Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6[10] September 2017 : 17-28

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Study on the Effect of Dates of Sowing on Growth, Flowering and Spike Yield of Gladiolus Cultivar American Beauty under Different Field Conditions

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ABSTRACT
The investigation was carried out at Precision Farming Development Centre (PFDC), Hyderabad of PJTSAU, Rajendranagar to study the effect of different field conditions (open field, shade net and polyhouse) and different dates of sowing (August 15th, September 1st, September 15t and October 1st) on vegetative and floral characteristics of gladiolus (Gladiolus grandiflora var. American beauty) . The experiment was laid out in a Randomized Block Design with factorial concept (FRBD). The vegetative and floral parameters were significantly influenced by different field conditions and dates of sowing. Among different field conditions, shade net condition had significant influence on vegetative parameters viz. days taken for sprouting, plant height, number of leaves per plant, spike length, weight of spike, and number of florets per spike. Whereas open field condition showed superior performance in influencing the floral characteristics viz. days taken for spike initiation, number of spikes per plant, number of spikes per plot and spike yield. Among different dates of sowing, the crop sown on September 1st evinced better performance in terms of growth parameters of gladiolus crop. Among the interactions, sowing of corms on September 1st was found superior with respect to growth, flowering and higher spike yield under the open field condition.
Keywords: *Gladiolus, American Beauty, sowing of corms, vegetative parameters, floral parameters*

Received 01.04.2017 Revised 15.05.2017 Accepted 19.07.2017

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.) is a flower crop grown throughout the world. Gladiolus is native to South Africa, belongs to the family *Iridaceae* and sub family Ixoideae has its elegant flower spikes which have rich variation of colours and long vase life is commercially grown for its fascinating flowers which are used as the most preferred line flowers in floral arrangements worldwide. Gladiolus is cultivated in most of the tropical and subtropical countries of the world. Gladiolus is grown on all types of soils having good structure and drainage. It is a winter season crop but can be grown during rainy season in low rainfall areas with mild climate. Planting season is the most important feature in regulating growth of gladiolus [1-3]. Vegetative growth and quality of gladiolus is improved by adopting proper planting times. Identifying the seasons suitable for this crop in a region is most important to schedule date of planting which intern is most essential to supply spikes progressively to the market. It is an important cut-flower crop in domestic as well as international market. Its cut-spikes are in huge demand for bouquets and flower arrangements because of long length, and variety of colors and forms of florets. Besides, it is also grown in the beds for garden display and in pots for its magnificent inflorescence. Gladiolus, being a potential cut flower has great demand and is cultivated all over the world for its attractive spikes having florets of huge forms, dazzling colors, varying sizes and long vase life [4]. At present, cut flower production focus has moved from traditional growers, such as the Netherlands, Germany and France, to countries where the climate are better and production costs are low [5]. The main objective of this investigation was to study on the effect of dates of sowing on growth, flowering and spike yield of

gladiolus cultivar American beauty under different field conditions of sub-tropical climatic zone in Telangana state.

MATERIAL AND METHODS

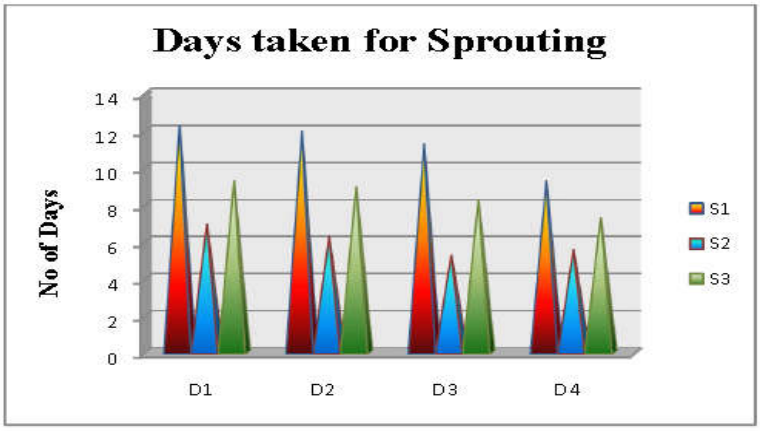
The trail was conducted during at Precession Farming Development Centre, Agricultural College Farm, ANGRAU, Rajendranagar, Hyderabad. The trail was laid out in Factorial Randomized Block Design (FRBD) with four treatments and three replications. The different treatments are T_1- August 15th planting, T_2- September 1st planting, T_3- September 15th planting, and T4- October 1st planting. According to the treatment schedule, gladiolus corms were sown during August, September and October months. Uniform cultural practices of irrigation, weeding and manuring were followed for all the treatments. Observations are recorded from five plants, were selected randomly from each plot for each treatment and replication for the purpose of recording the following observations. The following observations are recorded are Days taken for sprouting, Plant height, Number of leaves per plant, Number of spikes per plant, Number of spikes per plot, Length Spike, Spike emergency (days), Number of florets per spike, Weight of single spike (gm), Spike yield (spikes/ha) and Vase life (days).

