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IMPACTS OF COMPOST, BIOFERTILIZER AND/OR SOME ANTIOXIDANT TREATMENTS ON GLADIOLUS (*GLADIOLUS GRANDIFLORAS*)

B. Corms and cormels production and some chemical constituents

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ABSTRACT: Gladiolus is commercially propagated by its underground structure for production of flowers and corms as well as cormels. A field experiment was conducted during two successive seasons of 2018/2019 and 2019/2020 to investigate the effects of compost as an organic fertilizer (0, 5, 10 and 15 ton/fed) and Microbein biofertilizer (M.B.) at 50 ml/plant and/or some antioxidant treatments (salicylic and ascorbic acids) on corm and cormels production and chemical constituents of *Gladiolus grandiflorus* var. Jester plants. The obtained results indicated that corm diameter (cm), number of new cormels/plant, dry weight of corm and cormels (g), as well as, chemical constituents including chlorophyll a, b, carotenoids in the fresh leaves and percentages of N, P and K in the dry leaves were gradually increased by increasing levels of compost with significant differences. The highest corm diameter (5.27 cm) was produced by plants received compost at 15 ton/fed in combination with Microbein biofertilizer (M.B.) plus salicylic acid plus vitamin C while least size (2.5 cm) of corm was observed in control plants. All six treatments of Microbein biofertilizer (M.B.) at 50 ml/plant and/or some antioxidant (salicylic and ascorbic acids) treatments each at 50 ppm significantly increased corms and cormels production and the content of chemical constituents in comparison with control treatments. Treatments of Microbein biofertilizer (M.B.) plus salicylic acid plus ascorbic acid (vit. C) was more effective than other treatments for corm and cormels production, as well as, photosynthetic pigments content (mg/g. F.W.) and the percentage of nitrogen, phosphorus and potassium, in most cases. The interaction between compost, Microbein biofertilizer (M.B.) and/or some antioxidant (salicylic and ascorbic acids) treatments were significant for all previous characters. In some cases, the highest values of corms and cormels production were achieved by compost (15 ton/fed) in combination with Microbein biofertilizer (M.B.) plus salicylic acid plus ascorbic acid (vit. C) followed by 15 ton/fed compost with M.B. + vit. C then 10 ton/fed compost with M.B. + salicylic acid + vit. C which recorded the highest contents of pigments and elements of N, P and K.

Key words: Microbein biofertilizer, gladiolus, bulb production, antioxidants, chemical constituents.

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus*, L.) plant is considered as one of the most important flowering bulbs grown in Egypt. Gladiolus is an important bulbous ornamental plant, perennial geophyte, semirustice herbaceous annual bulbous plant belongs to the Iridaceae family and is used as cut flowers, garden and potted plants (Demir and Çelikel 2019). It is a monocotyledonous floral crop. There are fast expands in areas planted with gladiolus in Egypt in order to meet the increase demand for gladiolus flowers for local market and exporting, gladiolus plants propagated by corms. Gladiolus is a flower of glamour and perfection which is known as the queen of bulbous flowers due to its long spikes with florets of massive form, rich variations of colours, attractive shades, varying sizes of flowers and long vase life (Roy *et al*., 2017 and Rashid, 2018). Today gladiolus is one of the world's most important bulbous ornamental garden plant and as a cut flower crop used for bouquets and arrangements (Cantor and Tolety, 2011; Demir and Çelikel, 2019). 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. In Egypt, the year-round production of cut flower crops is a nature's boon, due to the country has varied agro-climatic conditions. Different gladiolus varieties as cut flowers are important cut flower crops used in flower arrangements, in making bouquets, garden display and in beautifying any landscape (Abdou *et al*., 2019). However, various stress factors are associated with any flower crop that directly and indirectly hampers the growth of plant and results in poor quality flower, deprived yield and low income. Both higher and lower levels of abiotic stresses lead to decrease in flower quality and adversely affect corms and cormels production and the yield of gladiolus flowers (Sisodia *et al.,* 2020).

Compost as organic fertilizer, Microbein biofertilizer (M.B.) and some antioxidant (salicylic and ascorbic acids) treatments are among the important agricultural treatments which have been proved to improve corm and cormels production of gladiolus plants. The effect of organic fertilization on increasing corm diameter, number of new cormels and dry weight of corm and cormels of gladiolus were reported by many investigators, such as Ahmed (2013), Abdou *et al.* (2018), Abdou *et al*. (2019) and Karagöz *et al.* (2019) on gladiolus, Kabir *et al.* (2011), Srivastava *et al*. (2014) and Suseela *et al*. (2016) on tuberose, Mirkalae *et al*. (2013) and Prasad *et al.* (2017) on lily, Pandey *et al.* (2017) on dahlia plant who found that compost fertilizer improved the chemical composition of gladiolus plants. Microbein biofertilizer (M.B.) treatments were found to have stimulating effect on corm and cormels production and chemical composition of gladiolus such as those raveled by Srivastava and Govil (2005), Kashyap (2016), Sathyanarayana *et al.* (2018) and Chakradhar *et al.* (2019) on gladiolus and Attia *et al.* (2018) on tuberose plant.

In regard to the roles of salicylic acid in increasing corm and cormels production, as well as, chemical constituents were mentioned by Pawar *et al.* (2018) and Al-Hasnawi *et al*. (2019) on gladiolus, Ahmad *et al.* (2018) on tuberose and Aashutosh *et al.* (2019) on chrysanthemum plant. Also, the role of ascorbic acid (vit. C) in improving on corm and cormels production and chemical composition was also investigated by Abdel Aziz *et al.* (2009) and Khalil (2015) on gladiolus, Mohammed *et al.* (2016) on dahlia plant and Farahat *et al.* (2017) on *Monstera delicious* plants.

