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EFFECT OF MINERAL AND BIOFERTILIZATION TREATMENTS ON: 2- CORMS PRODUCTIVITY AND CHEMICAL CONSTITUENTS OF GLADIOLUS CV. WHITE PROSPERITY

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ABSTRACT: A field experiment was conducted at Nursery of Ornamental Plants, Fac. Agric., Minia Univ. during 2013/2014 and 2014/2015 to investigate the effect of NPK (0, 50, 75 and 100% of recommended dose) and biofertilizers (phosphorein and/or E.M.) on corm and cormels productivity, as well as, chemical constituents of gladiolus cv. White Prosperity.

The obtained results indicated that, corm diameter, corm dry weight, number of cormels/plant, cormels dry weight/plant, as well as, chemical constituents (N, P, K and total sugars % in corms and total chlorophyll in leaves) were significantly increased with all levels of NPK in comparison with control. The highest values were obtained with NPK 100%.

All biofertilizer treatments significantly increased corm and cormels productivity, as well as, either chemical constituents in comparison with the control. Phosphorein + E.M. was more effective in this concern.

The interaction treatments were significant with the highest values being obtained due to NPK 75% in combination with phosphorein + effective microorganisms (E.M.).

Key words: *Gladiolus grandiflorus* cv. White Prosperity, NPK, biofertilization, phosphorein, E.M., corms productivity, chemical constituents.

INTRODUCTION

Gladiolus grandiflorus, L. plant is considered one of the most important flowering bulbs grown in Egypt. Gladiolus plants are propagated by corms and cormels.

The effect of NPK on increasing the corm and cormels productivity, fresh and dry weights of corms and cormels of gladiolus were reported by many investigators such as Pimpini and Zanin (2002); Atta-Alla *et al.* (2003); Khan and Iftikhar (2004); Butt (2005); Gaurav and Prabhakar (2007) ; Taha and Hassan (2008) and Kumar (2015).

With regard to chlorophyll content and NPK elements of gladiolus leaves and corms, NPK was found to increase chlorophyll contents and NPK elements (Atta-Alla *et al*., 2003; Abdou *et al*., 2004 and Taha and Hassan, 2008).

Biofertilizer treatments were found to have stimulating effects on bulb, corm and cormels productivity and pigments contents, as well as, N, P and K % as reported by Rajes *et al*. (2006); Taha and Hassan (2008) and Basoli *et al*. (2015) on gladiolus; Hussein (2004) and Allam and El-Tayeb (2008) on Iris and Yadav *et al*. (2011) on tuberose.

The aim of this work was to study the effect of application of NPK fertilization and

chemical constituents on *Gladiolus grandiflorus* cv. While Prosperity.

MATERIALS AND METHODS

The present study was carried out at the Nursery of Ornamental Plants, Fac. Agric., Minia Univ., during the two successive seasons of 2013/2014 and 2014/2015 on corm and cormels production and some chemical constituents of *Gladiolus graniflorus* cv. White Prosperity.

Gladiolus corms were obtained from Holland by Basiouny nurseries, Cairo, Egypt. Average corm diameter was 2.9 and 3.2 cm and corm weight was 9.7 and 9.9 g for the first and second seasons, respectively. Corms were planted on October, 15th for both seasons in 1.8×2 m plots containing 3 ridges, 50 cm apart. Corms were planted in hills, 20 cm apart (8 corms/ridge). Physical and chemical properties of the soil used are listed in Table (a). The split plot design with three replicates was followed in this experiment.

The four combined NPK fertilization treatments were considered as main plots (A) and four biofertilization treatments the sub-plots (B). The four NPK fertilization treatments were $N_0P_0K_0$ (0:0:0), $N_1P_1K_1$ (150:80:100), $N_2P_2K_2$ (225:120:150), $N_3P_3K_3$ (300:160:200). Nitrogen fertilization rates of N_0, N_1, N_2 and N_3 were represented by 0, 150, 225 and 300 kg/fed ammonium nitrate (33.5 % N). However, phosphorus was applied at P_0, P_1, P_2 and P_3 represented by 0, 80, 120 and 160 kg/fed calcium superphosphate (15.5% P_2O_5) and potassium was added at K_0, K_1, K_2 and K_3 represented by 0, 100, 150 and 200 kg/fed potassium sulphate (48.5% K_2O). The combined $N_1P_1K_1$, $N_2P_2K_2$ and $N_3P_3K_3$ presented 50, 75 and 100% respectively.

