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RESPONSE OF GLADIOLUS PLANTS TO HUMIC ACID, BORIC ACID AND POTASSIUM SILICATE

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ABSTRACT

A field experiment was conducted during two successive seasons, 2016/17 and 2017/18 to study the effect of humic acid (HA), boric acid (BA) and potassium silicate (PSi), as well their interaction on vegetative growth, flowering aspects, corm production and photosynthetic pigments of *Gladiolus grandiflorus* cv. Eurovision plants. The main plots included HA at 0, 0.25 and 0.50 g/l, while the sub-plots included BA at 25 and 50 mg/l, PSi at 50 and 100 mg/l and B/Si at low and high levels of both substances. Humic acid or BA and/or PSi augmented different studied traits, however the interaction treatment between the high level of HA plus the dual treatment of BA/PSi resulted in the best vegetative growth characters, flowering aspects and corm production. Meanwhile, flowering date was delayed and number of florets/spike was not affected due to this treatment. It is recommended to supply *Gladiolus grandiflorus* cv. Eurovision plants with HA at 0.50 g/l in combination with BA at 50 mg/l and PSi 100 mg/1 in order to obtain the best flowering aspects and the maximum corm and cormels production.

INTRODUCTION

Gladiolus grandiflorus which belongs to family Iridaceae is one of the most important bulb plants. It has decorative spike which carries numerous florets. Such flowers are excellent attractive cut flowers which are needed for local markets in winter and spring and for foreign markets, as well. In addition, *Gladiolus* plants are commonly used in borders and beds in many gardens. In this study *Gladiolus grandiflorus* cv. Eurovision was chosen for its popularity and adaptability Egyptian environmental conditions.

Soluble fulvic acids and humic acid (HA) that termed humic substances are organic acids reflect the final break down components of natural decay of many organic matters including microbial, animal and plant residues (**Lee et al, 2004**). A good number of scientists concluded the effective role of humic acid in improving different vegetative growth characters, flowering parameters, corm production and photosynthetic pigments on flowering bulb plants. Examples of those scientists are **Adam** (**2021**), **Hassanpur Asil et al (2018), Bashir (2016), Sanakari et al (2015)** and **Ahmed et al (2013)** on *Gladiolus* and **Ghani et al (2021)** on tuberose.

Boron is a plant micronutrient and considered as a unique nonmetal micronutrient which required for plants normal growth and development, (**Warington, 1923**). Its possible roles include cell wall structure and synthesis, lignification and structure integrity, sugar transport, respiration, as part of cell membrane, as well as, metabolism of carbohydrate, **rna, iaa** and phenol, (**Mengel and Kirkby, 2001 and Ahmed et al 2009) Sillanpad (1982**) considered boron deficiency as a major constraint to crop production. **Shorrocks (1997**) declared that boric deficiency has been documented as the second most important micronutrient restriction in crops after zinc on global scale. Working On *Gladiolus*, **Kashyap and Tikey (2022), Al-Sawaf et al (2019), Chopde et al (2016), Fahad et al (2014), Khalifa et al (2011)**, **Reddy and Chaturvedi (2009)** and **Halder et al (2007**) emphasized the importance of boric acid on growth, flowering, corm production and photosynthesis of the experimented plants.

Silicon is the plentiful element in the earth's crust representing 27.7% of its weight, (**Datnoff et al 2001**). It is not consider as an important element for plant growth, however, plant growth and development are closely correlated to soil physical and chemical processes and properties, (**Glinski et al 2011)**. Moreover, it found in soil as complexes with other elements such as **Al**, **Fe** and organic matter, (**Farmer et al 2005**). Silicic acid melted in soil solution and therefor, some part of it adsorbs to soil minerals, mostly in oxide and hydroxide forms of **Fe** and **Al**, **(Dietzel, 2002**). After adsorption, **Si** translocate rapidly into leaves in the transpiration stream, (**Ma, 2003**) moreover, it was found also that silicon increase the photosynthesis due to better light interception. and avoid chlorophyll destruction, the addition of **Si** to nutrient solution improve **Si** and **Ca** concentration in the leaves. and roots (**Kaya et al 2006)** and has a vital role in phosphorus nutrition. Different authors reported the positive role of silicon on improving growth, flowering, corm production and/or photosynthetic pigments of tuberose **(Shahzad et al 2012** and **Karimian et al 2021);** *Liulium* **(Sanchez-Navarro et al 2021** and **Mamrashpour** and **Nazaridaljon, 2019); Gladiolus (Farooq et al 2020 and Kenizy** and **Ibrahim, 2015)** and *Iris Tingitana* **(Abdou et al 2019).**

MATERIALS and METHODS

A field experiment was executed during the seasons of 2016/17 and 2017/18 in the nursery of Fac. of Agric., Minia University to investigate the effect of humic acid, boric acid and potassium silicate and their interaction on growth, flowering, corm production and photosynthetic pigments of *Gladiolus grandiflorus* cv. Eurovision plants.

