Research Article

Analysis of Phenological Development, Production Potentials and Quality Characteristics of Gladiolus cv. Forta Rosa Under Different Environmental Condition

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Abstract

Production of gladiolus is limited by persisting harsh climate and a short growing season in the India. An experiment was conducted in a covered polyhouse (T_3) and net house (T_2) along with an open field as control (T_1) condition at Model Floriculture Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) in 2014-15 to compare the phenological development, production potentials and quality characteristics of gladiolus cv. Forta Rosa. Experiment was laid using randomized block design with eight replications with three treatments. The study indicated that the effect of temperature, humidity, carbon dioxide concentration under protected condition on the performance of plant characters in respect of economic yield. The various production parameters viz. height of plants at 30, 60 & 90 days i.e (55.66 cm, 69.67 cm and 110.02 cm) respectively, spike length (115.98 cm) & rachis length (96.02 cm), number of florets per spike(18.13), fresh weight of corm per plant (81.88 g),corm diameter (7.88 cm) respectively were observed highest under polyhouse condition. The above microclimatic variabilities inside polyhouse favored the growth and development of Forta compared to the crop raised in open field condition. whereas, parameters like days taken to spike heading (89.88 days), days to opening of basal floret (95.38 days),floret diameter (10.36 cm), days to full bloom (159.50days), number of corms per plant (1.75),number of cormels per plant (172.38),fresh weight of cormel per plant was recorded under shade net condition T_2 (16.49 g) recorded maximum in shade net condition.

Keywords: Gladiolus, *Gladiolus grandiflorus*, Height of the plant, spike length, rachis length, days to opening of 1st floret, number of florets per spike, vase life etc.

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Introduction

Gladiolus, an important bulbous cut flower crop is adored all over the world for its attractive colour and exquisite florets. Its cut spikes remain fresh at least for a week and are in great demand for presentation and interior decoration. Gladiolus is very rich in varietal wealth with varying range of colours, shades, number of florets and keeping quality. Gladiolus hybrids currently under cultivation seem to have developed genetically form 23 sps [1]. Bulbous plants are frequently used as ornamental plants [2]. In the cut flower industry, gladiolus occupies the fourth place in international cut-flower trade. It is known as queen of the bulbous plants, which is valued for its good-looking flower spikes [3, 4]. Conventional cultural practices and mere application of chemical fertilizers are not enough to fill up the gaps between production and demand. Therefore, a sustainable and low cost technology for gladiolus cultivation is urgent in India. Phenological development governs the plant growth and productivity [5]. Days to flowering, fruiting and maturity of crop are the important phenological events which determine the productivity of a crop. Temperature plays a major role in phenological development and productivity of crop plants. It is relatively easy to control water and nutrient supplies through irrigation and fertilization through the process of photosynthesis light energy is used to produce ATP and NADPH in the light reaction and subsequently, in the light-independent reaction, carbon is fixed into carbohydrates and oxygen is produced. Under the high irradiance, however, the photosynthetic apparatus absorbs excessive light energy, resulting in the inactivation or impairment of the chlorophyll containing reaction centers of the chloroplasts [6]. As a consequence, photosynthetic activity is depressed by photo-inhibition [7]. In contrast, under low irradiance, insufficient ATP is produced to allow carbon fixation and carbohydrate biosynthesis. This leads to reduced

