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EFFECT OF FOLIAR SILICIC ACID ON GROWTH AND YIELD ATTRIBUTES OF ROSE CUT FLOWERS (*ROSA HYBRID*)

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Abstract

An experiment was conducted in Division of Horticulture to evaluate the effect of foliar application Silicic acid on growth and yield attributes of Rose cut flowers under naturally ventilated poly house with seven treatments, three replications and four varieties. Among the treatments application of foliar Silicic acid @ 4ml L-1 at 10 days interval recorded significantly highest plant height (75.35cm) and number of marketable flowers/plant (17.30). foliar Silici acid (SA) 6ml L-1 applied at 10 days interval recorded significantly highest plant spread (38.90cm2), number of shoots per plant (12.26), leaf area (11.08 cm2) and number of flowers/plant (31.62). Application of foliar Silicic acid proved to have beneficial effects on growth and yield attributes of cut rose flowers under naturally ventilated poly house conditions.

Key words : Silicon, rose flowers, growth and yield attributes.

Introduction

Rose is one of the world's most favourite and unchallenged "Queen of flowers" belonging to the family 'Rosacea'. It is one of the best known commericial cut flower that has become an integral part of our daily life. Variety of shapes, sizes, colours and varisatility has made it th queen of flower. Nutrients plays an important role in growth, quality and productivity. Among the nutrients silicon as a beneficial element its role in rose cultivation is not known and research in horticultural crops is limited. The role of Si in plant is also known to increase drought tolerance in plants by maintaining plant water balance, photosynthetic activity, erectness of leaves and structure of xylem vessels under high transpiration rates (Melo *et al*., 2003). The majority of studies with horticultural crops generally emphasized n disease management or physiological difference between silicon treated plant and untreated control. There is a limited evidence that silicon supplementation affects the growth, yield and quality in flower crops. Although, few studies have confirmed the benefits of silicon as foliar applications. Hence an attempt was made to evaluate the effect of foliar applied Silicic acid on growth and yield attributes of cut flowers.

Materials and Methods

The experiment was conducted at Dept. of Horticulture, U.A.S., G.K.V.K., Bangalore (Karnataka), India, which is situated at 12.680 north latitude, 77^0 35' East longitude at an altitude of about 930 m above the mean sea level. The average annual rainfall of the area is 953mm. the minimum and maximum temperature noticed during the study ranged from 12^0C to 27^0C, respectively and relative humidity ranged between 30 to 80 per cent. To impose treatments on uniformly grown plants, all the four cultivars were uniformly pruned on 15th August. Hard pruning was taken up at 20cm high from the ground. The cut ends were smeared with copper oxy chloride paste immediately after pruning to protect from disease.

The treatment were imposed fifteen days after pruning at regular intervals like treatment T_2, T_3 and T_4, Ten sprays of foliar silicon sprayed at 10 days intervals. Whereas, for T_5, T_6 and T_7, 5 sprays of foliar silicon sprayed at 20 days intervals were given. The varieties used for the study are Tropical Amazon, First red, Gold Strike, Tineke.

Treatment details

T_1: Soil application of recommended NPK fertilizers as per package of practice.

T_2: Foliar spray of silicic acid @ 2 ml L^{-1} at 10 days interval

T_3: Foliar spray of silicic acid @ 4 ml L^{-1} at 10 days interval.

T_4: Foliar spray of silicic acid @ 6 ml L^{-1} at 10 days interval.

T_5: Foliar spray of silicic acid @ 2 ml L^{-1} at 20 days interval.

T_6: Foliar spray of silicic acid @ 4 ml L^{-1} at 20 days interval.

T_7: Foliar spray of silicic acid @ 6 ml L^{-1} at 20 days interval

Preparation of soluble silicic acid solution

- Soluble Silicic acid was dissolved in fresh water in 1:5 dilution, kept it for 30 minutes for dissolution.
- Required quantity of diluted solution of Silicic acid was taken up, make up the volume of water based on need per plot.
- Spray was given to treatment plots along with the wetting agent / sticker.
- The foliar silicon spray was applied to plants as per the treatment till the entire foliage gets wet and drips down.