Phosphorus fertilizer was added before planting during the soil preparation. The amounts of N and K mineral fertilization were added at the three equal batches, one month, and two months from planting date and after flower cut for corm and cormels production.

The biofertilization treatments were as follows: (1) Control (without any biofertilizers), (2) Phosphorein, (3) E.M. (effective microorganisms), (4) E.M. + phosphorein.

The biofertilizers were applied three times to the soil beside the plants at 50 ml/plant E.M. or phosphorein. Application was carried out three times, 35 and 70 days after planting and after flower cut for corm and cormels productivity.

The following data were recorded:

1- Underground parts characters at harvesting, after the foliage had been dried (the underground parts were lifted 2 months after cut spikes) corm diameter (cm), corm dry weight (g), number of new cormels/plant and dry weights of new cormels/plant (g).

Table a. Physical and chemical properties of the used soil.

Soil Character	Value	Soil Character		Value
Sand %	28.20	**Available P %**		15.12
Silt %	30.7	**Exch. K^+ (mg/100 g soil)**		2.11
Clay %	41.10	**Exch. Ca^{++} (mg/100 g soil)**		31.74
Texture grade	Clayey loam	**Exch. Na^+ (mg/100 g soil)**		2.40
Organic matter %	1.62	**DTPA Ext. ppm**	**Fe**	8.54
$CaCO_3$ %	2.09		**Cu**	2.06
E.C. (mmhos/cm)	1.04		**Zn**	2.75
pH (1:2.5)	7.82		**Mn**	8.26
Total N %	0.08			

2- Determination of some chemical constituents: leaves samples were taken after 75 days from planting, but corms and cormels samples were taken after two months from flowering termination.

- Total chlorophyll (mg/g f.w.) was determined in the fresh leaves samples using the method described by Moran (1982).
- The percentage of N, P and K in the dry corms were estimated according to Page *et al*. (1982), then the contents of the three elements in the dry corms were calculated.
- Total sugars in the dry corms (mg/g) were determined according to Moore (1974).

All the obtained data were subjected to the statistical analysis of variance using MSTAT-C (1986). L.S.D. test at 5 % was used to compare the average means of treatments.

RESULTS AND DISCUSSION

1- Corm and cormels productivity:

Data presented in Tables (1 and 2) during both seasons indicated that corm diameter, corm dry weight, number of cormels/plant and dry weight of cormels were significantly increased with increasing NPK fertilizer levels in comparison with control ($N_0P_0K_0$). The highest level ($N_3P_3K_3$) treatment resulted the highest values for all corms and cormels productivity over the other used treatments in both seasons. Similar results were revealed on gladiolus plants such as those of Pimpini and Zanin (2002), Butt (2005) and Taha and Hassan (2008).

The increase in the corm and cormels productivity was attributed to the positive effect of NPK fertilizer on improving the vegetative growth traits which reflected on increasing the underground organs.

Data presented in Tables (1 and 2) indicated that the three treatments of biofertilizer significantly increased corm diameter, corm dry weight, number of cormels/plant and dry weight of cormels/plant in comparison with the control treatment in both seasons. The treatment of phosphorein + E.M. was more effective than the other two treatments in this concern. Similar observations were pointed out on gladiolus plant, Abdou *et al.* (2004); Rajes *et al*. (2006), Taha and Hassan (2008) and Basoli *et al*. (2015).

The stimulatory effect of biofertilizers on corms and cormels production may be due to the mode of action of biofertilizer on the soil, plant promoting hormone and enzymes, which came from addition of biofertilizers which gave better vegetative growth and better photosynthesis consequently more dry matter accumulation.