plant growth. Light change not only affects plant morphology, physiology and microstructure but also has an important impact on production. This is mainly because plant growth requires an appropriate light intensity; excessively high or low intensity will prevent photosynthesis in the plant. Shade, not only influences the amount of light received by plants but also changes other small environmental conditions, such as air and ground temperature, humidity, carbon dioxide (CO_2) concentrations and so on, which are important for plant growth. It is dependent on ample light, suitable temperature and plenty of soil moisture. Though gladiolus is coming up well in all the seasons, the best quality spikes are produced in winter.The coloured shade cloths are manufactured in the following colours: blue, grey, pearl, red, white, and yellow. Shading with nets causes minimum interference with the microclimate for plant growth, unlike selective polyethylene films and fluid dyes, because of the free airflow through the shade-nets, while enabling modification of both the quantity and quality of the transmitted sunlight. The farmers are unable to grow gladiolus due to absence of suitable production technology as well as growing condition which will be suited for open as well as controlled environmental condition. Adequate research work to select suitable high tech methodologies like different environmental conditions viz. open field, shade net and polyhouse leads to availability of gladiolus year round. The present study is one of the pillars to strengthen the edifice of floriculture industry. Keeping above in view, the present study was carried out to investigate the Comparative performance of gladiolus cv. Forta Rosa under different environmental conditions on growth and flowering.

Materials and Methods

The present study entitled "Comparative performance of Gladiolus cv. Forta Rosa under different environmental conditions was carried during 2014-2015. The experiment was conducted at Model Floriculture Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand).Pantnagar is situated at 29^o N latitude, 79^o 3'E longitude in the tarai belt of Himalayas with an altitude of 243.8 meters above mean sea level. The experiment was laid out according to Randomized Complete Block Design (RCBD) with three replications. The land was brought to a fine tilth by ploughing. A spacing of 15 x 15 cm^2 between two replications was provided for laying out irrigation channels and working space. Corms were then planted along the sides of the ridges at a depth of 5 cm. There were twelve plots; three plots were randomly allocated to each cultivar. Well decomposed farm yard manure at the rate of 5 kg/sq.m was applied at the time of land preparation. Recommended dose of NPK (30:20:20 g/m²) was applied in the form of Urea, Single Super Phosphate and Muriate of Potash respectively. At the time of planting half the dose of N, full dose of P2O5 and K2O were applied. The experimental site was kept free of weed by periodic hand weeding. Protective irrigations were given as and when required, during crop growth period. The spikes were harvested at first floret loosening stage (opening stage) and used for recording different parameters. The corms and cormels were lifted from the ground when the foliage turned to yellow color. Data was collected on number of leaves per plant, leaf length (cm), leaf area (cm2), plant height (cm), spike length (cm), days taken to start blooming, number of florets per plant, floret size (cm) and vase life. The experiments were subjected to analysis of variance technique (ANOVA). Least Significant Difference test (LSD) at 5% probability level was used to compare the means [8].

Table 1 Treatment Combinations arrangement for the experiment

T_1R_1	T_2R_1	T_3R_1
T_1R_2	T_2R_2	T_3R_2
T_1R_3	T_2R_3	T_3R_3
T_1R_4	T_2R_4	T_3R_4
T_1R_5	T_2R_5	T_3R_5
T_1R_6	T_2R_6	T_3R_6
T_1R_7	T_2R_7	T_3R_7
T_1R_8	T_2R_8	T_3R_8
Symbols of treatments: T_1- Openfield, T_2-Shade net, T_3-Polyhouse		

Results and Discussion

Data on vegetative characters (**Table 2** and **Figure 1**) showed that three different growing conditions affected plant height and maximum plant height at 30,60 and 90 after planting was recorded under polyhouse condition T_3 (55.66

cm), (69.67 cm) and (110.02 cm) as compare to open field T_1 and shade net condition T_2 respectively. This might be due to a modification of climatic condition throughout the crop growth period coupled with better assimilation of nutrients. Morphological development like plant height, number of branches per plant, leaf area expansion rate and leaf area index were positively favoured due to the warmer environment inside the polyhouse in tomato in spite of lower amount of PAR [9-12]. These findings were also in conformity with Medany and co workers [13]. There is no any significant effect on the no. of leaves in three different growing conditions.

