World Journal of Agricultural Sciences 17 (3): 222-241, 2021
ISSN 1817-3047
© IDOSI Publications, 2021
DOI: 10.5829/idosi.wjas.2021.222.241

Effect of Sodium Azide on Growth, Flowering and Corms of (*Gladiolus grandiflorus*) L. Cv. Rose Supreme Intercropping on Mulberry Field

[1]Hanan M.A. Youssef, [2]Taghreed E. Eissa, [3]Usama M. Ghazy and [4]Tahia A. Fouad

[1, 2]Ornamental Plants and Landscape Gardening Research Department,
Horticulture Research Institute, ARC, Giza, Egypt
[3, 4]Sericulture Research Department, Plant Protection Research Institute, ARC, Giza, Egypt

Abstract: This research aims to study genetic mutations and variations with best characteristics of *Gladiolus grandiflorus* L. cv. Rose supreme growth, flowering and corms by using sodium azide (SA), as well as, exploiting the empty space between mulberry field and studying the effect of this on silkworm , *Bombyx mori* L. traits. This experiment was conduct at mulberry field of the Sericulture Research Department Plant Protection Research Institute Agriculture Research Center Giza Egypt during seasons 2017/2018, 2018/2019 and 2019/2020 seasons. As factorial experiment was investigate the effects of sodium azide (SA) concentrations at (0.00, 0.01, 0.02, 0.04 % and blank (distilled water) and corms soaking period at (2.0 , 4.0 and 6.0 hours) on growth, flowering and corms characteristics in two generations (G1 and G2) of *G. grandiflorus* plants. The results showed that all SA concentrations and corms soaking period had significant impacts on several traits of postharvest quality such as plant height, leaf length, number of leaves per plant, stem diameter, fresh and dry weight of plants, number of days to flowering, number of florets per stem, flower head diameter, length of spike, vase life, plant variations and flower color, number of new cormels, cormels diameter, corm fresh and dry weight compared with the control. All concentrations of SA caused morphological variations in flower colors. The highest values of all recorded characters were obtained with SA at 0.01% for 6 hrs followed by 0.02% at the same time of G_1 and G_2 generations in all studied seasons as compared with control (untreated plants). No significant effect have been recorded for mulberry silkworm, *Bombyx mori* L. characters of cocoon weight, cocoon shell weight, pupae weight, cocoon shell ratio and silk productivity for females and males so using treated Gladiolus plant by sodium azide for intercropping with mulberry field is recommended to increase the income of agriculture land unite.

Key words: *Gladiolus grandiflorus* L. cv. rose supreme · Sodium azide · (NaN_3) · Mutation · Longevity · Mulberry field · Intercropping · Silkworm *Bombyx mori* L.

INTRODUCTION

Gladiolus is one of the most floral plants produced over in the world and importantly demanded in the world floral market. It is an important bulbous cut flower crop is adored all over the world for its attractive color and beautiful florets. Plants belongs to the Iridaceae family, it is an essential cut flower that is cultivated in all parts of the world, it is the second most important flower cut in Egypt afterrose and it is very appreciated to be used in floral arrangements in making bouquets, garden display and in beautifying any landscape, garden, potted plants and is used as specimen plant in flower shows and exhibitions. Gladiolus flowers not only offer aesthetical beauties, but also have become a commercial object, today in several countries and can contribute to national economies as long as millions of dollars. In addition to their potential usage as ornamental plants, their usage in phytomedicine due to the medical properties of the modified stems, leaves and in other related industries increases their importance. Production of inferior quality spikes is one of the major hurdles for their export, there is high demand of gladiolus in the world as cut flower [1-6].

Corresponding Author: Taghreed E. Eissa, Ornamental Plants and Landscape Gardening Res. Dept., Hort. Res. Inst., ARC, Egypt.

Sericulture considered as a most important agro-industrial activities. The discovery of silk production by *B. mori* dates to about 2700 BC, Mulberry silkworm, *Bombyx mori* L., is monophagous insect. It is mostly depending feed on many varieties of genius *Morus*. Silkworm larvae reared for commercial cocoon production [7]. Intercropping plays an important role in sericulture by using available land to increase the production of land unit area by using many species of crops such as solonaceous vegetables *Trifolium alexandrinum* (Barseem), *Sorghum vulgare*, greengram, blackgram, maize, cowpea toria, pea, spinach, amaranth as recommended by Misra *et al*. [8]; Singhvi and Katiyar [9]; Pandey and Dhar [10] and Vishaka *et al*. [11].

Sodium azide (NaN_3) is a chemical mutagen considers as one of the most powerful plants mutagens. It is a common bactericide and pesticide and known to be highly mutagenic in several organisms. Its application on plant is easy and inexpensive and creates mutation to improve their traits, SA is a chemical mutagen, which creates a point in the genome of plants through metabolite and thus created protein in mutant, is an essential mutagen to develop agronomic traits and induce new cultivars of many plants as found by Kapadiya *et al.* [12]; Ingelbrecht *et al*. [13] and Mohamed *et al*. [14].

Up to now, there have been no studies on effect the physical mutations in *Gladiolus grandiflorus* L. cv. rose supreme plants intercropping mulberry field.

The aims of this work were, to investigate the effect of sodium azide concentrations and corms soaking period on inducing mutations to improve growth, flower color and cormels production. Also, study the effect of cultivation the distance between rows of mulberry field with Gladiolus plants to increase the profit from the agriculture land unit in addition to income by sale crop of cocoons.

MATERIALS AND METHODS

Mulberry and Silkworm Procedures: To achieve the goal of this study, the present investigation was carried out during four successive seasons of (2017/2018, 2018/2019 and 2019/2020) at the mulberry field of the Sericulture Research Department (SRD) Plant Protection Research Institute Agriculture Research Center Giza Egypt. this investigations were conduct to induced genetic mutations and variations of *Gladiolus grandiflorus* L. cv. Rose supreme growth, flowering, corms and chemical composition by using sodium azide (SA), as well as, exploiting the empty space between mulberry field (highest 1.5-2 meter and lateral branch 50-70 cm) and studying the effect of this on silkworm, *Bombyx mori* L. characteristics.

Field was planted by *Morus alba* var Canava-2 the distance between plants are 30 cm in the same raw and the distance between rows are 2 meters. The treated Gladiolus corms were cultivated in the distance between rows.

The Gladiolus (*Gladiolus grandiflorus*) cv. rose supreme corms were treated with sodium azide concentrations at 0.01 (T_1), 0.02 (T_2), 0.04 (T_3) % and Blank (distilled water) and corms soaking period at 2.0 (S_1), 4.0 (S_2) and 6.0 (S_3) hours. Mulberry plant row takes the same codes of treated Gladiolus corms beside it, as well as blanks and control. The codes of mulberry rows were T_1S_1, T_1S_2, T_1S_3, T_2S_1, T_2S_2, T_2S_3, T_3S_1, T_3S_2, T_3S_3, BS_1, BS_2, BS_3 and control.

Local silkworm hybrid named Giza C (K_{232} X R_{153}) was obtained from silkworm breeding program of Sericulture Research Department [15]. Three replicates were kept for each treatment, 300 larvae were used for each replicate. Polythene sheets used as bottom and cover the young larvae, foam strips were surrounded the young larvae and shopped mulberry leaves were used for young silkworm larvae [16]. Whole leaves offered during fourth and fifth instars leaves were offered four times daily. Collapsible frames were used for mountage characters of fresh cocoon weight, cocoon shell weight, pupae weight, cocoon shell ratio and silk productivity were recorded.

Plant Material: Corms of Gladiolus (*G. grandiflorus* L.) cv. rose supreme plants were obtained from the local commercial greenhouses of Floramix Farm (El-Mansouria, Giza).

Experimental Design and Treatments: Fifteen treatments were arranged in a factorial experiment in a randomized complete block design was applied with two factors: (1) (0.00, 0.01, 0.02, 0.04 % and blank (distilled water) (2) corms soaking period at (2.0, 4.0 and 6.0 hours). Each treatment was included 18 corms in three replicates.

The effect of sodium azide and corms soaking period of Gladiolus (*G. grandiflorus* L.) cv. rose supreme. The treatments assessed were SA at (0.01, 0.02 and 0.04 %) was prepared by dissolving the powder in distilled water. The corms were soaked in the solutions for (2.0, 4.0 and 6.0 hours). Average corm diameter was 3.0 and 4.0 cm and corms weight were 9.3 and 10.2 g, for the first and second seasons, respectively .Corms were planted after soaked in SA. On Nov.1st during 2017/2018 and 2018 /2019 seasons

Table 1: Physical and chemical analyses for the used soil

Physical properties	Value	Soluble anions in saturation extract 1: 5 (mmole L^{-1})	Value
Sand (%)	26.02	CO_3^{2-}	--
Salt (%)	25.15	HCO_3^-	2.20
Clay (%)	48.83	Cl^-	7.46
Textural class	Clay	SO_4^{-2}	5.38
Chemical properties		pH	7.21
Soluble cations in saturation extract 1: 5 (mmole L^{-1})		EC dSm^{-1}	1.53
Ca^{2+}	2.94	Available N (mg/kg)	40.30
Mg^{2+}	2.44	Available P (mg/kg)	8.63
Na^+	6.06	Available K (mg/kg)	381
K^+	3.60	Organic matter (%)	1.82

in 1.5 × 2.0 m plots containing 2 ridges, 50 cm apart. The ridges were arranged in a North-South direction. Corms were planted in hills, 20 cm apart (10 corms per ridge) at a depth of 5 cm underground surface in clay soil in order to obtain the first generation (G_1). Plants of the G_1 plants, which survived in each treatment, were selected in order to obtain the second generation (G_2) corms. Other agricultural practices such as irrigation, fertilizer and weeding were carried out as recommended. At maturity all the surviving G_1 plants were harvested separately at the beginning of inflorescence coloring and corms were planted in the next season in plant progeny rows to raise G_2 generation.

G_2 Generation: The corms harvested from G_1 generation were taken from different treatments and used to raise G_2 generation plants. The G_2 generation was done in the second season on Nov. 1st, 2018/2019 and 2019/2020 seasons. All the recommended cultural practices namely, irrigation, fertilizer, weeding and plant protection methods were carried out during the plant growth period.

Experimental Data: Plant height, leaf length, number of leaves per plant, stem diameter, fresh and dry weight of plants, number of days to flowering, number of florets per stem, flower head diameter, length of spike, vase life, plant variations and flower color, number of new cormels, cormels diameter, corm fresh and dry weight.

The chemical and physical analysis for the used soil presented in Table (1) the chemical and physical analysis of experimental soil such as, EC, pH, cations and anions was carried out after Black [17]. N and P contents in the soil were determined according to King [18] while K was determined according to Jackson [19].

