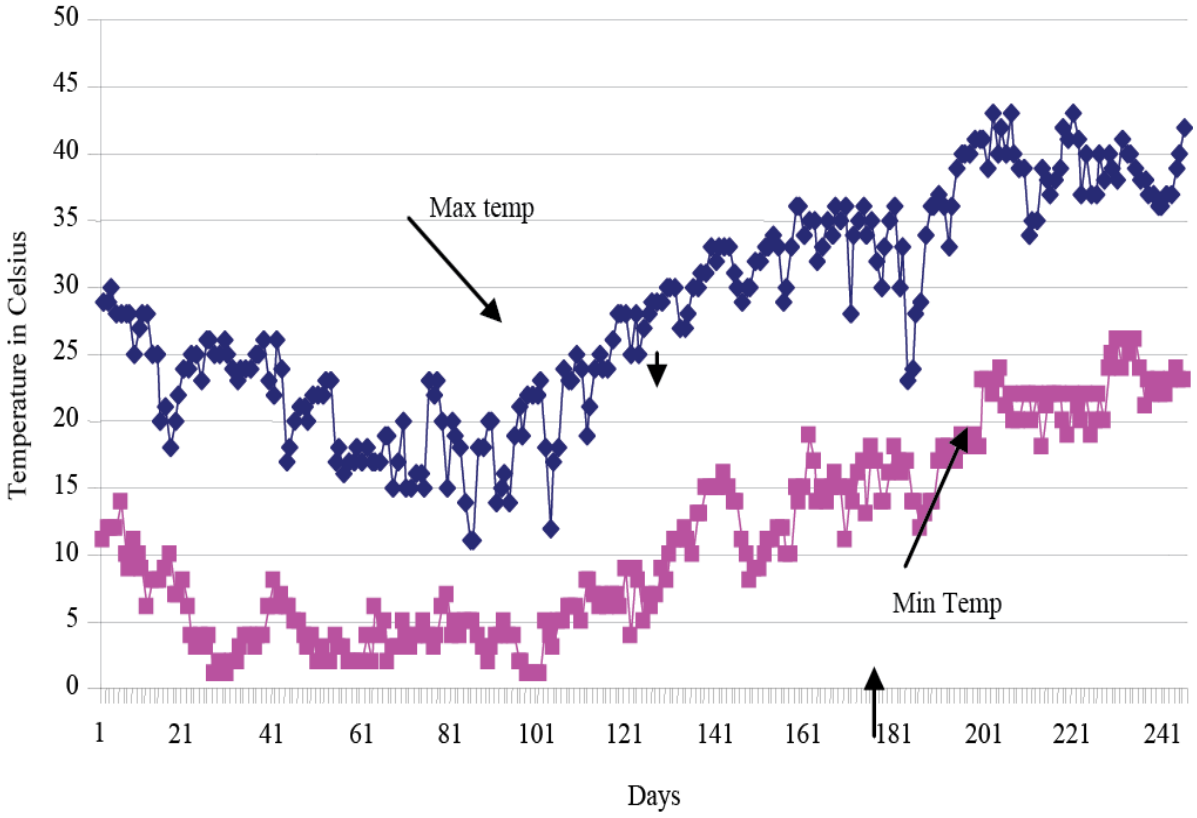

Fig. 1. Daily ambient air temperature during 2003-04.

