The Pharma Innovation Journal 2023; 12(8): 2363-2368

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(8): 2363-2368

www.thepharmajournal.com
Received: 13-05-2023
Accepted: 17-06-2023

Pooja Fartiyal
PG Scholar, Floriculture and Landscaping, Department of Horticulture, G.B. Pant University of Agriculture & Technology Pantnagar, Uttarakhand, India

BD Bhuj
Professor (Floriculture and Landscaping), G.B. Pant University of Agriculture & Technology Pantnagar, Uttarakhand, India

Ranjan Srivastava
Professor Horticulture
G.B. Pant University of Agriculture & Technology Pantnagar, Uttarakhand, India

Ajay Kumar
Assistant Professor, Department of Agronomy, G.B. Pant University of Agriculture & Technology Pantnagar, Uttarakhand, India

NK Singh
Professor, Department of Genetics and Plant Breeding, G.B. Pant University of Agriculture & Technology Pantnagar, Uttarakhand, India

Ajit Kumar
Professor Floriculture (Horticulture), G.B. Pant University of Science and Technology Agriculture & Technology Pantnagar, Uttarakhand, India

Ranjeet Singh
SMS Horticulture, KVK, Bareilly, Uttar Pradesh, India

Corresponding Author:
BD Bhuj
Professor, Department of Floriculture and Landscaping, G.B. Pant University of Agriculture & Technology Pantnagar, Uttarakhand, India

Effect of silica oxide concentrations on vegetative growth and flowering attributes of gladiolus cv. rose supreme under Tarai conditions of Uttrakhand

Pooja Fartiyal, BD Bhuj, Ranjan Srivastava, Ajay Kumar, NK Singh, Ajit Kumar and Ranjeet Singh

Abstract
Gladiolus (*Gladiolus grandiflora* L.), "Queen of bulbous flowers" is also known as "sword lily" because of sword like leaves, the term coined by "Pliny the Elder". It is a bulbous ornamental flowering plant native to South Africa. Gladiolus belongs to monocot family Iridaceae. The present experiment study described here was conducted at Model Floriculture Centre, GBPUA&T, Pantnagar, Uttarakhand, during 2020-21 to study the Effect of Silica Oxide Concentrations on Vegetative Growth and Flowering Attributes of Gladiolus cv. Rose supreme under Tarai Conditions of Uttrakhand. Experiment was laid out in factorial concept of randomized block design (RBD) in open field condition. The experiment consisted of medium sized (4-4.5 cm) corms of gladiolus variety viz. "Rose Supreme". Which were applied with different treatments of silica oxide as pre-planting soil application and foliar application at 30 and 60 days after planting in standing crop in different plot. The pre-planting soil application of SiO_2 *viz.* S_1 is control (0.0 kg/ha), S_2 (25 kg/ha), S_3 (50 kg/ha), S_4 (75 kg/ha) and S_5 (100 kg/ha) and for foliar application suspension was made of the same in water at 0% is control (Water spray), F_2 1% (4.7 g/m^2), F_3 2% (9.4 g/m^2) and F_4 3% (14.1 g/m^2) of silica oxide and applied at 30 and 60 days after planting. With silicon treatment, the relevant growth attributes, including the plant height and spike lengths, Rachis length and flower diameters as well as the number of floret were all remarkably increased. Taken silicon application together, as soil and foliar application was able to effectively enhance the quality of gladiolus flowers.

Keywords: Gladiolus, rose supreme, silica oxide, soil application, foliar application

Introduction

The scope of flower crop cultivation in Uttarakhand is expanding due to good climatic conditions and open cultivation of precious flowers, which lessens cultivation costs. Uttarakhand has 1635.05 ha area with production 1914.13 lakh of cut flowers and 3055.67 MT of loose flowers. Gladiolus in Uttarakhand is grown in an area of 321.42 ha with production of 649.89 lakh spikes (Anonymous, 2019-20) [4]. Gladiolus (*Gladiolus grandiflora* L.), "Queen of bulbous flowers" is also known as "sword lily" because of sword like leaves coined by "Pliny the Elder". It is a bulbous ornamental flowering plant native to South Africa. Gladiolus belongs to monocot family Iridaceae possessing approximately 260 species in genus Gladiolus (Singh, 2006) [12]. Gladiolus is one of the few flowering plants that produce pleasing cut flowers with flowering spikes and florets in a wide range of colors, including white, red, pink, purple, orange, yellow, salmon, bicolor and multicolor (Basoli *et al*., 2014) [5]. Gladiolus has a long vase life as well. It's grown for long, beautiful spikes with flowers of varied shapes and sizes in different colors (except true blue) (Shaukat *et al*., 2013) [11].