The vegetative attributes, flower and corm production in gladiolus could be positively influenced by different organic fertilizers treatments when applied in optimum concentration (Abdou *et al*., 2019; Ahmed and Rab, 2019). Good quality corms result in better vegetative growth with healthy foliage and enhanced photosynthetic activity (Sarkar *et al*., 2014). Keeping in mind, the significant role of organic, bio-fertilizers and antioxidants in plants and its potential effects on vegetative traits and quality production of gladiolus corms, an experiment was conducted during seasons 2018/2019 and 2019/2020.

This experiment was conducted to study effects of compost application, Microbein biofertilizer (M.B.) and/or spraying with some antioxidants (salicylic and ascorbic acids) treatments on corms and cormels production, as well as, chemical constituents of *Gladiolus grandiflorus* var. Jester plants.

MATERIALS AND METHODS

The present study was carried out at the Nursery and Laboratory of Ornamental plants, Faculty of Agriculture, Minia University during two successive seasons of 2018/2019 and 2019/2020 on gladiolus plants.

Gladiolus grandiflorus var. Jester corms were obtained from Holland by Basiony Nurseries, Cairo, Egypt. Average corm diameter was 2.6 and 3.2 cm and corms weight were 9.5 and 10.4 g for the first and second seasons, respectively. All corms were soaking for one minute in Pinilate (fungicide) at the concentration of 1 g/l before planting in both successive experimental seasons. Corms were planted on October 1st for both seasons in 1.5 × 2.0 m plots containing 3 ridges, 50 cm apart. Corms were planted in hills, 20 cm apart (10 corms/ridge) at a depth of 5 cm under ground surface in clay loam soil. The physical and chemical analysis of the used soil in both seasons were determined according to Jackson (1973) and Page *et al*. (1982) and shown in Table (1)

The split plot design with three replicates was followed in this experiment. The four levels of compost fertilization treatments were considered as main plots and the seven treatments of Microbein biofertilizer (M.B.) and/or some antioxidants (salicylic acid and vitamin C) treatments as the sub plots. The four levels of compost treatments were 0, 5, 10 and 15 ton/fed. The compost (plant residues) was obtained from Egypt company for circulate solid residues, at New El Minia city (organic Nile compost). The compost added during preparing the soil to cultivation in the two experimental seasons.

Physical and chemical properties of the used compost (organic Nile compost) are shown in Table (2).

Gladiolus plants were inoculated by Microbein biofertilizer (M.B.) at the rate of 50 ml/hill, as well as, some antioxidants (salicylic and ascorbic acids) treatments both at the concentration of 50 ppm 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 off. All agricultural practices were performed as usual in the region.

The Microbein was obtained from laboratory of Biofertilizers, Department of Genetics, Fac. of Agric., Minia Univ. and Salicylic and ascorbic acids were obtained from Shoura Company.

The following data were recorded:

1. Underground parts characters at harvesting after the foliage had dried (the

Table 1. Some soil physiochemical properties of the investigated soil.

Soil chemical properties				Soil physical properties	
Character	**Value**	**Character**	**Value**	**Character**	**Value**
pH (1:2.5 water)	7.7	**Total P (g kg^{-1})**	0.56	**F.C. %**	42.45
$CaCO_3$ (g kg^{-1})	17.9	**Available P (mg kg^{-1})**	13.11	**PWP %**	13.78
CEC (cmol$_c$ kg^{-1})	37.87	**Total K (g kg^{-1})**	4.37	**WHC %**	48.76
EC (dS m^{-1} at 25 °C)	1.35	**Exch. K^+ (mg/100 g soil)**	2.85	**A.V. (F.C. – PWP) %**	28.67
OM (g kg^{-1})	28.61	**Exch. Ca^{++} (mg/100 g soil)**	31.12	**A.V. (WHC-PWP) %**	34.98
Total N (g kg^{-1})	1.29	**Exch. Mg^{++} (mg/100 g soil)**	8.77	**Bulk density (BD) g/cm^3**	1.31
Total C/N ratio	22.17	**Exch. Na^+ (mg/100 g soil)**	2.52	**Particle density (PD) g/cm^3**	2.22
SOC (g kg^{-1})	18.48	**DTPA Ext. (mg kg^{-1}) Fe**	8.23	**Sand %**	28.9
Organic N (g kg^{-1})	0.76	**Cu**	2.01	**Silt %**	32.8
Organic C/N ratio	24.31	**Zn**	2.87	**Clay %**	38.3
Mineral N (mg kg^{-1})	58.46	**Mn**	8.11	**Soil texture**	Clay loam

Table 2. Nutrient composition and physicochemical properties for the investigated compost.

Compost property	Value	Compost property	Value
Dry weight of 1 m^3	450 kg	**C/N ratio**	26.50
Fresh weight of 1 m^3	650-700 kg	**N/P ratio**	2.00
Moisture weight (%)	36.60 %	**Total P (g kg^{-1}) (D.M.)**	5.0
pH (1:2.5)	7.90	**Total K (g kg^{-1}) (D.M.)**	9.0
EC (ds m^{-1} at 25 C^0)	2.20	**Total Ca (g kg^{-1}) (D.M.)**	26.3
CEC ($cmol_+$ kg^{-1})	45.66	**Total Mg (g kg^{-1}) (D.M.)**	6.6
Dry solids %	63.40	**NaCl (%)**	0.72-0.75
Ash %	9.90	**Fe (mg kg^{-1})**	150-200
Total N (g kg^{-1}) (D.M.)	10.0	**Mn (mg kg^{-1})**	25-56
Total Organic Matter (%)	32-34 %	**Cu (mg kg^{-1})**	75-150
Total Organic carbon (%)	18.5-19.7 %	**Zn (mg kg^{-1})**	150-225

underground parts were lifted 2 months after cut spikes): corm diameter (cm), number of new cormels/plant and dry weights of corm and cormels (g).

