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Khiromani Nag
Department of Agriculture Science and Technology, AKS University Satna, Madhya Pradesh, India

Akhilesh Jagre
Department of Agriculture Science and Technology, AKS University Satna, Madhya Pradesh, India

Vivek Kumar Singh
Department of Agriculture Science and Technology, AKS University Satna, Madhya Pradesh, India

Kuldeep Rajpoot
Department of Agriculture Science and Technology, AKS University Satna, Madhya Pradesh, India

Correspondence
Khiromani Nag
Department of Agriculture Science and Technology, AKS University Satna, Madhya Pradesh, India

To work out an appropriate planting geometry for growth, flowering and quality of gladiolus (*Gladiolus grandifloras* L.)

Khiromani Nag, Akhilesh Jagre, Vivek Kumar Singh and Kuldeep Rajpoot

Abstract
In order to explore the possibility of improving growth and yield of gladiolus an experiment entitled, 'To work out an appropriate planting geometry for growth, flowering and quality of gladiolus (*Gladiolus grandifloras* L.)' have been conducted at the research farm of AKS University Satna during rabi seasons of 2015-16. Experiment compromised of three spacing's viz. - 30 x 15cm (S1), 30 x 20cm (S2), and 30 x 25cm (S3). Experiment was laid out in RBD (with factorial concept) with three replications. The results of the experiment showed application use of spacing's had significantly. Influence on the most parameters such as – Sprouting percentage, height of plant, number of leaves per plant, length of spikes, days to opening of 1st florets, number of corms per plant and weight of corms per plant of the experiment conjunctions of three spacing's viz. 30 x 15cm (S1), 30 x 20cm (S2), and 30 x 25xcm (S3) had significantly. Increase on the most parameters such as Height of plant, corms per plant and weight of corms per plant was the higher yield on wider spacing's 30 x 25cm (S_3).

Keywords: gladiolus, planting geometry, growth, flowering, quality

Introduction
Gladiolus is a popular flowering plant grown all over the world, from South Africa to West Asia. The name gladiolus was derived from the Latin word gladioli, because of its sword-like leaves. It is popularly known as sword lily. It was introduced for the cultivation at the end of the 16th century (Parthasarathy and Nagaraju, 1999).The modern hybrids is botanically known as *Gladiolus grandifloras* belonging to family Iridaceae.In the international cut-flower trade gladiolus occupies fourth place. It is mainly cultivated for cut-flowers because of its elegant appearance and prolonged vase life. As a cut flower, it has great potentialities for the export to European countries during the winter months to even the valuable foreign exchange. Therefore, growing gladiolus on scientific footing is of immense needs for getting the quality blooms with exportable standards. Gladiolus spikes are most popular in flower arrangements and for preparing attractive bouquets (Mishra *et al*. 2006). The magnificent above inflorescence with various colours have made it attractive for use in herbaceous borders, beddings, rockeries, pots and for cut flower. Due to its immense potential as ornamental crop and utter dearth of plant material of such elite species for commercial cultivation, need was felt to recuperate our production technologies for better qualitative as well as quantitative traits. An exogenous application of gibberellins has brought major advances in field of agriculture. Among exogenous gibberellins, GA_3 has been commonly used to manipulate vegetative growth, flowering and quality aspects in flowering crops. Apart from ornamental value, gladiolus have extensively utilized in medicines for headache, lumbago, diarrhea. Rheumatism and allied pains. Flower and corm of some gladiolus are used as food in many countries (Khan, 2006). The flowers of different Gladiolus sp. are used as uncooked salad by nipping of their anthers. There are many factors which can affect plant growth and economic cultivation of gladiolus such as variety, size of corms and cormel, depth of planting, application of fertilizers etc. The number of florets per spike, longest spike and rachis length, flower quality, corm and cormel production etc. Proper plant spacing is also necessary for higher yield of spikes, corms and cormels. The spacing depends on the purpose for which the crop is grown. For commercial cultivation, high-density planting is recommended. The corm number, corm weight and cormel production per corm decreased in closer spacing's. However, even the closest spacing produced corms of top grade (Arora, 1987). Flower quality (Length of cut flower, length of spike and number of florets) was poor in higher density plots (Huh rut *et al.*, 1996).