Statistical Analysis: Data were tabulated and subjected to analysis of variance as a factorial experiment using MSTAT statistical software [20] and the means of treatments were compared by Duncan's Multiple Range Test at 5% level as indicated by Snedecor and Cochran [21] on gladiolus treated with SA and by using L.S.D. test at 5% probability, according to Snedecor and Cochran [21] on silkworm, *Bombyx mori* L. characteristics.

RESULTS AND DISSCUTION

Effect of Sodium Azide Concentrations and Corms Soaking Period on Some Growth Parameters

Vegetative Growth: It should be pointed out that, corms sprouting started simultaneously seven days after planting and the sprouting rate was 100 % in the control as well as in the treated corms of *G. grandiflorus* L. plants during the first and the second generation. The mutagenic effects of SA appear soon after planting can be observed by naked eyes. In general, SA had significant impact on vegetative growth i.e. plant height, leaf length, number of leaves per stem, stem diameter, plant fresh weight and plant dry weight as shown in Tables (2, 3, 4, 5, 6 and 7) the application of the low dose of sodium azide (0.01%) for 6 hours was the best treatment absolutely in all studied characteristics in first generation (G_1) and second generation (G_2), (2017/2018, 2018/2019 and 2019/2020) seasons respectively. In contrast the lowest value of most characteristics was recorded in untreated plants in G_1 and G_2, respectively.

The effect of SA on plant growth could be due to its ion influence which hinders the latter part of the electron transfer chain or inhibition of catalase, peroxidase and cytochrome oxidation which affects the respiratory process. In addition, inhibition of enzymes activity that catalyzes the biosynthesis of gibberellins which play a role in stem elongation probably was also affected. Also, the stimulative effect of sodium azide might be attributed to cell division rates as well as to activation of growth hormones, for example, auxin. These results are in consonance with These results are in consonance with Youssef and Saadawy [22] they mentioned that treating plants with sodium azide resulted significantly in the highest values of leaf area, number of peduncles/plant and number of flowers/plant. Also, Nimbalikar *et al*. [23];

Table 2: Effect of sodium azide concentrations, corms, soaking period and their interaction on plant height of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Plant height (cm)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h)				Corms soaking period (h)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
				First generation (G_1)				
Sodium azide at 0.01	102.110 h	106.141e	115.202 a	107.818 A	109.201 f	114.122 d	135.201 a	119.508 A
Sodium azide at 0.02	104.142 g	108.121 d	110.302 b	107.522 B	111.622 c	114.161 c	130.123 b	118.635 B
Sodium azide at 0.04	105.122 f	110.142 c	100.202 m	105.155 C	104.200 e	110.230 e	100.150 k	104.860 C
Blank (D.W.)	100.421 l	100.530 k	100.651 j	100.534 D	101.433 i	100.532 i	100.251 j	100.739 D
Control (0)	100.421 l	101.230 i	100.651 j	100.767 E	100.543 g	102.122 g	101.231 h	101.299 E
Mean A	102.443 C	105.233 B	105.402 A		105.400 C	108.233 B	113.391 A	
				Second generation (G_2)				
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	109.521 e	112.522 d	125.301 a	115.781A	104.250h	130.142 b	140.262 a	124.885 A
Sodium azide at 0.02	108.232 f	115.451 c	120.252 b	114.645B	106.523 f	126.232 c	123.260 d	118.672 B
Sodium azide at 0.04	101.202 g	100.141 h	100.141 h	100.495C	102.121 j	104.902 g	106.533 e	104.519 C
Blank (D.W.)	86.211 n	88.002 m	92.021 j	88.745 E	98.002 o	100.001 m	102.142i	100.048D
Control (0)	88.202 l	91.251 k	94.411 i	91.288D	99.152 n	100.152 k	100.122 l	99.809 E
Mean A	98.674 C	101.473B	106.425 A	102.010 C	112.286 B	114.464 A		

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 3: Effect of sodium azide concentrations, corms soaking period and their interaction on leaf length of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Leaf length (cm)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
				First generation (G_1)				
Sodium azide at 0.01	51.121 g	60.12 2 b	65.143 a	58.795 A	52.651 e	59.982 b	62.653 a	58.429 A
Sodium azide at 0.02	49.123 h	52.002 f	58.131 d	53.085 B	50.232 f	54.752 d	59.231 c	54.738 B
Sodium azide at 0.04	48.150 i	55.331 e	59.202 c	54.228 C	48.231 g	47.552 h	45.233 i	47.005 C
Blank (D.W.)	44.120 o	44.650 k	46.120 j	44.963 D	40.023 m	41.231 k	43.023 j	41.426 D
Control (0)	44.124 n	44.332 l	44.151 m	44.202 E	38.161 o	39.152 n	40.140 l	39.151 E
Mean A	47.328 C	51.287 B	54.549 A		45.860 C	48.534 B	50.056 A	
				Second generation (G_2)				
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	55.640 f	58.161 c	64.122 a	59.308A	53.144 c	57.894 c	62.651 a	57.896A
Sodium azide at 0.02	53.121 g	57.122 d	59.223 b	56.489B	52.304 h	55.642 e	58.641 b	55.529B
Sodium azide at 0.04	50.121 h	53.122 g	56.123 e	53.122C	50.321i	54.131 f	55.782 d	53.411C
Blank (D.W.)	40.391 k	41.023 j	41.541 i	40.985D	42.120 o	43.120 l	44.120 j	43.120D
Control (0)	37.151 m	39.151 l	35.140 n	37.147E	42.851 m	42.351 n	43.861 k	43.021E
Mean A	47.285C	49.716B	51.230A		48.148C	50.628B	53.011A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 4: Effect of sodium azide concentrations, corms soaking period and their interaction on number of leaves per stem of (*G. grandiflorus* L.) CV. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Number of Leaves per stem							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period(h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
				First generation (G_1)				
Sodium azide at 0.01	8.401 e	8.645 c	9.236 a	8.761 A	8.261 g	8.655 b	9.006 a	8.641 A
Sodium azide at 0.02	8.350 g	8.387 f	9.025 b	8.587 B	8.301 f	8.562 c	8.655 b	8.506 B
Sodium azide at 0.04	8.202 i	8.256 h	8.546 d	8.335 C	8.254 h	8.402 e	8.451 d	8.369 C
Blank (D.W.)	8.021 m	8.023 lm	8.041 k	8.028 D	8.140 j	8.120 k	8.152i	8.137 D
Control (0)	8.025 l	8.045 j	8.014 n	8.028 D	7.230 n	8.001 m	8.02 3 l	7.751 E
Mean A	8.200 C	8.271B	8.572 A		8.037 C	8.348 B	8.457 A	
				Second generation (G_2)				
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	8.394 d	8.651 b	8.743 a	8.596A	8.501 e	8.702 b	8.761 a	8.655 A
Sodium azide at 0.02	8.222 h	8.351 e	8.521 c	8.365B	8.450 f	8.602 d	8.692 c	8.581 B
Sodium azide at 0.04	8.142i	8.301 g	8.331 f	8.258C	8.241 h	8.401 g	8.452 f	8.365 C
Blank (D.W.)	7.960 m	8.020 k	8.052j	8.011D	8.119 k	8.109 l	8.200i	8.143 D
Control (0)	7.561 n	7.521 o	8.001 l	7.694E	8.14 l j	7.801 n	7.902 m	7.948 E
Mean A	8.056 C	8.169 B	8.330 A		8.290C	8.323B	8.401A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 5: Effect of sodium azide concentrations, corms soaking period and their interaction on stem diameter of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Stem diameter (cm)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period(h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
				First generation (G_1)				
Sodium azide at 0.01	0.711 f	0.731 d	0.922 a	0.788 A	0.875bc	0.878 b	0.885 a	0.879 A
Sodium azide at 0.02	0.722 e	0.740 c	0.811 b	0.758 B	0.873 cd	0.875bc	0.878 b	0.875 A
Sodium azide at 0.04	0.723 e	0.732 d	0.650 h	0.702 C	0.871 de	0.87 de	0.869 e	0.870 A
Blank (D.W.)	0.701 g	0.721 e	0.640i	0.687 D	0.741 h	0.762 g	0.774 f	0.759 B
Control (0)	0.700 g	0.721 e	0.641i	0.687 D	0.742 h	0.76 g	0.771 f	0.758 B
Mean A	0.711 C	0.729 B	0.733 A		0.820 C	0.829 B	0.835 A	
				Second generation (G_2)				
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	0.760 e	0.886 b	0.899 a	0.848 A	0.812 d	0.854 e	0.869 a	0.845 A
Sodium azide at 0.02	0.751ef	0.845 c	0.836 cd	0.811 B	0.752 f	0.793 hi	0.836 c	0.794 B
Sodium azide at 0.04	0.741 f	0.836 cd	0.828 d	0.802 B	0.731 g	0.720 hi	0.797 e	0.749 C
Blank (D.W.)	0.702 g	0.704 g	0.712 g	0.706 C	0.720 hi	0.725ghi	0.729 gh	0.725 D
Control (0)	0.691 h	0.701gh	0.704 g	0.699 C	0.742 b	0.762 f	0.716 i	0.740 C
Mean A	0.729 C	0.794 B	0.796 A		0.751 C	0.771 B	0.789 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 6: Effect of sodium azide concentrations, corms soaking period and their interaction on plant fresh weight of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Plant fresh weight (g)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period (h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
				First generation (G_1)				
Sodium azide at 0.01	54.300 f	58.521 c	69.124 a	60.648 A	65.251 c	63.141 d	72.121 a	66.838 A
Sodium azide at 0.02	54.121 g	56.251 d	63.121 b	57.831 B	60.132 f	59.221 g	68.141 b	62.498 B
Sodium azide at 0.04	45.142i	48.160 h	55.142 e	49.481 C	54.192i	58.122 h	60.141 e	57.485 C
Blank (D.W.)	35.620 l	36.201 k	36.320 j	36.047 D	41.230 m	42.023 l	43.210 j	42.154 D
Control (0)	34.302 o	34.661 n	35.121 m	34.695 E	40.651 n	40.101 o	43.150 k	41.301 E
Mean A	44.697 C	46.759 B	51.766 A		52.291 C	52.522 B	57.353 A	
				Second generation (G_2)				
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	51.831 e	53.651 c	59.786 a	55.089 A	47.141 e	48.171 c	55.321 a	50.211 A
Sodium azide at 0.02	50.421 g	52.202 d	54.637 b	52.420 B	43.151 h	46.221 f	50.151 b	46.508 B
Sodium azide at 0.04	49.17 h	48.201 i	50.984 f	49.452 C	41.504i	44.121 g	48.121 d	44.582 C
Blank (D.W.)	44.23 l	44.623 k	45.262 j	44.705 D	37.020 n	37.125 m	38.012 k	37.386 D
Control (0)	43.7 n	43.391 o	44.151 m	43.747 E	36.841 o	37.141 l	38.151 j	37.378 D
Mean A	47.870 C	48.414 B	50.964 A		41.131 C	42.556 B	45.951 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 7: Effect of sodium azide concentrations, corms soaking period and their interaction on plant dry weight of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Plant dry weight (g)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period (h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
				First generation (G_1)				
Sodium azide at 0.01	16.810 f	18.031 c	21.252 a	18.698 A	20.034 c	19.434 d	22.199 a	20.556 A
Sodium azide at 0.02	16.631 h	17.441 d	19.361 b	17.811 B	18.512 f	18.222 c	20.958 b	19.231 B
Sodium azide at 0.04	16.501 i	16.852 e	16.642 g	16.665 C	16.624i	17.853 h	18.538 e	17.672 C
Blank (D.W.)	10.652 m	10.723 l	10.851 j	10.742 D	12.560 l	12.642 k	13.250 j	12.817 D
Control (0)	10.561 o	10.622 n	10.832 k	10.672 E	12.551 l	12.304m	13.246 j	12.700 E
Mean A	14.231 C	14.734 B	15.788A		16.056 C	16.091 B	17.638 A	
				Second generation (G_2)				
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	15.401 e	15.862 d	16.987 a	16.083 A	15.514 c	15.634 b	16.041 a	15.730 A
Sodium azide at 0.02	15.204 f	16.562 b	16.405 c	16.057 B	14.001 g	14.231 f	15.444 d	14.559 B
Sodium azide at 0.04	15.116 g	16.401 c	16.395 c	15.971 C	12.601i	13.454 h	14.814 e	13.623 C
Blank (D.W.)	13.512 i	13.620 h	13.620 h	13.584 D	11.431 l	11.521 j	11.523 j	11.492 D
Control (0)	13.421 j	13.353 k	13.502 i	13.425 E	11.321 n	11.410 m	11.502 k	11.411 E
Mean A	14.531 C	15.160 B	15.382 A		12.974 C	13.250 B	13.865 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05