The observations on quality parameters like flower bud length (cm), bud diameter (cm), stalk length (cm), neck length (cm), flower stalk girth (cm), and vase life (days) were recorded. Five labeled plants which were selected per treatment per replication were used for recording the observation.

Results and Discussion

Growth parameters

Significantly highest plant height of 82.86 cm was recorded in var. First Red, the lowest plant height of 68.52 cm was recorded in variety Gold Strike. This height was reported by Nagaraja *et al*. (1999) and Dias and Patil (2003).

The foliar silicon applied treatments had significant effect on the plant height than untreated control. Among the treatments Foliar SA @ 4ml L^{-1} applied at 10 days interval (T_3) recorded maximum plant height of 75.34 cm and treatment (T_1) control was recorded minimum plant height 70.51 cm Similar results were observed by Kamenidou, (2010) in gerbera (2009) in Zinnia and (2008) in ornamental sunflower. This increase in plant height was due to the stimulation of growth by silicon may be either indirect, owing to the protective effects of Silicon against pathogens or direct originating from implications of Si to both morphological changes and physiological processes in plants. It seems that silicon is involved directly or indirectly in cell metabolism as well, although in most cases the mode of action is still unclear (Liang *et al*., 2003 and Zhu *et al*., 2004).

Table 1 : Effect of foliar spray of Silicic acid (SA) on growth parameter different varieties of rose (Rosa hybrid).

Direct Effect	Plant height (cm)	Plant spread (cm^2)	No. of shoots / plant	Leaf area (cm^2)
Varieties				
V_1: Tropical Amazon	72.83	40.56	13.13	10.74
V_2: First Red	82.86	41.03	13.47	11.74
V_3: Gold Strike	68.52	32.43	10.51	9.71
V_4: Tineke	69.61	38.14	10.79	11.86
F – Test	*	*	*	*
S. Em.±	0.72	0.22	0.18	0.03
CD (5%)	1.44	0.44	0.35	0.07
Treatments				
T_1: Control	70.51	36.55	11.25	10.90
T_2: SA @ 2 ml L^{-1} once in 10 days	73.10	38.12	11.72	10.99
T_3: SA @ 4 ml L^{-1} once in10 days	75.34	38.71	12.05	11.06
T_4: SA @ 6 ml L^{-1} once in10 days	74.90	38.90	12.62	11.08
T_5: SA @ 2 ml L^{-1} once in 20 days	72.43	37.78	11.85	10.98
T_6: SA @ 4 ml L^{-1} once in 20 days	74.08	38.11	11.98	11.00
T_7: SA @ 6 ml L^{-1} once in 20 days	73.83	38.10	12.18	11.04
F – Test	*	*	*	*
S.Em±	0.67	0.21	0.16	0.04
CD (5%)	1.90	0.58	0.47	0.09

* - Significant.

Table 2 : Effect of foliar spray of silicic acid (SA), different varieties and their interaction on growth parameter of rose (Rosa hybrid).