Planting of gladiolus at wider spacing resulted into maximum number of leaves, height of plant and diameter of corms/plant, the weight of daughter corms and corm-lets/plant also increased at wider spacing's (Sujatha and Singh, 1991). The commercial production is still at the initial stage due to lack of information regarding its cultivation technology, different factors such as size of corm and cormel, planting time and depth management, use of chemicals like GA_3 etc., which influence the production and quality of gladiolus flower as well as its corm and cormels. Bulbous crops are greatly influences by the corms size. Corm is the food-storing underground stem and propagation material of gladiolus. The size of corm highly influences the vegetative growth, development and ultimately the spikes, flowers and corms production (Bose *et al.,* 2003).

Materials and Methods

The materials used and methods employed during the tenure of investigation on the entitled "To work out an appropriate planting geometry for growth, flowering and quality of gladiolus" are as fallows. Experimental site. Trial was conducted during winter seasons of 2015 at the AKS university, Satna (M.P.) farm, (80^0 21' to 81^0 23' east longitude and 23^0 58' to 25^0 12' north latitude), the altitude of Satna is 317 meters above mean sea level.

Place	Instructional farm AKS University,Satna
Crops	Gladiolus (*Gladiolus grandifloras* L.)
Variety	Snow Princess
Design	RBD (with factorial concept)
Number of treatments (combinations)	09
Number of replications	03
Total number of plots	(9 x 3) = 27
Planting geometry	30 x 15, 30 x 20 and 30 x 25cm (R x P)
Level of Plant growth regulators	GA_3 = 50ppm, 100ppm and 150ppm
Net plot size	1.0 x 0.90m
Distance between replications	0.75m
Plot to plot distance	0.50m
Length of experimental field	13.0m
Width of experimental field	6.20m
Area of the experimental field	19.20m
Date of planting	19/October/2015

Spacing's

S_1 = Spacing 1^{st} = 30 x 15cm. (row x plant)
S_2 = Spacing 2^{nd} = 30 x 20cm. (row x plant)
S_3 = Spacing 3^{rd} = 30 x 25cm. (row x plant)

Observations

Five representative plants in each plot were selected randomly and tagged for observations. The observations with respect to growth, flowering and corm production in gladiolus are as follows:

(A) Corms characters

(I) Sprouting percent: The number of days taken for 7 corms to sprout in each treatment and each replications were taken as days to 50% sprouting.

(B) Growth parameters

(I) Height of plant (cm) at 30 and 60 DAP: The height of plant was recorded from ground level to the apex of the top most florets in the 5 tagged plants of each treatments and recorded in cm at 30 and 60 DAP.

(II) Number of leaves per plant at 30, 60 DAP: Number of functional leaves i.e. fully developed and green leaves were counted from each tagged plants at 30 and 60 DAP.

(C) Quality characters

(I) Days to opening of 1^{st} florets (Days): The number of days required for the initiation of first flower stick under each treatment was recorded.

(II) Number of spike per plant: The number of days taken for the initiation of florets from the stick under each treatment was recorded.

(III) Number of florets per spike: The number of first florets $spike^{-1}$ was counted on the days when last floret was fully opening in each treatment.

(IV) Length of spike (cm): Spike length was recorded by measuring the distance between first leaf and last floret of the spike at the time of last floret opening.

(D) Yield and Yield attributes

(I) Number of corms per plant: Corms first plant was counted at the time of lifting, taking into consideration all the shoots in a plant.

(II) Weight of corm per plant (g): The weight of corm was recorded after taking average weight of corms per plant.

Results and Discussion

In this chapter result embodies an elaborate account of various studies made during the period of investigation on the experimental crops of gladiolus, Cultivar "Snow Princess" (*Gladiolus grandifloras* L.). The analysis of variance (ANOVA) have been appended at the end of this thesis, after the bibliography and referred at appropriate places in the text.

(I) Sprouting percent Data collected on account of percentage of sprouting of gladiolus as affected by different plant spacing have been portrayed in table No. 01**.**Use of spacing also caused beneficial response on sprouting percent of gladiolus and maximum sprouting percent i.e. 14.01 was obtained when wider spacing (30 x 25cm) was used followed by 30 x 20cm.

Table 1: Sprouting percent of gladiolus as influenced by different plant spacing

Treatments	Sprouting percent
Spacing	
S_1 (30 x 15cm)	11.52
S_2 (30 x 20cm)	11.89
S_3 (30 x 25cm)	14.01
SEm±	0.45
CD (p=0.05)	1.36

Plant height (cm) Data assembled towards plant height of gladiolus as affected by different plant spacing have been portrayed in table No.02**.** Spacing also brought paramount

effect on height of the plant in gladiolus and maximum height of plant i.e. 68.83cm and 81.09cm was recorded at 30 and 60 days after planting respectively by use of 30 x 25cm plant spacing followed by 30 x 20cm.

