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Effect of Irrigation Methods and Mulching on Growth And Yield of Gladiolus

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ABSTRACT
An experiment was conducted at Department of Horticulture, CCSHAU, Hisar to study the response of irrigation methods and mulching on growth and yield of gladiolus variety Advance Red. The treatments constituted two types of beds viz., flat bed and raised bed with two levels of irrigation regimes viz., flooding and 80% of evaporation replenishment by drip irrigation under no mulch and with black polythene mulch laid out in RBD with three replication and seven treatments. The results of study revealed that growth and quality parameters like days to sprouting of corms (14.55 days), plant height (61.33 cm) and number of leaves (8.63), days to spike initiation (114.1 days) and basal floret opening (130.3 days), spike length (63.3 cm), rachis length (52.0 cm) and florets per spike (16.5) were recorded maximum in the T_7 Raised bed + Drip irrigation + Mulching treatment. Same treatment showed significantly superior results in corm and cormel characters viz, weight of corm (64.2 g), diameter of corm (6.32 cm) and number of cormels per plant (62.5). Similar trend followed in the second year of study. Thus, it was concluded that drip irrigation over raised beds with mulching proved to enhance the growth and quality of gladiolus.
Key words: *Drip irrigation, Mulching, Gladiolus, Advance Red.*

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INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* Ness) of family Iridiaceae is one of the important bulbous cut flower in the international as well as domestic market. Gladiolus is cultivated as a commercial cut flower crop in India. Among various factors, irrigation is one of the important factor governing the yield and quality of gladiolus crop. The global climatic change and increasing temperatures has resulted in the depleting ground water table levels and reduced rains. Irrigation and mulching provide favourable hydrothermal conditions of soil for better plant growth. Drip irrigation has proved its superiority over other conventional methods of irrigation, owing to precise and direct application of water in the root zone. The work carried out on drip irrigation in vegetables and fruits gave encouraging results in terms of plant growth and yield. Besides this, a considerable saving of water and fertilizers has been reported (Bafna *et al*., 1993; Raina *et al*., 1999). Studies carried out by Bastug *et al*.,(2006) showed that use of drip irrigation with 100% Epan replenishment has increased the flowering percentage in gladiolus up to 0.3 percent. Similar results were also given by Gupta *et al*. (2007) in gladiolus. It was also shown that use of different mulching materials enhanced the leaf nutrient status in aonla (Parshant Bakshi *et al*., 2015), use of black polythene mulch enhanced the floral and corm characters in gladiolus cultivars (Sindhu and Kumar (2013). However, information on the combined effect of irrigation and mulching on flower crops is very meager. Keeping the above considerations in the view, the present investigation was carried out to study the response of irrigation methods and mulching on growth and yield of gladiolus.

MATERIALS AND METHODS

The experiment was carried out at Precision Farming Development Centre, Department of Horticulture, CCS Haryana Agricultural University, Hisar. The experiment was carried out in randomized block design consisting of seven treatments with three replications. Uniform sized corms of gladiolus cultivar Advance Red were treated with bavistin 0.1% solution for one hour and shade dried before planting. A plot size of

1 m x 1.2 m was made in which 20 corms at a spacing of 30 cm x 20 cm were sown per replication. Black polythene (50 micron thickness) was used for mulching. Mulching was done 30 days after planting. The treatments were T_1-Flat bed + Flooding,T_2- Flat bed + Drip irrigation, T_3-Flat bed + Drip irrigation + Mulching,T_4- Raised bed + Furrow irrigation,T_5- Raised bed + Furrow irrigation + Mulching,T_6-Raised bed + Drip irrigation and T_7- Raised bed + Drip irrigation + Mulching. Flooding and furrow type of irrigation were scheduled at fortnight interval at 100%pan evaporation replenishment. Drip system was laid out by 12 mm diameter LLDPE lateral pipes, which were aligned in middle of two rows and six drippers per plot with a discharge rate of 2 liters per hour. The plants under drip system were irrigated twice a week at 80% pan evaporation replenishment.

Estimation of irrigation water requirement

The water requirement of the crop was computed on daily basis by using the following equation as suggested by Indian National Committee on Irrigation and Drainage as well as Drip Irrigation in India (Anonymous, 1994).

1. V1 = Ep. Kp. Kc
2. Net volume of water to be applied (Vn) Vn = V1 – Re
3. Number of operating hours of system (T) during a day

T = (Vn/1000) x No. of emitters per lateral x No. of laterals plot^{-1} x discharge rate of emitter (l/hr) x A

Where,

V1 = Volume of water required

Ep = Pan evaporation as measured by Class-A pan evaporimeter (mm /day)

Kc = Crop factor (depends on crop growth stage)

Kp = Pan factor

A = Area to be irrigated (sq.m)

Re = The effective rainfall (mm)

T = Number of operating hours of system (hr /day)

Observations were recorded in five randomly selected plants in each treatment for various vegetative, floral and corm parameters. The statistical method described by Pans and Sukhatme (1978) was followed for analysis and interpretation of the experimental results.