The corms of gladiolus were obtained from Holland by Basiouny Nurseries, Cairo, Egypt. Average corn diameter was 2.7 and 3.2 cm and weight were 9.5 and 10.2 g. for the two seasons, respectively. All corms were soaked in pinlate at the concentration of 1g/1 for one minute. The experiment was arranged in a randomized complete block design in split plot design with three replicates. The main plots (A) included three levels of HA, while seven treatments of potassium silicate and/or boric acid and control occupied the sub-plots (B). Therefore, the interaction treatments (AXB) were 21 Treatments. The experimental unit (plot) was 1.5 x 2.2 m and containing 3 ridges, 50 cm apart. Corms were planted on October 20th for both seasons in hills, 20 cm apart, on the upper third of one side of each ridge. Physical and chemical properties of the used soil are listed in Table (a).

Humic acid in from of potassium humate (hamate product) contains HA (80-83%), potassium (K_2O) (10%) and total Nitrogen (7%) was obtained from United Agriculture Development (UAD) Company, New Al-Nobaria City, Al-Behera Gov., Egypt. The plants received three foliar sprays in both seasons, the first spray of Humic acid suspension was applied by hand spraying till run of after 30 days from planting date, the second dose before flowering stage and the third one after flowering cut. Boric acid and/or Potassium silicate were applied. By hand sprayer, 3 times, one month and two months from planting date and after flowers cut for corm and cormels production. The plants were sprayed till run of. All agricultural practices were performed as usual in the region.

Data, for each season were recorded for number of leaves/plant, leaf area, leaf dry weight, flowering date, spike length, number of florets/spike, corm fresh weight, number of cormels/plant and cormels fresh weight, as well as, chlorophyll a, chlorophyll b and carotenoids content (mg/g F.W.) Obtained data were All obtained data were tabulated and statistically analyzed according to Mead et al. (1993) using MSTAT-C (1986) and the LSD test at 5% was followed to compare between the means

RESULTS and DISCUSSION

Vegetative Growth Characters:

The three vegetative characters, number of leaves/plant, leaf area and leaf dry weight of *Gladiolus* plants were significantly increased in the two seasons due to the use of humic acid. The high level of humic acid (o.50 g/1) proved to be much more effective than the low one(0.25 g/l) as clearly shown in Table 1.

The other investigated factor treatments, boric acid and/or silicon, were also significantly effective in promoting such three traits, except number of leaves/plant in the second season. Among the three treatments, the dual one (boric acid + silicon) gave, in both seasons, the highest values of each of leaf number, leaf area and leaf dry weight, followed by silicon treatment, while boric acid treatment resulted in the least values, (Table 1). The interaction between humic acid and Boric and/or silicon was significant, except for leaf number/plant in the second season, with the best results being obtained when Gladiolus plants received humic acid at the high level in combination with boric acid plus silicon as declared in Table (1).

In agreement with these results were the findings of **Bashir (2016**), **Sanakari et al (2015) and Ahmed et al (2013**) on *Gladiolus* concerning humic acid; the findings of **Kashyap and Tikey (2022) and Halder et al (2007)**on *Gladiolus***,** and **Lu et al (2011**) on *Lilium davidii* for boric acid, as well as, **Karimian et al (2021**) on tuberose**, Faroog et al (2020)** and **Khenizy** and **Ibrahim (2015)** on *Gladiolus* and **Abdou et al (2019)** on *Iris Tingintana* in regard to silicon.