2. Determination of some chemical constituents: fresh leaves samples were taken after 75 days from planting to determine chlorophyll a, b and carotenoids as (mg/g. F.W.) using the method described by Fadl and Sari El-Deen (1979). The percentages of N, P and K in the dry leaves were estimated according to the methods described by Wilde *et al.* (1985), Champan and Pratt (1975) and Cottenie *et al.* (1982), respectively. All obtained data were tabulated and statistically analyzed according to MSTAT-C (1986) and the L.S.D. test at 5% was followed to compare between the means.

RESULTS AND DISCUSSION

Corms and cormels production:

Data in Tables (3 and 4) indicated that corm diameter (cm), corm dry weight (g), number of cormels/plant and cormels dry weight (g) were significantly increased with increasing compost fertilizer levels, during both growing successive seasons, in comparison with control. The high level of compost (15 ton/fed) resulted in the highest values for all corm and cormels production traits. Similar results were investigated by Zaghloul and Moghazy (2001), Chandar *et al.* (2012), Abdou and Ibrahim (2015), Abdou *et al.* (2018) and Karagöz *et al.* (2019) on gladiolus, Abd El-Karim (2001), Abdel-Sattar *et al.* (2010), Srivastava *et al*. (2014) and Pattnaik (2016) on tuberose, El-Naggar and El-Nasharty (2009) on *Hippeastrum vittatum*, El-Sayed *et al.* (2012) on freesia and Prasad *et al.* (2017) on lily. The increase in corms and cormels production was attributed to the positive effect of organic fertilizers in improving the vegetative growth, as well as, stimulating chlorophyll (Mashali, 1997) which reflected on increasing the underground organs of gladiolus.

In relation to the sub-plot treatments, the seven tested ones surpassed, significantly at 5% level, the control treatment in both seasons in producing wider corm diameter, higher number of new cormels/plant and heavier dry weights of corm and cormels. Also, the use of three mixed Microbein biofertilizer (M.B.) plus salicylic acid plus vitamin C treatments were more effective than other treatments and resulted in the highest values in this concern. Similar observation was pointed out by Srivastava and Govil (2005), Sathyanarayana *et al.* (2018) and Chakradhar *et al.* (2019) on gladiolus and Khan *et al.* (2009) on tulip plant.

Table 3. Effect of experimental treatments on corm diameter (cm) and corm dry weight (g) of *Gladiolus grandiflorus* var. Jester during the first and second seasons.

Treatments (B)	Compost levels (ton/fed) (A)									
	1st season (2018/2019)					2nd season (2019/2020)				
	0	5	10	15	Mean (B)	0	5	10	15	Mean (B)
	Corm diameter (cm)									
Control	2.38	2.43	2.51	2.57	2.47	2.50	2.58	2.65	2.73	2.62
Salicylic acid (S.A.)	2.67	2.75	2.84	2.92	2.80	3.82	3.93	4.05	4.18	4.00
Ascorbic acid (vit. C)	2.86	2.95	3.03	3.13	2.99	4.03	4.15	4.28	4.40	4.22
Microbein biofertilizer	3.05	3.12	3.21	3.01	3.10	4.24	4.37	4.50	4.63	4.44
Microbein + S.A.	3.26	3.36	3.47	3.56	3.41	4.45	4.58	4.72	4.86	4.65
Microbein + vit. C	3.47	3.58	3.68	3.79	3.63	4.64	4.77	4.92	5.07	4.85
Microbein + S.A. + vit. C	3.68	3.79	3.91	4.04	3.86	4.83	4.97	5.12	5.27	5.05
Mean (A)	3.05	3.14	3.24	3.29		4.07	4.19	4.32	4.45	
L.S.D. at 5 %	A:0.04		B:0.07		AB:0.14	A:0.05		0.09		AB:0.18
	Corm dry weight (g)									
Control	26.00	27.40	28.12	29.25	27.69	28.50	29.64	30.83	32.06	30.26
Salicylic acid (S.A.)	28.10	29.22	30.39	31.61	29.83	30.59	31.81	33.09	34.41	32.48
Ascorbic acid (vit. C)	30.21	31.42	32.68	33.98	32.07	32.66	33.97	35.32	36.74	34.67
Microbein biofertilizer	32.33	33.62	34.97	36.36	34.32	34.73	36.12	37.56	39.07	36.87
Microbein + S.A.	34.44	35.82	37.25	38.74	36.56	36.84	38.31	39.85	41.44	39.11
Microbein + vit. C	36.55	38.01	39.53	41.11	38.80	38.95	40.50	42.12	43.80	41.34
Microbein + S.A. + vit. C	38.67	40.22	41.83	43.50	41.06	41.06	42.29	43.98	45.74	43.27
Mean (A)	32.33	33.67	34.97	36.36		34.76	36.09	37.54	39.04	
L.S.D. at 5 %	A:1.25		B:1.50		AB:3.00	A:1.30		B:1.65		AB:3.30

Table 4. Effect of experimental treatments on number of new cormels and cormels dry weight (g) of *Gladiolus grandiflorus* var. Jester during the first and second seasons.