Table 2: Plant height of gladiolus as influenced by different Plant spacing

Treatments	Plant height (cm)	
	30 DAS	60 DAS
Spacing		
S_1 (30 x 15cm)	56.35	66.38
S_2 (30 x 20cm)	58.18	68.88
S_3 (30 x 25cm)	68.83	81.09
SEm±	2.27	2.64
CD (p=0.05)	6.81	7.93
CD (p=0.05)	NS	NS

03 Number of leaves per plant Data regarding number of leaves per plant of gladiolus as affected by different plant spacing have been tabulated in table No.03.Use of spacing also caused beneficial response on number of leaves per plant and large number of leaves i.e. 5.46 and 7.80 per/plant were noticed at 30, 60 day after planting respectively when 30 x 25cm plant spacing was used followed by 30 x 20cm.

Table 3: Number of leaves of gladiolus as influenced by different Plant spacing.

Treatments	Number of leaves	
	30 DAS	60 DAS
Spacing		
S_1 (30 x 15cm)	4.47	6.40
S_2 (30 x 20cm)	4.49	6.42
S_3 (30 x 25cm)	5.46	7.80
SE m±	2.27	2.64
CD (p=0.05)	6.81	7.93

04 Days to opening of 1st florets (Days) Data accumulated in connection with days to first flowering in gladiolus have been tabulated in table No. 04. Spacing also highlighted the effect on days to opening of 1st florets in gladiolus and maximum days to opening of 1st florets i.e.- 67.04 was recorded by the use of wider spacing 30 x 25cm plant spacing followed by 30 x 20cm.

Table 4: Days to opening of first flowering of gladiolus as influenced by different Plant spacing.

Treatments	Days of first flowering
Spacing	
S_1 (30 x 15cm)	81.89
S_2 (30 x 15cm)	67.39
S_3 (30 x 15cm)	67.04
SEm±	2.12
CD (p=0.05)	6.37

05 Number of spike per plant Data collected on account of number of spike per plant of gladiolus as affected by different plant spacing have been portrayed in table No. 05. Use of spacing also caused beneficial response on number of spikes of gladiolus and maximum number of spikes per plant i.e. 1.49 was obtained when wider spacing (30 x 25cm) was used followed by 30 x 20cm.

Table 5: Number of spike of gladiolus as influenced by different Plant spacing.

Treatments	Number of Spike per Plant
Spacing	
S_1(30 x 15cm)	1.19
S_2(30 x 20cm)	1.23
S_3(30 x 25cm)	1.49
SEm±	0.04
CD (p=0.05)	0.12

06 Number of florets per spike Data accumulated in connection with number of florets per spike in gladiolus have been tabulated in table No. 06.Spacing also highlighted the effect on number of florets per spike in gladiolus and maximum number of florets i.e.- 23.21 spikes/plant was recorded by the use of wider spacing 30 x 25cm plant spacing followed by 30 x 20cm.

Table 6: Number of florets per spike of gladiolus as influenced by different Plant spacing.

Treatments	Number of florets per spike
Spacing	
S_1(30 x 15cm)	18.56
S_2(30 x 20cm)	19.10
S_3(30 x 25cm)	23.21
SE m±	0.67
CD (p=0.05)	2.00

07 Length of spike (cm) Data regarding length of gladiolus as affected by different plant spacing's have been tabulated in table No.07.Use of spacing also caused beneficial response on length of spike of gladiolus and maximum length of spikes i.e. 111.21cm was obtained when wider spacing (30 x 25cm) was used followed by 30 x 20cm.

Table 7: Spike length of gladiolus as influenced by different Plant spacing.

Treatments	Spike length
Spacing	
S_1(30 x 15cm)	88.92
S_2(30 x 20cm)	91.89
S_3(30 x 25cm)	111.21
SE m±	3.06
CD (p=0.05)	9.19

09 Number of corms per plant Data collected on account of number of corms per plant of gladiolus as affected by different plant spacing have been portrayed in table No. 09.Spacing also highlighted the effect on number of corms per plant in gladiolus and maximum number of corms per plant i.e. - 1.89 (days) was noticed by the use of wider spacing 30 x 25cm plant spacing followed by 30 x 20cm.