Flowering Parameters:

Table (2) shows that flowering date of *Gladiolus* plants was delayed, while each of spike length and number of florets/ spike were greatly augmented, in the two seasons, due to the application of humic acid in comparison with control plants. Moreover, significant differences were detected also between the high and the low level of humic acid in favor of the high level for the three studied flowering traits in the two seasons, (Table 2). In regard with boric acid and/or silicon, flowering date was significantly delayed, while spike length was significantly increased in comparison with those of control plants. The same trend was observed for number of florets/ spike, but the differences were not significant. These results. proved to be true in the two seasons. The combined boric acid/silicon treatment gave the best results, for the three flowering aspects, over those of boric acid or silicon treatments as given (in Table (2). The interaction between humic acid, on one side, and boric acid/silicon, on the other side, was significant for flowering date and spike length only, with similar trend for florets number/spike. The most overall pronounced results, for the three flowering parameters were due to the high level of humic acid in combination with the dual treatment of boric acid/silicon, (Table 2).

In accordance with the obtained results were those of **Ghani et al (2021) on** tuberose and each of **Bashir (2016), Sanakari et al (2015)** and **Ahmed et al (2013)** on *Gladiolus* in relation to humic acid. Meanwhile, **Chopde et al (2016), Fahad et al (2014), Reddy and Chatarvedi (2009)** and **Halder et al (2007**)on *Gladiolus* insured our results on boric acid, as well as**, Shahzad et al (2022) and Karimian et al (2021)** on tuberose and **Farooq et al (2020) and Khenizy and Ibrahim (2015**) on *Gladiolus* for silicon.

Corm Production:

Humic acid proved to be significantly effective in augmenting each of corm fresh weight and cormels number/plant and fresh weight when applied at eighter low or high level in comparison with those of untreated control plants as illustrated in Table (3). Moreover, the high level gave significantly higher values for the three traits than those of low level. The increase in corm fresh weight, cormels number/plant and cormels fresh weight due to the high humic level over those of control treatment reached 19.0 and 19.0 %, 13.4 and 13.2 % and 32.1 and 32.2 %, respectively, for the first and second seasons. Concerning the other factor (**B** and/or **Si**) significant differences were obtained, in the two seasons , due to such treatments in relation to corm fresh weight and cormels fresh weight over those of control treatment. Number of cormels/plant was also increased due to these treatments but the differences were not significant. The most effective treatment, in descending order, for the three corm production traits, in the two seasons, were boric plus silicon, silicon and boric acid as shown in Table (3).

The interaction between the two studied factors was significant in the two seasons, for corm and cormels fresh weight, (Table 3). The heaviest corm and cormels fresh weight were obtained when *Gladiolus* plants received the high level of humic acid in -addition to the dual **B/Si** treatment. Such treatment increased corm fresh weight by 28.7 % in the first season and 28.7 % in the second season and cormels fresh weight by 49.5 and 49.4% in the two respective seasons, in comparison with control treatment as clearly shown in Table (3).

The above mentioned results were on the line with those of **Hassanpur- Asil et al (2019), Bashir (2016)** and **Sanakari et al (2015**) on *Gladiolus* for humic acid; **Kashyap** and **Tikey (2022), Al-Sawaf et al (2019), Fahd et al (2014)** and **Khalifa et al (2011)** on *Gladiolus* for boric acid, as well as**, Karimian et al (2021**) on Tuberose, **Abdou et al (2019**) on *Iris Tingitana* and **Khenizy and Ibrahim (2015**) on *Gladiolus* **for silicon.**

Photosynthetic Pigments:

Table (4) shows that the three photosynthetic pigments, chlorophyll a, chlorophyll b and carotenoids were greatly and significantly induced due to the application of humic acid at both low and high levels. Significant differences were also detected, in both seasons, between high and low humic acid level in favor of the high one for the three estimated pigments. The trend of significant stimulation of the three pigments was also extended to the other investigated factor (boric acid and/or silicon) over those of control treatment. Among these treatments, the dual B/Si treatment gave the highest values followed by silicon, then boric treatment. Regarding the interaction between humic acid and boric acid and/or silicon, it was significant in the two seasons for the three photosynthetic pigments. The highest overall values were obtained when *Gladiolus* plants received the high humic acid in combination with both boric acid plus silicon as shown in Table (4).