Roychowdhury and Tah, [24]; Gruszka *et al*. [25]; Dewi *et al*. [26] who reported that alteration on growth may be attributed to the increase in growth promoters, the quick rise in metabolic status at certain levels of dose, the increase in destruction of growth inhibitors and drop in the auxin level or inhibition of auxin synthesis.

Table 8: Effect of sodium azide concentrations, corms soaking period and their interaction on number of days to flowering of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Number of days to flowering							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
	First generation (G_1)							
Sodium azide at 0.01	83.061 h	82.035 k	81.650 l	82.249 E	82.001 k	81.601 l	80.401 m	81.334 E
Sodium azide at 0.02	83.156 g	82.654 i	82.502 j	82.771 D	83.002 i	82.961 j	82.001 k	82.655 D
Sodium azide at 0.04	83.160 g	83.987 f	83.156 g	83.434 C	83.523 g	83.923 f	83.441 h	83.629 C
Blank (D.W.)	85.600 b	85.724 a	85.731 a	85.685 A	85.356 b	85.364 b	85.412 a	85.377 A
Control (0)	85.510 c	85.235 d	85.216 e	85.320 B	85.300 c	85.250 d	85.001 e	85.184 B
Mean A	84.097 A	83.927 B	83.651 C		83.836 A	83.820 B	83.251 C	
	Second generation (G_2)							
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	83.140 g	82.561 i	80.020 l	81.907 D	83.986 d	82.896 k	80.001 n	82.294 E
Sodium azide at 0.02	83.961 d	82.962 h	81.520 k	82.814 C	83.142 i	83.123 j	81.012 m	82.426 D
Sodium azide at 0.04	84.252 c	83.923 e	82.311 j	83.495 B	83.460 f	83.340 g	82.023 l	82.941 C
Blank (D.W.)	85.569 a	84.631 b	83.720 f	84.640 A	84.420 b	84.511 a	83.723 e	84.218 A
Control (0)	85.567 a	84.630 b	83.725 f	84.641 A	84.321 c	84.412 b	83.214 h	83.982 B
Mean A	84.498 A	83.741 B	82.259 C		83.866 A	83.656 B	81.995 C	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 9: Effect of sodium azide concentrations, corms soaking period and their interaction on number of florets per stem of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Number of florets per stem							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
	First generation (G_1)							
Sodium azide at 0.01	9.690 d	9.695 d	10.256 a	9.880 A	9.506 e	9.784 b	10.238 a	9.843 A
Sodium azide at 0.02	9.001 h	9.187 f	10.238 b	9.475 C	9.489 f	9.537 d	9.684 c	9.570 B
Sodium azide at 0.04	9.134 g	9.501 e	9.945 c	9.527 B	9.302 k	9.352 j	9.454 g	9.369 C
Blank (D.W.)	8.664 i	8.144 j	8.144 j	8.317 D	9.085 m	9.123 l	9.129 l	9.112 E
Control (0)	8.661 i	8.141 j	8.143 j	8.315 D	9.002 n	9.434 h	9.405 i	9.280 D
Mean A	9.030 C	8.934 A	9.345 B		9.277 C	9.446 B	9.582 A	
	Second generation (G_2)							
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	10.120 f	10.760 c	11.754 a	10.878 A	10.351 d	10.531 b	10.741 a	10.541 A
Sodium azide at 0.02	9.262 h	10.144 e	10.853 b	10.086 B	10.002 e	10.352 d	10.461 c	10.272 B
Sodium azide at 0.04	9.181 k	10.252 d	9.653 g	9.695 C	9.351 h	9.423 g	9.900 f	9.558 C
Blank (D.W.)	9.256 h	9.243 ij	9.240 ij	9.246 D	9.103 k	9.106 k	9.200 i	9.136 D
Control (0)	9.244 i	9.233 j	9.245 i	9.241 D	9.1002 k	9.104 k	9.140 j	9.115 D
Mean A	9.413 C	9.926 B	10.149 A		9.581 C	9.703 B	9.888 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 10: Effect of sodium azide concentrations, corms soaking period and their interaction on length of spike of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Length of spike (cm)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
	First generation (G_1)							
Sodium azide at 0.01	46.182 f	56.180 b	59.132 a	53.831 B	49.161 d	50.120 c	53.152 a	50.811 A
Sodium azide at 0.02	43.951 g	51.230 e	54.131 c	49.771 A	44.200 f	45.161 e	51.232 b	46.864 B
Sodium azide at 0.04	40.122 h	54.130 c	53.122 d	49.125 B	39.160 g	37.120 h	35.120 i	37.133 C
Blank (D.W.)	29.225 j	29.300 i	28.461 m	28.995 C	30.215 n	31.314 l	33.412 j	31.647 D
Control (0)	29.125 k	29.100 l	28.161 n	28.795 D	30.125 o	31.134 m	33.142 k	31.467 E
Mean A	37.721 C	43.988 B	44.601 A		38.572 C	38.970 B	41.212 A	
	Second generation (G_2)							
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	48.531 d	54.652 b	56.180 a	53.121 A	50.251 e	54.65 1 b	58.652 a	54.518 A
Sodium azide at 0.02	39.011 h	48.130 e	53.201 c	46.781 B	48.234 g	50.322 d	53.121 c	50.559 B
Sodium azide at 0.04	36.401 i	46.134 f	43.121 g	41.885 C	44.741i	46.122 h	49.182 f	46.682 C
Blank (D.W.)	34.651 j	34.001 l	34.102 k	34.251 D	31.410 k	31.121l	32.544 j	31.692 D
Control (0)	34.652 j	34.002 l	34.104 k	34.253 D	30.412 m	31.12 2 l	32.544 j	31.359 E
Mean A	38.649 C	43.384 B	44.142 A		41.010C	42.668B	45.209 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 11: Effect of sodium azide concentrations, corms soaking period and their interaction on flower diameter of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Flower diameter (cm)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
	First generation (G_1)							
Sodium azide at 0.01	11.201 d	11.305 c	12.235 a	11.580 A	10.331 h	10.344 g	11.501 b	10.725 A
Sodium azide at 0.02	11.005 c	11.130 f	12.002 b	11.379 B	10.401 e	10.441 d	10.921 c	10.588 B
Sodium azide at 0.04	10.451 h	10.232 i	11.160 e	10.614 C	10.382 f	10.411 j	10.521 l	10.438 C
Blank (D.W.)	10.032 k	10.041 jk	10.045 j	10.039 D	10.134 k	10.204 i	10.092 m	10.143 D
Control (0)	10.031 k	10.031 k	10.002 l	10.021 D	10.13 5 k	10.212 a	10.012 m	10.120 D
Mean A	10.544 C	10.548 B	11.089 A		10.277C	10.322 B	10.609 A	
	Second generation (G_2)							
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	10.354 e	10.451 b	10.480 a	10.428 A	10.160 g	10.292 c	10.336 a	10.263 A
Sodium azide at 0.02	10.121 h	10.301 f	10.391 c	10.271 B	10.091 h	10.262 d	10.296 b	10.216 B
Sodium azide at 0.04	10.123 h	10.231 g	10.361 d	10.238 C	10.000 i	10.232 f	10.245 e	10.159 C
Blank (D.W.)	9.651 i	9.544 k	9.426 m	9.540 D	9.012 m	9.061 l	9.075 k	9.049 D
Control (0)	9.646 j	9.456 l	9.403 m	9.502 E	9.002 n	9.061 l	9.105 j	9.056 D
Mean A	9.979 C	9.997 B	10.012 A		9.653 C	9.782 B	9.811 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 12: Effect of sodium azide concentrations, corms soaking period and their interaction on vase life of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Vase life (days)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period (h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
	First generation (G_1)							
Sodium azide at 0.01	14.024 f	14.565 c	15.855 a	14.815 A	14.964 e	15.235 c	16.531 a	15.577 A
Sodium azide at 0.02	14.121 e	14.354 d	14.981 b	14.485 B	14.541 f	15.145 d	16.021b	15.236 B
Sodium azide at 0.04	13.661i	13.821 h	14.001 g	13.828 C	13.562i	14.004 h	14.361g	13.976 C
Blank (D.W.)	12.022 m	12.341 j	12.060l	12.141 D	12.413 n	13.320 k	12.623l	12.785 D
Control (0)	12.022 m	12.342 j	12.064 k	12.143 D	12.410 n	13.324 j	12.612 m	12.782 D
Mean A	13.170 C	13.485 B	13.792A		13.578 C	14.206 B	14.430 A	
	Second generation (G_2)							
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	14.961 d	15.002 c	16.456 a	15.473 A	14.981 f	15.367 c	16.039 a	15.462 A
Sodium azide at 0.02	14.581 g	14.961 d	15.032 b	14.858 B	14.885 g	15.076 e	15.449 b	15.137 B
Sodium azide at 0.04	14.310 h	14.642 f	14.892 e	14.615 C	14.635 h	14.610i	15.088 d	14.778 C
Blank (D.W.)	12.125 k	12.136 j	12.142i	12.134 D	13.120 k	12.150 n	12.189 l	12.486 E
Control (0)	12.125 k	12.136 j	12.140i	12.134D	13.210 j	12.154 m	12.186 l	12.517 D
Mean A	13.620 C	13.775 B	14.132 A		14.166 C	13.871 B	14.190 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 13: Plant variations of *G. grandiflorium* L. as affected by different concentrations of sodium azid and corms soaking period