Treatments (B)	Compost levels (ton/fed) (A)									
	1st season (2018/2019)					2nd season (2019/2020)				
	0	5	10	15	Mean (B)	0	5	10	15	Mean (B)
	Number of new cormels									
Control	17.9	21.9	24.3	26.9	22.8	19.0	24.4	25.8	28.4	24.4
Salicylic acid (S.A.)	20.8	25.0	27.4	29.8	25.8	22.1	27.5	28.9	31.5	27.5
Ascorbic acid (vit. C)	23.3	27.5	29.9	32.3	28.3	24.2	29.7	30.9	33.5	29.6
Microbein biofertilizer	26.4	30.6	32.9	35.4	31.3	25.7	31.2	32.4	35.0	31.1
Microbein + S.A.	27.9	32.1	34.4	36.9	32.8	26.8	32.1	33.3	35.9	32.0
Microbein + vit. C	28.2	33.4	35.7	37.2	33.6	28.3	33.6	34.8	37.4	33.5
Microbein + S.A. + vit. C	30.3	35.5	37.9	42.7	36.6	31.4	36.7	37.9	41.5	36.9
Mean (A)	25.0	29.4	31.8	34.5		25.4	30.7	32.0	34.7	
L.S.D. at 5 %	A:0.9		B:0.7		AB:1.4	A:1.2		B:0.9		AB:0.18
	Cormels dry weight (g)									
Control	8.95	11.10	12.15	13.40	11.40	9.50	12.20	12.90	14.20	12.20
Salicylic acid (S.A.)	10.40	12.60	13.70	14.90	12.90	11.06	13.75	14.45	15.75	13.75
Ascorbic acid (vit. C)	11.65	13.75	14.95	16.15	14.13	12.34	15.15	15.76	17.09	15.09
Microbein biofertilizer	14.23	16.37	14.49	18.82	15.98	15.36	16.22	16.85	18.20	16.66
Microbein + S.A.	14.51	16.69	17.89	19.19	17.07	14.50	17.01	17.65	19.03	17.05
Microbein + vit. C	14.95	17.70	18.92	19.72	17.82	15.68	18.14	18.79	20.20	18.20
Microbein + S.A. + vit. C	16.36	19.17	20.47	23.06	19.77	17.27	20.19	20.85	22.83	20.29
Mean (A)	13.01	15.34	16.08	17.89		13.67	16.09	16.75	18.19	
L.S.D. at 5 %	A:0.61		B:0.31		AB:0.62	A:0.65		B:0.38		AB:0.76

The stimulatory effect of the treatment of biofertilizer on corm and cormels production may be due to the mode of action of biofertilizers on the soil or plant, plant hormone, enzymes and vitamins which came from addition of biofertilizers, which gave better growth consequently increase in all corm and cormels production parameters (Sorial *et al.*, 1992 and El-Haddad *et al.*, 1993). The role of salicylic acid treatments in increasing corm and cormels parameters was mentioned by Pawar *et al.* (2018) and Al-Hasnawi *et al.* (2019) on gladiolus, Ramtin *et al.* (2016) on carnation, Fouda and El-Gazairly (2017) on canola, Amir *et al*. (2017) on zinnia, Ahmad *et al.* (2018) and Nassour *et al.* (2019) on tuberose plant. The role of ascorbic acid (vit. C) in improving corm and cormels traits was also discussed by Mehdikhah *et al*. (2016) on gerbera, Mohammed *et al.* (2016) on dahlia plant and Dalawai and Naif (2017) on *Dianthus caryophyllus* and Gaber (2019) on *Pelargonium zonale* plant.

The interaction between the main and sub plot treatments was significant, in both seasons, in regard to corm diameter (cm), corm dry weight (g), number of new cormels/plant and cormels dry weight(g). In most case, the highest values were obtained for all corm and cormels production parameters when gladiolus plants received compost at 15 ton/fed in combination with Microbein biofertilizer (M.B.) plus salicylic acid plus vitamin C followed by the high level of compost (15 ton/fed) with the two mixed of Microbein biofertilizer (M.B.) plus vitamin C then the medium level of compost (10 ton/fed) with the three mixed of Microbein biofertilizer (M.B.) plus salicylic acid plus vitamin C. The highest corm diameter (5.27 cm) was produced by plants received compost at 15 ton/fed in combination with Microbein biofertilizer (M.B.) plus salicylic acid plus vitamin C, while least size (2.5 cm) of corm was observed in control plants (Fig., 1). Size of corm affects the growth, floral and corm yield attributes in gladiolus. Smaller sizes of the corms are poor yielder and larger sized corms add in cost of cultivation (Rashid, 2018). Therefore, it is essential to find out optimum size of corms for obtaining the best results.

Chemical constituents:

1. Photosynthetic pigments:

The contents of chlorophyll a, b and carotenoids in the fresh leaves of *Gladiolus grandiflorus* var. Jester were significantly promoted due to compost level treatments, in both growing seasons, in comparison with those of untreated plants as shown in Table (5). The high level of compost (15 ton/fed) gave the highest values for the three photosynthetic pigments in both seasons. These results may be attributed to the increase in nutrient elements and/or positive role of organic fertilizer on the physical and chemical properties of the soil, that reflected on the growth and the pigments content. In harmony with these results regarding organic fertilization treatments were those mentioned by Abdou *et al.* (2013), Khalil (2015), Abdou *et al.* (2018) and Abdou *et al.* (2019) on gladiolus, El-Naggar and El-Nasharty (2009) on *Hippeastrum vittatum* and Dalawai and Naif (2017) on *Dianthus caryophyllus.*

In relation to the influence of Microbein biofertilizer (M.B.) and/or some antioxidant (salicylic acid and vitamin C) treatments on chlorophyll a, b and carotenoids contents were promoted, in both seasons (Table, 5). Using both Microbein biofertilizer (M.B.) and/or some antioxidant (salicylic acid and vitamin C) treatments together was more effective than the other used treatments. Also, differences between any treatment and control was statistically significant. Among the six treatments, the three mixed Microbein biofertilizer (M.B.) plus salicylic acid plus vitamin C resulted the highest values over all other treatments. These results may be attributed not only to the increase in nutrient elements, but also to the role of Microbein biofertilizer (M.B.) treatment on stomatal regulation, photosynthesis and growth as indicated by