The role of humic acid in inducing the three photosynthetic pigments content, as found in this study, was reported by **Adam (2021), Hassanpur-Asil et al (2018) and Ahmed et al (2013)** on *Gladiolus*; while that of boric acid was revealed by **Al-Sawaf et al (2019), Fahad et al (2014) and Khalifa et al (2011**) on *Gladiolus*; meanwhile that of silicon was indicated by **Sanchez-Navarro et al (2021)** and **Mamrashpour** and **Nazarideljou (2019) on** *Lilium* **and Khenizy and Ibrahim (2015)on** *Gladiolus***.**

To discuss and explain the vital positive roles of humic acid in improving different vegetative growth characters, flowering parameters, corm production and photosynthetic pigments, it may be convenient to recognize its physiological, chemical and biological roles in plant growth and development. Humic acid consider a key soil structure material, and may be responsible for support many chemical reactions. It increases. the cation exchange capability and promotes the transformation of different elements into available forms, thereby enhancing its uptake and availability to the plants **(Sutton and Sposito, 2005** and **Canellas et al 2015**). **Trevisan et al (2010)** and **Jindo et al (2012**) suggested that humic substances have been known since long time as main contributors to soil fertility, and could act as soil physical, chemical and biological amendment. Humic acids are an amazing natural and organic process to provide plant and soil with concentrated dose of nutrients, trace elements and vitamins. Humic acids have hormonal properties, could alleviate stress protection and improve water use efficiency (**Vista, 2017**).

Boron as a plant micronutrient has different roles on plant growth and development including cell wall structure and synthesis, lignification, sugar transport, respiration and metabolism of carbohydrate, **RNA, IAA** and phenol and as part of cell membrane (**Mengel and Kirkby, 2001** and **Ahmed et al, 2009). Sillanpad (1982**) considered B deficiency is a major constraint to crop production and demonstrated as the second most important micronutrient restriction after zinc.

Concerning silicon, it accumulates in the plant body to anable them to tolerate abiotic stress. It tends to keep erectness of the leaves thereby increase the photosynthesis due to better light interception and avoid chlorophyll destruction, (**Savant et al 1997 and Ma and Takahashi, 2002) Kaya et al (2006)** found that silicon addition to nutrient solution improve silicon and calcium concentrations in the leaves and roots and enhance phosphorus nutrition. **Neto et al (2015)** showed that silicon could be beneficial for many horticultural crop characters including morphology and quality traits.

Table a: Physical and chemical analysis of the experimental soil (average of both seasons, 2016/2017 and 2017/ 2018):

Soil characters	Value	Soil characters		Value
Soil type	Clayey loam	Avail. P (%)		15.40
Sand (%)	28.59	Exch. K (mg/100g)		2.45
Silt (%)	30.29	Exch. Ca (mg/100g)		31.43
Clay	41.12	Exch. Na (mg/100g)		2.46
Organic Matter (%)	1.65	DTPA Ext.(ppm)	Fe	8.39
CaCO3 (%)	2.10		Cu	2.04
pH (1:2.5)	7.79		Zn	2.81
EC (mmhos/cm)	1.06		Mn	8.19
Total N (%)	0.08			

Table(1) Effect of humic acid and boric acid/potassium silicate on vegetative growth characters of *Gladiolus grandiflorus* cv. Eurovision during 2016/2017 and 2017/2018 seasons.

Boric acid and/or potassium silicate	Humic acid (A)							
	0.0	0.25g/1	0.50g/l	Mean	0.0	0.25g/1	0.50g/l	Mean
	First season (B)				Second season (B)			
Number of leaves/plant								
Control	5.5	6.9	8.7	7.0	7.0	7.6	8.0	7.5
BA 50 mg/1	6.6	8.4	10.1	8.4	7.2	7.7	8.2	7.7
PS 100 mg/1	7.9	9.6	11.5	9.7	7.3	7.8	8.3	7.8
BA+PS	9.3	11.0	12.8	11.0	7.5	8.0	8.4	8.0
Mean (A)	7.3	9.0	10.8		7.3	7.8	8.2	
L.S.D. at 5%	**A: 1.1**	**B:1.3**	**AB:2.3**		**A:0.6**	**B: N.S**	**AB:N.S**	
Leaf area (cm²)								
Control	24.4	42.2	65.1	43.9	30.1	52.1	80.3	55.2
BA 50 mg/1	29.7	48.2	65.1	43.9	30.1	52.1	80.3	61.7
PS 100 mg/1	35.7	54.2	78.3	56.1	44.1	66.9	96.7	69.2
BA+PS	45.8	65.3	88.1	66.4	56.5	80.6	108.8	82.0
Mean (A)	33.9	52.5	75.9		44.4	64.8	93.7	
L.S.D. at 5%	**A:4.0**	**B:2.6**	**AB:4.5**		**A:5.1**	**B:4.9**	**AB:8.5**	
Leaf dry weight (mg)								
Control	321	366	411	366	362	450	480	431
BA 50 mg/1	390	423	462	425	434	490	532	485
PS 100 mg/1	458	517	564	513	528	592	664	595
BA+PS	538	586	621	582	592	694	715	667
Mean (A)	427	473	517		479	557	598	
L.S.D. at 5%	**A:28**	**B:41**	**AB:71**		**A:42**	**B:49**	**AB:85**	

Table(2) Effect of humic acid and boric acid/potassium silicate on flowering parameters of *Gladiolus grandiflorus* cv. Eurovision during 2016/2017 and 2017/2018 seasons.