Silicon (Si) is a functional nutrient but not yet classed as an essential nutrient. Silicon accumulators (with a Si/Ca ratio >1) account for seven of the top ten most produced crops in the world (ordered by quantity). As a result, it's critical to comprehend involvement of silicon in crop production. The function of silicon in plants is still a subject of investigation (Raven, 2003) [9]. It improves agricultural yield as well as crop quality. It has a large capacity for holding water. Silicon has been shown to suppress insect pests such stem borers, brown plant hoppers, green leaf hoppers and white backed plant hoppers, as well as non-insect pests like spider mites (Savant *et al*., 1997 and Ma and Takahashi, 2002) [10, 8].

Materials and Methods

Plant Materials and Growth Conditions

The gladiolus corms of uniform size (4-4.5 cm diameter) were treated with 0.2% Bavistine solution for 30 minutes. After the treatment, corms were planted under open field conditions. The planting material was evaluated in factorial randomized block design (RBD) with two factorial concepts after application of silica dioxide as soil and foliar application. Each treatment combinations, with having three replications in which 300 corms accommodated in each replication. Planting the corns was done with the spacing of 30 cm row to row and 20 cm plant to plant distance.

Details of treatments

The planting material was evaluated in factorial randomized block design (RBD) with two factorial concepts after application of silica oxide as soil and foliar application. Each treatment combinations, with three replications in which 300 corms accommodated in each replication. Planting the corms was done with the spacing of 30 cm row to row and 20 cm plant to plant distance. The required observations were recorded on the 3 plants (2^{nd} to 4^{th} plant of middle row) in each treatment. Soil application of silica oxide in (5) treatment, Foliar application of silica oxide in (4) treatment. Total number of treatment combination (20), number of replication (3). Spacing used 30 cm X 20 cm, length of each plot 100 cm, width of each plot 90 cm and plot size (100X90 cm). Number of corms per treatment 15, total number of corms required 900. Field was periodically inspected and weeding was done, manually. Adequate irrigation was done periodically. Earthing up of the growing plants was done at the time of spike initiation stage in order to support the plants from winds. The spray of contact fungicide (Copper Oxychlodride @ 0.2 %) was done to prevent any disease to plants, as and when required.

Results and Discussion

The synergistic effect of silicon which enhances growth and development of plants and to minimizing various stresses including nutrient imbalance could be the reason for increased number of leaves in plants. Silicon also improved the external & internal characteristics of leaves which enhance tolerance to salinity and low temperature, protects cells against metal toxicity and also check oxidative phenolic browning. The findings of this experiment are in the agreement of Sivanesan and Park (2014) [13] in chrysanthemum, Khenizy and Ibrahim (2015) [7] in gladiolus. Silicon helps in the availability of macro and micro- nutrients necessary for best growth and high quality of plants. The increase in plant height might be because of the role of silicon in elongating and strengthening plant root thus resulted in increasing the ability to take up higher amount of nutrients from the soil solution. These findings are in accordance with the finding of Gayed (2019) [1] in zinnia, Khenizy *et al*. (2015) [7] in gladiolus, Ghait *et al.* (2007) [6] in straw flower and Whitted - Haag *et al.* (2014) [14] in annual bedding plants. Earliness in days to spike emergence and flowering was caused due to beneficial effects of silicon on promoting cell division increasing flower primordial differentiation within the flower bud. These results are in conformity with the findings of Ahmad *et al.* (2013) [2] and Khenizy and Ibrahim (2015) [7] in gladiolus and the increase in spike length attributed by silicon increases the amount of phenylalanine ammonia-lyase enzyme which involved in the production cycle of cellulose, lignin and increasing sclerenchyma tissue in spike, resulting in spike reinforcement and lignifications. The above findings are in confirmative with the findings of Alikhani *et al.* (2021) [3].

