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Effect of silicon and gibberellic acid on growth and flowering of gladiolus

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ABSTRACT

Gladiolus grandiflorus is known and grown for its high profit and excellent cut flower. To compete with other growers and to meet the consumer demand the grower should adopt new techniques and apply effective chemicals to the plant precisely which in result gives good quality flowers. For this an experiment was carried out on *Gladiolus grandiflorus* cv. Rose supreme in experimental area of department of horticulture, Bahauddin Zakariya University, Multan. There were 6 treatments and 3 replications and the corms were planted in pots. Each treatment in replications is replicated four times to get best results. The sowing was done on 3rd December 2018 and the first application of chemicals was applied on 15/02/2019. The total number of applications was 6 and each application was applied by foliar application after one week interval. The chemicals were silicon and gibberellic acid. Silicon is applied as T0 (0g), T1 (1g), T2 (2g), T3 (3g), T4 (4g) and T5 (5g) while gibberellic acid has a fixed dose of 200ppm in each treatment. The best results related to vegetative and floral parameters were observed in T4 treatment plants which showed best result and an increase in stalk length, spike length, diameter of floret, diameter of spike, number of leaves per plant, vase life, number of florets per spike, fresh weight of complete flower stalk and plant height.

Keywords: GA3, silicon, rose supreme

INTRODUCTION: Gladiolus is commonly known and grown for its high aesthetic and economical value, especially in Pakistan economy. It is placed second important cut flower in Pakistan while fourth most important cut flower in the world. The cultivated area of gladiolus is only 970 acre and is too small as compared to rose which is 9200 acre and tuberose which is 2787 acre (Khan, 2005). Gladiolus belongs to *Iridaceae* family; holds about 260 species but many of them are wild. Native to Africa but some species are also from Mediterranean, South Africa and from Europe (Dole and Wilkins, 1999). Progressive farmers in Pakistan are now converting to floriculture industry instead of growing traditional crops, for this rose, gladiolus, tuberose and carnation are the best flowers that give maximum profit in low time period. The total cultivated area of gladiolus in Punjab is more than 450 acres. Plant growth regulators are responsible especially for the physical attributes of a plant in an effective way. Treating plants with plant growth regulators is very mandatory to enhance the growth and yield of plants (Nuvale *et al.*, 2010). Different doses of GA3 can affect significantly on the vegetative as well as reproductive growth of gladiolus (Umrao *et al.*, 2007). GA3 can increase the height, number of florets and can initiate early sprouting of flowers (Taiz and Zeiger, 2002). Silicon is the 2nd most available element on Earth's crust; about 32 percent silicon is present in soil by weight. 1% to 10% silicon is present in plant dry matter. The available form of silicon that plant can easily uptake is called as Mono salicylic acid $Si(OH)_4$. Silicon is mostly required during vegetative as well as reproductive growth of the plant to attain healthy and maximum yield from plant (Savant *et al.*, 1997). Farmers now a days do not have proper knowledge of cultivating flowers that is the reason they apply extra chemicals to get maximum yield but cannot achieve it because the amount and type of chemical they are applying are used for traditional crops, ornamentals and flowers have their own need of different chemicals for this, the research is done to describe the role of chemicals on gladiolus to attain maximum yield with high quality flowers.

MATERIALS AND METHODS: The research was carried out at experimental area of Department of Horticulture, Bahauddin Zakariya University Multan, Pakistan. The research was done to get and to elaborate the outcome of foliar use of GA_3 and Silicon on growth, yield and flowering of *Gladiolus grandiflorus* cv. Rose supreme in pots. Soil samples were taken from various pots and then collected to check the soil properties i.e. its acid: base ratio, Electrical conductivity, form and the amount the nutrients present in the soil. The combination of soil media used in the research was 1:1 (Silt: Leaf manure) and the pots were placed according to the statistical design which was Randomized Complete Block Design (RCBD).

The corms of *Gladiolus grandiflorus* cv. Rose supreme was imported from Netherlands. The treatments were applied as 200 ppm of Gibberellic acid (GA_3) and 1, 2, 3, 4, 5 g/L of silicon as sodium meta-silicate. The treatments were applied by foliar application with different combination in a Randomized complete block design (RCBD) which is as follows in table 1.