Boric acid and/or potassium silicate	Humic acid (A)							
	0.0	0.25g/1	0.50g/l	Mean	0.0	0.25g/1	0.50g/	Mear
	First season (B)				Second season (B)			
Flowering date(day)								
Control	81.5	87.8	94.1	87.8	90.5	97.6	104.5	97.5
BA 50 mg/1	83.3	89.6	95.9	89.6	92.5	99.5	106.6	99.5
PS 100 mg/1	85.0	91.4	97.6	91.3	94.5	101.6	108.5	101.5
BA+PS	86.8	93.2	99.6	93.2	96.5	103.5	110.7	103.6
Mean (A)	84.2	90.5	96.8		93.5	100.6	107.6	
L.S.D. at 5%	**A: 4.7**	**B:3.2**	**AB:5.5**		**A:4.2**	**B: 2.5**	**AB:4.3**	
Spike length (cm)								
Control	41.8	47.3	52.4	47.2	46.4	53.2	59.5	53.0
BA 50 mg/1	43.8	48.8	60.8	51.1	48.6	54.8	61.0	54.5
PS 100 mg/1	45.4	50.1	62.3	52.6	50.4	56.3	62.4	56.4
BA+PS	47.9	52.9	64.0	45.9	53.3	59.4	46.1	58.6
Mean (A)	44.7	49.8	59.9		49.7	55.9	61.8	
L.S.D. at 5%	**A: 4.8**	**B:3.4**	**AB:5.9**		**A:4.4**	**B:3.1**	**AB:5.3**	
Nunmber of florets/spike								
Control	8.0	8.7	9.5	8.4	9.0	9.9	12.3	10.4
BA 50 mg/1	8.3	9.0	9.7	9.0	9.4	10.1	12.6	10.7
PS 100 mg/1	8.5	9.2	9.9	9.2	9.6	10.4	12.9	11.0
BA+PS	8.6	9.4	10.2	9.4	9.8	10.6	13.1	11.2
Mean (A)	8.4	9.1	9.8		9.5	10.3	12.7	
L.S.D. at 5%	**A:0.6**	**B:N.S.**	**AB:N.S.**		**A:0.8**	**B: N.S.**	**AB: N.S.**	

Table(3) Effect of humic acid and boric acid/potassium silicate on corm production of *Gladiolus grandiflorus* cv. Eurovision during 2016/2017 and 2017/2018 seasons.

Boric acid and/or potassium silicate	Humic acid (A)							
	0.0	0.25g/1	0.50g/l	Mean	0.0	0.25g/1	0.50g/l	Mean
	First season (B)				Second season (B)			
Corm fresh weight(gm)								
Control	63.4	69.7	76.1	69.7	70.4	77.4	84.5	77.4
BA 50 mg/1	65.3	71.6	77.8	71.6	72.6	79.5	86.5	79.5
PS 100 mg/1	67.1	73.3	79.7	73.4	74.5	81.5	88.5	81.5
BA+PS	68.8	75.1	81.6	75.2	76.4	83.5	90.6	83.5
Mean (A)	66.2	72.4	78.8		73.5	80.5	87.5	
L.S.D. at 5%	**A: 4.7**	**B:3.2**	**AB:5.5**		**A:4.9**	**B: 2.8**	**AB:4.8**	
Number of cormels/plant								
Control	85.8	92.2	97.8	91.9	95.3	102.5	108.6	102.1
BA 50 mg/1	87.6	93.2	99.7	93.5	97.3	103.5	110.6	103.8
PS 100 mg/1	89.6	95.1	101.3	95.3	99.6	105.6	112.6	105.9
BA+PS	91.4	96.5	103.1	97.0	101.5	107.2	113.7	107.5
Mean (A)	88.6	94.3	100.5		98.4	104.7	111.4	
L.S.D. at 5%	**A:5.1**	**B:N.S.**	**AB: N.S.**		**A:4.7**	**B: N.S.**	**AB: N.S.**	
Cormels fresh weight (g)								
Control	36.4	42.6	49.0	42.7	40.4	47.4	45.4	47.4
BA 50 mg/1	38.3	44.6	50.9	44.6	42.5	49.5	56.5	49.5
PS 100 mg/1	40.0	46.4	52.8	46.4	44.5	51.6	58.6	51.6
BA+PS	41.9	48.1	54.4	48.1	46.5	53.5	60.4	53.5
Mean (A)	39.2	45.4	51.8		43.5	50.5	57.5	
L.S.D. at 5%	**A:3.7**	**B:3.3**	**AB:5.7**		**A: 4.6**	**B:3.0**	**AB:5.2**	