Table 2 Influence of different environmental conditions on vegetative characters of gladiolus cv. Forta Rosa

Treatment	Plant height at 30 days after planting (cm)	Plant height at 60 days after planting (cm)	Plant height at 90 days after planting (cm)	Number of leaves
T1 (Open field)	32.10	52.16	72.93	8.14
T2 (Shade net)	46.16	61.97	89.20	8.13
T3 (Polyhouse)	55.66	69.67	110.02	8.55
CV	1.37	1.27	0.48	6.68

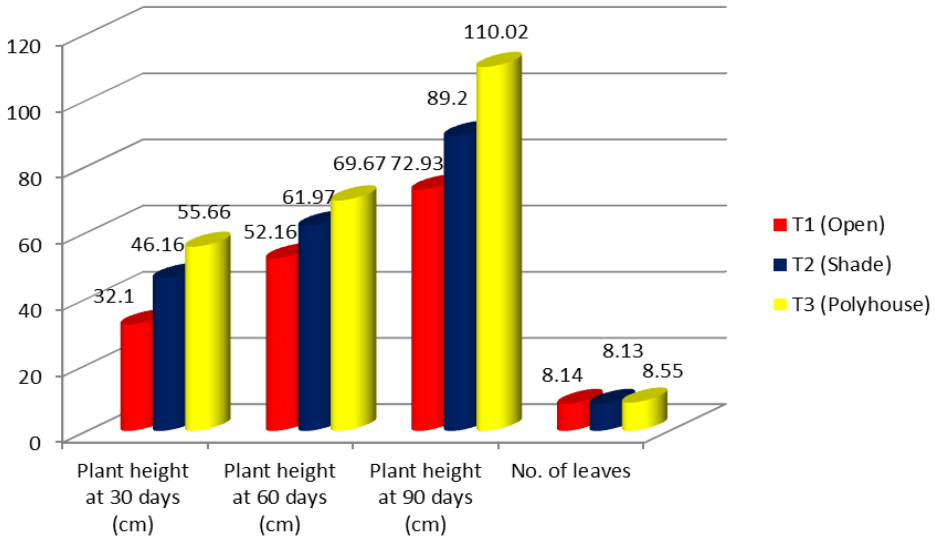

Figure 1 Influence of different environmental conditions on vegetative characters of gladiolus cv. Forta Rosa

Minimum days taken to spike heading was observed under shade net condition T_2 (89.88 days) which was significantly lower than open field T_1 (74.25 days) and polyhousecondition T_3 (65.50 days). This might be due to accumulation of photosynthates which triggered early initiation of flowers. Similar findings were reported by Rui and coworker in capsicum [14]. Polyhouse climate influenced the crops to open flower and mature of fruits earlier than open field due to the advancement of required heat unit or thermal time of the crops grown inside the polyhouse [15-17]. The early spiking of gladiolus was observed during high temperatures, which promoted quicker transition from the vegetative state to the reproductive state. A minimum days to opening of basal floret was observed under shade condition T_2 (95.38 days) which was significantly lower than open field conditions T_1 (86.38 days) and polyhouse T_3 (78.00 days). Similar findings were reported by Rui *and co worker* in capsicum [14]. Maximum spike length and rachis length observed under polyhouse condition T_3 (115.98 cm) and (96.02 cm) respectively which was found significantly higher than open field T_1 (95.94 cm) and shade net condition T_2 (80.82 cm). Germana *and* co worker attributed increased vegetative growth in citrus under shading to increased amount of far red as compared to red lights [18]. Mohanthy *and co worker* also reported the maximum stem length under protected environment than open field in rose [12]. Maximum days to full blloom was recorded under shade net condition T_2 (159.50 days) which was significantly higher than open field T_1 (138.25 days) and polyhouse condition T_3 (108.75 days). This might be attributed to better microclimate in terms of reduction in temperature, relative humidity, wind speed and light intensity as reported in sweet pepper [13].