Interaction effect		Plant height (cm)	Plant spread (cm^2)	No. of shoots/plant	Leaf area (cm^2)
Varieties × Treatments					
Tropical Amazon	**Control**	69.07	38.45	12.53	10.64
	SA @ 2 ml L^{-1} once in10 days	72.37	40.58	13.00	10.77
	SA @ 4 ml L^{-1} once in 10 days	74.90	42.88	13.33	10.79
	SA @ 6 ml L^{-1} once in 10 days	74.87	42.32	13.67	10.81
	SA @ 2 ml L^{-1} once in 20 days	72.07	39.78	13.13	10.75
	SA @ 4 ml L^{-1} once in 20 days	73.40	40.58	12.87	10.72
	SA @ 6 ml L^{-1} once in 20 days	73.13	39.32	13.40	10.68
First Red	Control	79.87	39.37	12.87	11.62
	SA @ 2 ml L^{-1} once in10 days	82.83	41.78	13.33	11.67
	SA @ 4 ml L^{-1} once in 10 days	85.47	42.55	13.67	11.82
	SA @ 6 ml L^{-1} once in 10 days	83.90	42.77	14.27	11.90
	SA @ 2 ml L^{-1} once in 20 days	81.57	40.12	13.33	11.67
	SA @ 4 ml L^{-1} once in 20 days	83.23	40.85	13.27	11.72
	SA @ 6 ml L^{-1} once in 20 days	83.17	39.80	13.53	11.80
Gold Strike	Control	66.07	31.03	9.40	9.61
	SA @ 2 ml L^{-1} once in10 days	68.10	32.17	10.13	9.63
	SA @ 4 ml L^{-1} once in 10 days	69.97	32.62	10.60	9.77
	SA @ 6 ml L^{-1} once in 10 days	69.87	32.48	11.20	9.60
	SA @ 2 ml L^{-1} once in 20 days	67.10	32.17	10.60	9.68
	SA @ 4 ml L^{-1} once in 20 days	69.40	32.57	10.87	9.81
	SA @ 6 ml L^{-1} once in 20 days	69.13	33.98	10.80	9.82
Tineke	Control	67.03	37.35	10.20	11.74
	SA @ 2 ml L^{-1} once in10 days	69.10	37.95	10.40	11.89
	SA @ 4 ml L^{-1} once in 10 days	71.03	36.78	10.60	11.89
	SA @ 6 ml L^{-1} once in 10 days	70.97	38.05	11.33	11.98
	SA @ 2 ml L^{-1} once in 20 days	68.97	39.07	10.33	11.84
	SA @ 4 ml L^{-1} once in 20 days	70.30	38.45	10.93	11.81
	SA @ 6 ml L^{-1} once in 20 days	69.87	39.30	11.00	11.83
F - Test		*	*	NS	*
S.Em.±		0.53	0.41	0.33	0.03
CD (5%)		1.50	1.16	-	0.08

*- Significant, NS - Non Significant.

The interaction between varieties and treatments had significant effect on the plant height at the treatment (V_2T_3) var. First Red with Foliar SA @ 4 ml L^{-1} applied at 10 days interval recorded highest plant height of 85.47 cm. The lowest plant height was recorded in treatment (V_3T_1) var. Gold Strike with control 66.07 cm this might be due to the synergetic interactions between two factors.

The maximum plant spread was observed in variety First Red to an extent of 41.03 cm^2, minimum plant spread was recorded in variety Gold Strike 32.43 cm^2. This variation was mainly due to the genetic makeup and varietal characteristics. Similar differences were also reported by Dias and Patil (2003) and Anamika and Sharma (2003).

Table 3 : Effect of foliar Silicic acid (SA) on yield attributes of different varieties of Rose (Rosa hybrid).

Direct effect	Number of flowers / plant	Number of marketable flowers /plant
Varieties		
V_1: Tropical Amazon	27.04	18.40
V_2: First Red	31.62	23.44
V_3: Gold Strike	21.18	11.25
V_4: Tineke	23.51	13.90
F – Test	*	*
S.Em±	0.21	0.25
CD (5%)	0.42	0.51
Treatments		
T_1: Control	23.83	15.58
T_2: SA @ 2 ml L^{-1} once in 10 days	25.88	16.67
T_3: SA @ 4 ml L^{-1} once in10 days	26.34	17.30
T_4: SA @ 6 ml L^{-1} once in10 days	26.69	17.22
T_5: SA @ 2 ml L^{-1} once in 20 days	25.88	16.88
T_6: SA @ 4 ml L^{-1} once in 20 days	25.62	16.42
T_7: SA @ 6 ml L^{-1} once in 20 days	26.62	17.17
F – Test	*	*
S.Em±	0.20	0.24
CD (5%)	0.56	0.67

* - Significant.