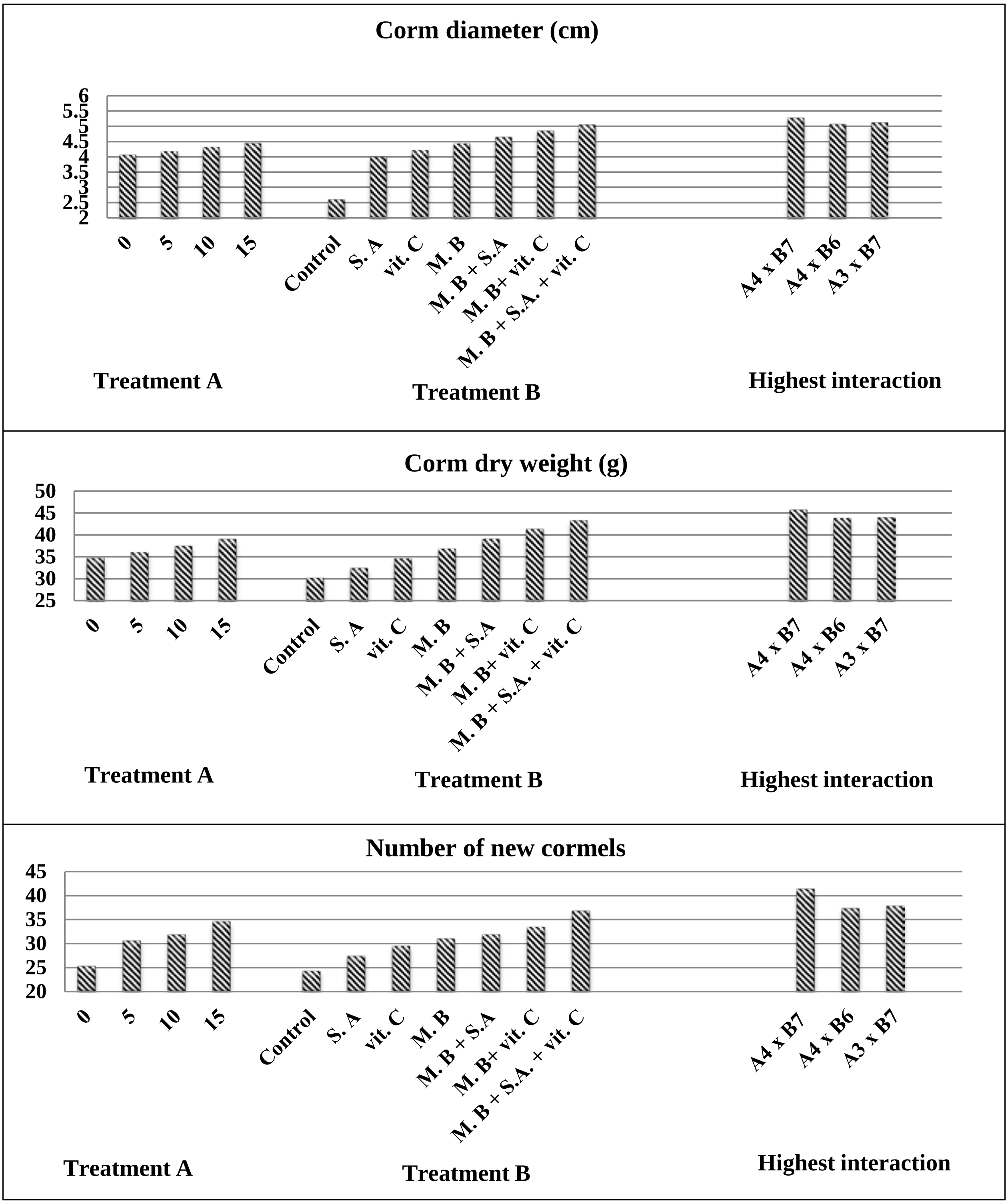

Fig. 1. Quality parameters of gladiolus (corm diameter (cm), corm dry weight (g) and number of new cormels) as affected by experimental treatments, compost 15 ton/fed + M.B. + S.A. + V.C (A4 x B7); compost 15 ton/fed + M.B. + V.C (A4 x B6); compost 10ton/fed + M.B. + S.A. + V.C (A3 x B7).

Table 5. Effect of experimental treatments on photosynthetic pigments (mg/g F.W.) of *Gladiolus grandiflorus* var. Jester during the first and second seasons.