As per observed data in **Table 3** and **Figure 2** showed that three different environmental conditions affected the no. of floret per spike significantly. Maximum number of florets per spike was recorded under polyhouse condition T_3 (18.13) which was significantly higher than shade net T_2 (15.38) and open field conditions T_1 (14.25). Bhatt and Rao

findings were also observed in Indra var. of capsicum recorded maximum no. of flowers and fruits [19]. This might be due to favourable climatic conditiond coupled with faster growth, higher number of secondary branches and sufficient accumulation of photosynthates inside the polyhouse as compared to shadow hall. As per data recorded in **Table 4** and **Figure 3** flower quality characters revealed that three different environmental conditions affected the floret size significantly. Maximum floret diameter was recorded under shade net condition T_2 (10.36 cm) which was found statistically at par with polyhouse condition T_3 (10.25 cm), while, it was found significantly higher than open field condition T_1 (9.66 cm). Floral quality characters such as floret size and number of petals per flower and total yield of flowers under polyhouse condition were found to be better as compared to other growing environments in rose and gerbera [12]. This might be due to improved light and temperature conditions and more number of leaves per plant as well as greater leaf area development would have resulted in production and accumulation of maximum photosynthates resulted in production of more number of flowers with bigger size. Three different growing conditions did not affected number of corms per plant and fresh weight of corm per plant significantly.

Table 3 Influence of different environmental conditions on floral characters of gladiolus cv. Forta Rosa

Treatment	Days taken to spike heading	Days to Opening of basal floret	Spike length (cm)	Rachis length (cm)	Days to full bloom (days)
T1(Open field)	74.25	86.38	95.94	76.30	138.25
T2 (Shade net)	89.88	95.38	80.82	60.54	159.50
T3 (Polyhouse)	65.50	78.00	115.98	96.02	108.75
CV	5.37	3.07	0.52	2.96	3.90
CD@0.05	4.41**	2.85 **	0.54**	2.47**	5.66**

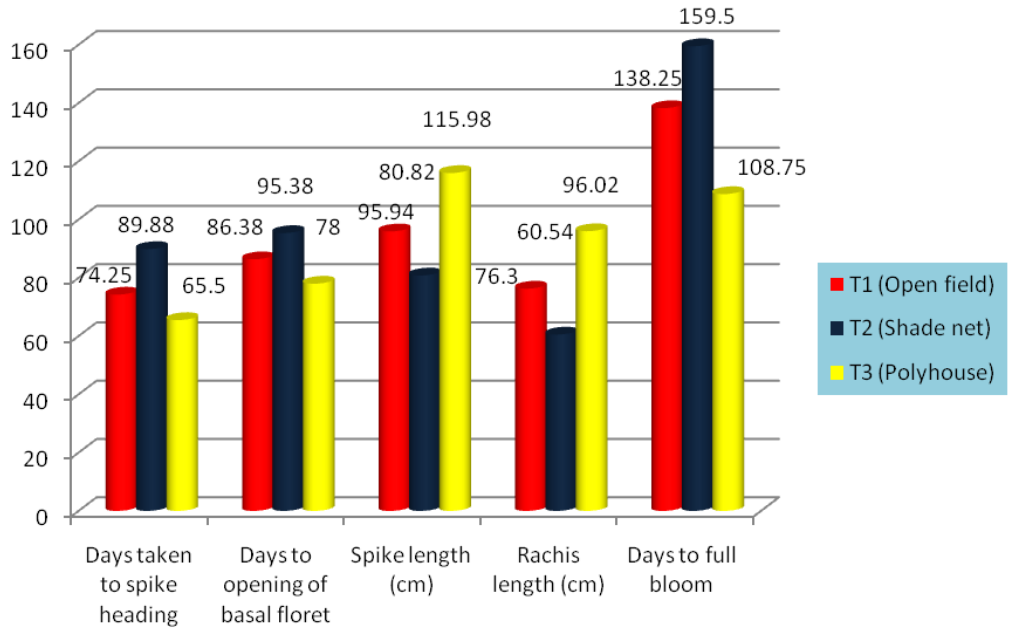

Figure 2 Influence of different environmental conditions on Floral characters of gladiolus cv. Forta Rosa