RESULT

Vegetative characters

The data on analysis showed that the vegetative parameters like days of sprouting and sprouting percentage were influenced by the method of irrigation and mulching in both the years of study (Table 1). Minimum days for sprouting of corms (14.55), significantly lower than raised bed and furrow irrigation with and without mulching were recorded in raised bed with drip irrigation along with mulching during first year of study. Furrow irrigation delayed corm sprouting as compared to flooding and drip irrigation. As a whole raised beds were found to be superior to flat bed treatments. Similar trend was observed during next year. However, per cent sprouting of corms was not significantly affected by different irrigation methods and mulching.

Plant height (61.33 cm) and number of leaves (8.63) were recorded maximum in treatment 7 i.e, drip irrigation on raised beds with mulching where as furrow irrigation with and without mulch recorded least vegetative parameters in both the years.

Table 1: Effect of different irrigation methods and mulching on vegetative characters of gladiolus

Treatments	Days taken for sprouting		Per cent sprouting		Plant height (cm)		Number of leaves / plant	
	First year	Second year	**First year**	**Second year**	**First year**	**Second year**	**First year**	**Second year**
Flat bed + Flooding	14.65	18.40	51.60	52.84	51.60	52.84	7.37	7.60
Flat bed + Drip irrigation	15.66	17.73	54.60	56.03	54.60	56.03	7.47	7.83
Flat bed + Drip irrigation + Mulching	15.13	15.43	56.07	58.99	56.07	58.99	7.60	8.17
Raised bed + Furrow irrigation	23.00	18.50	45.73	45.29	45.73	45.29	6.47	7.23
Raised bed + Furrow irrigation + Mulching	23.10	20.35	48.20	48.29	48.20	48.29	6.80	7.42
Raised bed + Drip irrigation	14.77	17.40	56.87	59.80	56.87	59.80	8.07	8.13
Raised bed + Drip irrigation + Mulching	14.55	16.43	61.33	64.51	61.33	64.51	8.63	8.90
SEm±	**0.79**	**0.53**	**1.24**	**0.76**	**1.24**	**0.76**	**0.16**	**0.24**
CD (P=0.05)	**2.46**	**1.72**	**3.86**	**2.36**	**3.86**	**2.36**	**0.51**	**0.76**

Floral characters

Floral characters like days to spike initiation and basal floret opening, spike length, rachis length, number of florets per spike were greatly influenced by the treatments. From the analyzed data in the table 2 it is evident that the plants under raised bed with drip irrigation along with mulching took significantly minimum number of days for spike initiation (114.1 and 113.2) and days to basal floret opening (130.3 and 127.3) in both the years respectively. Similarly spike length (63.3 and 65.1 cm), rachis length (52.0 and 54.0 cm) florets per spike (16.5 and 17.9) were recorded maximum in treatment with drip irrigation on raised beds with mulching. Further it was observed that mulched treatments were better over un-mulched ones and drip irrigation was superior over flooding and furrow method. However, diameter of floret was not influenced by the treatments.

Table 2: Effect of different irrigation methods and mulching on floral characters of gladiolus

Treatments	Days taken for				Spike length (cm)		Rachis length (cm)		Number of florets per spike		Diameter of floret (cm)	
	Spike initiation		Basal floret opening									
	First year	Second year	First year	Second year	First year	Second year	First year	Second year	First year	Second year	First year	Second year
Flat bed + Flooding	122.7	119.2	136.3	131.3	48.2	51.5	41.0	43.2	14.0	15.0	11.0	12.1
Flat bed + Drip irrigation	121.6	118.3	134.1	130.9	54.0	58.3	43.1	47.0	15.0	15.2	10.4	11.4
Flat bed + Drip irrigation + Mulching	119.5	117.5	133.4	130.4	58.6	61.2	45.5	49.5	15.4	16.0	11.4	12.4
Raised bed + Furrow irrigation	125.2	123.1	136.3	134.0	42.6	45.2	32.0	35.2	14.0	13.1	10.1	11.4
Raised bed + Furrow irrigation + Mulching	123.6	120.8	136.5	136.6	133.4	48.7	35.5	39.7	14.5	14.0	10.4	12.3
Raised bed + Drip irrigation	117.8	116.7	132.1	129.9	136.3	62.2	48.9	51.3	16.0	16.4	11.5	13.0
Raised bed + Drip irrigation + Mulching	114.1	113.2	130.3	127.3	63.3	65.1	52.0	54.0	16.5	17.9	12.0	12.3
SEm±	**0.6**	**0.8**	**0.7**	**1.2**	**0.8**	**0.6**	**0.6**	**0.6**	**0.5**	**0.4**	**0.5**	**0.5**
CD (P=0.05)	**2.1**	**2.5**	**2.3**	**3.6**	**2.6**	**2.0**	**1.8**	**1.9**	**1.7**	**1.2**	**N.S.**	**N.S.**