RESULTS AND DISCUSSION

VEGETATIVE CHARACTERS

Days taken for sprouting of corms

The sprouting of corms is an important parameter in vegetative growth. A significant difference in number of days taken for sprouting of corms was observed due to variations in different conditions, dates of sowing and their interaction effects are shown in (Fig.1).The corms of American beauty in polyhouse (S1) recorded significantly more number of days to sprout (11.23 days), followed by shorter period for sprouting in shade net (S2) house (6.05 days) and it has taken of (8.48 days), in the open condition (S1). The results pertaining to dates of sowing also showed significant variations. Sowing on October 1st resulted in early sprouting of corms (7.4 days) and where as sowing on August 15th resulted late sprouting of corms (9.5 days). Statistically significant differences were observed between different conditions and dates of sowing. The earliest sprouting was recorded in shade net in all the dates of sowing while sowing the polyhouse recorded the late sprouting. In all the conditions, gradual increase in the number of days was observed for sprouting of corms with delay in sowing time in all the growing conditions. Earlier sprouting of the corms might be due to their intrinsic factor or corm storage temperature and duration [6]. According to Dalal *et al*. [7], early sprouting of the varieties might be due to permeability of water in the tissue of corms resulting in faster activation of meristematic tissue. The delay in sprouting might be due to non readiness of the freshly supplied corms to sprout [8]. The fluctuations in day (29°c) and night temperatures (12°c) might be the reason for delayed sprouting in late planting. The results are also in conformity with Sanjib sharma and Talukdar [9] who observed that delay in planting from 15th October to 15th December delayed the sprouting of corms. Sheikh and Jhon [10] also reported that with the delay in planting time from 1st March to 15th May, the days taken for sprouting declined under Jammu and Kashmir conditions, the possible reason they attributed to the fact that genotypes had an early exposure to congenial climatic conditions as compared to early planting during which temperature is low.



Growing condition:
S1- Polyhouse
S2- Shade net

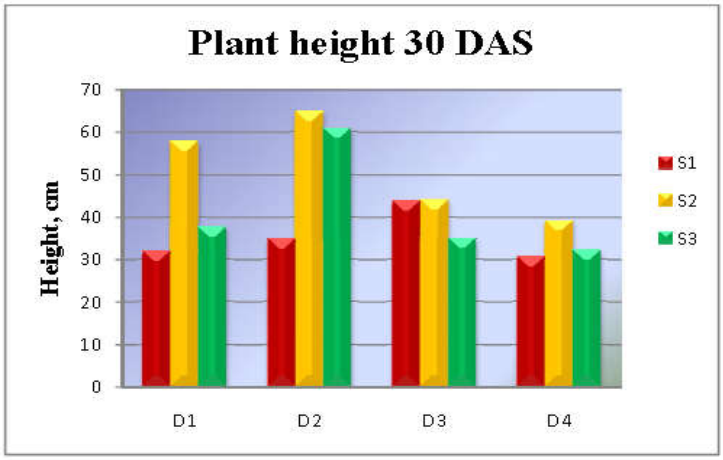
Date of Sowing:
D1- 15th August
D2- 1st September

S3- Open condition D3- 15th September
D4- 1st October

Fig. 1: Sprouting of corms of Gladiolus variety as influenced by dates of Sowing

Plant height (cm) at 30 DAS

Plant height was influenced significantly among different conditions, dates of sowing and their interactions are shown in (Fig.2).Among the growing conditions, shade net (S2) house recorded maximum plant height (51.43 cm) and polyhouse (S3) observed least plant height (35.25 cm). Highest plant height (53.5 cm) was noticed in September 1st Date of sowing and least plant height of (34.0 cm) in October 1st Date of sowing. Data on the interaction between different conditions and sowing dates revealed that in all the three conditions, September 1st recorded the maximum plant height in shade net and October 1st recorded least plant height in polyhouse.

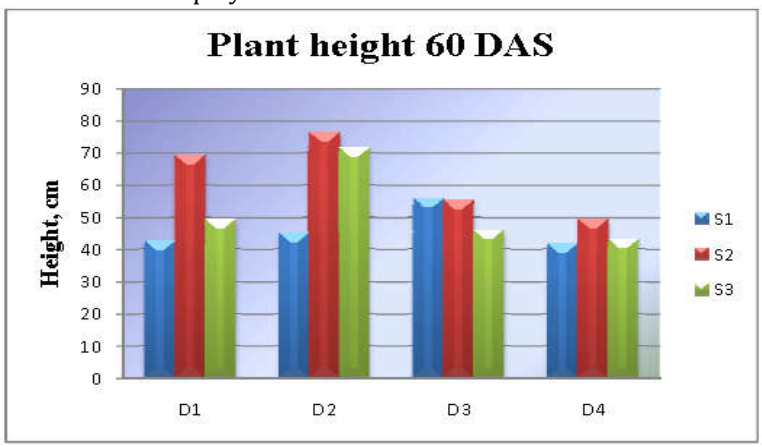


Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September
D4- 1st October

Fig. 2: Plant heights (cm) of gladiolus variety at 30 DAS as influenced by dates of sowing

Plant height (cm) at 60 DAS

Plant height was influenced significantly among different conditions, dates of sowing and their interactions is presented and depicted in (Fig. 3). Among the growing conditions, shade net house (S2) recorded maximum plant height (62.55 cm), least plant height (46.25 cm) was observed in the polyhouse (S1). The results on dates of sowing showed that, plant height at 60 days after sowing decreased with delay in sowing time. September 1st recorded highest plant height (64.24 cm) and October 1st recorded lowest plant height (44.8 cm). The interaction between different conditions and sowing dates revealed that in all the three conditions, September 1st recorded highest plant height in shade net and October 1st lowest plant height was recorded in polyhouse.