Treatments (B)	Compost levels (ton/fed) (A)									
	1st season (2018/2019)					2nd season (2019/2020)				
	0	5	10	15	Mean (B)	0	5	10	15	Mean (B)
	Chlorophyll a content (mg/g. F.W.)									
Control	2.335	2.374	2.380	2.415	2.376	2.364	2.403	2.409	2.445	2.405
Salicylic acid (S.A.)	2.407	2.418	2.442	2.448	2.429	2.436	2.448	2.472	2.478	2.458
Ascorbic acid (vit. C)	2.439	2.454	2.478	2.493	2.466	2.469	2.484	2.508	2.523	2.496
Microbein biofertilizer	2.472	2.487	2.505	2.531	2.499	2.502	2.517	2.535	2.562	2.529
Microbein + S.A.	2.499	2.510	2.537	2.567	2.528	2.529	2.541	2.568	2.598	2.559
Microbein + vit. C	2.513	2.546	2.576	2.609	2.561	2.544	2.577	2.607	2.640	2.592
Microbein + S.A. + vit. C	2.558	2.579	2.614	2.647	2.600	2.589	2.610	2.646	2.679	2.631
Mean (A)	2.460	2.481	2.505	2.530		2.490	2.511	2.535	2.561	
L.S.D. at 5 %	A:0.016		B:0.025		AB:0.050	A:0.020		B:0.028		AB:0.056
	Chlorophyll b content (mg/g. F.W.)									
Control	0.778	0.791	0.793	0.805	0.792	0.788	0.801	0.803	0.815	0.801
Salicylic acid (S.A.)	0.802	0.806	0.814	0.816	0.809	0.812	0.816	0.824	0.826	0.819
Ascorbic acid (vit. C)	0.813	0.818	0.826	0.831	0.822	0.823	0.828	0.836	0.841	0.832
Microbein biofertilizer	0.824	0.829	0.835	0.843	0.833	0.834	0.839	0.845	0.854	0.843
Microbein + S.A.	0.833	0.837	0.845	0.855	0.842	0.843	0.847	0.856	0.866	0.853
Microbein + vit. C	0.838	0.848	0.858	0.869	0.853	0.848	0.859	0.869	0.880	0.864
Microbein + S.A. + vit. C	0.852	0.859	0.871	0.882	0.866	0.863	0.870	0.882	0.893	0.877
Mean (A)	0.820	0.827	0.835	0.843		0.830	0.837	0.845	0.853	
L.S.D. at 5 %	A:0.006		B:0.008		AB:0.016	A:0.007		B:0.010		AB:0.020
	Carotenoids content (mg/g. F.W.)									
Control	0.942	0.957	0.960	0.974	0.958	0.953	0.969	0.971	0.986	0.970
Salicylic acid (S.A.)	0.970	0.975	0.985	0.987	0.979	0.982	0.987	0.997	0.999	0.991
Ascorbic acid (vit. C)	0.983	0.989	0.999	1.005	0.994	0.995	1.002	1.011	1.017	1.006
Microbein biofertilizer	0.997	1.003	1.010	1.021	1.007	1.009	1.015	1.022	1.033	1.020
Microbein + S.A.	1.007	1.012	1.023	1.035	1.019	1.020	1.025	1.035	1.048	1.032
Microbein + vit. C	1.013	1.027	1.039	1.052	1.033	1.026	1.039	1.051	1.065	1.045
Microbein + S.A. + vit. C	1.031	1.040	1.054	1.067	1.048	1.044	1.052	1.067	1.080	1.061
Mean (A)	0.992	1.000	1.010	1.020		1.004	1.013	1.022	1.033	
L.S.D. at 5 %	A:0.006		B:0.009		AB:0.0018	A:0.008		B:0.012		AB:0.024

Taha and Hassan (2008) on gladiolus and Attia *et al.* (2018) on tuberose. Also, salicylic acid increased pigments as reported by Pawar *et al.* (2018) and Al-Hasnawi *et al.* (2019) on gladiolus, Ramtin *et al.* (2016) on carnation and Nassour *et al.* (2019) on tuberose plant. Vitamin C gave the same results as obtained by Abdel Aziz *et al.* (2009) and Abo Leila and Eid (2011) on gladiolus, Abd El-Aziz *et al.* (2007) on syngonium, Kasim and Adil (2014) on freesia, Nikee *et al*. (2014) on summer savory, Mohammed *et al.* (2016) on dahlia and Gaber (2019) on *Pelargonium zonale* plant.

Effect of the interactions between compost, Microbein biofertilizer (M.B.) and/or some antioxidant (salicylic acid and vitamin C) treatments was significant in both seasons, for the photosynthetic pigments with the highest values being obtained due to the use of compost at 15 ton/fed in combination Microbein biofertilizer (M.B.) plus salicylic acid plus vitamin C followed by 15 ton/fed compost with M.B. + vit. C then 10 ton/fed with M.B. + salicylic acid +

vit. C, in most cases as shown in Table (5). Chlorophyll a and b are very important pigmented compounds in autotrophic plants, required for the process of photosynthesis by capturing photosynthetically active radiations (PAR) for plant growth and development (Saeed *et al*., 2013). The influence of compost application may be attributed to the increased vegetative as well as the chlorophyll content, and hence increased photosynthesis. It is likely to assume greater allocation of photosynthates to the daughter corms, that resulted in corms with larger size (Reddy and Sarkar, 2016).

2. Nitrogen, phosphorus and potassium percentages:

In both seasons, increasing the level of compost linearly increased the percentages of N, P and K in the dry leaves. In this concern, the treatment with high level of compost (15 ton/fed) gave the highest percentages (Table, 6). On the other hand, the lowest values of N, P and K percentages in the dry leaves of gladiolus were recorded by the control plants. Moreover, significant differences were detected between compost treatments and control one, also between compost treatments in all cases. The results mentioned above, could be attributed to that application of organic fertilizer improved soil properties, increase nutrients in area of roots, which increase nutrients uptake which in turn reflects on the corm quality.

These results are in agreement with those obtained by Sönmez *et al.* (2013), Khalil (2015), Abdou *et al.* (2018) on gladiolus, Abd El-Karim (2001) and Suseela *et al*. (2016) on tuberose, Eliwa *et al.* (2009) on Iris, El-Sayed *et al.* (2012) on freesia and Dalawai and Naif (2017) on *Dianthus caryophyllus.*

The percentages of N, P and K were significantly increased, in both seasons, as a result of inoculating gladiolus with Microbein biofertilizer (M.B.) and spraying gladiolus with some antioxidant (salicylic acid and vitamin C) treatments in comparison with the control (Table, 6). The treatment of M.B. + salicylic acid + vit. C recorded the highest values for N, P and K% in both seasons. N- fixing bacteria enhance the uptake of different nutrients (Sorial *et al.*, 1992). Also, salicylic acid is involved in a wide range of important functions as antioxidant defense and leaf development which increased photosynthetic rate (Jacquot *et al*., 2002). Ascorbic acid promoted nutrient elements uptake (Havaux *et al.*, 2000). This positive effect of the used treatments led to promoted nutrient uptake and finally reflexes on the percentages of N, P and K.