Table 4 Influence of different environmental conditions on yield and quality characters of gladiolus cv. Forta Rosa

Treatment	Number of floret per Spike	Floret diameter(cm)	Number of corms per plant	Fresh weight of corm per plant (g)
T1 (Open field)	14.25	9.66	1.500	79.63
T2 (Shade net)	15.38	10.36	1.75	78.13
T3 (Polyhouse)	18.13	10.25	1.38	81.88
CV	7.59	3.73	45.03	6.36
CD@0.05	1.29**	0.40**	0.74	5.45

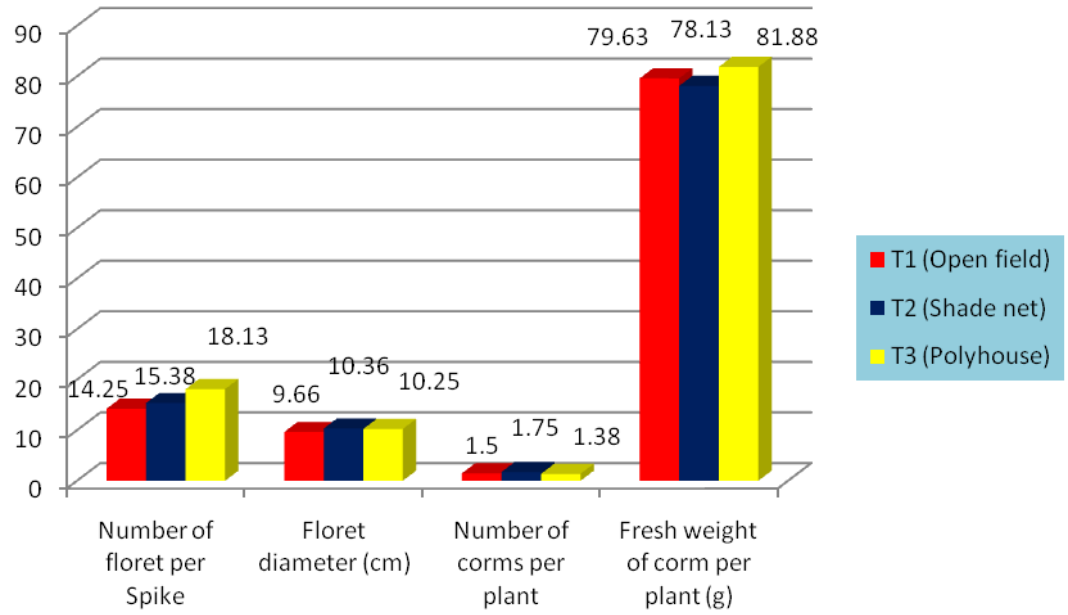

Figure 3 Influence of different environmental conditions on Yield and quality characters of gladiolus cv. Forta Rosa

Data presented in **Table 5** and **Figure 4** revealed that three different growing conditions affected corm diameter significantly. Maximum corm diameter was recorded under polyhouse condition T_3 (7.88 cm) which was found statistically at par with open field T_1 (7.16 cm), while, it was found significantly lower in shade net condition T_2 (6.07 cm) while maximum number of cormels per plant was recorded under shade net condition T_2 (172.38) which was found significantly higher than open field T_1 (156.13) and polyhouse condition T_3 (167.50). However, minimum corm diameter was recorded in shade net condition..Maximum fresh weight of cormel per plant was recorded under shade net condition T_2 (16.49 g) while minimum fresh weight of cormel per plant was found in open field T_1 (15.45 g) which was found statistically at par with polyhouse condition T_3 (15.92 g) (Table 5 and Figure 4). Islam and co worker also reported more number of cormels per plant and fresh weight of cormel per plant in protected condition under polytunnel as compared to open field condition in gladiolus [20].