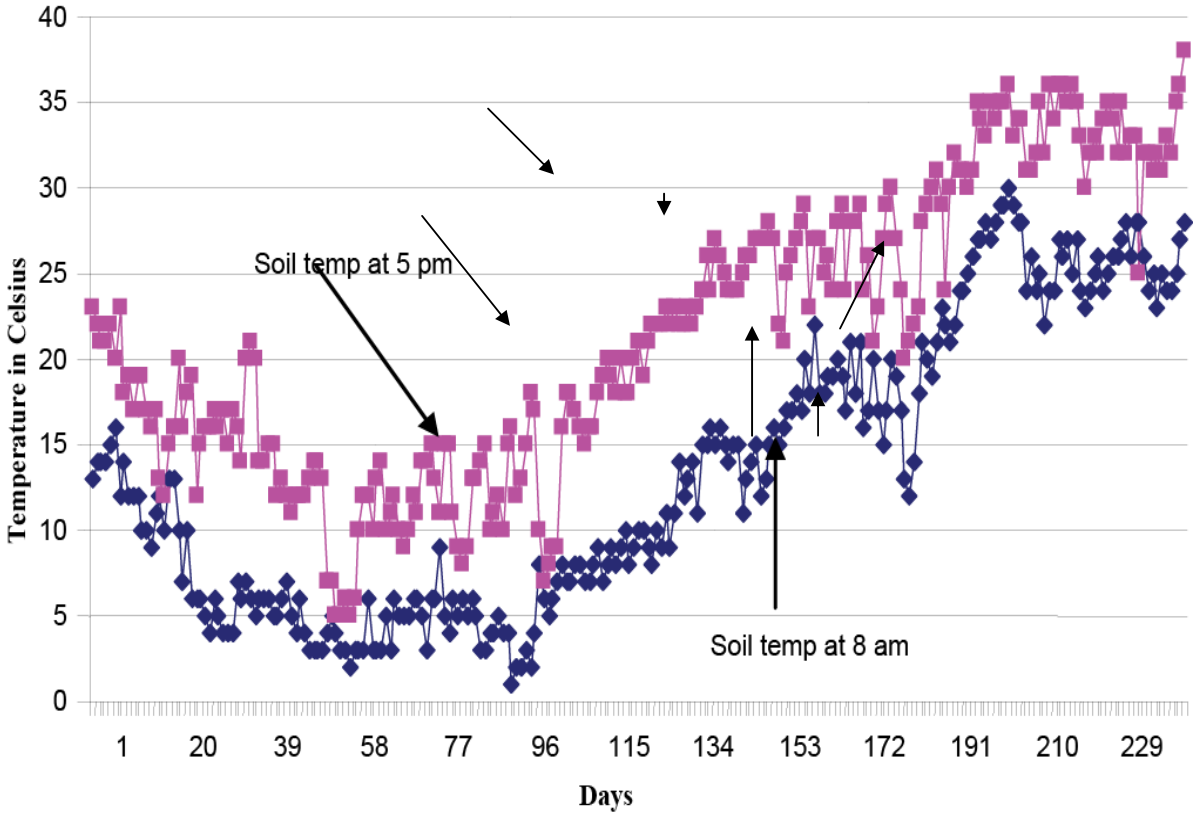

Fig. 2. Daily soil temperature at a depth of 10 cm during 2003-04.

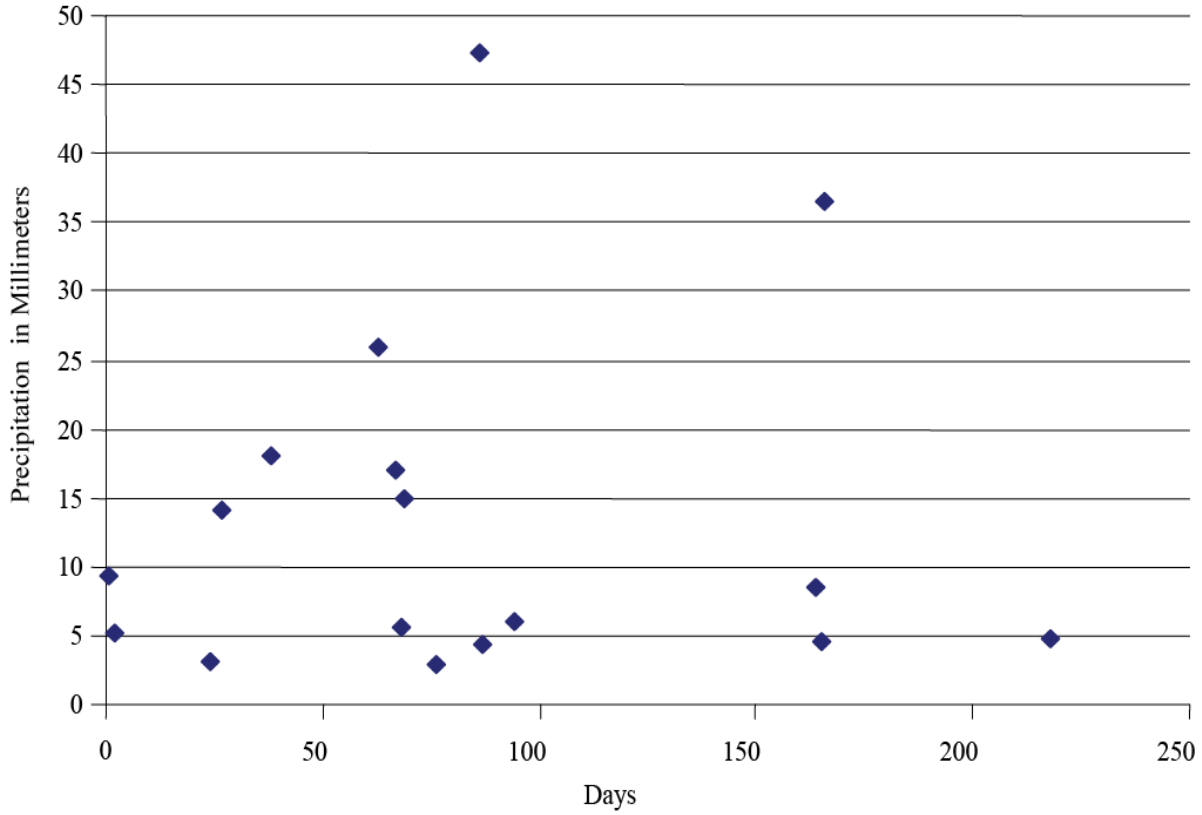

Fig. 3. Daily precipitation during 2003-04.