Corm and cormel characters

The data pertaining to corm and cormel characters revealed that treatment seven was found to have recorded significantly higher values in both the seasons(Table 3). Weight of corms (64.2 g), diameter of corm (6.32 cm) and cormels per plant (62.5) were recorded maximum in drip irrigation with mulching on raised bed treatment. Furthermore it was observed that drip irrigation increased the corm and cormel characters as compared to flooding and furrow irrigation. There was no significant difference between the treatments for weight of cormels per plant.

Table 3: Effect of different irrigation methods and mulching on corm and cormel characters of gladiolus

Treatments	Weight of corm (g)		Diameter of corm (cm)		Cormels/plant		Weight of cormels/plant (g)	
	First year	Second year	First year	First year	First year	Second year	First year	Second year
Flat bed + Flooding	32.4	32.2	4.91	4.70	48.7	47.6	12.7	11.3
Flat bed + Drip irrigation	47.4	45.2	5.80	5.53	53.3	51.3	22.5	19.9
Flat bed + Drip irrigation + Mulching	65.1	63.7	6.62	6.53	50.0	48.2	22.0	19.6
Raised bed + Furrow irrigation	31.4	30.0	4.89	4.77	36.9	31.3	21.1	17.8
Raised bed + Furrow irrigation + Mulching	36.1	35.2	5.19	4.90	41.7	38.5	19.0	17.5
Raised bed + Drip irrigation	56.2	55.4	6.12	5.99	56.6	54.7	22.9	20.4
Raised bed + Drip irrigation + Mulching	64.2	62.8	6.32	6.10	62.5	57.9	28.4	25.8
SEm±	**2.6**	**3.5**	**0.1**	**0.2**	**1.9**	**1.3**	**4.8**	**4.2**
CD (P=0.05)	**8.0**	**10.8**	**0.38**	**0.68**	**6.0**	**4.2**	**N.S.**	**N.S.**

DISCUSSION

Effect on plant growth and vegetative parameters

Plant growth parameters which are directly influenced by the availability of nutrients and moisture in the soil are also affected by the mode of irrigation methods and mulching. Vegetative parameters like number of days to sprouting of corms, percent sprouting, plant height, number of leaves exhibited marked variation with respect to the type of beds in combination with method of irrigation and mulching.

Effect on number of days to sprouting and percent sprouting

It is evident that the drip irrigation on raised beds with mulching resulted in early sprouting of corms as compared to flooding and furrow irrigation treatments. Raised beds with furrow irrigation delayed sprouting of corms irrespective of mulching. It is presumed that delayed sprouting in raised bed with furrow irrigation might be due to rapid loss of soil moisture around the corms as the surface area exposed was more in raised bed with furrow irrigation. There was no significant effect of irrigation methods and mulching on percent sprouting of corms. As sprouting of corms depends on the viability of planting material and carbohydrates stored in the corms, optimum sprouting percentage of corms was observed in the treatments irrespective of irrigation methods and mulching. Hirekuruber *et al.* (1991) reported that flooding caused compaction of the soil which might be attributed to increase in the bulk density of the soil resulting in the decrease in the total percent pore space. Bastug *et al*. (2006) also reported that early sprouting of corm was observed in drip irrigation at 1.00 E pan treatments in gladiolus. Similarly, Gupta *et al*. (2007) observed that early sprouting of gladiolus corms was observed in seepage irrigation system.

Effect on plant height and number of leaves

Plant height and number of leaves which are important parameter of vegetative growth were significantly affected by the method of irrigation and mulching. Maximum plant height and number of leaves were recorded in raised bed with drip irrigation and mulching. Drip irrigation over raised beds in combination with mulching showed its superiority over flooding and furrow irrigation. Mulching was found to be better irrespective of method of irrigation over unmulched treatments. Similar results were reported by Gupta *et al*. (2007) in gladiolus,Pritee Awasthy *et al.,* (2014) in maize. Pradeep kumar (2001) in his studies on chrysanthemum reported that the distribution of nutrients in the soil depends on their solubility, moisture distribution and gradients. Under drip irrigation less volume of water produced a hydraulic gradient of less magnitude which results in the penetration of wetting front to the lesser depth and there by less leaching of N and K fertilizers. On the other hand, in case of flooding irrigation due to hydraulic gradient of high magnitude, this lengthened the transmission zone with higher water content leached N and K salts along with water into lower profile depth.