On 3rd December, corm sowing was done. One corm was in each pot. There were total 6 treatments one was control which has only 200 ppm GA_3 while others have different silicon doses as well as has fixed dose of GA_3. Each treatment was divided into 4 pots thus total No. of pots were (6 × 3 × 4) = 72 having three replications. GA_3 and silicon was applied by foliar application with one week interval. The first foliar application was done before stick formation and the date was 15/02/2019, while the last application was done on 22/03/2019. The total number of applications was six and was applied through foliar implementation of chemicals. The cultural practices, integrated pest management and fertilizer application were done thoroughly on each replication with equal amount of dose.

Data collection: Following were the some parameters in table 2 taken to elaborate the outcome of foliar use of GA_3 and silicon on the growth, flowering and yield of *Gladiolus grandiflorus* cv. Rose supreme.

RESULT AND DISCUSSION: Stalk length (cm): Table 3 showed the best effect of silicon and Gibberellic acid as T4 which showed maximum stalk length T4 (80.543) after that T1 (78.833), T0 (76.667), T3 (73.417) and T5 (73.167) while T2 (72.833) showed minimum stalk length. The stalk length was taken in cm. The length of stalk was approximately similar to each other by the application of silicon and Gibberellic acid. On the other hand table 4 showed the ANOVA for stalk length of gladiolus. Maximum stalk length will give maximum profit to flower growers that's why it is important to choose efficient chemicals that enhance the flower growth as well as the accurate dose of chemical is also important to get maximum results. Increase in stalk length was also reported in anthurium through foliar allocation of GA_3 (Dhaduk *et al.*, 2007).

Spike length (cm): The best results were shown in different concentrations among those T4 concentration showed best result and then T1, T3, T0, T2 and T5 respectively. The results of the chemicals on spike length are shown in table 5. Different concentrations imparts favorable impact on spike length and increase their size as T4 (33.350), T1 (31.750), T3 (29.707), T0 (28.833), T2 (28.267) and T5 (27.303). More spike length increased the profit ratio of flower grower and meets the consumer demand more precisely. Good spike length is an important constituent to increase the quality of flower. The statistical analysis i.e. ANOVA for spike length of gladiolus is shown in table 6. To increase the quality of flower it is mandatory to choose best and most effective chemical and applied with the recommended dose which in result gives maximum quality flower. It was reported that spike length and stalk length can be increased via foliar allocation of GA_3 on anthurium (Dhaduk *et al.*, 2007).

Diameter of spike (cm): The best results were shown in different concentrations among those T4 concentration showed best result and then T1, T3, T2, T0 and T5 respectively. Different concentrations imparts favorable impact on spike length and increase their size as T4 (0.5990), T1 (0.5990), T3 (0.5887), T2 (0.5867), T0 (0.5700) and T5 (0.5443) as shown in table 7. In table 8 ANOVA for diameter of spike of gladiolus showed significant results. More diameter of spike increased the profit ratio of flower grower and meets the consumer demand more precisely. Good diameter of spike is an important constituent to increase the quality of flower. To increase the quality of flower it is mandatory to choose best and most effective chemical and applied with the recommended dose which in result gives maximum quality flower.

Diameter of floret (cm): The best results were shown in different concentrations among those T4 concentration showed best result and then T1, T2, T3, T5 and T0 respectively. Different concentrations imparts favorable impact on diameter of floret and increase their size as T4 (0.6890), T1 (0.6817), T2 (0.6700), T3 (0.6600), T5 (0.6300) and T0 (0.6100) as shown in table 9. Significant results were seen in ANOVA table 10.

Quality of flower i.e. its size and color is very important to get maximum profit and to sustain in a competitive market. To achieve best flower size different chemicals and plant growth regulators are applied which have positive effects on the growth and nourishment of flower. Silicon and Gibberellic acid showed their best result at the concentrations as 200ppm Gibberellic acid and 4g of silicon.