No	Sodium azide concentration % and corms soaking period (h.)	Abnormal phenotype	No	Concentration and corms soaking period	Abnormal phenotype
1	Control	Normal plant (original color) (a)	6	0.02 at 4 h.	Flower color (g)
2	0.01 at 2 h.	Flower color (b)	7	0.02 at 6 h.	Flower color (h, i)
3	0.01 at 4 h.	Flower color (c)	8	0.04 at 2 h.	Flower color (j)
4	0.01 at 6 h.	Flower color (d , e)	9	0.04 at 4 h.	Flower color(k)
5-	0.02 at 2 h.	Flower color (f)	10	0.04 at 6 h	Flower color(l)

Floral Characters: In fact, there were remarkable variations in the range of all floral characters due to the sodium azide treatments such as i.e. number of days to flowering, number of florets per stem, length of spike, flower diameter, vase life, plant variations and flower color as shown in Tables (8, 9, 10, 11, 12, 13 and Fig. 2) the application of the low dose of sodium azide (0.01 %) for 6 hours was the best treatment in all studied characteristics in first generation (G_1) and second generation (G_2) (2017/2018, 2018/2019 and 2019/2020) seasons , respectively. In contrast the lowest value of most characteristics was recorded in untreated plants in G_1 and G_2 respectively. These results might be attributed to SA (NaN_3) is a chemical mutagen which is consider as one of the most powerful mutagens in plants. Its application on plant is easy and inexpensive and creates mutation to improve their traits. All the concentrations of SA produced changes in the flower color, these changes may be due to chromosomal disturbances and these changes could be referred also to the layer rearrangement as a result of the chemical mutagens effect. The efficiency of mutant production depends on many conditions such as pH, soaking into water, temperature, concentration of azide and treatment duration. These results were in a good harmony with Youssef and Saadawy [22] sodium azide concentrations on some plant characteristics could be utilized in making flowering pot plants out of bougainvillea that can be of good marketing value. Also, El-Mokadem *et al.* [27] who declared that SA is powerful mutagens for the induction mutations.

It is likely that the obtained mutants in flowers color (b, c, d, e, f , g, h, i, j, k and l) may be due to a mutation in the biosynthetic pathway of structural or regulatory genes may cause a change in flower color, NaN3 induced changes in flower color, flower shape. These results were in harmony with Nakatsuka, *et al*. [28] Who reported that NaN3 induced strikingly attractive flower color modifications. When the blockage occurs at the early stages of anthocyanin synthesis, white flowers will result, while a blockage at later stages leads to different flower colors due to the accumulation of particular anthocyanins.

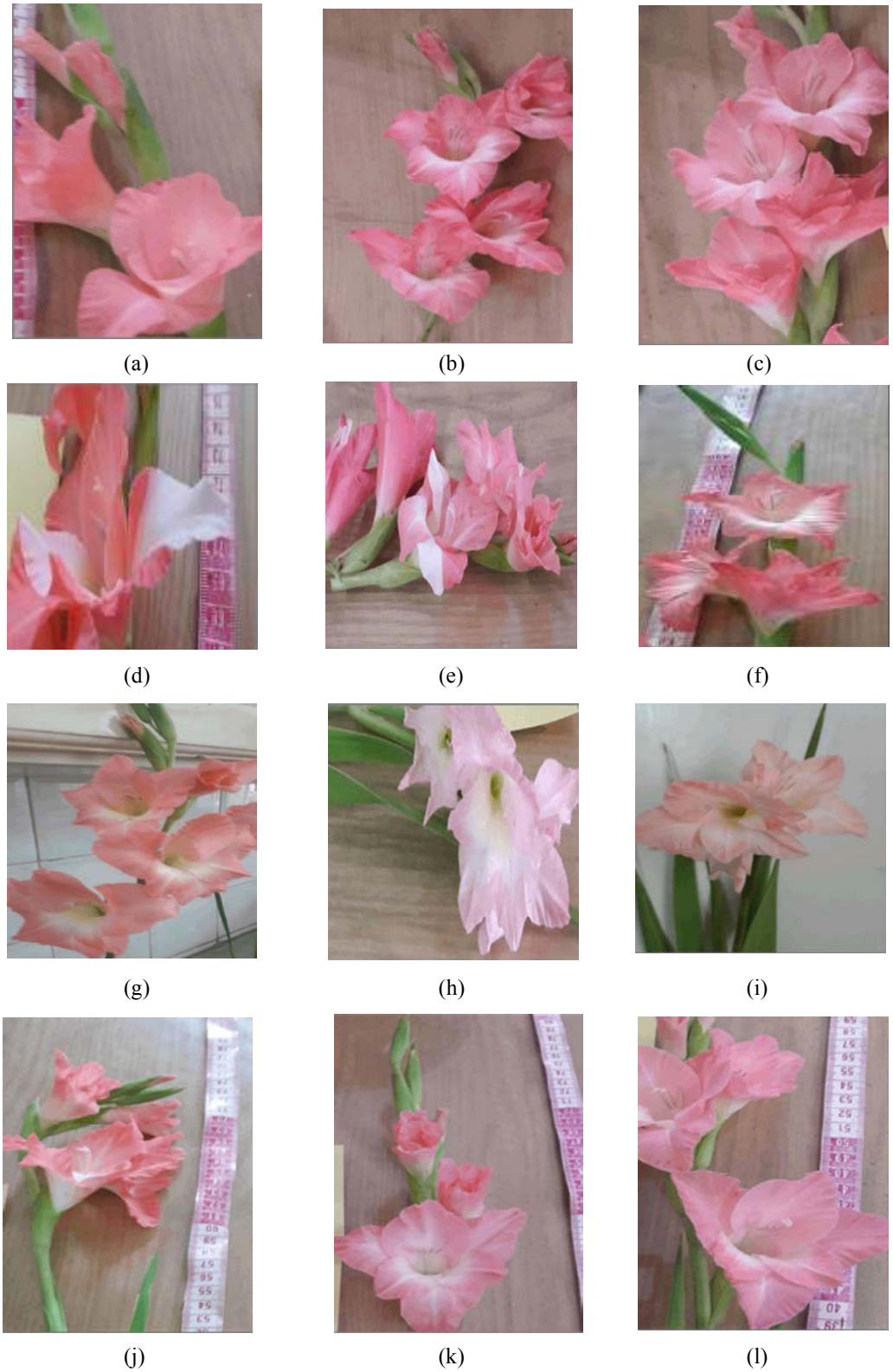

Fig. 1: Showing the plant variations of *G. grandiflorus* L. as affected by different concentrations of sodium azide on inflorescence color and control plant in G1 and G2 generation

Table 14: Effect of sodium azide concentrations, corms soaking period and their interaction on number of new cormels of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Number of new cormels							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
				First generation (G_1)				
Sodium azide at 0.01	60.520 f	65.614 c	72.614 a	66.249 A	69.152 e	78.153 c	85.575 a	77.627 A
Sodium azide at 0.02	56.122 h	62.601 e	68.614 b	62.446 B	64.153 g	73.153 d	78.415 b	71.907 B
Sodium azide at 0.04	53.120 i	58.612 g	62.642 d	58.125 C	60.181 h	65.184 f	69.155 e	64.840 C
Blank (D.W.)	43.104 o	45.102 k	44.002 m	44.069 E	54.651 j	55.423 i	53.753 l	54.609 D
Control (0)	43.113 n	45.112 j	44.102 l	44.109 D	54.615 k	55.422 i	53.735 m	54.591 E
Mean A	51.196 C	55.408 B	58.395 A		60.550 C	65.467 B	68.127 A	
				Second generation (G_2)				
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	64.204 g	68.243 d	78.832 a	70.426 A	67.145 h	89.145c	95.517 k	83.936 A
Sodium azide at 0.02	62.125 h	65.133 e	72.572 b	66.610 B	68.504 g	80.895 d	93.614 a	81.004 B
Sodium azide at 0.04	60.260i	64.554 f	69.135 c	64.650 C	63.842i	75.545 e	73.405 b	70.931 C
Blank (D.W.)	52.243 k	51.115 o	52.165 l	51.841 E	54.313 m	55.223 e	56.155 f	55.230 D
Control (0)	52.146 m	51.214 n	52.262 j	51.874 D	54.133 n	55.250 l	56.156 j	55.180 E
Mean A	58.196 C	60.052 B	64.993 A		61.587 C	71.212 B	74.969 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 15: Effect of sodium azide concentrations, corms soaking period and their interaction on cormels diameter of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Cormels diameter (cm)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
				First generation (G_1)				
Sodium azide at 0.01	1.514 g	1.805 b	1.906 a	1.742 A	1.704 g	1.805 c	2.201 a	1.903 A
Sodium azide at 0.02	1.504 h	1.536 f	1.756 c	1.599 B	1.720 f	1.752 d	2.002 b	1.825 B
Sodium azide at 0.04	1.545 e	1.502 h	1.605 d	1.551 C	1.734 e	1.453 i	1.305 n	1.497 C
Blank (D.W.)	1.412 k	1.425 j	1.435 i	1.424 D	1.450i	1.462 h	1.423 j	1.445 D
Control (0)	1.406 l	1.413 k	1.436 i	1.418 D	1.360 m	1.373 l	1.393 k	1.375 E
Mean A	1.476 C	1.536 B	1.628 A		1.594 C	1.569B	1.665A	
				Second generation (G_2)				
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	1.457 i	1.721 c	1.882 a	1.687 A	1.601 f	1.851 c	2.258 a	1.903 A
Sodium azide at 0.02	1.531 g	1.680 d	1.786 b	1.666 B	1.635 e	1.678 d	2.140 b	1.818 B
Sodium azide at 0.04	1.582 f	1.462 h	1.606 e	1.550 C	1.544 i	1.556 h	1.590 g	1.563 C
Blank (D.W.)	1.404 m	1.422 k	1.435 j	1.420 D	1.339 j	1.335 k	1.336 jk	1.337 D
Control (0)	1.409 l	1.423 k	1.436 j	1.423 D	1.231 m	1.235 l	1.236 l	1.234 E
Mean A	1.477 C	1.542 B	1.629 A		1.470 C	1.531 B	1.712 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 16: Effect of sodium azide concentrations, corms soaking period and their interaction on corm diameter of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Corm diameter (cm)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period (h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
	First generation (G_1)							
Sodium azide at 0.01	4.901 m	5.302 b	5.901 a	5.368 A	4.805 d	4.956 c	5.619 a	5.127 A
Sodium azide at 0.02	4.822 f	5.202 c	5.203 c	5.076 B	4.403 f	4.553 e	5.208 b	4.721 B
Sodium azide at 0.04	4.403 g	5.153 d	5.093 e	4.883 C	4.204 l	4.353 g	4.215 k	4.257 D
Blank (D.W.)	4.201 j	4.320 i	4.333 h	4.285 D	4.312 j	4.325 h	4.326 h	4.321 C
Control (0)	4.120 l	4.130 k	4.133 k	4.128 E	4.319 i	4.325 h	4.326 h	4.323 C
Mean A	4.489C	4.821B	4.933A		4.409 C	4.502 B	4.739 A	
	Second generation (G_2)							
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	4.751 d	4.83 4 c	5.122 a	4.902 A	4.890 d	4.921 c	5.564 a	5.125 A
Sodium azide at 0.02	4.651 f	4.735 e	4.862 b	4.749 B	4.736 f	4.860 e	5.165 b	4.920 B
Sodium azide at 0.04	4.530 h	4.624 g	4.523 i	4.559 C	4.625 i	4.730 g	4.704 h	4.686 C
Blank (D.W.)	4.135 l	4.334 j	4.334 j	4.268 D	4.411 n	4.430 m	4.453 k	4.431 E
Control (0)	4.131 m	4.331 j	4.236 k	4.233 E	4.414 n	4.438 l	4.457 j	4.436 D
Mean A	4.440 C	4.572 B	4.615 A		4.615C	4.676B	4.869 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 17: Effect of sodium azide concentrations, corms soaking period and their interaction on corm fresh weight of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons