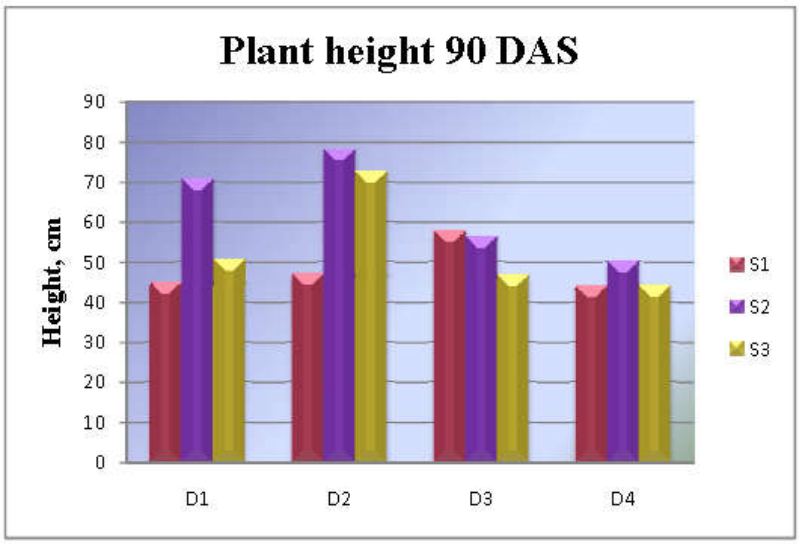
Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September

D4- 1st October

Fig. 3: Plant height (cm) of Gladiolus variety at 60 DAS as influenced by dates of sowing

Plant height (cm) at 90 DAS

Plant height was influenced significantly among different conditions, dates of sowing and their interactions as shown in (Fig.4). Among the growing conditions, Shade net house (S2) recorded maximum plant height (63.78 cm) and least plant height (48.33 cm) was observed in the polyhouse (S1). Data on dates of sowing showed that, plant height at 90 days after sowing decreased with delay in sowing time. September 1st recorded highest plant height (65.80 cm) and October 1st recorded lowest plant height (46.0 cm). Interaction between different conditions and sowing dates revealed that in all the three conditions, September 1st recorded maximum plant height in shade net and October 1st recorded minimum plant height in polyhouse. The increased plant height might be the result of increased synthesis of proteins and protoplasm by nitrogen which was recorded more at that time. Moreover, polyhouse took a longer time to sprout and gradually it was exposed to higher temperatures and there by the growth was less. Maximum plant height in September 1st and September 15th planting might be due to favourable temperature, atmospheric humidity and day length prevailing during that period results were obtained by Dod *et al*. [11], Saini *et al*. [12]and Dalal *et al*. [7]. It was also proved that under low light intensities, auxins synthesized were less subjected to photo oxidation and photo destruction leading to taller plants in early planting dates [13]. Kahlon and Bilga [14] and Dhankar and Ranvir Singh [15] noticed greatest plant height in October planting. The differential response of gladiolus to different dates of planting in different locations may be due to the climatic conditions prevailing in those regions. According to Bankar and Mukhopadhyay [16], plant growth was markedly effected by temperature and plants grown in warmer district made better growth compared to those grown at the same time in a district having low temperature.



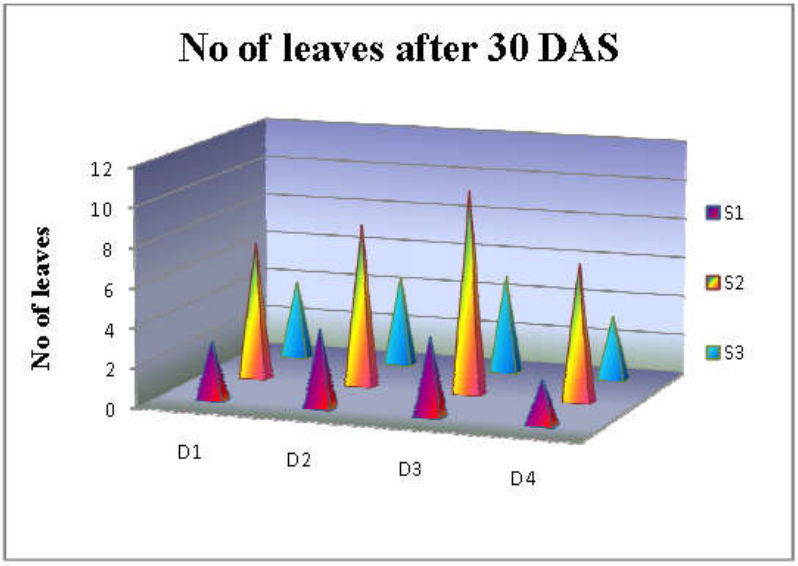
Growing condition:
S1- Polyhouse
S2- Shade net
S3- Open condition

Date of Sowing:
D1- 15th August
D2- 1st September
D3- 15th September
D4- 1st October

Fig. 4: Plant height (cm) of Gladiolus variety at 90 DAS as influenced by dates of sowing

Number of leaves per plant at 30 DAS

The data on number of leaves of Gladiolus was influenced by conditions, sowing dates and their interactions was presented and depicted in (Fig. 5). Among the growing conditions shade net (S2) produced maximum number of leaves (8.2), polyhouse (S1) was observed minimum number of leaves (3.3). The data pertaining to dates of sowing revealed that September 15th recorded more number of leaves in shade net (6.4), and October 1st produced less number of leaves (4.2). The data regarding the interaction revealed that, September 15th recorded more number of leaves per plant was produced in shade net house. October 1st recorded least number of leaves in polyhouse.