Kashyap *et al*. (2009) reported that drip irrigation treatments irrespective of mulching showed significantly better performance in plant height, leaf number and other growth parameters in broccoli. He suggested that drip irrigation kept the soil near field capacity throughout the growth period in the active root zone, resulted in low soil suction which facilitated better water, nutrient uptake by the plant and excellent soil-water-air relationship with higher oxygen concentration in the root zone which ultimately reflected in the better plant growth in the drip irrigated plants.

Effect on Floral attributes

Floral quality and yield parameters like number of days to spike initiation, days to basal floret opening, spike length, rachis length, number of florets per spike and floret diameter were significantly influenced by different irrigation methods and mulching.

Number of days for spike initiation and basal floret opening

In present investigation, early spike initiation and basal floret opening was observed in raised beds in combination with drip irrigation and mulching treatment. Drip irrigation either with raised bed or with flat bed resulted in early spike initiation as compared to flooding and furrow irrigation. Irrespective of irrigation methods, mulching aided in early spike initiation and basal floret opening over unmulched treatments. Maximum plant height and number of leaves promoted increased photosynthetic activity thereby more photosynthates might have accumulated which resulted in early bud differentiation. Gupta *et al*. (2007) also revealed that seepage irrigation system resulted in maximum vegetative growth which caused early spike initiation in gladiolus. Similar results were reported by Bastug *et al*. (2006) in gladiolus.

Spike length, rachis length, number of florets per spike and floret diameter

Length of spike and rachis length are the major attributes determining the grade and quality of gladiolus spike. In the present study spike length and rachis length were recorded maximum in drip irrigation on raised beds with mulching over all other treatments. It was also observed that drip irrigation with mulching showed its superiority irrespective of type of bed (either flat bed or raised bed) in increasing spike length and rachis length over flooding and furrow irrigation. Kashyap *et al*. (2009) also reported increased quantitative increase in growth parameters due to application of drip irrigation, which may be

related to the turgidity of the cell with increase in the available soil moisture leading to quicker cell division and enlargement. Further increase of these growth parameters due to the application of plastic mulch might be due to the favourable soil moisture status and soil temperature. Similarly, longest spike length and rachis length were recorded in plants grown in plots mulched with black polythene, transparent polythene and dry weed in gladiolus cv. Jester (Barman *et al*., 2005).

Maximum number of florets per spike was recorded in drip irrigation on raised bed treatment irrespective of mulching. Flooding and furrow irrigation recorded minimum number of florets. Mulching showed its positive effect over its counterpart in all the treatments. Raina *et al*. (1999) reported in their studies on tomato that increased yield under drip irrigation resulted due to better water utilization, higher water uptake of nutrients and excellent water relationships with higher oxygen concentration in the root zone. Pradeep kumar (2001) reported that higher flower yield obtained under drip irrigation may be ascribed to the fact that drip irrigation aided in better mobilization of nutrients and also adequate soil moisture might have enhanced source capacity and sink strength which in turn might have increased the quality and yield in chrysanthemum. It was also shown that use of black polythene mulch and drip irrigation had increased the yield in maize by controlling the weed growth (Pritee Awasthy *et al.,*2014). In addition, there might have been higher leaching losses of nutrients, mainly nitrogen, due to deep percolation of water. These conditions adversely affected the magnitude of yield under flood irrigation. The present findings are in accordance with Singadhupe *et al*., 2000; Neeraja *et al*., 2001 and Gupta *et al*. 2007 in gladiolus. However, floret diameter was not affected by various irrigation methods and mulching. This can be attributed to the flower character specific to the variety.

Effect on corm and cormel production

The results revealed that maximum weight of corm and diameter of corm was recorded in drip irrigation with mulching both on flat beds and raised beds. And mulching was significantly effective over unmulched beds in increasing weight of corms and diameter of corm. The findings are in accordance with the results reported by Gupta *et al*. (2007) in gladiolus that seepage irrigation system increased weight of corm and diameter of corm. Barman *et al*. (2005) reported that use of black polythene mulch in gladiolus recorded maximum corm weight. Similarly, Maheria *et al*. (2013) indicated that conservation of moisture by mulching with 20 micron plastic sheet and application of irrigation through low pressure irrigation system is better for higher crop yield and water use efficiency in cumin thereby improving water productivity. Increase in yield under drip irrigation might be due to increase in total N, P, K uptake due to conditions of adequate soil moisture availability, higher photosynthetic rate due to lesser loss of water through evapo-transpiration and increase in available soil moisture (Pradeep kumar, (2001). Similar explanation was given under the findings of Bastug *et al*. (2006) in gladiolus and Kashyap *et al*. (2009) in broccoli. Moreover, maximum growth and yield attributes were recorded in mung bean by application of four irrigations over lesser irrigations (Singh *et al,* 2014).This suggests that more frequency of irrigation application increases the yield which can be achieved by drip irrigation (every alternate day) rather than flooding irrigation (every fortnight).

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