Number of leaves per plant: Table 11 showed the best results in different concentrations among those T4 concentrations showed best result and then T1, T2, T3, T0 and T5 respectively. Different concentrations imparts favorable impact on number of leaves per plant and increase their size as T4 (8.9167), T1 (8.8333), T2 (8.6667), T3 (8.6333), T0 (8.4667) and T5 (7.5100). Number of leaves in each treatment from T0-T4 was approximately same but in T5 the number of leaves decreased. Number of leaves in any plant was most important because they are responsible for the photosynthesis which in result provides energy to the plant body to grow well. Table 12 showed statistical approach of number of leaves per plant. More number of plants will cause more photosynthesis and in result the plant grow well with good quality flowers for the consumer thus gives maximum profit to the flower grower. It is reported in different experiments that Gibberellic acid is responsible to increase the number of leaves in chrysanthemum and other cut flowers (Naira *et al.*, 2003).

Vase life (days): The best results were shown in different concentrations among those T4 concentration showed best result and then T5, T2, T0, T1 and T3 respectively. Different concentrations imparts favorable impact on vase life and increase as T4 (10.580), T5 (8.777), T2 (8.763), T0 (8.750), T1 (8.583) and T3 (8.5800). Table 13 and table 14 showed the significant results.

Concentration showed best result and then T1, T2, T3, T0 and T5 respectively. Different concentrations imparts favorable impact on days to spike emergence and the results are as T5 (122.40), T0 (115.83), T3 (114.92), T2 (114.58), T1 (113.83) and T4 (112.33). By the application of silicon and Gibberellic acid the days to spike emergence decrease significantly in each treatment while the best and early results were shown in T4 and the dose was 200ppm Gibberellic acid along with 4g of silicon. Table 15 showed different treatments and their result while table 16 showed significant results of days to spike emergence. The flower grower can get maximum profit by introducing its flowers earlier than other growers in the market, thus less competition will give more profit. It was reported that Gibberellic acid is responsible to maximum spike length and it is observed that minimum number of days required for spike emergence when Gibberellic acid is sprayed on plants (Devadanam *et al.*, 2007).

Number of florets per spike: The best results were shown in different concentrations among those T4 concentration showed best result and then T1, T3, T2, T0 and T5 respectively. The results were significantly described in table 17 and table 18. Different concentrations imparts favorable impact on number of florets per spike and the results are as T4 (10.583), T1 (9.660), T3 (9.333), T2 (9.250), T0 (8.550) and T5 (8.167). More number of florets on a single flower stalk will give more profit because it met the demand of consumer. Consumer will pay more to get more flowers on a single flower stalk. A significant increase in number of florets per spike was noted. An increase in number of flowers was reported on some flowering plants by the foliar application of gibberellic acid (Kumar *et al.*, 2003).

Fresh weight of complete flower stalk (g): The best results were shown in different concentrations among those T4 concentration showed best result and then T1, T3, T2, T0 and T5 respectively. The results were significantly described in table 19 and table 20. Different concentrations imparts favorable impact on weight of newly harvested whole inflorescence stalk and results are as T4 (39.000), T1 (34.750), T3 (31.040), T2 (30.833), T0 (29.200) and T5 (25.320). More fresh weight of flower stalk is considered to be a good indicator for good quality flower which in result give consumer mental satisfaction as well as more profit to flower grower. Fresh weight of anthurium flower increase by the application of gibberellic acid as well as the increase the flower yield to some extent (Kumar *et al.*, 2003). It was reported in chrysanthemum that an increase in fresh weight, dry weight and size of flower was observed significantly.

Dry weight of complete flower stalk (g): Table 21 showed the best results in different concentrations among those T5 concentration showed best result and then T4, T0, T1, T2 and T3 respectively, while table 22 showed ANOVA for dry weight of complete flower stalk. Different concentrations imparts favorable impact on dry weighing of whole inflorescence stalk and the results are as T5 (13.423), T4 (13.363), T0 (13.313), T1 (13.280), T2 (13.160) and T3 (12.420). Dry weight of complete flower stalk of all treatments was approximately same. There is a very minute difference among them. It was reported in chrysanthemum that an increase in fresh weight, dry weight and size of flower was observed significantly (Nagarjuna *et al.*, 1983).