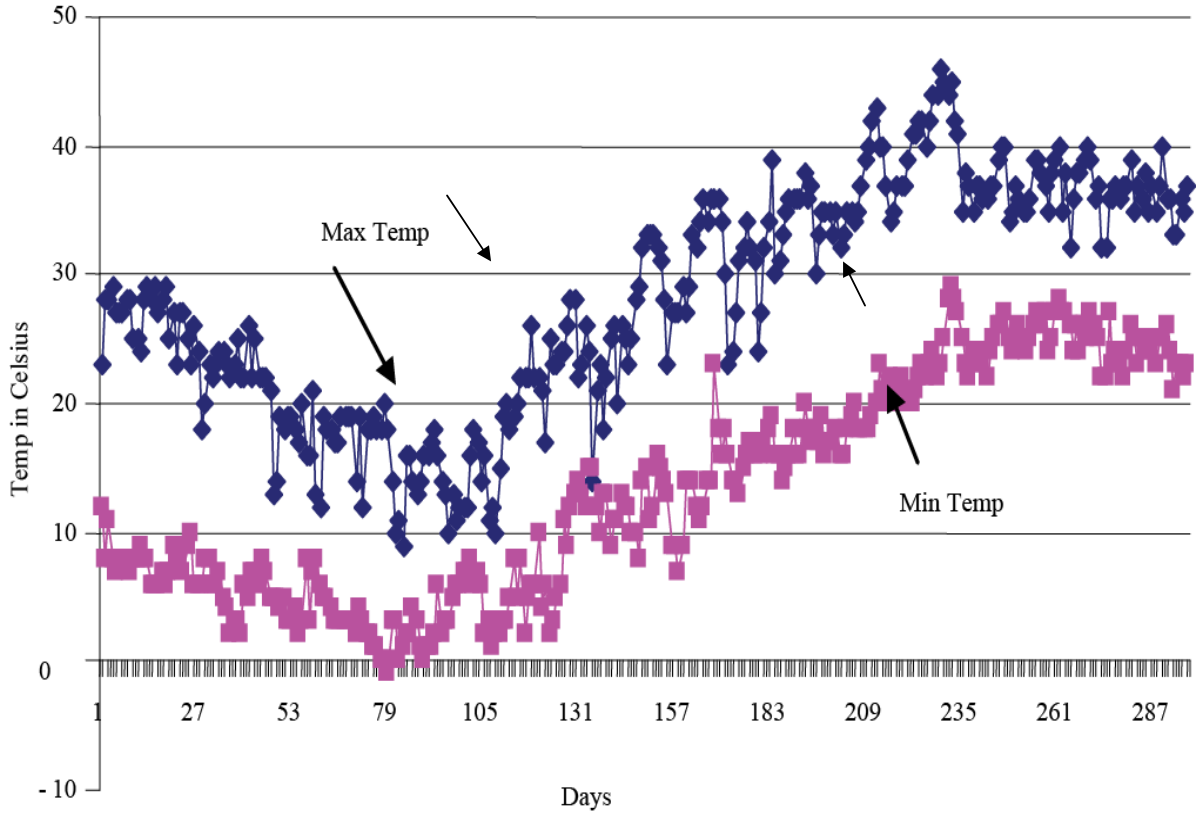

Fig. 4. Daily ambient air temperature during 2004-05.

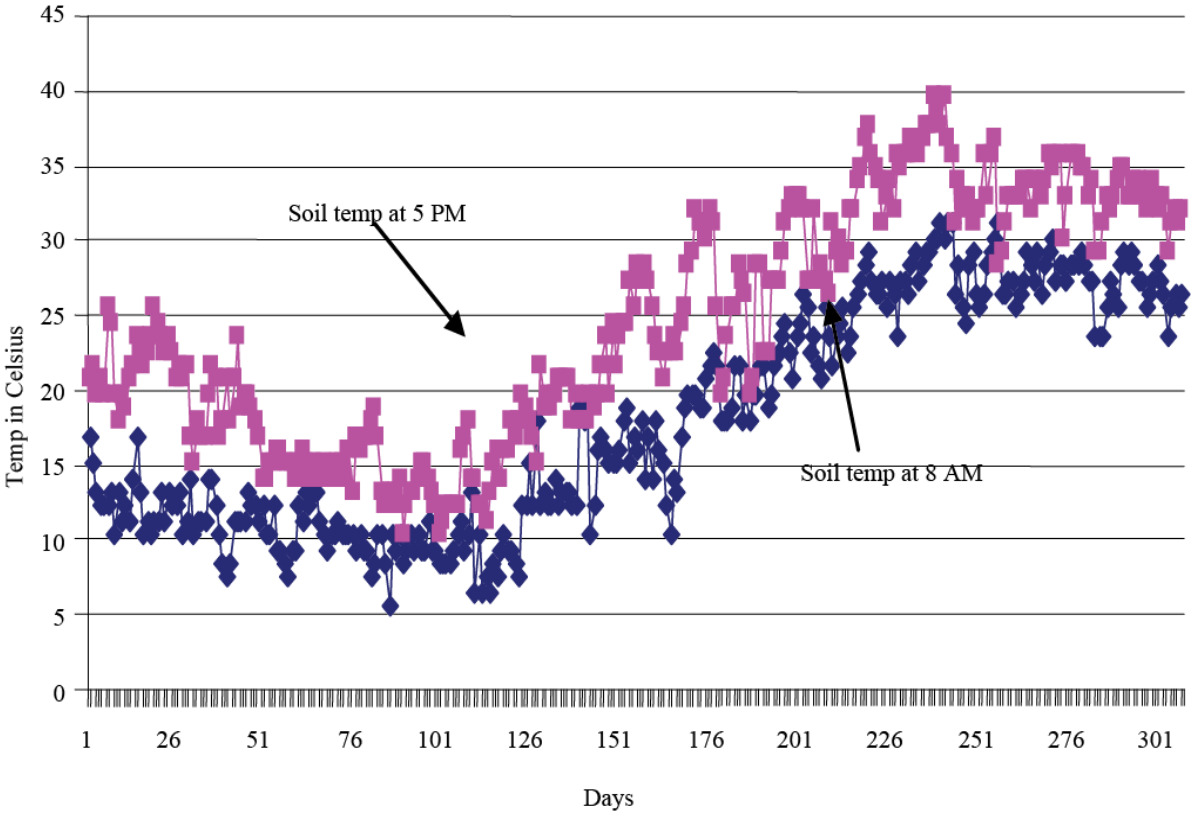

Fig. 5. V Daily soil temperature at a depth of 10 cm during 2004-05.