	Corm fresh weight (g)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
	First generation (G_1)							
Sodium azide at 0.01	33.144 e	36.145 c	40.126 a	36.472 A	39.454 e	44.535 b	48.167 a	44.052 A
Sodium azide at 0.02	30.236 g	34.512 d	38.139 b	34.296 B	37.053 g	40.125 d	44.126 c	40.435 B
Sodium azide at 0.04	28.151 j	32.126 f	30.158 i	30.145 C	35.233 h	38.125 f	34.896 i	36.085 C
Blank (D.W.)	26.255 k	26.235 m	26.253 l	26.248 D	30.322 n	32.124 l	34.125 j	32.190 D
Control (0)	26.251 l	26.234 m	26.154 kl	26.213 E	30.312 o	32.114 m	34.115 k	32.180 D
Mean A	28.807 C	31.050 B	32.166 A		34.475 C	37.405 B	39.086 A	
	Second generation (G_2)							
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	34.254 e	38.656 c	42.526 a	38.479 A	36.541 e	39.841 c	45.652 a	40.678 A
Sodium azide at 0.02	30.085 h	34.625 d	39.846 b	34.852 B	33.983 f	37.512 d	41.262 b	37.586 B
Sodium azide at 0.04	29.546 k	31.785 f	30.186 g	30.506 C	33.651 g	33.981 f	31.201 m	32.944 C
Blank (D.W.)	29.320 l	28.624 n	29.624 i	29.189 D	32.182 j	32.604 i	32.626 h	32.471 D
Control (0)	29.310 m	28.614 o	29.604 j	29.176 D	31.184 n	31.642 l	31.666 k	31.497 E
Mean A	30.503 C	32.461 B	34.357 A		33.508 C	35.116B	36.481 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Table 18: Effect of sodium azide concentrations, corms soaking period and their interaction on corm dry weight of (*G. grandiflorus* L.) cv. rose supreme during the (2017/2018, 2018/2019&2019/2020) seasons.

	Corm dry weight (g)							
	First season 2017/2018				Second season 2018/2019			
	Corms soaking period (h.)				Corms soaking period(h.)			
Concentrations (%)	2.0	4.0	6.0	Mean B	2.0	4.0	6.0	Mean B
				First generation (G_1)				
Sodium azide at 0.01	10.073 e	11.026 c	13.289 a	11.463 A	11.990 e	13.582 c	15.954 a	13.842 A
Sodium azide at 0.02	9.193 g	10.520 d	12.639 b	10.784 B	11.262 h	12.232 d	14.615 b	12.703 B
Sodium azide at 0.04	8.796 i	9.796 h	9.989 f	9.527 C	10.712 i	11.623 f	11.552 g	11.296 C
Blank (D.W.)	7.372 n	7.564 j	7.549 l	7.495 D	8.622 l	8.780 k	8.890 j	8.764 D
Control (0)	7.370 n	7.560 k	7.543 m	7.491 E	8.522 n	8.580 m	8.890 j	8.664 E
Mean A	8.561 C	9.293 B	10.202 A		10.222 C	10.959 B	11.980 A	
				Second generation (G_2)				
	First season 2018/2019				Second season 2019/2020			
Sodium azide at 0.01	10.410 e	11.784 c	14.086 a	12.093 A	11.112 e	12.150 c	15.122 a	12.795 A
Sodium azide at 0.02	9.145 h	10.555 d	13.194 b	10.965 B	10.333 g	11.444 d	13.662 b	11.813 B
Sodium azide at 0.04	8.981 i	9.691 g	9.991 f	9.554 C	10.001 h	10.362 f	10.333 g	10.232 C
Blank (D.W.)	8.191 j	8.031 m	8.062 l	8.095 D	9.091 j	9.020 k	9.120 i	9.077 D
Control (0)	8.091 k	8.030 m	8.062 l	8.061 E	9.091 j	9.020 k	9.023 k	9.045 E
Mean A	8.964 C	9.618 B	10.679 A		9.926 C	10.399 B	11.452 A	

Means followed by the same letters in a column or row do not differ significantly according to Duncan's New Multiple Range test at P = 0.05.

Corms Production: Actually, The mutagenic effects of sodium azide on corms can be observed by naked eyes, there were remarkable variations in the range of all corm traits due to the SA treatments such as i.e. number of new cormels, cormels diameter, corm diameter, corm fresh weight and corm dry weight as shown in Tables (14, 15, 16, 17 and 18) the application of the low dose of sodium azide (0.01 %) for 6 hours was the best treatment in all studied characteristics followed by SA. (0.02 %) for 6 hours in G_1 and G_2 (2017/2018 and 2018/2019 and 2019/2020) seasons respectively. In contrast the lowest value of most characteristics was recorded in untreated plants in first generation (G_1) and second generation (G_2), respectively. The application of SA on *G. longiflorum* is easy and inexpensive for improvement of corm traits and create resistance to them against biotic and abiotic stresses. These results are in a good harmony with Khan *et al*. [29].

Effect of Intercropping Treated (*Gladiolus grandiflorus*) L. cv. Rose Supreme with Sodium Azide on Mulberry Field of Mulberry Silkworm, *Bombyx mori* L. Characters: Data in Tables 19, 20, 21 and 22 showed the effect of intercropping of treated Gladiolus with mulberry field on silkworm, *Bombyx mori* L. cocoon weight (g) character and its interactions.

It revealed that insignificant differences were obtained between of treatments, soaking periods, interactions of Year X Treatment, Year X Soaking period, Treatment X Soaking period, Year X Treatment X Soaking period and Year X Treatment X Soaking period X Sex. Highly significant differences were observed between years, Sex and Year X Sex. The results declare that, the treatment, soaking periods have not any effect on cocoon characters.

Tables 23, 24, 25 and 26 showed that, effect of intercropping treated Gladiolus with sodium azide on cocoon shell trait of mulberry silkworm the same trend of cocoon weight were obtained. So there is no effect of sodium azide treatment and soaking period.

Tables 27, 28, 29 and 30 showed the effect of intercropping of treated Gladiolus with sodium azide on mulberry field of silkworm, *Bombyx mori* L. the results reappeared that, there are no significant differences between of treatments, soaking periods, Treatment X Soaking period, Year X Treatment, Year X Soaking period, Year X Time X Sex and Year X Time X Soaking period X Sex. Highly significant differences were observed between of years, Sex and Y X Sex planted treated Gladiolus with mulberry field had no effect on silkworm rearing treats.

Tables 31, 32, 33 and 34 showed the effect of intercropping of treated Gladiolus with sodium azide on mulberry field of cocoon shell ratio trait of mulberry silkworm. So similar trend of the previous character were obtained.

Table 19: Effect of intercropping of Gladiolus treated with mulberry field on silkworm, Bombyx mori L. cocoon weight (g) character

	Year						
Treatments	Y_1	Y_2	Y_3	Y_4	Mean	Fbetween treatments	LSD 0.05
T_1	1.747	1.736	1.937	2.026	1.862	1.000	-
T_2	1.724	1.763	1.889	1.995	1.843		
T_3	1.747	1.787	1.911	1.998	1.861		
Blank	1.725	1.764	1.902	2.018	1.852		
Control	1.719	1.758	1.898	1.980	1.839		
Mean	1.732	1.762	1.907	2.003			
F between Years			191.940**				
LSD 0.05			0.025				
F between interaction Y X T			0.610				
LSD 0.05			-				

where: Y_1, Y_2, Y_3 (Years), T_1, T_2, T_3 (treatments) & (*) significant at 0.05, (**) highly significant at 0.01

Table 20: Effect of time application for different treatments of Gladiolus intercropping with mulberry field on mulberry silkworm, *Bombyx mori* L. cocoon weight (g) trait

	Soaking period					
Treatments	S_1	S_2	S_3	Mean	Fbetweeninteraction T X S	LSD 0.05
T_1	1.851	1.867	1.867	1.862	0.07	-
T_2	1.835	1.848	1.845	1.843		
T_3	1.849	1.872	1.861	1.861		
Blank	1.848	1.856	1.853	1.852		
Control	1.839	1.839	1.839	1.839		
Mean	1.844	1.857	1.853			
F between Soaking period			0.620			
LSD 0.05			-			

where: S_1, S_2, S_3 (Soaking period), T_1, T_2, T_3 (Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 21: Interactions between different treatments, soaking period and years of silkworm cocoon weight (g) characters