	R1	**R2**	**R3**
T0	200+0	200+1	200+3
T1	200+2	200+3	200+5
T2	200+5	200+2	200+1
T3	200+4	200+5	200+2
T4	200+1	200+4	200+0
T5	200+3	200+0	200+4

Table 1: Treatments and replications design layout of research plan.

Stalk length (cm)	**Spike length (cm)**	**Diameter of floret (cm)**
Diameter of spike (cm)	Number of leaves per plant	Vase life (days)
Days to spike emergence	Number of florets per spike	Plant height (cm)
Fresh weight of complete flower stalk (g)	Dry weight of complete flower stalk (g)	

Table 2: Parameters which are taken to evaluate the research.

Treatments	**Stalk length**
T0 (control)	76.667 AB
T1 (200ppm GA_3+1g silicon)	78.833 A
T2 (200ppm GA_3+2g silicon)	72.833 B
T3 (200ppm GA_3+3g silicon)	73.417 B
T4 (200ppm GA_3+4g silicon)	80.543 A
T5 (200ppm GA_3+5g silicon)	73.167 B

Table 3: Effect of silicon and gibberellic acid on stalk length of *Gladiolus grandiflorus* L. CV. rose supreme.

Source	**Df**	**SS**	**MS**	**F**	**P**
Blocks	2	0.709	0.3545		
Treatments	5	161.384	32.2768	5.31	0.0122
Error	10	60.780	6.0780		
Total	17	222.873			

Table 4: Analysis of variance for stalk length of *Gladiolus grandiflorus* L. CV. rose supreme as affected by silicon and gibberellic acid.

Treatments	**Spike length (cm)**
T0 (control)	28.833 BC
T1 (200ppm GA_3+1g silicon)	31.750 A
T2 (200ppm GA_3+2g silicon)	28.267 BC
T3 (200ppm GA_3+3g silicon)	29.707 B
T4 (200ppm GA_3+4g silicon)	33.350 A
T5 (200ppm GA_3+5g silicon)	27.303 C

Table 5: Effect of silicon and gibberellic acid on spike length of *Gladiolus grandiflorus* L. CV. rose supreme.

Source	Df	SS	MS	F	P
Blocks	2	2.8272	1.4136		
Treatments	5	77.7138	15.5428	17.84	0.0001
Error	10	8.7135	0.8713		
Total	17	89.2545			

Table 6: Analysis of variance for spike length of *Gladiolus grandiflorus* L. CV. rose supreme as effected by silicon and gibberellic acid.

Treatments	Diameter of spike (cm)
T0 (control)	0.5700 AB
T1 (200ppm GA_3+1g silicon)	0.5990 A
T2 (200ppm GA_3+2g silicon)	0.5867 A
T3 (200ppm GA_3+3g silicon)	0.5887 A
T4 (200ppm GA_3+4g silicon)	0.5990 A
T5 (200ppm GA_3+5g silicon)	0.5443 B

Table 7: Effect of silicon and gibberellic acid on diameter of spike on *Gladiolus grandiflorus* L. CV. rose supreme.

Source	Df	SS	MS	F	P
Blocks	2	0.00024	0.00012		
Treatments	5	0.00586	0.00117	2.68	0.0870
Error	10	0.00438	0.00044		
Total	17	0.01047			

Table 8: Analysis of variance for diameter of spike of *Gladiolus grandiflorus* L. CV. rose supreme as affected by silicon and gibberellic acid.

Treatments	Diameter of floret
T0 (control)	0.6100 C
T1 (200ppm GA_3+1g silicon)	0.6817 A
T2 (200ppm GA_3+2g silicon)	0.6700 A
T3 (200ppm GA_3+3g silicon)	0.6600 AB
T4 (200ppm GA_3+4g silicon)	0.6890 A
T5 (200ppm GA_3+5g silicon)	0.6300 BC

Table 9: Effect of silicon and gibberellic acid on floret diameter of *Gladiolus grandiflorus* L. CV. rose supreme.

