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Influence of Irrigation Levels and Plant Density on Growth Parameters of Gladiolus (*Gladiolus grandiflorous* L.)

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ABSTRACT

The experiment was conducted at Precision Farming Development Centre (PFDC) of the Department of Horticulture, CCS Haryana Agricultural University, Hisar to find out optimum irrigation level and suitable plant density for better establishment and growth of gladiolus during the year 2015-16 and 2016-17. Per cent sprouting of corms was increased successively with increase in irrigation levels over flood irrigation but in case of plant density and their interaction with irrigation levels had failed to produce any significant effect on per cent sprouting of gladiolus. Number of leaves per plant were found maximum with highest irrigation level (I_5), whereas minimum leaves per plant were recorded with control treatment (flood irrigation).In case of plant density, the maximum number of leaves were counted in plant density of 20 plants/m^2, whereas, minimum number of leaves per plant were counted with 32 plants/m^2. Corm sprouting was not significantly influenced by different irrigation levels and plant density.

Key words: *Gladiolus, Per cent sprouting, Irrigation level, CPE, Plant density.*

INTRODUCTION

Floriculture is emerging as a profitable venture due to divergence of farmers towards high value floral crops and utilization of flowers in social and industrial level[1]. International trade in cut flowers is growing at a rate of 25 per cent annual growth. Flowers have been grown in India for aesthetic, social and economic consideration since prehistoric times and they form an integral part of our heritage and tradition since ancient time. Floriculture, which is the art of flower cultivation, is now considered a viable diversification from the traditional crops because of the increasing demand of flowers for different occasions. In the modern era, floriculture is gaining importance as a good source of income apart from giving pleasure and happiness. In this regard, gladiolus (*Gladiolus grandiflorous* L.) is one of the most prominent bulbous cut flower plants grown commercially for its fascinating flowers and cut-flower trade in many parts of the world, generally called *Glad* or *Queen of bulbous* flowers, a member of family Iridaceae and sub-family Ixiodeae, originated from South Africa. It is also known as Sword Lily due to its sword shaped foliage or Corn Lily since it is found wild as weed in the corn fields.

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Gladiolus (*Gladiolus* spp.) has gained much importance as a cut flower as it is valued for its majestic and beautiful spikes with florets of diverse attractive colors and shapes and for garden display. The florets open from bottom to upwards. This crop possesses a great export potential to European countries especially during winter. It occupies fifth place in the international floriculture trade and 4th position in bulbous flower trade[5]. The leading gladiolus growing countries for cut flowers are the Netherland, Germany, USA, Holland, Italy, France, Poland, Bulgaria, Brazil, Australia and also Israel. The domestic floriculture industry is growing at an annual rate of 11.4 per cent with an area of 309.26 thousand ha under flower cultivation, producing 1653 thousand tonnes of loose flowers and 593.41 thousand tonnes of cut flowers[8]. Increased flower production, quality of flowers and perfection in the form of plants are greatly influenced by climatic, geographical, water for irrigation and nutritional factors. Out of them, irrigation water is playing a major role. Deficit irrigation has been used as water saving strategies mainly through two ways, *i.e.*, (i) by controlled water supply through drip irrigation and (ii) by adopting appropriate plant density to maximize the production by using the limited resources properly. The flower quality and spike length of gladiolus can be improved by adopting proper package of cultural practices like, timely planting, optimum planting distances between rows and plants, efficient weeding and timely irrigation. Keeping in view the about facts, the present investigation entitled "Effect of Irrigation Levels and Plant Density on Growth Parameters of Gladiolus (*Gladiolus grandiflorous* L.) var. Punjab Dawn" was carried out with consideration of water conservation, utilization of space and their effect on growth parameters of different treatments with the objective: To find out the optimum irrigation level and optimum plant density for better establishment and growth of gladiolus.

MATERIAL AND METHODS

The present experiment was conducted under open conditions at Precision Farming Development Centre (PFDC) of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during 2015-16 and 2016-17. It is a semi-arid zone and situated at an altitude of 215 meters above mean sea level. The geographical situation is 29.09°N latitude and 75.43°E longitude. Two field trials comprising of five different irrigation levels, *i.e.*, I_1: control, I_2: 6 mm, I_3: 8 mm, I_4: 10 mm and I_5: 12mm water applied after 10 mm of cumulative pan evaporation (CPE) and four plant densities, *i.e.*, D_1: 20,D_2: 24,D_3: 28 and D_4: 32 corms/m^2,were conducted at Precision Farming Development Centre of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during the year 2015-16 and 2016-17.The same irrigation intervals were used for all the treatments based on CPE. Total 3 treatment combinations were laid out in randomized block design and replicated three times. The planting was done in the month of October in both the years of study. Gladiolus corms of uniform size (3-5 cm diameter) were planted in a plot size of 1x1 m at depth of 5 cm with four different plant density keeping four corms at a row spacing of 25 cm and were kept under uniform conditions of management during the study period where all the agronomic practices were adopted as per the package of practices. A 0.5 m wide walking space was left around the plots and beds.