	Y_1			Y_2			Y_3			Y_4				
Treatments	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	Fbetween interaction Y X T X S	LSD 0.05
T_1	1.738	1.766	1.738	1.721	1.743	1.744	1.937	1.933	1.940	2.006	2.028	2.045	0.140	-
T_2	1.727	1.713	1.731	1.747	1.766	1.779	1.889	1.897	1.882	1.979	2.017	1.989		
T_3	1.736	1.766	1.740	1.776	1.805	1.779	1.924	1.920	1.889	1.961	1.996	2.035		
Blank	1.725	1.726	1.724	1.764	1.765	1.763	1.907	1.896	1.904	1.995	2.038	2.022		
Control	1.719	1.719	1.719	1.758	1.758	1.758	1.898	1.898	1.898	1.980	1.980	1.980		
Mean	1.729	1.738	1.730	1.753	1.768	1.765	1.911	1.910	1.903	1.984	2.012	2.014		
Average Year	1.733			1.762			1.907			2.003				
F Interaction Y X S							0.290							
LSD 0.05							-							

where: (Y_1, Y_2, Y_3 = Years); (S_1, S_2, S_3 =Soaking period); (T_1, T_2, T_3 =Treatments) & (*) significant at 0.05, (**) highly significant at 0.01

Table 22: Interactions between different treatments, soaking period, sexes and years on silkworm cocoon weight (g) trait

	Y_1						Y_2						Y_3						Y_4					
	S_1		S_2		S_3		S_1		S_2		S_3		S_1		S_2		S_3		S_1		S_2		S_3	
Treatments	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
T_1	1.897	1.580	1.947	1.584	1.883	1.593	1.812	1.630	1.837	1.649	1.830	1.657	2.150	1.725	2.129	1.737	2.142	1.738	2.178	1.834	2.200	1.856	2.218	1.872
T_2	1.888	1.566	1.860	1.566	1.907	1.555	1.845	1.648	1.820	1.712	1.859	1.698	2.083	1.695	2.096	1.698	2.088	1.677	2.169	1.789	2.203	1.830	2.172	1.806
T_3	1.906	1.555	1.906	1.566	1.947	1.584	1.863	1.689	1.904	1.706	1.855	1.704	2.118	1.729	2.116	1.725	2.065	1.713	2.144	1.778	2.173	1.820	2.228	1.842
Blank	1.885	1.565	1.885	1.567	1.891	1.556	1.842	1.688	1.842	1.688	1.848	1.678	2.090	1.723	2.089	1.702	2.112	1.697	2.167	1.823	2.240	1.836	2.219	1.824
Control	1.888	1.549	1.888	1.549	1.888	1.549	1.845	1.671	1.845	1.671	1.845	1.671	2.095	1.701	2.095	1.701	2.095	1.701	2.156	1.804	2.156	1.804	2.156	1.804
Mean	1.729		1.738		1.730		1.753		1.767		1.765		1.911		1.909		1.903		1.984		2.012		2.014	
F Sex												1171.630**												
LSD 0.05												0.018												
FY X Sex												29.760**												
LSD 0.05												0.060												
F InteractionY XTX S X Sex											0.080													
LSD 0.05												-												

where: (Y_1, Y_2, Y_3 = Years); (S_1, S_2, S_3 = Soaking period); (T_1, T_2, T_3 = Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 23: Effect of intercropping of Gladiolus treated with mulberry field on silkworm, *Bombyx mori* L cocoon shell weight (g) character

Treatment	Y_1	Y_2	Y_3	Y_4	Mean	Fbetween treatments	LSD 0.05
T_1	0.330	0.332	0.379	0.418	0.365	0.600	-
T_2	0.323	0.336	0.365	0.413	0.359		
T_3	0.330	0.343	0.372	0.4119	0.364		
Blank	0.325	0.337	0.371	0.416	0.362		
Control	0.320	0.333	0.367	0.412	0.358		
Mean	0.325	0.336	0.371	0.414			
F between years			147.400**				
LSD 0.05			0.009				
F Y X T			0.240				
LSD 0.05			-				

where: Y_1, Y_2, Y_3 (Years), T_1, T_2, T_3 (treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 24: Effect of time application for different treatments of Gladiolus intercropping with mulberry field on mulberry silkworm cocoon shell weight (g) trait

Treatments	S_1	S_2	S_3	Mean	Fbetweeninteraction T X S	LSD 0.05
T_1	0.364	0.366	0.364	0.365	0.080	-
T_2	0.358	0.360	0.361	0.359		
T_3	0.361	0.369	0.362	0.364		
Blank	0.360	0.364	0.362	0.362		
Control	0.358	0.358	0.358	0.358		
Mean	0.360	0.363	0.361			
F between Soaking period		0.330				
LSD 0.05		-				

where: S_1, S_2, S_3 (Soaking period), T_1, T_2, T_3 (Treatments) & (*) significant at 0.05, (**) highly significant at 0.01

Table 25: Effect of interactions between different treatments, soaking period and years of silkworm cocoon shell weight character

	Y_1			Y_2			Y_3			Y_4				
Treatments	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	Fbetweeninteraction Y X T X S	LSD 0.05
T_1	0.329	0.336	0.324	0.328	0.332	0.336	0.379	0.378	0.380	0.419	0.417	0.417	0.160	-
T_2	0.326	0.318	0.327	0.332	0.336	0.332	0.364	0.368	0.362	0.410	0.417	0.412		
T_3	0.328	0.336	0.325	0.336	0.340	0.341	0.377	0.377	0.361	0.399	0.413	0.424		
Blank	0.324	0.326	0.324	0.338	0.336	0.337	0.372	0.371	0.370	0.406	0.423	0.418		
Control	0.320	0.320	0.320	0.333	0.333	0.333	0.367	0.367	0.367	0.412	0.412	0.412		
Mean	0.325	0.327	0.324	0.334	0.337	0.337	0.372	0.372	0.368	0.409	0.416	0.416		
Average Year	0.325			0.336			0.371			0.414				
F betweeninteraction Y X S							0.190							
LSD 0.05							-							

where: (Y_1, Y_2, Y_3 = Years); (S_1, S_2, S_3 =Soaking period); (T_1, T_2, T_3 =Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 26: Interactions between different treatments, soaking periods, sexes and years on silkworm cocoon shell weight (g) trait

	Y_1						Y_2						Y_3						Y_4					
	S_1		S_2		S_3		S_1		S_2		S_3		S_1		S_2		S_3		S_1		S_2		S_3	
Treatments	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
T_1	0.327	0.331	0.342	0.331	0.322	0.326	0.330	0.326	0.331	0.333	0.336	0.336	0.406	0.351	0.402	0.354	0.404	0.355	0.437	0.400	0.436	0.397	0.440	0.393
T_2	0.326	0.326	0.310	0.326	0.329	0.326	0.338	0.326	0.324	0.347	0.337	0.344	0.385	0.343	0.391	0.345	0.390	0.334	0.430	0.389	0.435	0.399	0.432	0.391
T_3	0.330	0.326	0.342	0.331	0.324	0.326	0.342	0.340	0.354	0.346	0.337	0.341	0.401	0.352	0.403	0.351	0.382	0.338	0.416	0.381	0.429	0.396	0.442	0.404
Blank	0.326	0.322	0.323	0.329	0.325	0.322	0.338	0.337	0.337	0.335	0.337	0.336	0.395	0.347	0.397	0.345	0.397	0.341	0.423	0.388	0.447	0.398	0.437	0.397
Control	0.320	0.319	0.320	0.319	0.320	0.319	0.333	0.334	0.333	0.334	0.333	0.334	0.382	0.352	0.382	0.352	0.382	0.352	0.427	0.396	0.427	0.396	0.427	0.396
Mean	0.325		0.327		0.323		0.334		0.337		0.337		0.372		0.372		0.367		0.409		0.416		0.416	
F Sex												40.010**												
LSD 0.05												0.007												
FY X Sex												13.670**												
LSD 0.05												0.018												
F Y X T X S X Sex												0.090												
LSD 0.05												-												

where: (Y_1, Y_2, Y_3 = Years); (S_1, S_2, S_3 =Soaking period); (T_1, T_2, T_3 =Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 27: Effect of intercropping of Gladiolus treated with mulberry field on silkworm, *Bombyx mori* L. pupal weight (g) character.

Treatments	Y_1	Y_2	Y_3	Y_4	Mean	Fbetween treatment	LSD 0.05
T_1	1.356	1.342	1.497	1.548	1.435	0.710	-
T_2	1.339	1.365	1.463	1.520	1.422		
T_3	1.356	1.381	1.478	1.524	1.435		
Blank	1.339	1.365	1.469	1.541	1.429		
Control	1.336	1.362	1.469	1.507	1.418		
Mean	1.345	1.363	1.475	1.528			
F between Years			118.950**				
LSD 0.05			0.022				
F Y X T			0.520				
LSD 0.05			-				

Where: Y_1, Y_2, Y_3 (Years), T_1, T_2, T_3 (treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 28: Effect of time application for different treatments of Gladiolus intercropping with mulberry field on mulberry silkworm, *Bombyx mori* L pupal weight (g) trait

Treatments	S_1	S_2	S_3	Mean	Fbetweeninteraction T X S	LSD 0.05
T_1	1.426	1.440	1.441	1.435	0.060	-
T_2	1.416	1.427	1.423	1.422		
T_3	1.426	1.441	1.437	1.434		
Blank	1.430	1.430	1.430	1.429		
Control	1.418	1.418	1.418	1.418		
Mean	1.422	1.431	1.430			
F between soaking period		0.460				
LSD 0.05		-				

where: S_1, S_2, S_3 (Soaking period), T_1, T_2, T_3 (Treatments) & (*) significant at 0.05, (**) highly significant at 0.01

Table 29: Effect of interactions between different treatments, soaking period and years of silkworm pupal weight (g) character

	Y_1			Y_2			Y_3			Y_4				
													Fbetween interaction	
Treatments	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	Y X T X S	LSD 0.05
T_1	1.348	1.367	1.352	1.331	1.349	1.346	1.497	1.494	1.499	1.526	1.549	1.567	0.080	-
T_2	1.340	1.334	1.342	1.353	1.368	1.376	1.463	1.467	1.458	1.507	1.538	1.515		
T_3	1.346	1.367	1.353	1.372	1.393	1.379	1.485	1.481	1.4668	1.501	1.522	1.550		
Blank	1.339	1.338	1.339	1.365	1.366	1.365	1.473	1.462	1.472	1.528	1.554	1.542		
Control	1.336	1.366	1.366	1.362	1.362	1.362	1.469	1.469	1.469	1.507	1.507	1.507		
Mean	1.342	1.348	1.344	1.356	1.368	1.365	1.478	1.475	1.473	1.514	1.534	1.536		
Average Year	1.345			1.363			1.475			1.528				
F between Y X S							0.200							
LSD 0.05							-							

where: (Y_1, Y_2, Y_3 = Years); (S_1, S_2, S_3 =Soaking period); (T_1, T_2, T_3 =Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 30: Interactions between different treatments, soaking period, sexes and years on silkworm pupal weight (g) trait.