Among the treatments (T_4) foliar SA @ 6 ml L^{-1} applied at 10 days interval recorded maximum plant spread 38.90 cm^2. This was on par with the treatment (T_3) foliar SA @ 4ml L^{-1} applied at 10 days interval *i.e.* 38.71 cm^2. The lowest plant spread was recorded in control 36.55 cm^2. It is in accordance with Morgan (1999), who reported that plants supplied with Si resist lodging. It seems that the mechanical strength of the plants, which enables them to achieve and maintain an upright growth habit. The interaction between varieties and foliar SA applied treatments had significant effect on the plant spread. The treatment (V_2T_4) var. First Red with foliar SA @ 6 ml L^{-1} applied at 10 days intervals recorded the maximum plant spread of 42.77 cm^2, which is followed by the treatment (V_2T_3) var. First Red with Foliar SA @ 4 ml L^{-1} at 10 days intervals 42.55 cm^2. The minimum plant spread was recorded in (V_3T_1) var. Gold Strike with control 31.03 cm^2. It might be due to growth habit of the variety and stimulation by the silicon application.

The significant differences were observed due to direct effect between varieties and treatments. However, no significant differences were obtained due to their interaction effect. The variety first red showed highest number of shoots per plant 13.47. The lowest number of shoots recorded in variety Gold Strike 10.51 this could be attributed to genetic makeup and difference in varietal characteristics. Similar variations in number of shoots per plant were reported by Chandrashekar (1993) and Nagaraja *et al*. (1999).

The foliar application of silicon treatments had significant influence on number of shoots per plant than untreated control, among the treatments (T_4) foliar SA @ 6 ml L^{-1} applied at 10 days intervals recorded maximum number of shoots per plant *i.e.* 12.62. Which is followed by the treatment (T_7) Foliar SA @ 6ml L^{-1} applied at 20 days intervals *i.e.*, 12.18. The minimum number of shoots produced per plant was recorded in (T_1) control *i.e.*, 11.28. Increase in number of shoots per plant might be due to stimulation of growth by the silicon application. These results were in accordance with Seung (2005) in rose.

The varieties had significant effect on the leaf area. The variety Tineke (V_4) has shown highest leaf area *i.e.*, 11.86 cm^2 whereas, lowest leaf area of 9.71cm^2 was found in variety Gold strike. The variation among the varieties was mainly due to varietal character and early stages of leaf growth. These results are in according with Manjula (2005) in rose.

The foliar application of silicon treatments had significant influence on leaf area than untreated control, Among the treatments the leaf area was highest in (T_4) Foliar SA @ 6 ml L^{-1} applied at 10 days intervals *i.e.*, 11.08 cm^2, whereas minimum leaf area was found in control 10.90 cm^2. It might be due to maintenance of upright growth habit and allows maximum light interception, comes from the structural components of the plants cell walls and increased photosynthetic activity as well as leaf chlorophyll content. Similar results were also obtained by Saeed *et al*. (2009) in Rose hybrid. The interaction between varieties and foliar SA applied treatments had significant influence on the leaf area the highest leaf area of 11.98 cm^2 was found in (V_4T_4) var. Tineke with Foliar SA @ 6 ml L^{-1} applied at 10 days intervals, whereas, the minimum leaf area of 7.42cm^2 was found in (V_3T_1) var. Gold Strike with control. It might be due to synergetic effects between varieties and treatments.

Yield parameters

The varieties had significant effect with regard to

Table 4 : Effect of foliar Silicic acid (SA), different varieties and their interaction on yield attributes of rose (Rosa hybrid).