Irrigation treatments were based on the evaporation data (Epan, mm) obtained from a Class 'A' Pan located at Agro meteorology field where all the meteorological activities were carried out. The Pan was located on wooden support at a height of 15 cm above soil surface. Readings were recorded every day, and whenever the Cumulative Pan Evaporation (CPE) reached to 10 mm, the irrigation was applied to the plots according to the treatments. The experimental plots were irrigated with drip system. Flooding and furrow type of irrigation was scheduled at fortnight interval at 100% pan evaporation replenishment in control. Drip system was laid out by 12 mm diameter LLDP lateral pipes, which were aligned with planting rows and six drippers per plot with a discharge rate of 2 litres per hour. The laterals were arranged in such a way that every row of plant had a lateral with 25 cm intervals. The plants under drip system were irrigated according to the treatments in respect of CPE. Irrigation water was pumped out from a deep-water tank near by the experimental area. An amount of 40 mm pre-irrigation was applied in all treatments before planting of the corms[3]. The number of days required for sprouting was recorded from the date of planting to the visible sprouts of the corm. For observation purpose, five plants were selected randomly from each plot and tagged for recording the data. The number of leaves per plant was calculated from five randomly selected plants and average number of leaves per plant was worked out. The number of corms sprouted after 25 days after planting was recorded. The count of plant emergence in each plot was recorded at 25 days after planting and was converted into percent.

$$\text{Sprouting (\%)} = \frac{\text{Number of corms sprouted per plot}}{\text{Total number of corms per plot}} \times 100$$

RESULTS AND DISCUSSION

Days taken for the initiation of sprouting:

The data pertaining to days taken for the initiation of sprouting as influenced by different irrigation levels and plant density are presented in Table 1. It is evident from the data that different irrigation levels and the plant density had no significant effect on days taken for initiation of sprouting in gladiolus during both the years of study.

Table 1: Effect of irrigation levels and plant density on days taken for initiation of sprouting in gladiolus

Irrigation levels (water applied after 10 mm of CPE)	Plant density (per m^2)									
	2015-16					2016-17				
	D_1: 20	D_2: 24	D_3: 28	D_4: 32	Mean	D_1: 20	D_2: 24	D_3: 28	D_4: 32	Mean
I_1: Control	7.20	7.27	7.07	7.20	**7.18**	7.70	7.27	7.20	7.27	**7.36**
I_2: 6 mm after 10 mm CPE	7.67	7.33	7.00	7.93	**7.48**	7.60	7.40	7.00	7.47	**7.37**
I_3: 8 mm after 10 mm CPE	7.13	7.20	7.27	7.33	**7.23**	7.20	7.40	7.27	7.47	**7.33**
I_4: 10 mm after 10 mm CPE	7.13	7.33	7.13	6.93	**7.13**	7.27	7.53	7.20	7.07	**7.27**
I_5: 12 mm after 10 mm CPE	7.27	7.13	7.00	7.07	**7.12**	7.33	7.27	7.27	7.20	**7.27**
Mean	**7.28**	**7.25**	**7.09**	**7.29**		**7.42**	**7.37**	**7.19**	**7.29**	

CD at 5% level of significance	2015-16	2016-17
Irrigation	NS	NS
Plant density	NS	NS
Irrigation x Plant density	NS	NS

Per cent sprouting (%):

The data pertaining to per cent sprouting as influenced by different irrigation levels and plant density are presented in Table 2. It is evident from the data that different irrigation levels and the plant density had no significant effect on per cent sprouting in gladiolus during both the years of experimentation.

Table 2: Effect of irrigation levels and plant density on per cent sprouting (%) in gladiolus

Irrigation levels (water applied after 10 mm of CPE)	Plant density (per m²)									
	2015-16					2016-17				
	D_1: 20	D_2: 24	D_3: 28	D_4: 32	Mean	D_1: 20	D_2: 24	D_3: 28	D_4: 32	Mean
I_1: Control	96.67	97.22	98.81	93.75	**96.61**	98.33	100.00	100.00	95.83	**98.54**
I_2: 6 mm after 10 mm CPE	91.67	97.22	96.42	93.75	**94.77**	98.33	94.44	96.42	94.79	**96.00**
I_3: 8 mm after 10 mm CPE	93.33	95.83	94.04	97.89	**95.27**	95.00	98.61	97.61	96.87	**97.02**
I_4: 10 mm after 10 mm CPE	96.67	98.61	98.81	96.87	**97.74**	98.33	98.61	98.81	98.96	**98.68**
I_5: 12 mm after 10 mm CPE	100.00	98.61	97.61	96.87	**98.27**	96.67	100.00	100.00	98.96	**98.91**
Mean	**95.67**	**97.5**	**97.14**	**95.83**		**97.33**	**98.33**	**98.57**	**97.08**	