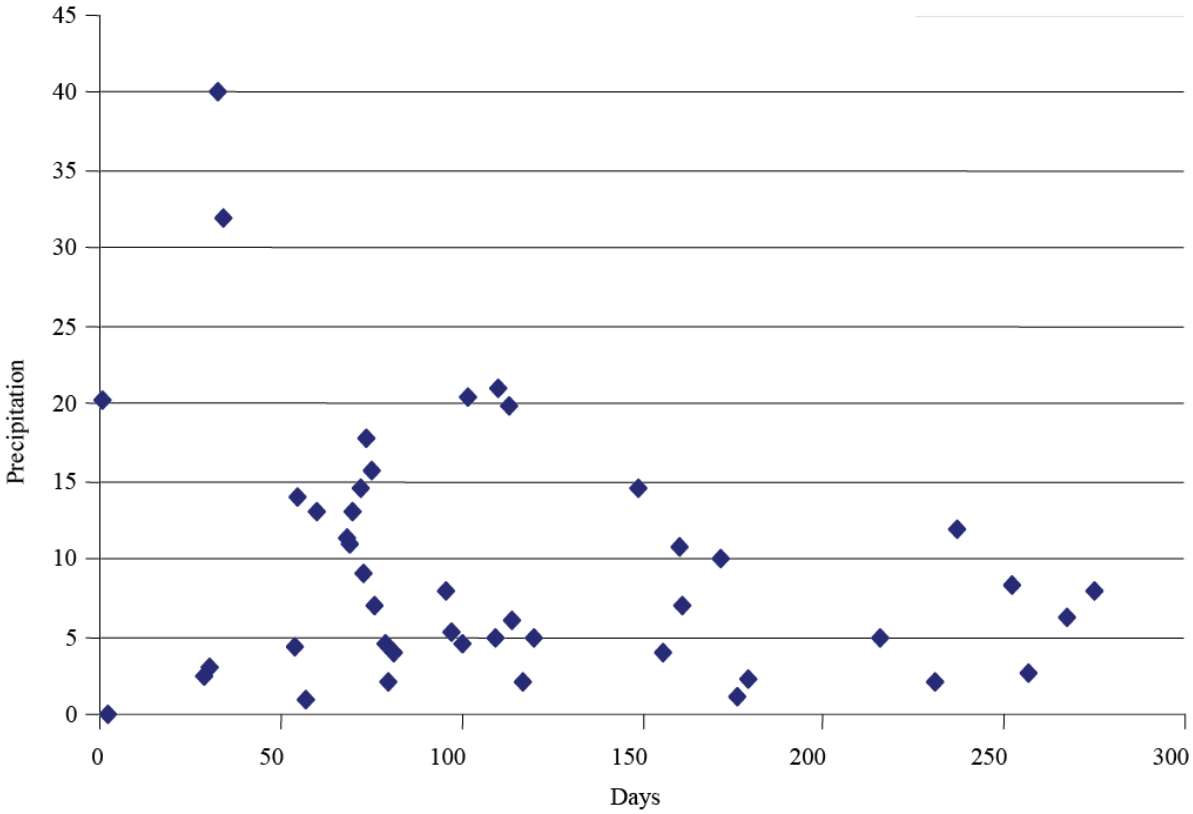

Fig. 6. Daily precipitation during 2004-05.
Source: NWFP Agricultural University Peshawar

Table 1. Results of ANOVA on days to plants emergence, days to spike emergence, days to first florets opening, days to full spike opening, average number of plants corm^{-1} (plants corm^{-1}) and average plant height (cm) of gladiolus cultivars planted on 1st Nov., 1st Dec. and 1st Jan. of 2003-04 and 2004-05.

Source	df	days to plants emergence	days to spike emergence	days to first florets opening	days to full spike opening	Plants corm^{-1}	Plant height (cm)
Model	51						
Error	92						
Corrected total	143						
Year (Y)	1	**	**	**	**	NS	**
Planting date (PD)	2	**	**	**	**	**	NS
Cultivar (C)	7	**	**	**	**	**	**
Interactions							
Y X PD	2	**	**	**	**	**	NS
Y X C	7	**	**	**	**	**	**
PD X C	14	**	**	**	**	NS	NS
Y X PD X C	14	**	**	**	**	**	**

** = Significant at p<0.01, NS = Non-significant

Table 2. Effect of years, planting dates (1st Nov., 1st Dec. and 1st Jan. of 2003-04 and 2004-05) on days to plants emergence (DE), days to spike emergence (DSE),days to first floret opening (DFFO), days to full spike opening (DFSO), plants corm^{-1} and average plant height (cm) of gladiolus cultivars.