Effect of silica dioxide on vegetative characters: The growth attributes of gladiolus plant, including the plant height, shoot length, stem diameter, leaf length, leaf width, and bud diameter, were significantly affected by Si application. As shown in Table 1. The tallest plant height (131.15 cm) at first floret show color was found in S_4 (8.8 g soil application of silica oxide in per square meter area) whereas it was shortest (125.02 cm) in S_5 (11.8 g application of silica dioxide in soil). As shown in Fig. 1. Among the interaction 8.8 g soil application and 3% foliar application of silica dioxide (S_4F_4) had highest plant height (139.44 cm) while it was lowest in 2.9 g soil application and 0% foliar application of silica dioxide/ m^2 S_2F_1 (111.11 cm). The plant height is significantly increased by 3.06% with respect to control in soil application and 8.44% in foliar application while the interaction of soil and foliar doses with respect to control is increased by 11.55% with respect to control. The maximum numbers of leaves at first floret show color was observed in S_4 {(7.93) 8.8 g soil treatment} while it was minimum (7.39) in S_1 (0 g application of silicon dioxide). As shown in Fig. 2. Among the interaction highest number of leaves recorded in 8.8 g soil application and 3% foliar application {S_4F_4 (8.32)} whereas it was minimum (6.44) in S_1F_1 (0 g soil + 0% foliar application). The number of leaves is significantly increased by 7.31% with respect to control in soil application and in foliar application by 6.37% while the interaction of soil and foliar application is increased by 29.19% with respect to control.

Effect of silica dioxide on flowering: The days to spike emergence was found lowest (96.78 days) in S_4 i.e. 8.8 g soil application of silica dioxide while maximum in 0% soil treatment i.e. control {S_1 (99.69 days)}. From the Fig. 3. Among the interactions lowest days to spike initiation (91.57 days) found in 8.8 g soil application and 3% foliar application (S_4F_4) whereas, maximum (102.00 days) was observed in S_1F_2 i.e. 0 g soil application and 1% foliar application. The number of days to spike emergence is significantly decreased by 2.91 days with respect to control in soil application and by 3.22days in foliar application while interaction of soil and foliar application is decreased by 6.87days with respect to control. The earlier flowering (103.09 days) was recorded in treatment S_4 (8.8 g soil application of silica oxide) while flowering delayed in S_1 that is 0 g soil treatment of silica dioxide i.e. control (104.19 days). From the Fig.4. Interaction of 8.8 g soil treatment with 3% foliar treatment showed earlier flowering S_4F_4 (100.82 days) while the 0 g soil application and 2% foliar application of silica dioxide takes maximum (105.33 days) for flowering i.e. S_1F_3. Days to flowering is significantly decreased by 1.01days with respect to control in soil application and 1.23days in foliar application while there interaction with respect to control is decreased by 2.29days. The longest spike length (72.00 cm) was found in S_4 (8.8 g soil application in per square meter) whereas it was minimum in 2.9 g soil application {S_2 (67.58 cm)} respectively. As shown in Fig. 5. Interaction of 8.8 g soil + 3% foliar application of silica dioxide exhibited longest spike i.e. S_4F_4 (78.11 cm) whereas, minimum was found in S_2F_1 (62.55 cm) i.e. 2.9 g soil + 0% foliar application. The spike length is significantly increased by 0.60% with respect to control in soil application and 4.76% in foliar application while there interaction with respect to control is increased by 8.23%. The maximum rachis length was recorded in S_3 (55.43 cm) 5.9 g soil treatment of silica dioxide. Minimum rachis length 50.14 cm was found in S_2 i.e. 2.9 g soil application. Fig.6 depicts among interaction 8.8 g soil and 3% foliar application exhibited maximum rachis length (63.00 cm) was recorded in S_4F_4, whereas it was smallest (44.67 cm) in S_5F_1. The rachis length is significantly increased by 3.01% with respect to control in soil application and in foliar application by 8.79% while the interaction of soil and foliar application is increased by 19.12% with respect to control. The maximum numbers (16.97) of florets was observed in S_4 (8.8 g soil application in per square meter of silica dioxide) and it was minimum in 2.9 g soil application of silica dioxide {S_2 (16.17)}. The maximum number of florets is significantly increased by 1.80% with respect to control in soil application and in foliar application by 7.23%. Fig. 7 depicts the interactions, soil application of 8.8 g silica dioxide and 3% foliar application of silica dioxide produces maximum number of florets per spike in S_4F_4 (18.22) whereas it was minimum (14.78) in {S_1F_1 (0 g soil + 0% foliar application in per m^2 area)}.While the interaction of soil and foliar application is increased by 22.27% with respect to control.