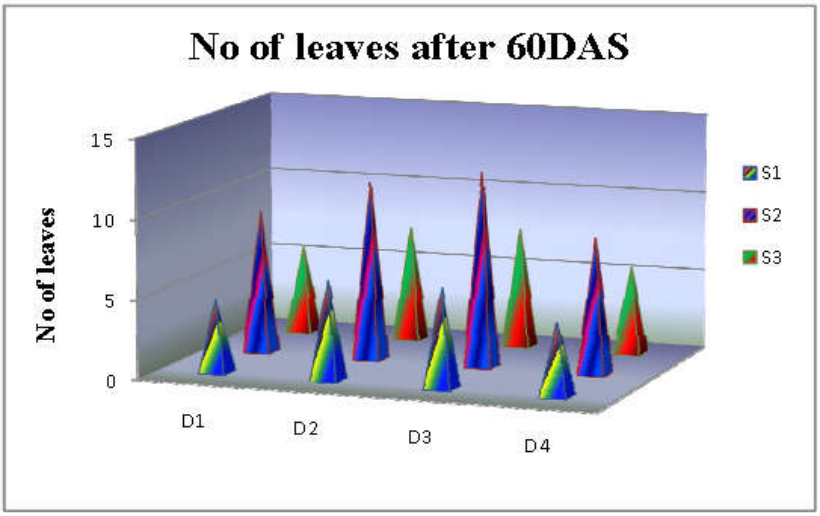


Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September
D4- 1st October

Fig. 5: Number of leaves of Gladiolus variety at 30 DAS as influenced by dates of sowing

Number of leaves per plant at 60 DAS

The data on number of leaves per plant as affected by different conditions, sowing dates and their interactions is shown in (Fig. 6). From the fig. 6 it was evident that shade net (S2) had resulted in more number of leaves (10.3), polyhouse (S1) was observed less number of leaves (5.5) Regarding the influence of dates of sowing on number of leaves, it was observed that sowing on September 15th recorded maximum number of leaves (8.7) and October 1st recorded less number of leaves (6.3). The data regarding the interaction effects revealed that, September 15th recorded highest number of leaves per plant was produced by shade net house and October 1st recorded least number of leaves in polyhouse.



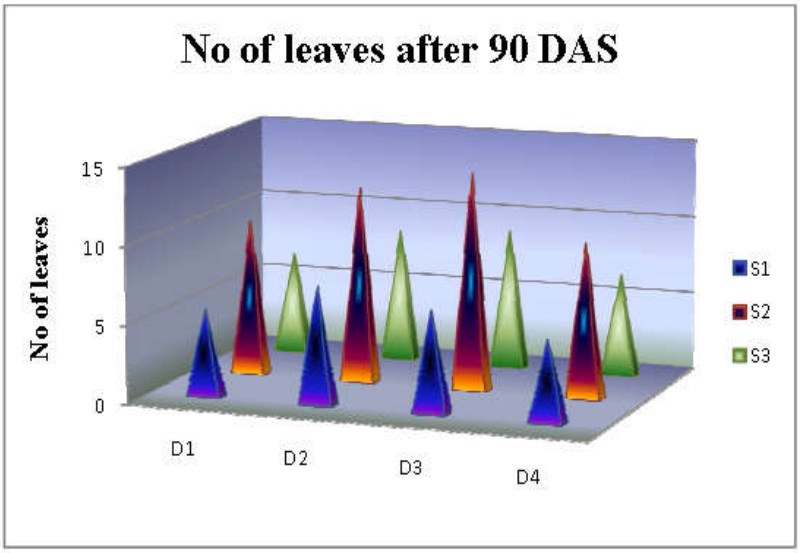
Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September
D4- 1st October

Fig. 6: Number of leaves of gladiolus variety at 60 DAS as influenced by dates of sowing

Number of leaves per plant at 90 DAS

The data on number of leaves per plant was showed significant differences among different conditions, dates of sowing and their interaction effects are shown in (Fig.7). The data pertaining to the number of

leaves produced by different conditions indicated that shade net (S2) produced significantly more number of leaves (11.7), less number of leaves were (6.3) observed in polyhouse (S1)**.** The data regarding dates of sowing reveals that September 15th recorded maximum number of leaves (9.9) and 1st October produced less number of leaves (7.3). The data regarding the interaction effects revealed that, September 15th recorded highest number of leaves per plant in shade net house and October 1st recorded least number of leaves in polyhouse. The number of leaves per plant influenced significantly by varieties and planting dates. The difference among the varieties is also attributed to the varietal variation. The difference among planting dates can be attributed to the fact that under short day conditions, high humidity and favorable temperatures the plants put forth maximum number of leaves [17]. Leaf area of the plant showed an increasing trend during the crop growth among the different conditions and planting dates. The maximum leaf area in 15th September planting may be due to the reason that in early plantings favourable temperatures might have promoted more uptake of nutrients in initial stages of plant growth there by leading to maximum leaf area and more photosynthetic area. According to Hematzadet *et al*. [18], the time of planting might have significant effect on leaf area. Early planting date was shown to promote the leaves in full growth with maximum leaf area.