	Y_1						Y_2						Y_3						Y_4					
	S_1		S_2		S_3		S_1		S_2		S_3		S_1		S_2		S_3		S_1		S_2		S_3	
Treatments	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
T1	1.509	1.187	1.543	1.191	1.499	1.205	1.420	1.242	1.443	1.254	1.433	1.258	1.683	1.312	1.666	1.322	1.677	1.321	1.681	1.371	1.704	1.395	1.719	1.415
T2	1.501	1.179	1. 489	1.179	1.517	1.167	1.445	1.260	1.434	1.301	1.460	1.292	1.636	1.290	1.644	1.290	1.637	1.279	1.679	1.335	1.710	1.366	1.680	1.351
T3	1.514	1.179	1.543	1.191	1.511	1.195	1.458	1.286	1.488	1.298	1.301	1.441	1.656	1.314	1.652	1.312	1.621	1.312	1.669	1.333	1.684	1.361	1.727	1.373
Blank	1.496	1.181	1.500	1.175	1.505	1.173	1.441	1.288	1.445	1.288	1.450	1.280	1.633	1.313	1.631	1.294	1.652	1.292	1.685	1.370	1.734	1.373	1.723	1.362
Control	1.505	1.167	1.505	1.167	1.505	1.167	1.450	1.274	1.449	1.274	1.449	1.274	1.625	1.286	1.652	1.286	1.653	1.286	1.670	1.343	1.670	1.343	1.670	1.343
Mean	1.342		1.348		1.344		1.356		1.368		1.365		1.477		1.475		1.473		1.514		1.534		1.536	
F Sex											1329.630**													
LSD 0.05											0.016													
F Y X Sex											26.840**													
LSD 0.05											1.044													
F InteractionY X T X S X Sex											0.700													
LSD 0.05											-													

where: (Y_1, Y_2, Y_3 = Years); (S_1, S_2, S_3 =Soaking period); (T_1, T_2, T_3 =Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 31: Effect of intercropping of Gladiolus treated with mulberry field on silkworm, *Bombyx mori* L cocoon shell ratio (%) character.

Treatments	Y_1	Y_2	Y_3	Y_4	Mean	Fbetween treatments	LSD 0.05
T_1	18.987	19.534	19.616	20.712	19.712	0.050	-
T_2	18.857	19.434	19.301	20.805	19.599		
T_3	18.991	19.646	19.440	20.661	19.685		
Blank	18.940	19.522	19.517	20.668	19.662		
Control	18.708	19.364	19.438	20.921	19.608		
Mean	18.897	19.500	19.463	20.753			
F between Year			16.390**				
LSD 0.05			0.537				
F between interaction Y X T			0.070				
LSD 0.05			-				

where: Y_1, Y_2, Y_3 (Years), T_1, T_2, T_3 (treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 32: Effect of time application for different treatments of Gladiolus intercropping with mulberry field on mulberry silkworm cocoon shell ratio (%) trait

Treatments	S_1	S_2	S_3	Mean	Fbetweeninteraction T X S	LSD 0.05
T_1	19.743	19.731	19.662	19.712	0.06	-
T_2	19.616	19.521	19.661	19.599		
T_3	19.675	19.849	19.529	19.685		
Blank	19.585	19.750	19.650	19.662		
Control	19.608	19.608	19.608	19.608		
Mean	19.645	19.692	19.622			
F between Soaking period		0.050				
LSD 0.05		-				

where: S_1, S_2, S_3 (Soaking period), T_1, T_2, T_3 (Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 33: Effect of interactions between different treatments, soaking period and years of silkworm cocoon shell ratio (%) character

	Y_1			Y_2			Y_3			Y_4				
													Fbetween interaction	
Treatments	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	Y X T X S	LSD 0.05
T_1	19.060	19.168	18.732	19.389	19.498	19.716	19.607	19.609	19.631	20.916	20.650	20.569	0.05	-
T_2	18.968	18.561	19.041	19.391	19.324	19.588	19.253	19.430	19.221	20.851	20.768	20.795		
T_3	19.026	19.168	18.778	19.682	19.824	19.433	19.652	19.666	19.003	20.341	20.740	20.902		
Blank	18.911	19.019	18.890	19.566	19.454	19.545	19.458	19.662	19.432	20.405	20.867	20.732		
Control	18.708	18.708	18.708	19.364	19.36	19.36	19.438	19.43	19.43	20.921	20.921	20.921		
Mean	18.935	18.925	18.830	19.478	19.493	19.529	19.482	19.561	19.345	20.687	20.789	20.784		
Average Year	18.897			19.500			19.463			20.753				
F Interaction Y X S							0.04							
LSD 0.05														

where: (Y_1, Y_2, Y_3 = Years); (S_1, S_2, S_3 =Soaking period); (T_1, T_2, T_3 =Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 34: Interactions between different treatments, soaking period, sexes and years on silkworm cocoon shell ratio (%) trait

	Y_1						Y_2						Y_3						Y_4					
	S_1		S_2		S_3		S_1		S_2		S_3		S_1		S_2		S_3		S_1		S_2		S_3	
Treatments	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
T_1	17.207	20.913	17.487	20.849	17.059	20.405	18.827	19.951	18.697	20.298	19.031	20.401	18.839	20.374	18.843	20.375	18.840	20.423	20.089	21.744	19.817	21.482	19.811	21.327
T_2	17.203	20.733	16.389	20.733	17.176	20.907	19.011	19.770	18.307	20.342	18.837	20.338	18.314	20.193	18.536	20.324	18.570	19.872	19.851	21.852	19.700	21.837	19.889	21.700
T_3	17.319	20.733	17.487	20.849	17.031	20.524	19.127	20.237	19.295	20.352	18.839	20.027	18.895	20.410	18.98	20.346	18.334	19.672	19.284	21.397	19.695	21.785	19.826	21.978
Blank	17.306	20.515	17.082	20.956	17.140	20.639	19.114	20.018	18.890	20.018	18.950	20.142	18.798	20.118	20.319	18.722	20.142	18.072	19.457	21.353	19.965	21.770	19.680	21.784
Control	16.887	20.529	16.887	20.529	16.887	20.529	18.695	20.033	18.695	20.033	18.695	20.033	20.804	18.072	20.804	18.072	20.804	18.072	19.775	22.068	19.775	22.068	19.775	22.068
Mean	18.935		18.925		18.830		19.478		19.493		19.529		19.482		19.561		19.345		20.687		20.789		20.784	
F Sex												122.800**												
LSD 0.05												0.380												
FY X Sex												6.760**												
LSD 0.05												0.053												
FY X T												0.06												
X S X Sex																								
LSD 0.05												-												

where: (Y_1, Y_2, Y_3 = Years); (S_1, S_2, S_3 =Soaking period); (T_1, T_2, T_3 =Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 35: Effect of intercropping of Gladiolus treated with mulberry field on silkworm, *Bombyx mori* L. silk productivity (cg/day) character

Treatments	Y_1	Y_2	Y_3	Y_4	Mean	Fbetween treatment	LSD 0.05
T_1	3.271	4.081	3.757	4.771	3.970	0.630	-
T_2	3.228	4.092	3.619	4.655	3.898		
T_3	3.270	4.145	3.711	4.664	3.948		
Blank	3.219	4.083	3.675	4.748	3.931		
Control	3.170	4.045	3.674	4.664	3.888		
Mean	3.231	4.089	3.687	4.700			
F between Years			267.310**				
LSD 0.05			0.106				
F between interaction Y X T			0.190				
LSD 0.05			-				

where: Y_1, Y_2, Y_3 (Years), T_1, T_2, T_3 (treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 36: Effect of time application for different treatments of Gladiolus intercropping with mulberry field on mulberry silkworm silk productivity (cg/day) trait

Treatments	S_1	S_2	S_3	Mean	Fbetweeninteraction T X S	LSD 0.05
T_1	3.960	3.980	3.969	3.970	0.09	-
T_2	3.863	3.907	3.925	3.898		
T_3	3.922	3.999	3.921	3.948		
Blank	3.906	3.959	3.933	3.931		
Control	3.888	3.888	3.888	3.888		
Mean	3.908	3.946	3.927			
F between Soaking period			0.330			
LSD 0.05			-			

where: S_1, S_2, S_3 (Soaking period), T_1, T_2, T_3 (Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 37: Effect of interactions between different treatments, soaking period and years of silkworm silk productivity (cg/day) character

	Y_1			Y_2			Y_3			Y_4				
													Fbetween interaction	
Treatments	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	Y X T X S	LSD 0.05
T_1	3.262	3.335	3.215	4.038	4.070	4.137	3.757	3.750	3.764	4.787	4.766	4.761	0.150	-
T_2	3.229	3.160	3.295	4.031	4.096	4.148	3.613	3.650	3.594	4.580	4.720	4.664		
T_3	3.252	3.335	3.223	4.127	4.211	4.098	3.777	3.777	3.579	4.531	4.675	4.786		
Blank	3.215	3.233	3.208	4.091	4.076	4.084	3.681	3.679	3.665	4.638	4.832	4.774		
Control	3.170	3.170	3.170	4.045	4.045	4.045	3.674	3.674	3.674	4.664	4.664	4.664		
Mean	3.225	3.247	3.222	4.066	4.099	4.103	3.700	3.706	3.655	4.640	4.731	4.730		
Average Year	3.231			4.089			3.687			4.700				
F interaction Y X S							0.200							
LSD 0.05							-							

where: (Y_1, Y_2, Y_3 = Years); (S_1, S_2, S_3 =Soaking period); (T_1, T_2, T_3 =Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Table 38: Interactions between different treatments, soaking period, sexes and years on silkworm, *Bombyx mori* L. silk productivity (cg/day) trait

	Y_1						Y_2						Y_3						Y_4					
	S_1		S_2		S_3		S_1		S_2		S_3		S_1		S_2		S_3		S_1		S_2		S_3	
Treatments	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
T_1	3.238	3.286	3.390	3.281	3.196	3.233	4.063	4.012	4.061	4.078	4.137	4.136	4.030	3.483	3.989	3.509	4.011	3.517	5.003	4.572	4.993	4.538	5.033	4.489
T_2	3.229	3.228	3.092	3.228	3.308	3.282	4.093	3.970	3.973	4.220	4.115	4.182	3.825	3.401	3.876	3.425	3.869	3.319	4.800	4.360	4.919	4.520	4.893	3.512
T_3	3.275	3.228	3.390	3.281	3.217	3.229	4.139	4.115	4.254	4.168	4.081	4.116	4.022	3.531	4.044	3.512	3.798	3.359	4.728	4.334	4.865	4.484	4.999	4.572
Blank	3.236	3.194	3.206	3.260	3.226	3.191	4.100	4.081	4.070	4.081	4.090	4.078	3.917	3.445	3.934	3.424	3.942	3.388	4.835	4.441	5.110	4.555	4.998	4.551
Control	3.176	3.164	3.176	3.164	3.176	3.164	4.040	4.051	4.040	4.051	4.040	4.051	3.812	3.536	3.812	3.536	3.812	3.536	4.839	4.489	4.839	4.489	4.839	4.489
Mean	3.225		3.247		3.222		4.066		4.099		4.103		3.700		3.706		3.655		4.640		4.731		4.730	
F Sex												33.160**												
LSD 0.05												0.075												
F between Y X Sex												11.000**												
LSD 0.05												0.209												
F Interaction Y X T X S X Sex												0.070												
LSD 0.05												-												

where: (Y_1, Y_2, Y_3 = Years); (S_1, S_2, S_3 =Soaking period); (T_1, T_2, T_3 =Treatments) & (*) significant at 0.05, (**) highly significant at 0.01.