The role of biofertilizer in improving N, P and K%, which is in harmony with the obtained results was stated by Hassanein and El-Sayed (2009), and Sathyanarayana *et al.* (2018) on gladiolus, Abdou (2004) on dahlia, and Parmar *et al*. (2017) on Golden rod, Attia *et al.* (2018) on tuberose. Also, salicylic acid increased N, P and K% as revealed by Pal *et al*. (2015), Pawar *et al.* (2018) and Al-Hasnawi *et al.* (2019) on gladiolus, Mohamed (2017) on Aster, Ahmad *et al.* (2018) and Nassour *et al.* (2019) on tuberose plant. Vitamin C made the same trend to increase these characters was mentioned by Abdel Aziz *et al.* (2009) and Abo Leila and Eid (2011) on gladiolus, Abd El-Aziz *et al.* (2007) on syngonium, Abdou and Mohamed (2014) on mint and Mohammed *et al.* (2016) on dahlia plant.

Effect of the interaction treatments was significant, in both seasons, for N and P% only. The highest values were obtained with the interaction treatments of 15 ton/fed compost in combination with M.B. plus salicylic acid plus ascorbic acid as shown in Table (6). Gladiolus is commercially propagated and grown from its specialized underground structure for production of flowers and corm as well as cormels (Adkins and Miller, 2008). Usually one daughter corm (new corm) along a number of cormels is produced (depending upon the size of daughter corm) in one season.

Table 6. Effect of experimental treatments on N, P and K percentages in the dry leaves of *Gladiolus grandiflorus* var. Jester during the first and second seasons.

Treatments (B)	Compost levels (ton/fed) (A)									
	1st season (2018/2019)					2nd season (2019/2020)				
	0	5	10	15	Mean (B)	0	5	10	15	Mean (B)
					N %					
Control	1.627	1.699	1.729	1.791	1.711	1.647	1.719	1.750	1.813	1.732
Salicylic acid (S.A.)	1.757	1.803	1.876	1.936	1.843	1.778	1.825	1.899	1.960	1.865
Ascorbic acid (vit. C)	1.822	1.977	2.071	2.093	1.991	1.845	2.001	2.096	2.119	2.015
Microbein biofertilizer	2.028	2.085	2.145	2.228	2.121	2.052	2.111	2.171	2.255	2.147
Microbein + S.A.	2.113	2.196	2.255	2.293	2.214	2.139	2.223	2.282	2.321	2.241
Microbein + vit. C	2.198	2.261	2.297	2.368	2.281	2.225	2.289	2.325	2.397	2.309
Microbein + S.A. + vit. C	2.273	2.344	2.371	2.391	2.345	2.301	2.372	2.400	2.420	2.374
Mean (A)	1.974	2.052	2.106	2.157		1.998	2.077	2.132	2.184	
L.S.D. at 5 %	A:0.048		B:0.021		AB:0.042	A:0.051		B:0.024		AB:0.048
					P %					
Control	0.222	0.233	0.253	0.292	0.250	0.225	0.236	0.256	0.296	0.253
Salicylic acid (S.A.)	0.267	0.295	0.303	0.305	0.293	0.270	0.299	0.307	0.309	0.296
Ascorbic acid (vit. C)	0.296	0.321	0.335	0.339	0.323	0.300	0.325	0.339	0.343	0.327
Microbein biofertilizer	0.323	0.338	0.359	0.366	0.346	0.327	0.342	0.363	0.370	0.351
Microbein + S.A.	0.350	0.361	0.371	0.386	0.367	0.354	0.365	0.375	0.391	0.371
Microbein + vit. C	0.364	0.376	0.391	0.406	0.384	0.368	0.380	0.396	0.411	0.389
Microbein + S.A. + vit. C	0.377	0.401	0.408	0.414	0.400	0.382	0.406	0.413	0.419	0.405
Mean (A)	0.314	0.332	0.346	0.358		0.318	0.336	0.350	0.363	
L.S.D. at 5 %	A:0.010		B:0.005		AB:0.010	A:0.012		B:0.006		AB:0.012
					K %					
Control	1.528	1.537	1.546	1.555	1.542	1.547	1.556	1.565	1.574	1.561
Salicylic acid (S.A.)	1.548	1.562	1.568	1.571	1.562	1.567	1.581	1.587	1.590	1.581
Ascorbic acid (vit. C)	1.566	1.573	1.582	1.593	1.579	1.585	1.592	1.601	1.612	1.598
Microbein biofertilizer	1.580	1.589	1.596	1.616	1.595	1.600	1.608	1.615	1.636	1.615
Microbein + S.A.	1.594	1.597	1.621	1.632	1.611	1.613	1.617	1.641	1.652	1.631
Microbein + vit. C	1.611	1.622	1.637	1.643	1.628	1.631	1.642	1.657	1.663	1.648
Microbein + S.A. + vit. C	1.625	1.641	1.648	1.652	1.642	1.645	1.661	1.668	1.672	1.662
Mean (A)	1.579	1.589	1.600	1.609		1.598	1.608	1.619	1.628	
L.S.D. at 5 %	A:0.007		B:0.003		AB:0.006	A:0.009		B:0.004		AB:0.008

The daughter corm produces flowering spike in the same season whereas the cormels needs 2-4 seasons in order to get the reasonable size and produce marketable spikes (Memon *et al*., 2009). The corms and cormels of gladiolus remain dormant for 4-5 months with slight variations depending upon the cultivars and growing conditions (Priyakumari and Sheela, 2005). Production of both, flowering spikes and corms depends upon the size of mother corm and or cormels (Bose *et al*., 2003; Chourasia *et al*., 2015). Therefore, the vegetative characteristics, flower and corm production in gladiolus could be absolutely affected by different organic and bio-fertilizers in combination with antioxidants treatments when applied in optimal concentration (Abdou *et al*., 2019). Good quality corms give rise to better vegetative growth with healthy verdure and boosted photosynthetic activity (Sarkar *et al*., 2014; Ahmed and Rab, 2019). From the above results, it can be concluded that in respect of cultivation of gladiolus, applying of compost at the rate of 15 ton/fed in combination with Microbein biofertilizer

(M.B.) plus salicylic acid plus vitamin C was most effective treatment for enhancing corms and cormels quality and chemical constituents of gladiolus.