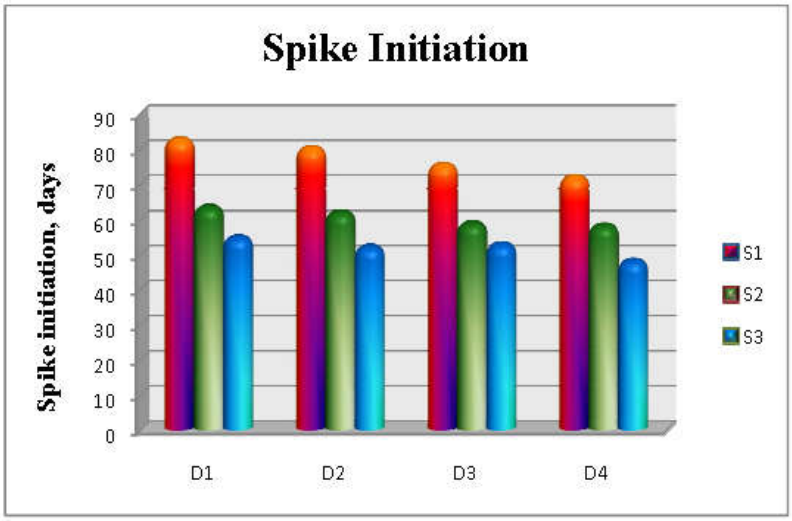
Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September
D4- 1st October

Fig. 7: Number of leaves of gladiolus variety at 90 DAS as influenced by dates of sowing

FLORAL CHARACTERS

Days taken for spike initiation

Days taken for spike initiation is significantly influenced by different field conditions, dates of sowing as well as their interaction affects are shown in (Fig.8). Among the growing conditions, Open condition (S3) has recorded earliest spike initiation with less number of days (52.1 days), polyhouse (S1) took more number of days for spike initiation (77.7 days). The data on sowing dates revealed that, less number of days taken for spike initiation on October 1st sowing (59.6 days). August 15th sowing took more number of days for spike initiation (67.2 days). Among the interaction between different conditions and sowing dates, days taken for spike initiation increased with delay in sowing. Comparatively October 1st recorded less number of days taken for spike initiation in open condition and August 15th sowing took more number of days for spike initiation with polyhouse. Difference in varietal response for flowering time and quality in different growing conditions was also observed by Passannavar *et al*. [19]. The plants in 15th December planting passed through long day lengths and so there was a delay in spike initiation. Also high temperatures delayed the transition to reproductive state and rates of floret initiation and differentiation [20].

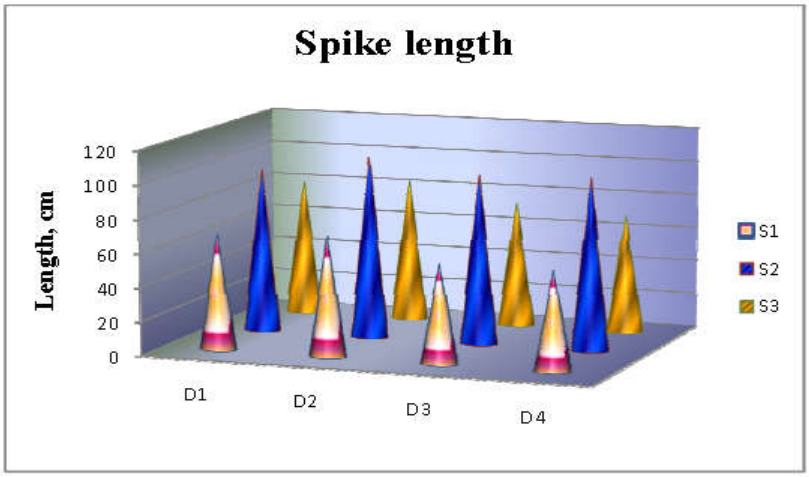


Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September
D4- 1st October

Fig. 8: Spike initiation of Gladiolus variety as influenced by dates of sowing

Spike length (cm)

Data regarding length of spikes had shown significant differences for different conditions, sowing dates and their interactions (Fig. 9). Among the different conditions significantly larger (101. 5 cm), spike length was produced by Shade net (S2) the lesser (63.6 cm) spike length was observed in polyhouse (S1). The dates of sowing showed that September 1st sowing produced more spike length (87.3 cm) and October 1st recorded least spike length (76.7 cm). Among the interaction between different conditions and sowing dates, spike length was increased with delay in sowing. Comparatively September 1st recorded highest spike length in shade net condition and October 1st sowing recorded lowest spike length with polyhouse. Among the different conditions, the variation in spike length might be due to the difference in their genetic makeup. The results are in agreement with the findings of Patil *et al*. [21], Arora and Khanna [22] and Passannavar *et al*. [19] who also observed significant differences due to varieties. The increased plant height in 15th September planting date gave a balanced plant with maximum capability of cell division and elongation, due to favorable environmental conditions and it has resulted in maximum spike length. Similar results were obtained by Hematzadet *et al*. [18].