Table 9: Number of corm per plant of gladiolus as influenced by different Plant spacing

Treatments	Number of corm per/plant
Spacing	
S_1(30 x 15cm)	1.53
S_2(30 x 20cm)	1.58
S_3(30 x 25cm)	1.89
SE m±	0.06
CD (p=0.05)	0.19

10 Weight of corms per plant (g) The data gathered on account of weight of corms of gladiolus as affected by different spacing's have been tabulated in table No.10 Spacing also highlighted the effect on weight of corms per plant in gladiolus and maximum weight of corms per plant i.e. - 243.40g was recorded by the use of wider spacing 30 x 25cm plant spacing followed by 30 x 20cm.

Table 10: Weight of corm per plant of gladiolus as influenced by different Plant spacing.

Treatments	Weight of corm per/plant
Spacing	
S_1(30 x 15cm)	198.57
S_2(30 x 20cm)	205.03
S_3(30 x 25cm)	243.40
SEm±	7.88
CD (p=0.05)	23.62

Evaluation of different biological parameters of gladiolus cultivators was made during Rabi season of 2015-2016 with the object to see the most suitable, high quality and best cultivar for cultivation in Satna region of M.P. Study of various parameters is essential for such evaluation. Among them the most important ones are number of days taken for emergence of spike, number of days to opening of first florets, length of spike, number of spike per plant. In addition to these various other factors like sprouting percentage, height of plant, number of leaves per plant, length of spike, number of spikes per plant, number of florets per spike, number of corms per plant, and weight of corms also considered as these are the parameters which ultimately decide the yield and quality of flower spikes. A cultivar possessing the desirable characters as mentioned above would be considered good cultivars even through it lacks one or more other characters. The merits and demerit of one cultivars are dis-abuse based on the different parameter studied.The cultivars have shown highly significant different with respect to sprouting percentage at different growth stage of plant. The Cultivars highest sprouting percentage was recorded i.e. 14.01 (30 Days), found to highest sprouting percentage i.e. 14.01 at 60 DAP on wider spacing under these stages. Hona and Goo (1991) under Korean conditions found that sprouting was earlier in the corms of Cultivar "Snow princess" produced in Korean then in imported corms, days to sprouting and sprouting percent vary with corm shape. This trend may be attributed to varietal growth characters; it may differ in particulars variety according to temperature and season. Other growth parameters viz. number of leaves per plant, and length of spikes, showed highly significant differences, among the cultivars as for as number of leaves per plant was concerned this cultivars of spacing on maximum number of leaves per plant was recorded i.e. 5.46, 7.80 (30 and 60 days) respectively. This trend may be attributes to the varietal growth of characters are almost different. The parameters of further responsible for best quality and yield of gladiolus cut-flower. More number of leaves per plant resulted in increased height of plant, spike length and more number of florets per spike. Highly significant differences also existed with respect to plant height. The cultivars maximum plant height was recorded i.e. (68.83 & 81.69 at 30 and 60 days) respectively. Plant height is vary important, it decide the spike length. When plant height become more the spike and florets also become longer which are important characters of gladiolus. Induction of flowering plays important role with respect to cut flower production in gladiolus. The cultivars has maximum number of days to opening of 1st florets at wider spacing was recorded i.e. 81.09 (cm). The cultivars had shown highly significant differences for the time taken for full emergence of spikes. Cultivar was the earliest (67.04 days) to come for full emergence of spike followed by (67.34) was the latest one as compared to the cultivars on an average they have taken 60 days. Hong and God (1991) under vindhya region conditions and found that spikes emerged sooner and flowering was earlier in corms of gladiolus produced in maximum that the improved corms. This variation may be attributes to the different temperatures and seasonal conditions prevailing at different places in the particular area cultivars have maintained the difference, noticed in the number of days taken for full emergence of spikes with other characters as first florets to bloom. The results indicated that there is a particulars time period for each cultivars for flowering. Cultivars had shown highly significant a difference with respect to number of days to opening of first florets was recorded i.e. 67.04 days. Cultivars "Snow Princess" was earliest (67.04 day) to blooms the first florets, followed by largest was the later (81.89 days) one. The cultivars under study had shown highly significant differences with respect to spike length. The cultivars for spacing 30 x 25cm with a range of 88.92 to 111.21cm. It is a desirable character for cut flower because large spike. High significantly differences also existed with respect to the production of number of corms per plant and weight of corms per plant was observed on spacing i.e. 1.89g. Similar results were reported by gladiolus (Leena *et al.*, (1993).

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