Source	days to plants emergence	days to spike emergence	days to first florets opening	days to full spike opening	Plants corm^{-1}	Plant height (cm)
Years						
1st Year (2003-4)	25.9b	110.7b	123.7b	135.2b	1.2	104.8b
2nd Year (2004-05)	59.5a	143.5a	157.9a	172.8a	1.2	123.0a
Planting dates						
1st November	35.0b	130.3a	146.2a	161.2a	1.4a	113.0
1st December	46.9a	129.0a	142.3a	154.7b	1.2b	116.3
1st January	46.4a	121.9b	134.1b	146.1c	1.0c	112.4
LSD for planting dates	**4.5**	**4.4**	**4.1**	**4.2**	**0.12**	
Cultivars						
Deciso	56.0a	136.9b	149.5b	162.4b	1.0d	124.4b
Hong Kong	58.8a	144.5a	159.1a	171.0a	0.7e	106.8d
Jessica	45.1b	120.9dc	134.3d	146.4d	1.9a	101.6d
Jester ruffled	53.3a	143.5ab	158.1a	169.4a	1.1cd	122.6b
Madonna	35.8c	127.3c	141.7c	154.5c	1.2bc	117.1bc
Peters pears	40.7cb	126.8c	138.4cd	151.8cd	1.2bc	114.7c
Rose supreme	26.1d	119.0d	134.4d	148.9cd	1.4b	137.5a
White friendship	26.0d	97.8e	111.3e	127.7e	1.1cd	86.6e
LSD for cultivars	**7.3**	**7.3**	**6.8**	**6.8**	**0.2**	**7.5**

Days to spike emergence: Years, planting dates, and interactions (years X planting dates, years X cultivars, planting dates X cultivars, years X planting dates X cultivars) significantly affected days to spike emergence of gladiolus cultivars (Table 1). Means of the two years showed that in 1st year the spike emergence was earlier (110.7 days) as compared to 2nd year (143.5 days) (Table 2). Days to emergence played its role and affected days to spike emergence. Emergence was earlier in first year and therefore spike emergence was earlier. Planting dates had a significant effect and it was observed that late plantation (1st January) resulted in earlier (121.9 days) spike emergence as compared to earlier plantation that took 130.3 days to spike emergence (Table 2). The days to emergence did not affect the number of days to spike emergence, as days from planting to spike emergence were decreased by later planting dates. These results opposed the findings of Young (2005) who reported that later planting dates increased the number of days from emergence to bud. According to the means of cultivars across planting dates and years, cultivar White Friendship took minimum number of 97.8 days to spike emergence while cultivar Hong Kong took maximum number of 144.5 days to spike emergence. The rest of the cultivars were in between these two extremes (Table 2). Means of different planting dates in 1st year revealed that 1st November and 1st December plantations resulted in earlier spike emergence with 108.3 and 108.7 days respectively whereas 1st January plantation caused one-week lateness (115.2 days) in spike emergence. However, in 2nd year days to spike emergence showed a specific trend that days to spike emergence decreased with a delay in planting dates (Table 3). According to years X cultivars, average days to spike emergence in 1st year showed that cultivars White Friendship and Jessica were found earlier in spike emergence with 92.8 and 93.9 days respectively while cultivar Jester Ruffled took maximum number of 124.3 days to spike emergence (Table 3). Whereas days to spike emergence in 2nd year indicated that cultivar White Friendship and Hong Kong were earlier and late with 102.9 and 170.1 days to spike emergence respectively (Table 3). Cultivar White

Friendship remained consistent in both of the years as far as days to spike emergence are concerned. Interaction between planting dates and cultivars revealed that cultivars White Friendship and Hong Kong took minimum and maximum numbers of 87.5 and 162.1 days to spike emergence respectively when planted on 1st November (Table 3). Means of individual planting dates for each of eight cultivars in 1st year showed fluctuations and there was no specific trend except in cultivar Peters Pears where spike emergence delayed with a delay in planting dates while in cultivars White Friendship and Jessica days to spike emergence decreased with a delay in planting dates (Table 4). In 2nd year a specific trend was observed in fifty percent of the cultivars that days to spike emergence were decreased as the planting dates were delayed in cultivars Jessica, Deciso, Hong Kong and Jester Ruffled while in cultivar White Friendship spike emergence was delayed with a delay in planting dates (Table 4). This was expected as the plants were emerged earlier in these cultivars. In addition, there was earliness in spike emergence with a delay in planting dates. This may be due to fact that earlier plantation had more time at a lower temperature as earlier plantation (1st November) was the starting time of entering cold days and hence took maximum time to reach spike emergence. The late plantation resulted in earlier spike emergence because of higher temperature as the plants entered hot weather in shorter period of time. This can be confirmed from the data of the first year of the two experimental years where the spikes emerged earlier as compared to 2nd year as in 2nd year hot weather was a little bit delayed (Figs. 1-6).

Days to first floret opening: Years, planting dates and all their interactions (Table 1) had a significant effect on days to first floret opening of gladiolus cultivars. Means for different years across cultivars and planting dates showed that first floret opening was earlier (123.7 days) in 1st year as compared to 2nd year (157.9 days) (Table 2). Review of the means of planting dates revealed that a delay in planting dates resulted in earliness of first florets opening (Table 2). It is observed that cultivar White Friendship was the earliest that opened its first florets in 111.3 days while cultivars Hong Kong and Jester Ruffled were found late which took 159.1 and 158.1 days respectively to open their first florets. However, the remaining cultivars were noted medium as far as days to first florets opening (Table 2). Means of different planting dates across cultivars showed fluctuations in 1st year and it was observed that mid (1st December) plantation caused earliness. While means of different planting dates in 2nd year showed a specific trend that was earliness in first floret opening with a delay in planting dates (Table 3). Means of cultivars in 1st year indicated that cultivars Jessica and White Friendship were the earliest that took 107.1 and 107.2 days to open their first florets while cultivar Jester Ruffled with 137.7 days was found to be late in opening its first florets (Table 3). Means of cultivars in 2nd year revealed that cultivar White Friendship opened its first florets in 115.4 days while cultivar Hong Kong took maximum (185.3) days to open its first florets (Table 3).