Data in Tables 35, 36, 37 and 38 registered the effect of intercropping of treated Gladiolus with sodium azide on mulberry field of mulberry silk productivity character. Significant and insignificant differences are following the same trend of the previous character.

From the above results it could be concluded that, cultivated treated Gladiolus had no harmful effect on silkworm, *Bombyx mori* L. rearing characters. These results are accordance with Duragappa *et al*. [30] who revealed that, cocoon yield did not differ significantly due to intercropping of Rauvolfia, Plumbago, Asparagus and Sarpagandha is practiced along with mulberry for enhancement of income of farmers and silk farms without affecting sericulture [31]. Also, Jayaramaiah *et al*. [32] proved that the intercropping system may be enhancement the profit of sericulture by raising the production of unit area.

The distance between rows of mulberry field can planted with Gladiolus corms to increase the profit from the agriculture land unit in addition to income by sale crop of cocoons.

CONCLUSION

The application of sodium azide on *G. longiflorius* cv. rose supreme is easy and inexpensive for improvement of growth, flowering, corm and cormels production. Based on the results of this study, it could be concluded that gladiolus plants treated with sodium azide can be intercropping in mulberry fields, the best treatment was sodium azide at 0.01% with corms soaking period at 6 h. in first generation (G_1) and second generation (G_2) in both seasons, for all studied traits. Also, intercropping treated Gladiolus between the mulberry rows did not adversely affect the mulberry silkworm rearing and can increase the profitability of sericulture by increasing the unit area of land income.

REFERENCES

1. Sarkar, I. and S. Sharma, 2016. Comparison of performance of Gladiolus cultivars under polyhouse and open conditions. International Journal of Environment, Ecology, 6(5): 41- 46.
2. El-Hanafy H., S. Safia, Helmy Samoa, A.M. Abou Dahab, E. Metwally Neveen and R. Hamed Wafaa, 2018. Soilless culture technique for producing Gladiolus (*Gladiolus grandiflorus*). Middle East J. Appl. Sci., 8(4): 1080-1093.
3. Abdou, M.A.H., F.S. Badran, E.T. Ahmed, R.A. Taha and M.A.M. Abdel-Mola, 2018. Effect of compost and some natural stimulant treatments on: II. Corms production and chemical constituents of (*Gladiolus grandiflorus* cv. Peter Pears) plants. Proc. of the 4th Conf. of SSFOP, Scientific J. Flowers and Ornamental Plants, 5(2): 115-126.
4. Abdou, M.A.H., M.K. Aly and A.S.A. Ahmed, 2019. Influence of organic manure, biofertilizer and/or some vitamin treatments on: A. Vegetative growth and flowering aspects of *Gladiolus grandiflorus* var. Gold field plants. Scientific J. Flowers and Ornamental Plants, 6(2): 113-124.
5. Demir, S. and F.G. Gelikel, 2019. Endangered gladiolus species of Turkey. Turkish Journal of Agriculture-Food Science and Technology, 7(5): 693-697.
6. Hassan, A.A. and M.M. Abd El-Azeim, 2020. Impact of compost biofertilizer and/ or some antioxidant treatment on Gladiolus (*Gladiolus grandiflorus*) B. Corms and cormels production and some chemical constituents. Scientific Journal of Flowers and Ornamental Plants, 7(3): 285-301.
7. Ghazy, U.M., T.A. Fouad and G.M. Ahmed, 2018. Enhancement of Mulberry Silkworm *Bombyx mori* L. Characters Using Foliar Fertilizers Ascobein. J. Plant Prot. and Path., Mansoura Univ., 9(12): 783-786.
8. Misra, A.K., G.C. Setua, A.Ghosh, M. Setua, N.K. Das and A.K. Bajpai, 2009. Yield potential and economics of mulberry – based parallel multiple cropping system under irrigated condition. Journal of Crop and Weed, 5(1): 48-52.
9. Singhvi, N.R. and R.L. Katiyar, 2009. Performance of Moong as intercrop in newly planted mulberry garden. International Journal of Plant Sciences, 4(2): 365-366.
10. Pandey, R.K. and A. Dhar, 2013. Mulberry Intercropping for Sustainable Livelihood in Kandi Area of Rural Sub-Himalayan, India. Research Journal of Agricultural Sciences, 4(4): 484-487.
11. Vishaka, G.V., H.R. Ra Bharath, T.K. Narayanaswamy, K.M. Harinikumar and R. Narayanareddy, 2017. Intercropping of solonaceous vegetables in mulberry-a profitable way to farming community. Scire Science Multidisciplinary J., 1(1): 36-45.
12. Kapadiya, D.B., S.L. Chawla, A.L. Patel and T.R. Ahlawat, 2014. Exploitation of variability through mutagenesis in Chrysanthemum (*Chrysanthemum morifolium* Ramat.) var. Maghi, Journal of Life Sci., 9(4): 1799-1804.

13. Ingelbrecht, I., J. Jankowicz-Cieslak, M. Szurman, B.J. Till and I. Szarejko, 2018. Chemical mutagenesis in: manual on mutation breeding (ed) Ed. Spencer-lopes, M.M., Forster, B.P. and Jankuloski, L. (3rd). pp: 51-81. FAO, Vienna.
14. Mohamed, M.A.H., M.K. Aly, G.G. Mostafa and H.R AbdAlaziz, 2019. Evaluation of *Chrysanthemum morifolium*cv. Maghi plants after sodium azide treatment. Scientific Journal of Agricultural Sciences, 1(1): 14-20.
15. Ghazy, U.M.M., 2012. Estimation of hybrid vigor of some single local hybrids of mulberry silkworm, *Bombyx mori* L. Bull. Ent. Soc. Egypt, Econ. Ser., 38: 101-112.
16. Ghazy, M.U., 2008. Rearing first three instars of mulberry silkworm *Bombyx mori* L., under polythene cover. Bull. Ent. Soc. Egypt, 85: 271-279.
17. Black, C.A., 1965. Methods of Soil Analysis. Amer. Soc. Agron. Inc. Publishers, Madison, USA. 223.
18. King, E.J., 1951. Micro Analysis in Medical Biochemistry. 2nd Ed. Churchill, London.
19. Jackson, M.L., 1967. Soil Chemical Analysis. Prentice-Hall Inc. Publisher, Madison, USA.
20. MSTAT Computer Program, 1985. Software program for design, management and analysis experimental (version 4.0), Michigan State Univ.
21. Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods, 7th ed. Iowa State Univ. Press, Ames, Iowa, U.S.A.
22. Youssef Hanan, M.A. and M.F. Saadawy, 2008. Effect of sodium azide on growth and flowering of *Bouganivillea Glabra* choicy var sanderiana. Annals of agric. Sc. Moshtohor, 46(1): 41-48.
23. Nimbalikar, C.A., S.M. Katwate, B.R. Singh, D.S. Kakade and S.B. Gurav, 2007. Selection strategy for improvement in economic traits of Gladiolus. J. Ornamental Horticulture, 10(1): 9-14.
24. Roychowdhury, R. and J. Tah, 2011. Chemical mutagenic action on seed germination and related agro-metrical traits in G1 Dianthus generation. Current. Botany, 2(8): 19-23.
25. Gruszka, D., I. Szarejko and M. Maluszynski, 2012. Sodium azide as mutagen. In: Plant Mutation Breeding and Biotechnology. CABI International, Willing ford, UK, pp: 159-166
26. Dewi, K., G. Meidana and S. Sudjino, 2016. Effects of sodium azide (NaN_3) and cytokininon vegetative growth and yield of black rice plant (*Oryza sativa* L. 'CempoIreng'). AIP Conference Proceedings, Earth and Environmental Science, pp: 102.
27. El-Mokadem, Hoda E. and Gehan Mostafa, 2013. Induction of mutations in *Browallia speciosa* using sodium azide and identification of the genetic variation by peroxidase isozyme.African Journal of Biotechnology, 13(1): 106-111.
28. Nakatsuka, T., M. Nishihara, K. Mishiba and S. Yamamura, 2005. Two different mutations are involved in the formation of white-flowered gentian plants, Plant Science., 169(5): 949-958.
29. Khan, S., F. Al-Qurainy and Firoz Anwar, 2009. Sodium Azide: a Chemical mutagen for enhancement of agronomic Traits of Crop Plants. Environ. We Int. J. Sci. Tech., 4: 1-21.
30. Duragappa, K., G.M. Hadimani, S.C. Patiland and Alagunagi, 2004. Economics of mulberry legume intercropping system and silkworm rearing. Karnataka J. Agri. Sci., 17(3): 498-501.
31. Srivastav, P.K., C. Thapliyal, M. Chamoli, M.M. Bhat and M.A. Khan, 2010. Blending of sericulture with medicinal industries. Annals of Forests, 18(2): 243-253.
32. Jayaramaiah, M., M.A. Shankar, B.T. Anithapeter, B.S. Rangaswamy, B.S. Lingappa and G.B. Mallikarjuna, 2002. Mulberry leaf quality and cocoon production as influenced by intercropping of flower crops. Proc. Of the XIXth Cong. Of the Inter. Seric. Comm. Bangkok, Tailand, pp: 1-4.