Interaction		**Number of flowers/plant**	**Number of marketable flowers/plant**
Varieties × Treatments			
Tropical Amazon	Control	24.63	16.33
	SA @ 2 ml L^{-1} once in 10 days	27.17	18.13
	SA @ 4 ml L^{-1} once in 10 days	28.10	19.07
	SA @ 6 ml L^{-1} once in 10 days	28.02	19.13
	SA @ 2 ml L^{-1} once in 20 days	27.10	19.00
	SA @ 4 ml L^{-1} once in 20 days	27.07	18.27
	SA @ 6 ml L^{-1} once in 20 days	27.18	18.87
First Red	Control	29.35	22.40
	SA @ 2 ml L^{-1} once in 10 days	31.63	23.40
	SA @ 4 ml L^{-1} once in 10 days	32.08	24.20
	SA @ 6 ml L^{-1} once in 10 days	33.22	24.13
	SA @ 2 ml L^{-1} once in 20 days	31.60	23.33
	SA @ 4 ml L^{-1} once in 20 days	31.33	22.93
	SA @ 6 ml L^{-1} once in 20 days	32.13	23.67
Gold Strike	Control	19.30	10.20
	SA @ 2 ml L^{-1} once in 10 days	21.20	11.27
	SA @ 4 ml L^{-1} once in 10 days	22.02	11.80
	SA @ 6 ml L^{-1} once in 10 days	21.05	11.20
	SA @ 2 ml L^{-1} once in 20 days	21.00	11.27
	SA @ 4 ml L^{-1} once in 20 days	21.17	11.00
	SA @ 6 ml L^{-1} once in 20 days	22.50	12.00
Tineke	Control	22.05	13.40
	SA @ 2 ml L^{-1} once in 10 days	23.52	13.87
	SA @ 4 ml L^{-1} once in 10 days	23.17	14.13
	SA @ 6 ml L^{-1} once in 10 days	24.45	14.40
	SA @ 2 ml L^{-1} once in 20 days	23.82	13.93
	SA @ 4 ml L^{-1} once in 20 days	22.90	13.47
	SA @ 6 ml L^{-1} once in 20 days	24.65	14.13
F – Test		*	*
SEM ±		0.35	0.31
CD (5%)		0.98	0.88

* - Significant.

the number of flowers per plant. Among the varieties studied, variety First red (V_2) produced maximum 31.62 flowers per plant, which was followed by the variety Tropical amazon (V_1) *i.e.*, 27.04 flowers per plant while the minimum number of flowers produced by the variety Gold strike (V_3) 21.18 flowers per plant. In the present investigations, higher yield may be due to increased morphological parameters, like plant height, more number of leaves, more number of branches and leaf area, which helps in production of more photosynthesis resulting in greater accumulation of dry matter, which in turn directly or indirectly leads to production of more number of flowers per plant. Variation in flower yield was also observed previously in rose by Nagaraja *et al*. (2003).

Significant influence of foliar SA treatments was noticed with respect to number of flowers produced per plant than untreated control. Among the treatments ($\mathbf{T_4}$) Foliar SA @ 6ml L^{-1} applied at 10 days intervals recorded 26.69 maximum flowers per plant, which is on par with the treatment ($\mathbf{T_3}$) Foliar SA @ 4ml L^{-1} applied at 10 days intervals produced 26.34 flowers per plant, while the minimum (23.83) flowers per plant was produced by control ($\mathbf{T_1}$). It might be due to increase in the mechanical strength of the plant, which enables them to achieve and maintain an upright growth habit and allows maximum light interception comes from the structural components of the plant cell wall likewise. These treatments could increase number of flowers per plant. Hwang *et al*. (2005) reported similar results in roses.

The interaction between varieties and foliar SA applied treatments had significant influence on number of flowers produced per plant. Among the interaction effects (V_2T_4) variety first red with Foliar SA @ 6 ml L^{-1} applied at 10 days intervals recorded maximum 33.22 flowers per plant, which is on par with the (V_2T_7) var. First red with Foliar SA @ 6ml L^{-1} at 20 days intervals recorded 32.13 flowers per plant and (V_2T_3) var. First red with Foliar SA @4 ml L^{-1} applied at 10 days interval recorded 33.08 flowers per plant, whereas, the treatment (V_3T_1) var. Gold Strike with control recorded minimum of 19.30 flowers per plant. It might be due to the varietal effect and response of variety to the foliar silicon application.

Varietal differences existed with regard to production of marketable flowers per plant. Among the varieties studied First red (V_2) produced maximum 23.44 marketable flowers per plant, which is followed by the variety Tropical amazon (V_1) *i.e.*, 18.40 marketable flowers per plant. While the minimum number of marketable flowers per plant produced by the variety Gold strike (V_3) 11.25.