Table 1: Effect of different silica oxide doses on vegetative growth and flowering attributes of Gladiolus

Main factor Soil	Plant height (cm) at first floret show color	No. of leaves	Days to spike emergence	Days to flowering	Spike length (cm)	Rachis length (cm)	No. of spike per plant
S1	127.25	7.39	99.69	104.19	71.57	53.81	16.67
S2	126.17	7.74	97.92	104.03	67.58	50.14	16.17
S3	127.83	7.41	98.94	103.25	71.85	55.43	16.56
S4	131.15	7.93	96.78	103.09	72.00	55.22	16.97
S5	125.02	7.77	98.39	103.96	69.94	50.81	16.58
C.D at 5%	2.78	0.06	1.39	N/A	1.25	1.17	0.35
SEm±	0.97	0.02	0.49	0.39	0.44	0.41	0.12
F1	121.07	7.38	99.56	103.76	68.74	50.73	16.04
F2	126.51	7.66	99.24	104.17	69.97	51.93	16.40
F3	131.07	7.71	98.24	104.36	71.65	54.47	16.71
F4	131.29	7.85	96.34	102.53	72.01	55.19	17.20
C.D at 5%	2.49	0.05	1.25	0.99	1.12	1.05	0.32
SEm±	0.87	0.02	0.43	0.35	0.39	0.36	0.11