Source	Df	SS	MS	F	P
Blocks	2	0.00101	0.00051		
Treatments	5	0.01424	0.00285	8.31	0.0025
Error	10	0.00343	0.00034		
Total	17	0.01869			

Table 10: Analysis of variance for diameter of floret of *Gladiolus grandiflorus* L. CV. rose supreme as affected by silicon and gibberellic acid.

Treatments	Number of leaves per plant
T0 (control)	8.4667 A
T1 (200ppm GA_3+1g silicon)	8.8333 A
T2 (200ppm GA_3+2g silicon)	8.6667 A
T3 (200ppm GA_3+3g silicon)	8.6333 A
T4 (200ppm GA_3+4g silicon)	8.9167 A
T5 (200ppm GA_3+5g silicon)	7.5100 B

Table 11: Effect of silicon and gibberellic acid on number of leaves per plant of *gladiolus grandiflorus* L. CV. rose supreme,

Source	Df	SS	MS	F	P
Blocks	2	1.44521	0.72261		
Treatments	5	3.93411	0.78628	3.65	0.0386
Error	10	2.15372	0.21537		
Total	17	7.53304			

Table 12: Analysis of variance for number of leave per plant of *Gladiolus grandiflorus* L. CV. rose supreme as effected by silicon and gibberellic acid.

Treatments	Vase life
T0 (control)	8.750 B
T1 (200ppm GA_3+1g silicon)	8.583 B
T2 (200ppm GA_3+2g silicon)	8.763 B
T3 (200ppm GA_3+3g silicon)	8.500 B
T4 (200ppm GA_3+4g silicon)	10.580 A
T5 (200ppm GA_3+5g silicon)	8.777 B

Table 13: Effect of silicon and gibberellic acid on vase life of *Gladiolus grandiflorus* L. CV. rose supreme.

Source	Df	SS	MS	F	P
Blocks	2	0.7283	0.36416		
Treatments	5	9.2641	1.85282	3.59	0.0405
Error	10	5.1587	0.51587		
Total	17	15.1511			

Table 14: Analysis of variance for vase life per spike of *Gladiolus grandiflorus* L. CV. rose supreme as affected by silicon and gibberellic acid.

Treatments	Days to spike emergence
T0 (control)	115.83 B
T1 (200ppm GA_3+1g silicon)	113.83 B
T2 (200ppm GA_3+2g silicon)	114.58 B
T3 (200ppm GA_3+3g silicon)	114.92 B
T4 (200ppm GA_3+4g silicon)	112.33 B
T5 (200ppm GA_3+5g silicon)	122.40 A

Table 15: Effect of silicon and gibberellic acid on days to spike emergence on *Gladiolus grandiflorus* L. CV. rose supreme.

Source	Df	SS	MS	F	P
Blocks	2	16.043	8.0217		
Treatments	5	184.717	36.9433	0.69	0.0014
Error	10	38.125	3.8125		
Total	17	238.885			

Table 16: Analysis of variance for days to spike emergence of *Gladiolus grandiflorus* L. CV. Rose supreme as effected by silicon and gibberellic acid.

Treatments	Number of florets per spike
T0 (control)	8.550 BC
T1 (200ppm GA_3+1g silicon)	9.660 AB
T2 (200ppm GA_3+2g silicon)	9.250 BC
T3 (200ppm GA_3+3g silicon)	9.333 B
T4 (200ppm GA_3+4g silicon)	10.583 A
T5 (200ppm GA_3+5g silicon)	8.167 C

Table 17: Effect of silicon and gibberellic acid on number of floret per spike on *Gladiolus grandiflorus* L. CV. Rose supreme.

Source	Df	SS	MS	F	P
Blocks	2	0.0305	0.01527		
Treatments	5	10.8484	2.16967	5.63	0.0100
Error	10	3.8505	0.38505		
Total	17	14.7294			

Table 18: Analysis of variance for number of florets per spike of *Gladiolus grandiflorus* L. CV. rose supreme as effected by silicon and gibberellic acid.