Interaction of planting dates and cultivars exhibited that cultivar White Friendship planted on 1st November opened its first florets earlier (106.2 days) whereas cultivar Hong Kong was late (176.6 days) in opening its first florets when planted on 1st November (Table 3). According to the means of interaction among years, planting dates and cultivars, fluctuations were noted in days to first florets opening. Nevertheless, cultivars White Friendship, Jessica and Deciso showed a specific trend that earliness in first florets opening was associated with a delay in planting dates in 1st year (Table 4). Similarly, in 2nd year fluctuations were also observed but cultivars Jessica, Deciso, Hong Kong and Jester Ruffled showed a specific trend that a delay in planting dates caused earliness. In cultivar, White Friendship first floret opening delayed with a delay in planting dates in 2nd year that is opposite to the response showed by the same cultivar in 1st year. However, cultivars Jessica and Deciso remained consistent in their response to planting dates in both of the years (Table 4). Plants and spikes emergence were earlier in these cultivars and hence these earliness contributed to the earliness in first floret opening. Furthermore, it was observed that a delay in planting dates caused earliness in first floret opening. It will not be out of place to quote the same reason that earlier plantation was the start of winter and the temperature was lowering steadily. However, late plantation was close to the days from which the temperature started rising and hence enhanced flowering.

Days to full spike opening: Years, planting dates, and their interactions (Table 1) had a significant effect on days to full spike opening of gladiolus cultivars. Means of years over cultivars and planting dates indicated that the spikes were fully opened in 135.2 days in 1st year while in 2nd year the spikes were fully opened in 172.8 days (Table 2). This might be due to lower temperature and more precipitation events in 2nd year. A delay in planting dates resulted in earliness of full spike opening (Table 2). This may be due to the higher temperature which occurred fewer days after late plantation. According to the means of different cultivars over planting dates and years cultivar White Friendship was the earliest and took 127.7 days for opening its full spikes while cultivars Hong Kong and Jester Ruffled took maximum days (171.0 and 169.4 days respectively) to open their full spikes. The rest of the cultivars under test remained in between these two extremes (Table 2). According to means of planting dates across cultivars, mid (1st December) plantation resulted in earliness in full spike opening in 1st year followed by late (1st January) and early (1st November) plantations with an average number of days of 131.6, 135.6 and 138.3 days respectively. While number of days to full spike opening decreased with a delay in planting dates in 2nd year (Table 3). Means of cultivars across planting dates for individual years showed that cultivar White Friendship remained earlier in 1st year and 2nd year and took 118.3 and 137.0 days respectively to open its full spikes. While cultivars Jester Ruffled and Hong Kong were late in opening their full spikes and took an average number of 147.8 and 198.1 days in 1st year and 2nd year respectively (Table 3). Minimum numbers of days (125.7) to full spike opening were observed in cultivar White Friendship when planted on December 1 whereas maximum numbers of days (188.3) to full spike opening were noted in Hong Kong when planted on 1st November (Table 3). Upon the examination of means of three-way interaction (years X planting dates X cultivars)

fluctuations were observed in most of the cultivars in both years. But a specific trend in cultivars Jessica and Deciso where a linear decrease in number of days to full spike opening with a delay in planting dates was observed and hence these two cultivars remained consistent in their response to planting dates in both years. Moreover, numbers of days to full spike opening were decreased with a delay in planting dates in cultivars White Friendship in 1st year and cultivars Hong Kong and Jester Ruffled in 2nd year. Besides, numbers of days to full spike opening were increased with a delay in planting dates in cultivar White Friendship when grown in 2nd year (Table 4). Cultivar White Friendship proved to be earlier in full spike opening. The same cultivar was earlier in the aforementioned characteristics and hence it opened full spikes earlier.

Table 3. Effect of interactions on DE, DSE, DFFO, DFSO, plants corm^{-1} and average plant height (cm) of gladiolus cultivars planted on 1st Nov., 1st Dec. and 1st Jan. of 2003-04 and 2004-05.