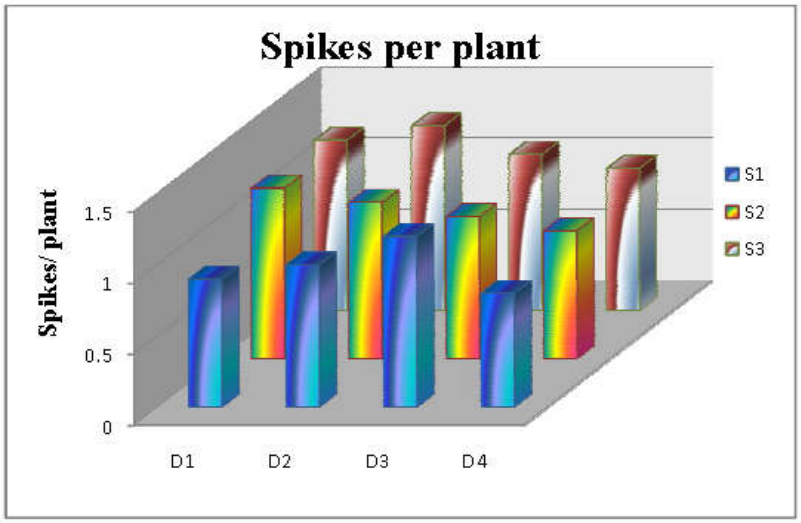


Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September
D4- 1st October

Fig. 9: Length of the spike (cm) of gladiolus variety as influenced by dates of sowing

Number of spikes per plant

The number of spikes per plant is significantly influenced by different conditions, sowing dates and their interactions as illustrated in (Fig.10). In the results pertaining to number of spikes/plant, it was observed that the open condition (S3) recorded more number of spikes (1.2) which was on par with (S2) shade net (1.1) as well as (S3) polyhouse (1.0). Among the different sowing dates, August 15th recorded (1.1), September 1st recorded (1.1) and September 15th recorded, October 1st recorded (1.1) which was at on par with each other. Significant differences were recorded either for sowing dates or the interactions between different conditions and sowing dates with regard to number of spikes per plant. Significantly there was no difference between interactions i.e., between different dates of sowing and three different conditions. The difference between numbers of spike per plant is due to the production of more than one shoot from the mother corm and there by resulting in extra spike. According to Nagaraju and Parthasarathy [23], production of more than one shoot from a corm is the varietal character and not influenced by the seasonal conditions.



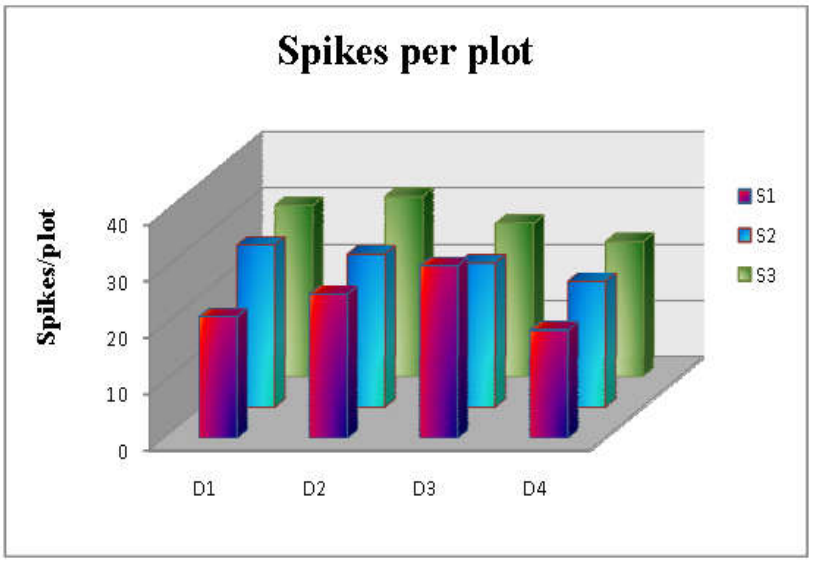
Growing condition:
S1- Polyhouse
S2- Shade net
S3- Open condition

Date of Sowing:
D1- 15th August
D2- 1st September
D3- 15th September
D4- 1st October

Fig. 10: Spikes per Plant of gladiolus variety as influenced by dates of sowing.

Number of spikes per plot

The data regarding number of spikes per plot as influenced by different conditions, sowing dates and their interactions is illustrated in (Fig.11). Regarding the effect of different conditions, number of spikes per plot was observed in the open condition recorded maximum number of spikes per plot (28.4), where as the shade net (26.0) and polyhouse (24.3) which was at on par with each other. Among the different sowing dates, September 1st recorded maximum number of spikes (28.3) followed by September 15th recorded (27.8) and then by August 15th recorded (26.9) which were on par with each other and October 1st recorded minimum number of spikes (21.9). Significant differences were recorded either for sowing dates and different conditions. Among the interaction between different conditions and sowing dates, number of spikes per plot increased with delay in sowing. Comparatively, September 1st recorded highest number of spikes per plot in open condition and October 1st sowing recorded lowest number of spikes per plot with polyhouse.