Table(4) Effect of humic acid and boric acid/potassium silicate on photosynthetic pigments in the fresh leaves of *Gladiolus grandiflorus* cv. Eurovision during 2016/2017 and 2017/2018 seasons.

Boric acid and/or potassium silicate	Humic acid (A)							
	0.0	0.25g/1	0.50g/l	Mean	0.0	0.25g/1	0.50g/l	Mean
	First season			(B)	Second season			(B)
Chlorophyll A content (mg/g F.W.).								
Control	2.314	2.384	2.474	2.391	2.437	2.513	2.572	2.507
BA 50 mg/1	2.337	2.407	2.480	2.408	2.461	2.530	2.595	2.529
PS 100 mg/1	2.359	2.439	2.510	2.436	2.482	2.544	2.609	2.545
BA+PS	2.370	2.463	2.535	2.456	2.502	2.566	2.628	2.565
Mean (A)	2.345	2.423	2.500		2.471	2.538	2.601	
L.S.D. at 5%	**A:0.034**	**B:0.021**	**AB:0.036**		**A:0.031**	**B: 0.018**	**AB:0.031**	
Chlorophyll B content (mg/g F.W.)								
Control	0.525	0.595	0.662	0.594	0.753	0.814	0.881	0.816
BA 50 mg/1	0.543	0.614	0.679	0.612	0.769	0.835	0.902	0.835
PS 100 mg/1	0.563	0.631	0.699	0.631	0.785	0.853	0.922	0.853
BA+PS	0.584	0.652	0.720	0.652	0.806	0.872	0.943	0.874
Mean (A)	0.554	0.623	0.690		778	0.844	0.912	
L.S.D. at 5%	**A:.020**	**B: 0.015**	**AB: 0.026**		**A:0.034**	**B:0.030**	**AB:0.052**	
Carotenoids content (mg/g F.W.)								
Control	0.604	0.666	0.723	0.664	0.710	0.794	0.852	0.785
BA 50 mg/1	0.627	0.680	0.742	0.683	0.732	0.816	0.876	0.808
PS 100 mg/1	0.646	0.702	0.767	0.705	0.764	0.832	0.895	0.830
BA+PS	0.668	0.716	0.778	0.721	0.788	0.847	0.916	0.850
Mean (A)	0.636	0.691	0.753		0.749	0.822	0.885	
L.S.D. at 5%	**A:0.024**	**B:0.021**	**AB:0.036**		**A:0.028**	**B:0.020**	**AB:0.035**	

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الملخص العربي

استجابة نباتات الجلاديولس لحامض الهيوميك وحامض البوريك وسليكات البوتاسيوم

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تم إجراء تجربة حقليه خلال موسمي ٢٠١٦/٢٠١٧ و ٢٠١٧/٢٠١٨م المتتابعين بغرض دراسة تأثير كل من حامض الهيوميك وحامض البوريك وسيليكات البوتاسيوم ، والتفاعل بينهم على النمو الخضري ومواصفات التزهير وانتاج الكورمات وصبغات البناء الضوئي لنباتات الجلاديولس جراند فلورس صنف إيروفيجن

اتضح أن حامض الهيوميك وكل من حامض البوريك و سيليكات البوتاسيوم أوهما معا قد حسنوا مختلف الصفات الخضرية والزهرية وإنتاج الكورمات وصبغات البناء الضوئي. ولقد وجد ان معاملة التداخل بين كل من حامض الهيوميك بالمستوى المرتفع مع المعاملة المشتركة من حامض البوريك وسليكات البوتاسيوم قد أعطت افضل النتائج من حيث الصفات الخضرية والزهرية وإنتاج الكورمات. في حين ظهر أن هذه المعاملة قد أخرت ميعاد التزهير بينما لم يتأثر عدد الأزهار على الشمراخ الزهري نتيجة هذه المعاملة.