Source				DE	DSE	DFFO	DFSO	Plants corm^{-1}	Plant height (cm)
Year	**x**	**Planting date**	**LSD**	**6.3**	**6.3**	**5.9**	**5.9**	**0.2**	**NS**
2003-04		1st Nov.		13.0	108.3	123.8	138.3	1.5	104.5
		1st Dec.		23.5	108.7	121.5	131.6	1.2	108.5
		1st Jan.		41.3	115.2	126.0	135.6	0.8	101.4
2004-05		1st Nov.		56.9	152.4	168.6	184.1	1.3	121.4
		1st Dec.		70.2	149.3	163.0	177.8	1.2	124.1
		1st Jan.		51.5	128.6	142.2	156.6	1.3	123.5
Year	**x**	**Cultivars**	**LSD**	**10.3**	**10.4**	**9.6**	**9.7**	**0.3**	**10.4**
2003-04	x	Deciso		25.4	115.0	126.3	139.4	1.0	112.6
		Hong Kong		33.9	118.9	132.9	143.9	0.8	99.4
		Jessica		24.6	93.9	107.1	119.0	2.1	94.4
		Jester ruffled		27.9	124.3	137.7	147.8	0.9	113.3
		Madonna		28.9	113.1	127.0	137.3	1.3	104.4
		Peters pears		27.4	114.7	127.4	139.0	0.9	102.8
		Rose supreme		16.8	113.1	124.3	136.8	1.0	124.3
		White friendship		22.7	92.8	107.2	118.3	1.2	87.2
2004-05	x	Deciso		86.6	158.9	172.7	185.3	1.0	136.2
		Hong Kong		83.8	170.1	185.3	198.1	0.7	114.2
		Jessica		65.7	148.0	161.6	173.9	1.6	108.7
		Jester ruffled		78.7	162.6	178.5	191.1	1.3	131.9
		Madonna		42.7	141.4	156.4	171.7	1.1	129.8
		Peters pears		54.0	138.9	149.3	164.5	1.5	126.5
		Rose supreme		35.3	124.9	144.4	161.1	1.7	150.7
		White friendship		29.3	102.9	115.4	137.0	0.9	85.7
Planting date	**x**	**Cultivars**	**LSD**	**12.6**	**12.7**	**11.7**	**11.8**	**NS**	**NS**
1st Nov.	x	Deciso		71.9	149.6	163.6	177.2	1.2	122.3
		Hong Kong		70.4	162.1	176.6	188.3	0.7	104.6
		Jessica		38.5	136.5	149.5	163.2	2.1	100.6
		Jester ruffled		52.0	148.7	165.6	176.1	1.3	119.4
		Madonna		12.6	127.1	143.7	158.4	1.5	123.5
		Peters pears		15.4	119.7	129.5	147.7	1.4	115.1
		Rose supreme		10.1	111.7	134.9	151.0	1.5	137.2
		White friendship		8.7	87.5	106.2	127.8	1.3	80.9
1st Dec.	x	Deciso		55.8	140.1	151.5	164.6	1.0	121.1
		Hong Kong		48.5	137.5	154.0	166.3	0.9	112.7
		Jessica		52.7	122.3	138.8	148.0	1.9	104.2
		Jester ruffled		49.4	143.2	158.1	170.1	0.9	128.8
		Madonna		48.7	129.5	144.0	154.5	1.2	115.9
		Peters pears		56.0	131.4	143.7	155.7	1.4	120.2
		Rose supreme		36.7	126.8	138.7	152.9	1.2	137.1
		White friendship		27.1	101.3	109.5	125.7	1.1	90.5
1st Jan.	x	Deciso		40.3	121.2	133.5	145.3	0.8	129.8
		Hong Kong		57.6	134.0	146.7	158.5	0.5	103.1
		Jessica		44.2	104.0	114.8	128.1	1.6	99.9
		Jester ruffled		58.6	138.5	150.6	162.1	1.1	119.6
		Madonna		46.1	125.3	137.5	150.7	0.9	111.9
		Peters pears		50.7	129.3	141.8	151.9	1.0	108.7
		Rose supreme		31.4	118.5	129.5	142.8	1.5	138.2
		White friendship		42.2	104.8	118.3	129.5	0.8	88.3

Table 4. Effect of interaction on DE, DSE, DFFO, DFSO, plants corm^{-1} and average plant height (cm) of gladiolus cultivars planted on 1st Nov., 1st Dec. and 1st Jan. of 2003-04 and 2004-05.

Source				DE	DSE	DFFO	DFSO	Plants corm^{-1}	Plant height (cm)
Cultivars x P-date x Year			**LSD**	**17.9**	**17.9**	**16.6**	**16.8**	**0.5**	**18.1**
Deciso	Nov. 1	1		16.3	114.7	128.0	142.0	1.3	103.1
		2		127.4	184.5	199.1	212.4	1.1	141.4
	Dec. 1	1		25.3	116.7	126.7	141.7	1.1	117.9
		2		86.3	163.4	176.3	187.4	0.9	124.2
	Jan. 1	1		34.7	113.7	124.3	134.7	0.5	116.7
		2		46.0	128.7	142.6	155.9	1.1	142.9
Hong Kong	Nov. 1	1		22.0	112.7	127.7	140.0	0.9	93.8
		2		118.8	211.6	225.5	236.5	0.5	115.5
	Dec. 1	1		21.7	110.3	126.3	138.0	1.0	104.1
		2		75.3	164.6	181.7	194.6	0.8	121.5
	Jan. 1	1		58.0	133.7	144.7	153.7	0.4	100.5
		2		57.1	134.2	148.8	163.3	0.6	105.7
Jessica	Nov. 1	1		14.0	105.0	118.3	136.3	2.5	97.8
		2		63.0	168.0	180.6	190.1	1.7	103.4
	Dec. 1	1		25.0	95.0	111.0	118.0	2.1	98.9
		2		80.4	149.7	166.6	178.0	1.8	109.4
	Jan. 1	1		34.7	81.7	92.0	102.7	1.9	86.6
		2		53.7	126.2	137.6	153.4	1.3	113.3
Jester ruffled	Nov. 1	1		13.7	112.0	129.3	139.7	0.9	101.2
		2		90.3	185.3	201.9	212.6	1.7	137.6
	Dec. 1	1		23.7	132.0	144.0	153.0	1.0	127.6
		2		75.1	154.4	172.2	187.2	0.7	129.9
	Jan. 1	1		46.3	129.0	139.7	150.7	0.7	111.0
		2		70.8	148.0	161.6	173.5	1.4	128.2
Madonna	Nov. 1	1		8.0	105.7	122.3	136.7	2.1	114.8
		2		17.2	148.4	165.0	180.1	1.0	132.2
	Dec. 1	1		29.3	101.3	114.3	123.0	1.4	100.7
		2		68.0	157.6	173.6	186.0	0.9	131.2
	Jan. 1	1		49.3	132.3	144.3	152.3	0.5	97.8
		2		42.9	118.2	130.7	149.0	1.4	126.0
Peters pears	Nov. 1	1		12.3	103.3	121.0	138.0	1.2	108.5
		2		18.5	136.0	138.1	157.4	1.5	121.7
	Dec. 1	1		27.0	108.3	120.3	129.3	1.1	110.2
		2		85.0	154.6	167.1	182.0	1.6	130.1
	Jan. 1	1		43.0	132.3	141.0	149.7	0.4	89.7
		2		58.4	126.2	142.7	154.1	1.5	127.8
Rose supreme	Nov. 1	1		10.0	111.0	125.0	140.0	1.3	120.1
		2		10.2	112.3	144.8	162.1	1.7	154.3
	Dec. 1	1		15.0	111.0	122.0	133.7	0.9	124.2
		2		58.3	142.7	155.4	172.1	1.5	150.0
	Jan. 1	1		25.3	117.3	126.0	136.7	0.8	128.7
		2		37.4	119.7	133.0	149.0	2.1	147.7
White friendship	Nov. 1	1		8.0	102.0	118.3	134.0	1.5	97.0
		2		9.3	72.9	94.1	121.7	1.2	64.8
	Dec. 1	1		21.3	94.7	107.7	116.3	1.3	84.6
		2		32.9	107.9	111.2	135.1	0.9	96.3
	Jan. 1	1		38.7	81.7	95.7	104.7	0.9	80.2
		2		45.7	127.8	140.8	154.3	0.8	96.5