The interaction between NPK and biofertilization treatments was significant, in both season, for corm diameter, corm dry weight, number of cormels/plant and cormels dry weight/plant (Tables, 1 and 2). The highest values were obtained when gladiolus cv. White Prosperity plants received either $N_3P_3K_3$ or $N_2P_2K_2$ in combination with biofertilizers (phosphorein + E.M.).

2- Chemical constituents:

a. Total chlorophyll:

The content of total chlorophyll (mg/g f.w.) was significantly promoted with all NPK treatments in comparison with control ($N_0P_0K_0$). The treatment of $N_3P_3K_3$ gave the highest content of total chlorophyll in both seasons (Table, 2). These results may be due to the increase in nutrient elements. Similar results were obtained by Abdou *et al*. (2004), Taha and Hassan (2008) and Abdou *et al.* (2013) on gladiolus.

Total chlorophyll content was significantly promoted in both seasons comparing with control treatment due to phosphorein and/or E.M. treatments. Using phosphorein plus E.M. was effective in this concern. This result may be attributed to the increase in N and P elements and/or plant promoting hormone, which came as a result from inoculation of bacteria, that reflect on

Table 1. Effect of mineral NPK fertilization and biofertilization treatments on corm diameter (cm), corm dry weight (g) and number of cormels/plant of gladiolus cv. White Prosperity during 2013/2014 and 2014/2015.

Biofertilization treatments (B)	NPK fertilization from recommended dose (A)									
	1st season					2nd season				
	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)
Corm diameter (cm)										
Control	3.11	3.62	4.10	4.51	3.84	3.18	3.70	4.22	4.60	3.93
Phosphorein	3.52	4.01	4.50	4.91	4.24	3.59	4.10	4.61	5.00	4.33
E.M.	3.81	4.32	4.80	5.21	4.54	3.90	4.40	4.91	5.21	4.61
Phos. + E.M.	4.22	4.71	5.22	5.64	4.95	4.23	4.74	5.24	5.69	4.98
Mean (A)	3.67	4.17	4.66	5.07		3.73	4.24	4.75	5.13	
L.S.D. at 5 %	A: 0.22		B: 0.21		AB: 0.42	A: 0.31		B: 0.23		AB: 0.46
Corm dry weight (g)										
Control	10.41	12.09	13.74	15.11	12.84	10.65	12.40	14.14	15.41	13.15
Phosphorein	11.79	13.43	15.08	16.45	14.19	12.03	13.74	15.44	16.75	14.49
E.M.	12.76	14.47	16.07	17.45	15.19	13.06	14.73	16.45	17.41	15.41
Phos. + E.M.	14.12	15.77	17.49	18.90	16.57	14.17	15.87	17.56	19.07	16.67
Mean (A)	12.27	13.94	15.60	16.98		12.48	14.19	15.90	17.16	
L.S.D. at 5 %	A: 0.86		B: 0.72		AB: 1.44	A: 0.98		B: 0.82		AB: 1.64
Number of cormels/plant										
Control	29.14	33.85	38.45	42.30	35.94	29.82	34.71	39.59	43.14	36.82
Phosphorein	33.01	37.50	42.22	46.00	39.68	33.65	38.45	43.21	46.50	40.45
E.M.	35.70	40.51	44.95	48.81	42.49	36.55	41.23	46.01	48.75	43.14
Phos. + E.M.	39.51	44.15	48.97	52.92	46.39	39.66	44.44	49.17	53.40	46.67
Mean (A)	34.34	39.00	43.65	47.51		34.92	39.71	44.50	47.95	
L.S.D. at 5 %	A: 3.11		B: 2.05		AB: 4.10	A: 3.15		B: 2.31		AB: 4.62

Phos.= Phosphorein , E.M.= Effective microorganisms
$N_0P_0K_0$= 0%, $N_1P_1K_1$= 50%, $N_2P_2K_2$= 75%, $N_3P_3K_3$= 100%

Table 2. Effect of mineral NPK fertilization and biofertilization treatments on cormels dry weight (g), total chlorophyll (mg/g f.w.) and corm nitrogen content (mg/g d.w.) of gladiolus cv. White Prosperity during 2013/2014 and 2014/2015.