Treatments	Fresh weight of complete flower stalk
T0 (control)	29.200 C
T1 (200ppm GA_3+1g silicon)	34.750 B
T2 (200ppm GA_3+2g silicon)	30.833 C
T3 (200ppm GA_3+3g silicon)	31.040 C
T4 (200ppm GA_3+4g silicon)	39.000 A
T5 (200ppm GA_3+5g silicon)	25.320 D

Table 19: Effect of silicon and gibberellic acid on fresh weight of complete flower stalk of Gladi olus grandiflorus L. CV. Rose supreme.

Source	Df	SS	MS	F	P
Blocks	2	3.924	1.9620		
Treatments	5	332.199	66.4398	48.23	0.0000
Error	10	13.775	1.3775		
Total	17	349.898			

Table 20: Analysis of variance for fresh weight of complete flower stalk of *Gladiolus grandiflorus* L. CV. rose supreme as affected by silicon and gibberellic acid.

Treatments	Dry weight of complete flower stalk
T0 (control)	13.313 A
T1 (200ppm GA_3+1g silicon)	13.280 A
T2 (200ppm GA_3+2g silicon)	13.160 A
T3 (200ppm GA_3+3g silicon)	12.420 A
T4 (200ppm GA_3+4g silicon)	13.363 A
T5 (200ppm GA_3+5g silicon)	13.423 A

Table 21: Effect of silicon and gibberellic acid on dry weight of complete flower stalk of *Gladiolus grandiflorus* L. CV. rose supreme.

Source	Df	SS	MS	F	P
Blocks	2	1.4700	0.73500		
Treatments	5	2.0886	0.41772	0.41	0.8295
Error	10	10.1152	1.01152		
Total	17	13.6738			

Table 22: Analysis of variance for dry weight of complete flower stalk of *Gladiolus grandiflorus* L. CV. Rose supreme as effected by Silicon and Gibberellic acid.

Plant height (cm): The best results were shown in different concentrations among those T4 concentration showed best result and then T1, T0, T3, T2 and T5 respectively. The results were significantly described in table 23 and table 24. Different concentrations imparts favorable impact on plant height and the results are as T4 (65.350), T1 (64.070), T0 (61.340), T3 (58.383), T2 (57.633) and T5 (57.513). Plant height is one of the most important parts of any plant. Consumers like the flowers which have more height because more flower height will increase the number of floret per spike. 4g silicon along with 200ppm of Gibberellic acid is recommended to increase the plant height effectively. An increase in plant height, number of leaves and branches was reported by the foliar application on Gibberellic acid on chrysanthemum and on other cut flowers (Kumar *et al.*, 2003; Naira *et al.*, 2003).

Treatments	Plant height
T0 (control)	61.340 B
T1 (200ppm GA_3+1g silicon)	64.070 A
T2 (200ppm GA_3+2g silicon)	57.633 C
T3 (200ppm GA_3+3g silicon)	58.383 C
T4 (200ppm GA_3+4g silicon)	65.350 A
T5 (200ppm GA_3+5g silicon)	57.513 C

Table 23: Effect of silicon and gibberellic acid on plants height of *Gladiolus grandiflorus* L. CV. rose supreme.

Source	Df	SS	MS	F	P
Blocks	2	2.545	1.2727		
Treatments	5	174.942	34.9883	34.15	0.0000
Error	10	10.247	1.0247		
Total	17	187.734			

Table 24: Analysis of variance for plant height of *Gladiolus grandiflorus* L. CV. Rose supreme as effected by silicon and gibberellic acid.

Conclusion

The research was done in research area of Horticulture department, Bahauddin Zakariya University Multan. Randomized complete block design (RCBD) was the model on which the experiment was laid out. Total number of treatments were 6 which are as T0 (200ppm GA3), T1 (200ppm GA3+ 1g Silicon), T2 (200ppm GA3+ 2g Silicon), T3 (200ppm GA3+ 3g Silicon), T4 (200ppm GA3+ 4g Silicon) and T5 (200ppm GA3+ 5g Silicon). The best results were observed in T4 plants which has maximum effect of silicon as well as gibberellic acid. In most parameters T5 showed repellent effects due to high amount of silicon dose.

CONFLICT OF INTEREST

The Author has no conflict of Interest

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