Table 5 Influence of different environmental conditions on Corm characters of gladiolus cv. Forta Rosa

Treatment	Corm diameter (cm)	Number of cormels per plant	Fresh weight of cormel per plant (g)
T1 (Open field)	7.16	156.13	15.45
T2(Shade net)	6.07	172.38	16.49
T3(Poly house)	7.88	167.50	15.92
CV	13.82	0.44	2.73
CD@0.05	1.04**	0.78**	0.47**

Table 6(a) Influence of different environmental conditions affected fresh weight of spike of gladiolus cv. Forta Rosa.

Treatment	F.w. of spike at 1st day of V.T. (gm)	F.w. of spike after 1 week of V.T. (gm)	F.w. of spike after 2 week of harvesting in V.T. (gm)	3rd Floret size after V.T. (cm)	Spike length at 1st day of V.T. (cm)
T1(Open)	75.03	74.86	75.25	9.85	54.85
T2(Shade)	63.76	65.74	273.94	10.01	48.44
T3(Poly house)	62.44	66.25	513.48	9.78	52.29
CV	11.19	10.63	218.09	7.07	8.22
CD@0.05	8.05*	7.86*	672.48	0.75	4.57*

Table 6(b) Influence of different environmental conditions affected fresh weight of spike of gladiolus cv. Forta Rosa.

Treatment	Spike length at 4th day of V.T. (cm)	Spike length at 8th day of V.T. (cm)	Vase life (days)
T1 (Open)	54.24	54.99	5.88
T2 (Shade)	59.05	59.98	5.25
T3 (Polyhouse)	62.15	62.76	7.38
CV	9.28	9.44	11.40
CD@0.05	5.81*	5.99*	0.75**

Data presented in **Table 6(a)** and **Figure 5(a)** revealed that three different growing conditions affected fresh weight of spike at 1st day of vase treatment significantly. Maximum fresh weight of spike at 1st, 4th and 8th day of vase treatment was recorded under open field condition T_1 however, it was minimum recorded in polyhouse condition. Kohl and co worker also reported increased fresh weight of chrysanthemum flower at 17˚C (low temperature) i.e. in open field condition as compared to 21˚C (high temperature) i.e. in polyhouse condition [21]. Maximum 3rd floret size after vase treatment was recorded under shade net condition T_2 (10.01cm) as compare to open field T_1 (9.85cm) and polyhouse condition T_3 (9.78cm). However, minimum 3rd floret size after vase treatment was found in polyhouse condition.This might be attributed to better microclimate in terms of reduction in temperature, relative humidity, wind speed and light intensity under shade net as reported by Medany and co worker in sweet pepper [13]. Data presented in Table 6(b) and Figure 5(b) revealed that three different growing conditions significantly affected spike length at 4th day of vase treatment. Maximum spike length at 4th day of vase treatment was recorded under polyhouse condition T_3 (104.06 cm) which was significantly higher than open field T_1 (86.00cm) and shade net condition T_2 (69.07cm). However, minimum spike length at 4th day of vase treatment was recorded in shade net condition. The increase in spike length at 4th day of vase treatment is due to opening of florets and gradual uptake of water during this period. Increase in spike length has earlier been reported by Singh in gladiolus cv. Melody. Maximum spike length at 8th day of vase treatment was recorded under polyhouse condition, T_3 (102.90 cm) which was significantly higher than open field, T_1 (85.15 cm) and shade net condition, T_2 (68.04 cm). This finding was in conformation with Kumar and coworker [22]. Maximum vase life (Table 6(b) and Figure 5(b) was recorded under polyhouse condition T_3 (7.50 days) which was significantly higher than open field T_1 (6.00 days) and shade net condition T_2 (5.63 days). The vase life of gerbera was found to be significantly higher in the plants grown under naturally ventilated polyhouse [22]. It is difficult to get good quality cut flowers of gerbera under open field conditions. To meet the qualitative and quantitative standards, hybrid cultivars have to be grown under protected conditions because it meant for protection of crops from unfavourable environmental conditions, thereby extending the growing season, quality and vase life.