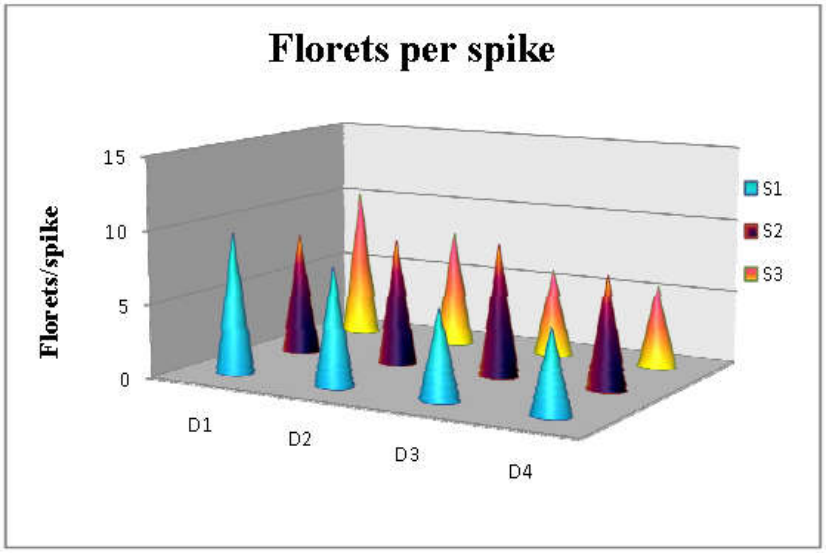
Growing condition:
S1- Polyhouse
S2- Shade net
S3- Open condition

Date of Sowing:
D1- 15th August
D2- 1st September
D3- 15th September
D4- 1st October

Fig.11: Spikes per plot of gladiolus variety as influenced by dates of sowing

Number of florets per spike

Data pertaining to number of florets per spike influenced by different conditions, dates of sowing and their interactions are shown in (Fig.12). Regarding the effect of different conditions, the number of florets produced per spike differed significantly. Shade net recorded number of florets per spike (8.4), which was on par with both polyhouse recorded (7.3) and open condition recorded (7.5). Among the sowing dates experimented sowing on, August 15th obtained maximum number of florets per spike (9.4) and sowing date of October 1st recorded less number of florets per spike (6.3). September 1st recorded (8.2) and September 15th recorded (7.0) which were on par with each other. With respect to the interaction between different conditions and sowing dates, August 15th produced more number of florets per spike in shade net and October 1st produced less number of florets per spikes. The production of more number of florets per spike is a genetical character and is also influenced to a large extent by the environmental factors particularly light [24]. Under optimum conditions of light and temperature prevailing during the growth of plants from 15th September and 15th October planting resulted in maximum number of florets per spike. The spike length and rachis length were the two major factors influencing number of florets per spike directly [25].

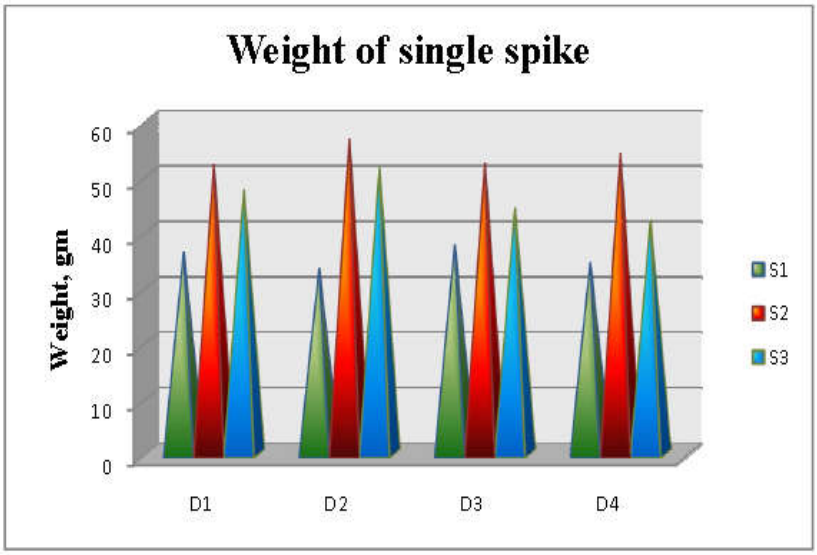


Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September
D4- 1st October

Fig. 12: Florets per spike of gladiolus variety as influenced by dates of sowing

Weight of single spike (gm)

Data pertaining to weight of single spike influenced by different conditions, dates of sowing and their interactions are shown in (Fig.13). Regarding the effect of different conditions, spike weight was observed in the shade net (S2) recorded (54.08 gm), open condition (S3) recorded (46.6 gm) and poly house recorded (35.6 gm) which was on par with each other. Among the different sowing dates, September 1st recorded higher spike weight (47.5 gm) and October 1st obtained less spike weight (51.84 gm). August 15th recorded (45.5 gm) and September 15th recorded (45.0 gm) which were on par with each other. With respect to the interaction between different conditions and sowing dates, September 1st recorded maximum spike weight in shade net and October 1st resulted less spike weight in polyhouse. It might be due to the reason that by the time the spike is produced the plants have already completed their growth and development and the photosynthesis that was produced in excess of their requirement. Also the nutrient uptake was more in the early planting dates which help in better translocation of food material there by resulting in more spike weight. In the late planting as the photosynthetic activity is less, hence the less translocation of food material, there by leading to less spike weight.