CONCLUSION

Gladiolus is the second most important flower cut in Egypt after roses, with good export earnings potential. Gladiolus has a wide range of varieties and flowers available in various colors, shapes, and sizes. Besides its cut flowers, gladiolus is also planted in flower beds in landscape gardening and is used as specimen plant in flower shows and exhibitions. Results of this research indicated that the statistical analysis revealed significant differences in in the studied parameters in response to fertilization by compost in combination with Microbein biofertilizer (M.B.) and/or some antioxidants (salicylic and ascorbic acids) and the interaction of both factors was also significant. Plants of gladiolus treated with compost at the rate of 15 ton/fed in combination with Microbein biofertilizer (M.B.) plus salicylic acid plus vitamin C resulted in largest corm diameter (cm), corm dry weight (g), number of cormels/plant and cormels dry weight (g), highest leaf chlorophyll a and b content, carotenoids and percentages of N, P and K in the dry leaves. Good quality corms give rise to better vegetative growth with healthy flowers and boosted healthy plants verdure.

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تأثيرات معاملات الكمبوست والسماد الحيوي و/أو بعض مضادات الأكسدة على نباتات الجلاديولس
ب. إنتاج الكورمات والكريمات وبعض الصفات الكيميائية لنباتات الجلاديولس

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تتكاثر نباتات الجلاديولس تجاريًا بالأجزاء تحت الأرضية (الكورمات وكذلك الكريمات) لإنتاج الزهور. أجريت تجربة حقلية خلال موسمي ٢٠١٨/٢٠١٩ ٢٠١٩/٢٠٢٠ لدراسة تأثير سماد الكمبوست بمستويات (صفر، ٥، ١٠ و ١٥ طن/فدان) مع إضافة السماد الحيوي الميكروبين بمعدل ٥٠ مل/النبات و/أو الرش ببعض مضادات الاكسدة (حمضي السالساليك والأسكوربيك) كلاً بتركيز ٥٠ جزء فى المليون على إنتاجية الكورمات والكريمات والمحتوى الكيماوي لنباتات الجلاديولس صنف Jester. أوضحت النتائج أن قطر الكورمة (سم) وعدد الكريمات الجديدة/نبات والوزن الجاف للكورمة والكريمات (جم) والمحتوى الكيماوي متضمناً صبغات البناء الضوئي (كلوروفيل أ ، ب والكاروتينويدات) والنسبة المئوية للنتروجين والفوسفور والبوتاسيوم في الأوراق الجافة زاد تدريجياً بزيادة مستوى السماد العضوي الكمبوست. يوجد فرق معنوي بين المعاملات الأربعة. المستوى العالي من سماد الكمبوست أعطى أعلى القيم. تم إنتاج أعلى قطر للكورمة (٥,٢٧ سم) عن طريق النباتات التي حصلت على السماد العضوي بمعدل ١٥ طن/فدان بالاشتراك مع السماد الحيوي ميكروبين (M.B.) بالإضافة إلى حمض الساليسيليك وحمض الأسكوربيك بينما لوحظ أقل حجم (٢,٥ سم) من الكورمة في نباتات المقارنة. كل معاملات السماد الحيوي الميكروبين و/أو بعض مضادات الاكسدة (حمضي السالساليك والأسكوربيك) منفردين أو مجتمعين أحدثت زيادة معنوية في إنتاجية الكورمات والكريمات والتقديرات الكيماوية مقارنة بمعاملة المقارنة. معاملات خليط من السماد الحيوي (الميكروبين) + حمض السالساليك + حمض الأسكوربيك (فيتامين ج) كانت أكثر فاعلية

من المعاملات الأخرى فيما يخص إنتاجية الكورمات والكريمات وصبغات البناء الضوئي والنسبة المئوية للنتروجين والفوسفور والبوتاسيوم في أغلب الحالات. تأثير التفاعل كان معنوياً لكل الصفات المدروسة. ولقد نتجت أعلى القيم لإنتاجية الكورمات والكريمات الحالات عن إضافة السماد العضوي الكمبوست بمعدل ١٥ طن/فدان مع إضافة خليط من السماد الحيوي (الميكروبين) + حمض السالساليك + حمض الأسكوربيك تليها معاملة إضافة سماد الكمبوست بمعدل ١٥ طن/فدان مع سماد الميكروبين + فيتامين ج تليها استعمال سماد الكمبوست بمعدل ١٠ طن/فدان مع خليط من السماد الحيوي (الميكروبين) + حمض السالساليك + فيتامين ج كذلك أعطت أعلى محتوى أيضاً من الصبغات والنسب المئوية للنتروجين والفوسفور والبوتاسيوم. أشارت نتائج هذا البحث إلى أمكانية أنتاج كورمات وكريمات الجلاديولس ذات النوعية الجيدة تحت الظروف المصرية مما يؤدي إلى زيادة الإمكانات العالية لتصدير أزهارها.