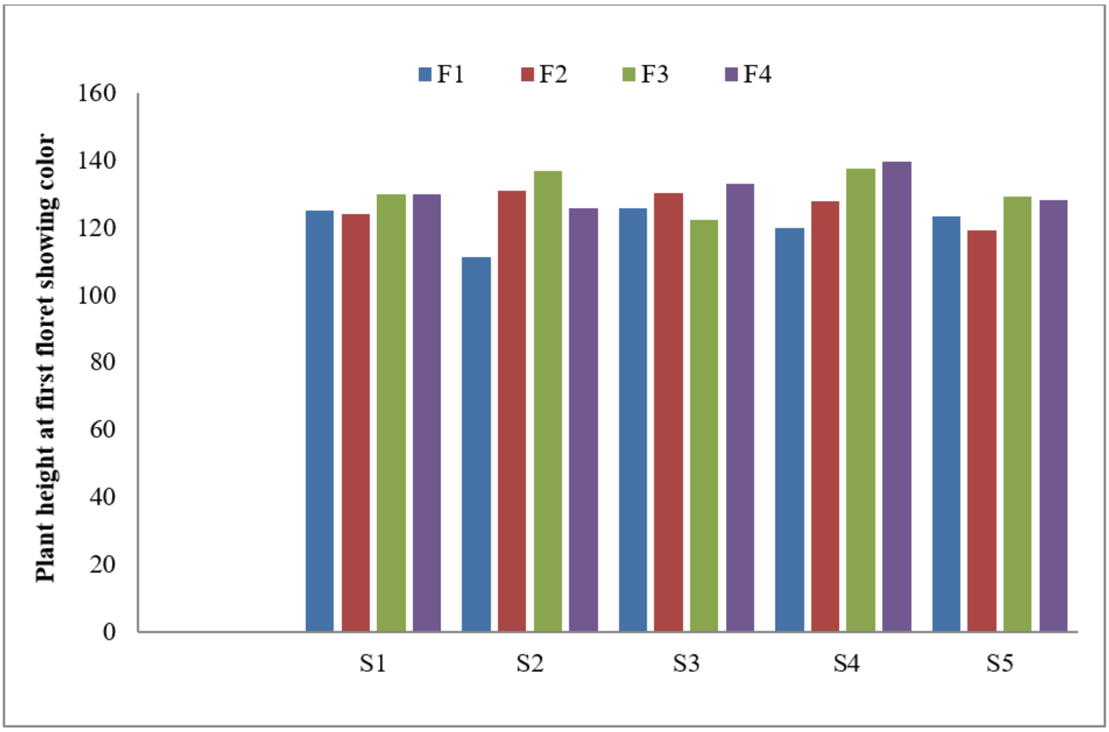

Fig 1: Effect of different silica oxide doses on Plant height at first floret showing color

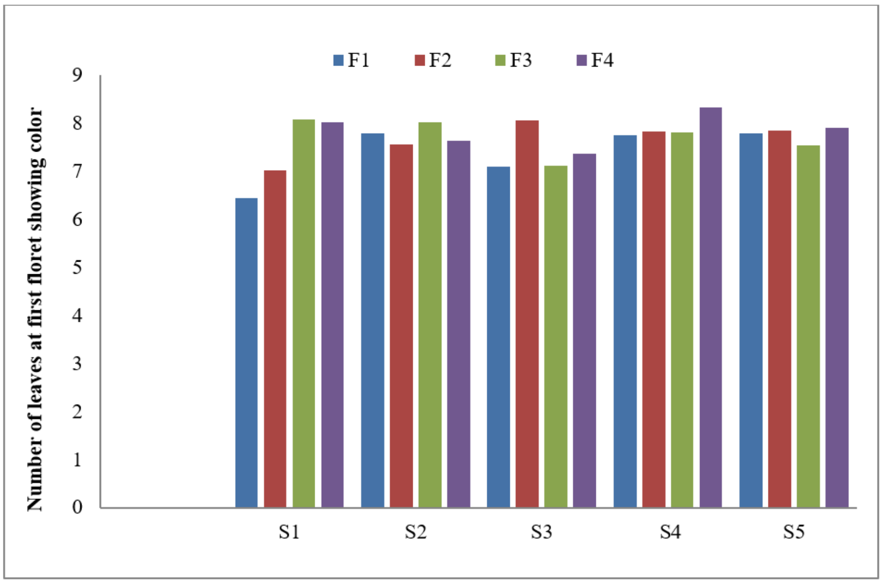

Fig 2: Effect of different silica oxide doses on number of leaves at first floret showing color

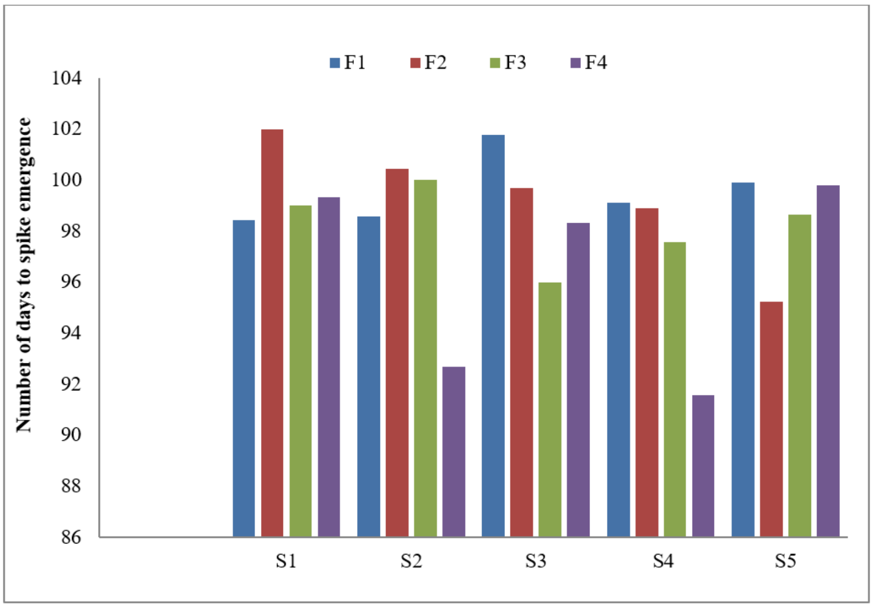

Fig 3: Effect of different silica oxide doses on number of days to spike emergence