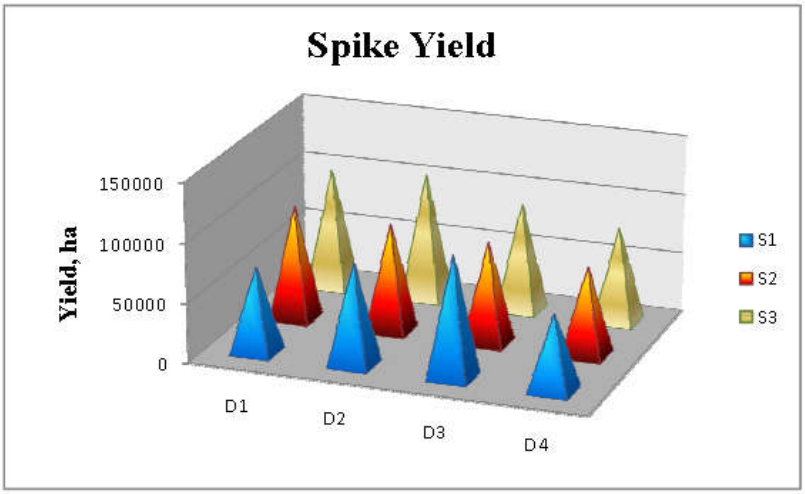


Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September
D4- 1st October

Fig. 13: Weight of single spike of gladiolus variety as influenced by dates of sowing

Spike yield (Spikes/ha)

Spike yield of gladiolus was influenced significantly by different conditions, sowing dates (Fig.14). Regarding the effect of different conditions, spikes yield was observed in the open condition (S3) which has yielded maximum number of spikes per hectare (94666.7 Spikes/ha), polyhouse (S1) recorded low number of spikes per hectare with (80888.8 Spikes/ha). Among the different sowing dates, September 1st recorded more number of spikes per hectare (94222.2 Spikes/ha) and October 1st recorded less number of spikes per hectare (72888.9 Spikes/ha). September 15th recorded (92740.6 Spikes/ha) and August 15th recorded (89777.8 Spikes/ha) which were on par with each other. With respect to the interaction between different conditions and sowing dates, September 1st recorded highest spike yield in open condition and October 1st recorded lowest spike yield in polyhouse.

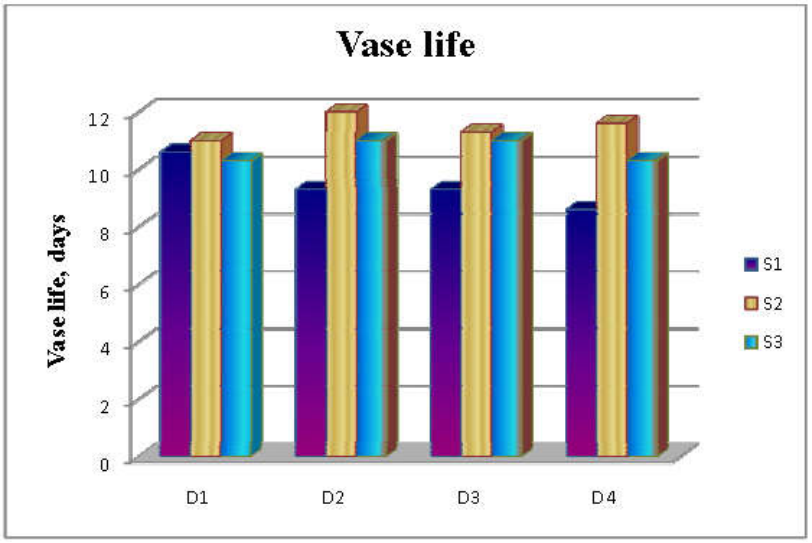


Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September
D4- 1st October

Fig. 14: Spike yield (Spikes/ha) of gladiolus variety as influenced by dates of sowing

Vase life (days)

Vase life of Gladiolus was influenced significantly by different conditions, sowing dates (Fig.15). With regard to varieties, Shade net (S2) and open condition (S3) imparted maximum vase life (11.5 days) and (10.7 days) which were on par with each other and where as polyhouse (S1) imparted a shorter vase life (9.5 days). The data on sowing dates showed that September 1st vase life recorded (10.8 days), August 1st vase life recorded (10.6 days), September 15th vase life recorded (10.5 days) and 1st October vase life recorded (10.5 days) vase life which was on par with each other, and there was no difference among all the dates of sowing**.** The interaction between different conditions, sowing dates showed that significantly highest vase life was recorded by shade net, followed by open condition. A tremendous heat along with longer day's periods caused a reduction in growth, quality and vase life of gladiolus considerably. Effect of planting dates on vase life was also reported by several authors [6, 10, 18]. Variations in vase life and other quality parameters among the varieties may be attributed to the differential accumulation of carbohydrates due to varied leaf production and sensitivity of varieties to ethylene. In turn, variations in these aspects might be due to genetical makeup of the plants [26].



Growing condition: **Date of Sowing:**
S1- Polyhouse D1- 15th August
S2- Shade net D2- 1st September
S3- Open condition D3- 15th September
D4- 1st October

Fig. 15: Vase life (days) of gladiolus variety as influenced by dates of sowing

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CITATION OF THIS ARTICLE

D. Kalyana Srinivas, B Vimala, T. Himabindu, G. Chandra Mouli · Study on the Effect of Dates of Sowing on Growth, Flowering and Spike Yield of Gladiolus Cultivar American Beauty under Different Field Conditions. Bull. Env. Pharmacol. Life Sci., Vol 6[10] September 2017: 17-28