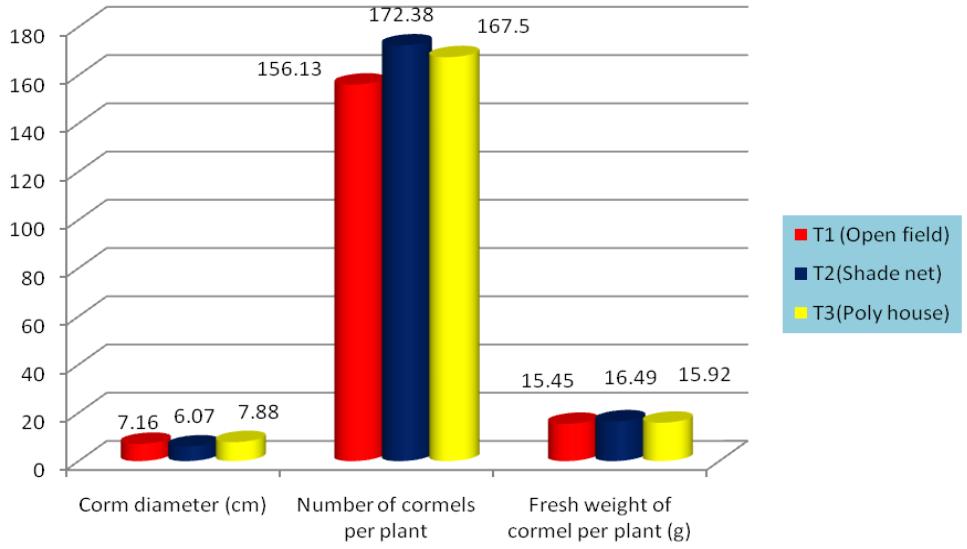

Figure 4 Influence of different environmental conditions on Corm characters of gladiolus cv. Forta Rosa.

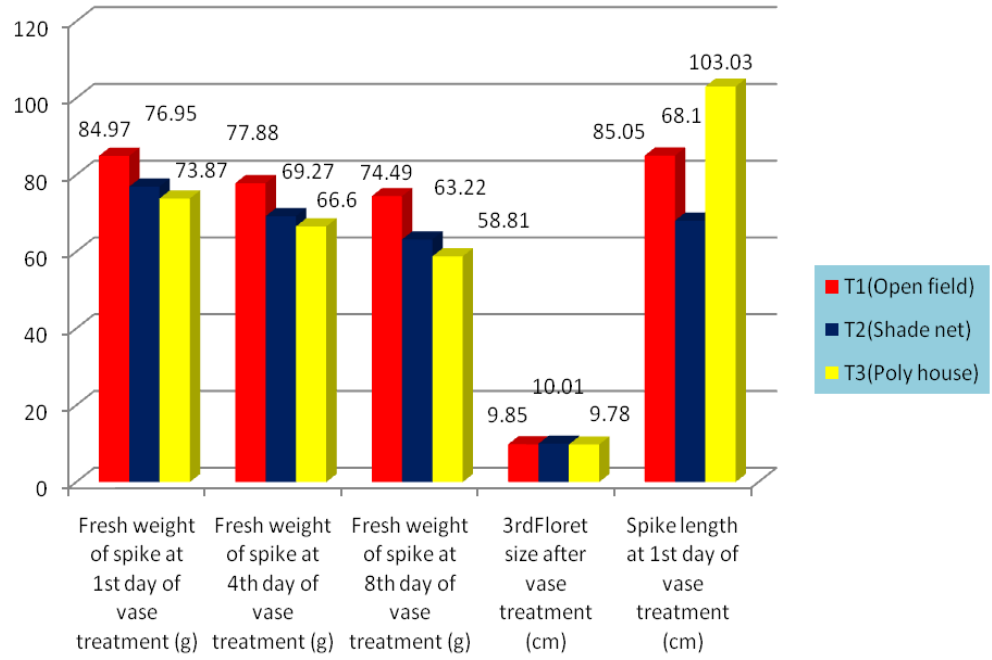

Figure 5(a) Influence of different environmental conditions on Vase life characters of gladiolus cv. Forta Rosa