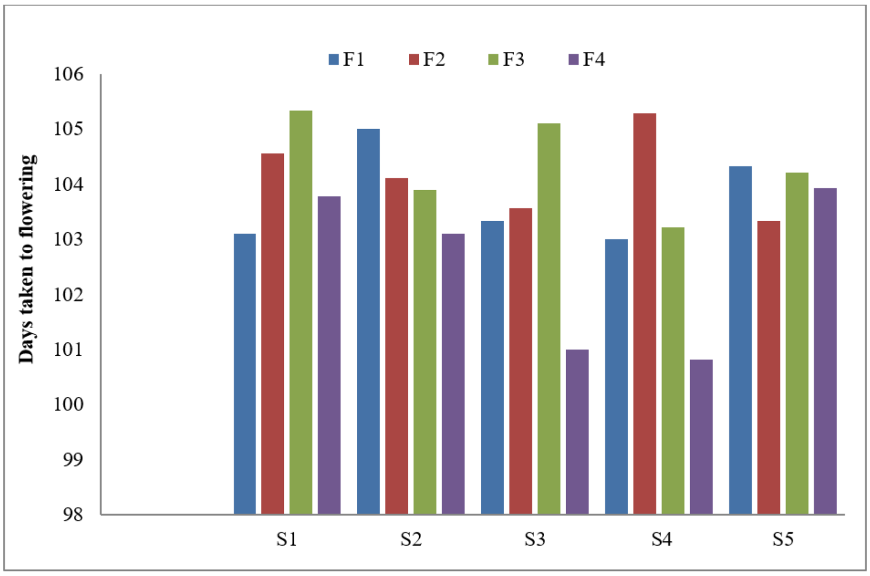

Fig 4: Effect of different silica oxide doses on number of days to flowering

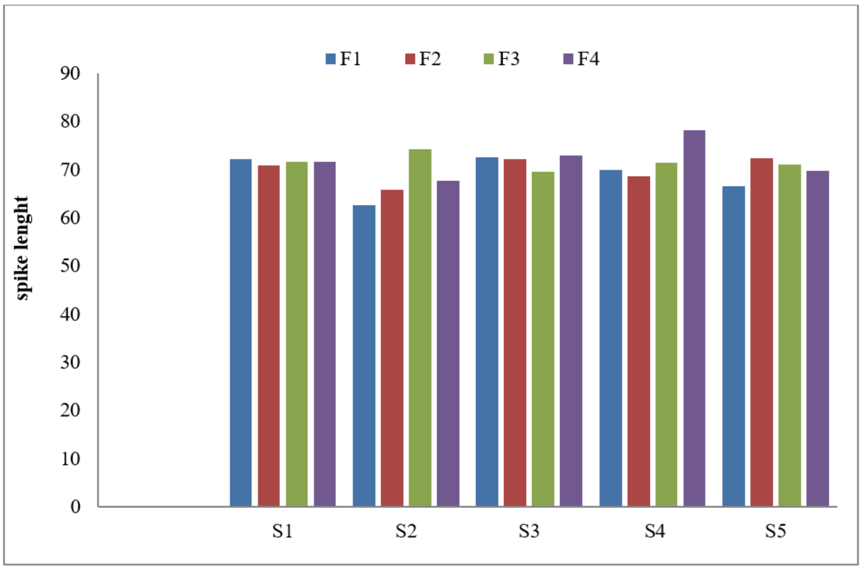

Fig 5: Effect of different silica oxide doses on Spike length

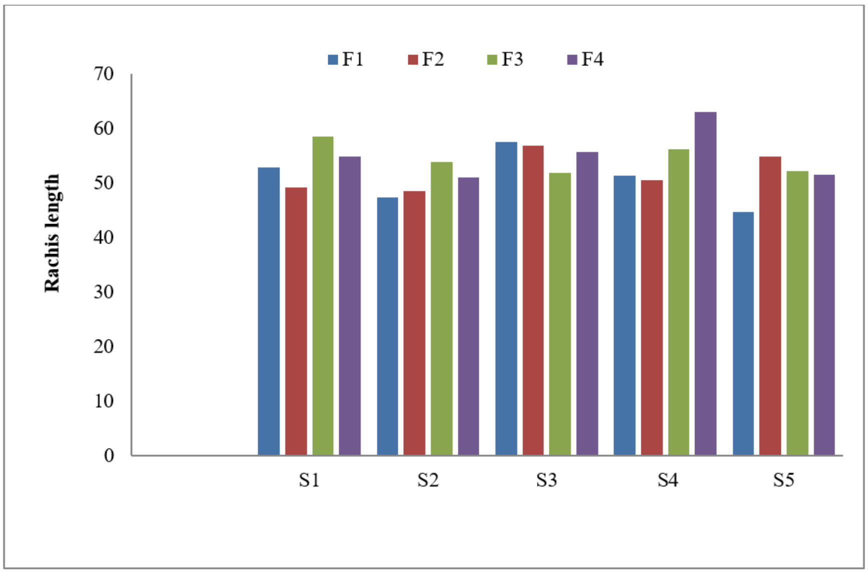

Fig 6: Effect of different silica oxide doses on Rachis length

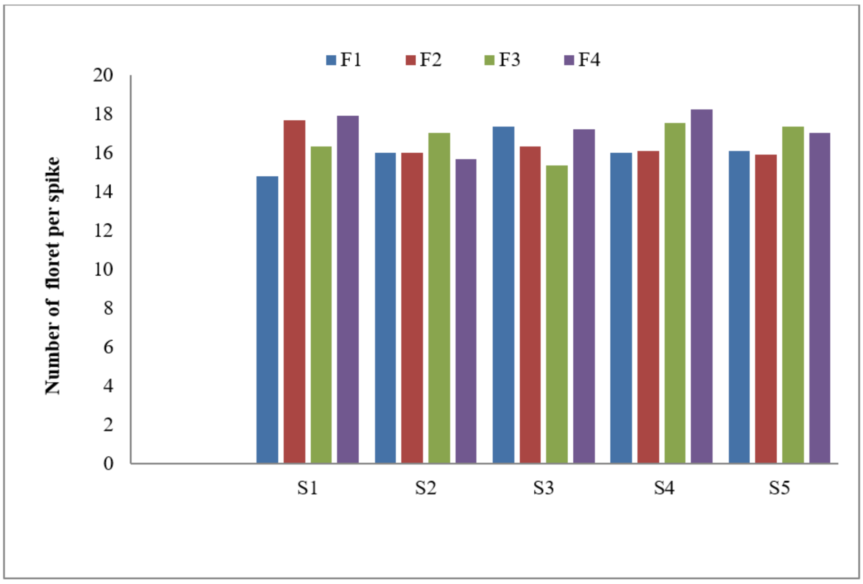

Fig 7: Effect of different silica oxide doses on number of floret per spike

Conclusion

On the basis of above statements it can be stated that silicon application together, as soil and foliar application was able to effectively enhance the quality of gladiolus flowers. Sole application as foliar or soil might not be that much beneficial however soil supplementation with Si is more beneficial than the foliar application. Based on the findings of current investigation it may be concluded that application of (75 kg/ha soil application + 3% foliar application of silica dioxide) could be beneficial for vegetative, floral characters in the leaves of gladiolus under Tarai region of Uttarakhand.

Acknowledgement

We thank to Director and Dean, GBPUAT- Govind Ballabh Pant University of Agriculture and Technology, Pantnagar Uttrakhand, for providing the facility and encouragement to carry out the research work and we also express sincere gratitude to the Department of Floriculture and Landscape Architecture for financial and technical support throughout the research period.

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