Among the treatments Foliar SA @ 4ml L^{-1} applied at 10 days intervals ($\mathbf{T_3}$) produced 17.30 maximum flowers per plant, which is on par with the treatment ($\mathbf{T_4}$) Foliar SA @ 6ml L^{-1} applied at 10 days intervals produced 17.22 flowers per plant and ($\mathbf{T_7}$) Foliar SA @ 6 ml L^{-1} applied at 20 days interval produced 17.17 marketable flowers per plant while, the minimum 23.83 flowers per plant was produced by control ($\mathbf{T_1}$). Silicon application increased the quality parameters like, stalk length, neck length, stalk girth, bud diameter, bud length and inhibited the entry of pathogens thus collectively increased the marketability of the flowers. Similar results were reported by Hwang *et al*. (2005) in rose.

The interaction between varieties and foliar SA applied treatments had significant influence on number of marketable flowers produced per plant. Among the interaction effects (V_2T_3) var. First red with Foliar SA @ 4 ml L^{-1} applied at 10 days intervals recorded maximum of 24.20 marketable flowers per plant, which is on par with the (V_2T_4) var. First red with Foliar SA @ 6ml L^{-1} at 10 days intervals recorded 24.13 marketable flowers per plant and (V_2T_7) var. First red with Foliar SA @6 ml L^{-1} applied at 20 days interval recorded 23.67 marketable flowers per plant, whereas the treatment (V_3T_1) var. Gold Strike with control recorded minimum of 10.20 marketable flowers per plant. It might be due to the qualitative character of the variety and due to antimicrobial activity of the foliar applied silicon.

References

Anamika, S. and S. K. Sharma (2003). Scoring technique for rose evaluation. *J. Ornamental Hort., New series*, **6(1)** : 50-54.

Bhattacharjhee, S. K., V. C. Singh and N. K. Saxena (1993). Studies on vegetative growth, flowering, flower quality and vase life of roses. *Singapore J. of Primary Industries*, **21 (2)** : 67-71.

Dias, S. M. F. and A. A. Patil (2003). Performance of elite rose varieties at different population levels under transitional tract of Northern Karnataka. *Karnataka J. Agric. Sci.*, **16(2)** : 271-275.

Hwang, S. J., B. R. Jeong and H. M. Park (2005). Effects of Potassium Silicate on the Growth of Miniature Rose 'Pinocchio' Grown on Rockwool and its Cut Flower Quality. *J. Jpn. Soc. Hort. Sci*., **74** : 242-247.

Kamenidou, S., J. Todd and M. Stephen (2009). Evaluation of silicon as nutritional supplement for greenhouse Zinnia and ornamental Sunflower production. *Hort. Sci.*, **119** : 297-307.

Kamenidou, S., J. Todd and M. Stephen (2010). Silicon supplements affect floriculture quality traits and elemental nutrient concentrations of greenhouse produced gerbera. *Scientia Hort*., **123** : 390-394.

Liang, Y. C., X. M. Chen, T. S. MA and L. R. Liu (1993). Effect of silicon on growth, yield and quality of Tomato. *Jiangle Agri. Sci*., **4** : 48:50.

Manjula, B. (2005). Performance of rose cultivars under naturally ventilated polyhouse. *M.Sc. Thesis*, Univ. Agril. Sci., Dharwad.

Melo, S. P., G. H. Korndorfer, C. M. Korndorfer, R. M. Lana and D. G. Santan (2003). Silicon accumulation and water deficient tolerance in grasses. *Scientia Agricola*., **60** : 755-759.

Morgan, L. (1999). *Silica in Hydroponics*. Practical Hydroponics and Greenhouse, July/August: 51-66.

Nagaraja, G. S., Narayana Gowda and N. B. Nagaraja (1999). Influence of growing condition and cultivars on growth,

yield and quality parameters of exotic rose cultivars. *Mysore J. Agri. Sci*., **33** : 139-144.

Seung, J., P. Han-Min and R. Byoung (2005). Effect of potassium silicate on the growth of miniature rose 'pinocchio' grown on rockwool and its cut flower quality. *J. Japan Soc. Hort. Sci*., **74 (3)** : 242-247.

Zhu, J. K., G. Q. Wei, J. Li, Q. Q. Qian and J.Q. Yu (2004). Silicon alleviates salt stress and increases antioxidant enzymes activity in leaves of salt-stressed cucumber (*Cucumis sativus* L.). *Plant Sci*., **167** : 527533.