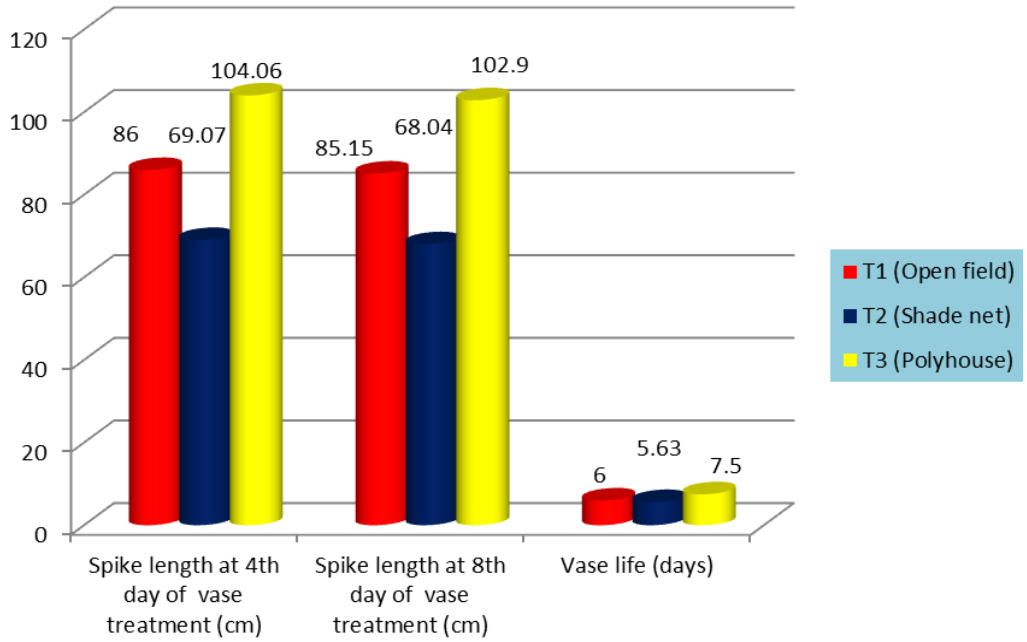

Figure 5(b) Influence of different environmental conditions on Vase life characters of gladiolus cv. Forta Rosa

Conclusion

The study indicated that the congenial conditions like temperature, humidity, carbon dioxide concentration under protected condition gave the best performance in respect to phenological development, production potentials and quality characteristics of gladiolus cultivar Forta Rosa. Vegetative traits like Plant height at 30, 60 and 90 days after planting and Number of leaves are of prime importance for plant establishment were luxurious under protected cultivation (poly house) in comparison of open condition. This might be due to favourable climatic conditiond coupled with faster growth, higher number of secondary branches and sufficient accumulation of photosynthates

inside the polyhouse as compared to shadow hall. While traits associated with quality which decides the economy of production in gladiolus viz. Spike length, Rachis length, Number of floret per Spike and Floret diameter showed better result under net house condition. This might be due to improved light and temperature conditions and more number of leaves per plant as well as greater leaf area development would have resulted in production and accumulation of maximum photosynthates resulted in production of more number of flowers with bigger size. Therefore identifying the congenial micro climate for gladiolus cultivation of indeed importance for growers to get the higher economic returns through quality cut flower production.

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