CD at 5% level of significance	2015-16	2016-17
Irrigation	NS	NS
Plant density	NS	NS
Irrigation x Plant density	NS	NS

The number of days taken to sprouting and per cent sprouting were not significantly influenced by various levels of irrigation and plant density since the sprouting of corms depends on the viability of planting material and the availability of stored carbohydrates in the corms, not on the levels of irrigation and plant density. The observations of present experiment confirm that the gladiolus corms required less moisture during sprouting, resulting in lesser or no effect of irrigation on days taken to sprouting. The results of present study contradicted the findings of Gupta *et al.*[4] who observed early sprouting of gladiolus corms with seepage irrigation system and Bastug *et al.*[2] who reported maximum per cent sprouting of corm under drip irrigation at 1.00 Epan treatment in gladiolus.

Number of leaves/plant:

A perusal of the data shows that the number of leaves per plant was significantly affected by different irrigation levels during both the years of experiment (Table 3). The number of leaves per plant increased with increasing levels of irrigation. The number of leaves was found maximum (8.42 and 8.55) when12 mm water applied after 10 mm of CPE, whereas, the minimum number of leaves per plant (6.23 and 6.27) was obtained in control treatment (I_1) during the year 2015-16 and 2016-17, respectively. All the given irrigation levels had pronounced effect over control.

It is obvious from the data that various plant densities significantly influenced the number of leaves per plant. The maximum number of leaves per plant (8.13 and 8.25) was observed with plant density of 32 plants/m^2, while the minimum number of leaves per plant (6.95 and 7.05) was recorded at plant density of 20 plants/m^2 during both the years of experiment, respectively.

The interaction between irrigation levels and plant density significantly affected the number of leaves per plant significantly. The highest number of leaves per plant (9.80 and 9.93) was recorded when 12 mm water applied after 10 mm of CPE with plant density of 32 plants/m^2, whereas, the least number of leaves per plant (6.07 and 6.13) was noticed in plots where surface irrigation was applied (control treatment) with plant density of 20 plants/m^2 during the year 2015-16 and 2016-17, respectively. Hence, the interaction between different irrigation levels and plant density had distinct effect on number of leaves over control.

Table 3: Effect of irrigation levels and plant density on number of leaves per plant in gladiolus

Irrigation levels (water applied after 10 mm of CPE)	Plant density (per m^2)									
	2015-16					2016-17				
	D_1: 20	D_2: 24	D_3: 28	D_4: 32	Mean	D_1: 20	D_2: 24	D_3: 28	D_4: 32	Mean
I_1: Control	6.33	6.27	6.27	6.07	**6.23**	6.40	6.27	6.27	6.13	**6.27**
I_2: 6 mm after 10 mm CPE	7.33	7.80	7.27	6.73	**7.28**	7.47	7.33	7.20	6.87	**7.22**
I_3: 8 mm after 10 mm CPE	8.13	7.40	7.27	7.07	**7.47**	8.27	7.73	7.47	7.20	**7.67**
I_4: 10 mm after 10 mm CPE	9.07	8.13	7.47	7.33	**8.00**	9.20	8.27	7.73	7.40	**8.15**
I_5: 12 mm after 10 mm CPE	9.80	8.33	8.00	7.53	**8.42**	9.93	8.47	8.13	7.67	**8.55**
Mean	**8.13**	**7.59**	**7.25**	**6.95**		**8.25**	**7.61**	**7.36**	**7.05**	

CD at 5% level of significance	2015-16	2016-17
Irrigation	0.28	0.27
Plant density	0.25	0.24
Irrigation x Plant density	0.57	0.53

Irrigation and plant density both significantly affected the number of leaves per plant (Table 3). The highest number of leaves per plant was recorded when 12 mm water applied after 10 mm of CPE with the plant density of 32 plants/m^2. The results obtained in the present investigation revealed that increasing levels of irrigation significantly increased number of leaves per plant as compared to minimum level of irrigation. The effect of water replacement levels on the vegetative growth of the plant can be explained in that the stimulation of water promotes greater assimilation of carbohydrates as an important component of photosynthesis, which then results in increased number of leaves per plant. It might be due to the reason that with the higher availability of moisture in the soil the growth of the plant roots was maximum which ultimately resulted into higher absorption of nutrients. Higher mineral nutrients in the plant tissues initiate the growth processes. All these consequently increased the development of the higher number of leaf primordia. According to Melo *et al* .[6], the rates of leaf expansion and photosynthesis are associated with their contribution to the rate of vegetative growth, maximum leaf number and greater leaf area implies improvement to the production of assimilates required for quality production. Higher plant density leads to competition for moisture, nutrients and solar radiation leading to higher plant height. Irrigation I_5 and plant density D_1 found most effective in increasing the number of leaves. The findings of present experiment corroborate the findings of Rajib *et al*.[7] who reported the maximum number of leaves per plant was obtained from wider plant density as compared to closer plant density.

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