Number of plants corm^{-1}: Analysis of variance revealed that planting dates, year X planting dates, year X cultivars and year X planting dates X cultivars significantly affected average number of plants corm^{-1} of gladiolus cultivars (Table 1). The overall means of planting dates over years and cultivars revealed that a delay in planting dates resulted in reduced number of plants corm^{-1}. 1st November plantation produced maximum (1.4) number of plants corm^{-1} followed by 1st December and 1st January with 1.2 and 1.0 plants corm^{-1} (Table 2). This might be because of lengthy cold period that encouraged vegetative growth. Upon examination of the means of cultivars across years and planting dates it was noted that cultivar Jessica produced maximum number (1.9) of plants corm^{-1} while cultivar Hong Kong produced minimum number (0.7) of plants corm^{-1} (Table 2). Planting dates over cultivars for individual years showed that a delay in planting dates caused a reduction in number of plants corm^{-1} in 1st year. However, in 2nd year 1st November and 1st January plantations produced maximum number (1.3) of plants corm^{-1} followed by 1st December plantation with an average number of 1.2 plants corm^{-1} respectively (Table 3). Cultivars Jessica and Hong Kong produced maximum and minimum number of 2.1 and 0.5 plants corm^{-1} when planted on 1st November and 1st January respectively (Table 3). Means of cultivars for individual years over planting dates indicated that cultivars Jessica in 1st year and Rose Supreme in 2nd year produced maximum number of plants (2.1, 1.7 respectively) per corm whereas cultivar Hong Kong remained consistent in producing minimum number of plants corm^{-1} respectively in both years (Table 3). Interaction among years, planting dates and cultivars indicated that maximum number (2.5) of plants were observed in cultivar Jessica planted on 1st November in 1st year whereas minimum number (0.4) of plants corm^{-1} were noted in cultivars Peters Pears and Hong Kong planted on 1st January in 1st year (Table 4). Variation in production of plants corm^{-1} was observed and it might be due to the different genotypes and their interaction with different environmental conditions. However, the overall performance of cultivar Jessica was better as far as number of plants corm^{-1}.

Plant height (cm): Average plant height of gladiolus cultivars was significantly affected by years, years X cultivars, and years X planting dates X cultivars (Table 1). Means of years across cultivars and planting dates showed that 2nd year resulted in taller plants (123.0 cm) as compared to 1st year that produced shorter plants with an average value of 104.8 cm (Table 2). This may be because of warmer conditions in 1st year that caused earlier flowering that did not give enough time to plants for attaining heights. The overall means of cultivars across planting dates and years showed that the cultivars Rose Supreme and White Friendship attained maximum (137.5 cm) and minimum plant height (86.6 cm) respectively (Table 2). Means for the interaction between years and cultivars indicated that cultivar Rose Supreme and White Friendship produced maximum and minimum plant heights (150.7 and 85.9 respectively cm) when planted in 2nd year (Table 3).

According to interaction among years, planting dates and cultivars maximum (154.3 cm) and minimum (64.8 cm) plant heights were observed in cultivars Rose Supreme and White Friendship respectively planted on 1st November of 2nd year (Table 4). From the review of the data it is clear that plant height of gladiolus is dependent on genotypes and to a certain extent on interaction between genotype and environment.

Conclusion and Recommendation

Preflowering growth affects the production and quality of cut flowers of gladiolus cultivars and hence various factors affecting preflowering growth are needed to be studied. Planting dates (1st Nov., 1st Dec. and 1st Jan.) and eight genotypes were studied during the experiment. A delay in planting dates caused earliness in spike emergence, first floret and full spike opening. However, number of plants corm^{-1} was decreased with a delay in planting dates. Besides, not only the genotypes but also the environment had a significant effect on preflowering growth of gladiolus cultivars.

It is therefore recommended that growers should plant different genotypes on different planting dates to meet the market requirements and to reduce the market risks

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