Biofertilization treatments (B)	NPK fertilization from recommended dose (A)									
	1st season					2nd season				
	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)
Cormels dry weight (g)										
Control	11.05	11.93	13.41	14.84	12.81	11.28	13.10	15.01	18.23	14.41
Phosphorein	11.56	12.45	13.95	15.30	13.32	11.79	13.65	15.55	18.71	14.93
E.M.	12.45	13.36	14.88	16.22	14.23	12.79	14.56	16.46	19.62	15.86
Phos. + E.M.	13.56	14.40	16.95	17.75	15.54	13.89	15.56	19.88	20.59	17.50
Mean (A)	12.16	13.04	14.80	15.90		12.44	14.24	16.73	19.29	
L.S.D. at 5 %	A: 0.88		B: 0.51		AB: 1.01	A: 1.12		B: 0.47		AB: 0.94
Total chlorophyll (mg/g f.w.)										
Control	3.828	3.869	3.905	3.948	3.888	3.837	3.878	3.920	3.958	3.898
Phosphorein	3.915	3.965	4.008	4.045	3.983	3.935	3.979	4.021	4.055	3.998
E.M.	4.020	4.070	4.105	4.149	4.086	4.040	4.080	4.122	4.158	4.100
Phos. + E.M.	4.221	4.275	4.315	4.351	4.291	4.241	4.185	4.328	4.361	4.279
Mean (A)	3.996	4.045	4.083	4.123		4.013	4.031	4.098	4.133	
L.S.D. at 5 %	A: 0.035		B: 0.092		AB: 0.184	A: 0.017		B: 0.100		AB: 0.200
Corm nitrogen content (mg/g d.w.)										
Control	111.5	152.0	193.1	224.1	170.2	116.1	158.3	196.8	225.0	174.1
Phosphorein	126.4	168.3	208.9	238.0	185.4	132.0	174.1	211.1	240.0	189.3
E.M.	147.0	190.5	229.1	259.2	206.4	153.0	195.2	231.9	260.0	210.0
Phos. + E.M.	159.1	201.0	262.1	271.3	223.4	164.1	206.3	264.1	270.1	226.2
Mean (A)	136.0	178.0	223.3	248.2		141.3	183.5	226.0	248.8	
L.S.D. at 5 %	A: 21.8		B: 4.7		AB: 9.4	A: 22.1		B: 4.1		AB: 8.2

Phos.= Phosphorein , E.M.= Effective microorganisms
$N_0P_0K_0$= 0%, $N_1P_1K_1$= 50%, $N_2P_2K_2$= 75%, $N_3P_3K_3$= 100%

Table 3. Effect of mineral NPK fertilization and biofertilization treatments on corm phosphorus content (mg), corm potassium content (mg) and corm total sugars content (mg/g d.w.) of gladiolus cv. White Prosperity during 2013/2014 and 2014/2015.

Biofertilization treatments (B)	NPK fertilization from recommended dose (A)									
	1st season					2nd season				
	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)
Corm phosphorus content (mg/g d.w.)										
Control	30.1	35.2	39.4	42.1	36.7	31.1	36.8	40.5	43.3	37.9
Phosphorein	33.6	39.0	41.5	45.0	39.8	34.0	39.1	43.6	45.9	40.7
E.M.	34.5	40.1	42.7	46.3	40.9	34.9	40.5	45.8	46.3	41.9
Phos. + E.M.	36.1	42.2	46.9	48.0	43.3	37.0	42.6	47.1	48.9	43.9
Mean (A)	33.6	39.1	42.6	45.4		34.3	39.8	44.3	46.1	
L.S.D. at 5 %	A: 2.8		B: 0.85		AB: 1.7	A: 1.8		B: 1.3		AB: 2.6
Corm potassium content (mg/g d.w.)										
Control	71.1	90.3	109.4	119.5	97.6	72.3	94.5	110.1	121.1	99.3
Phosphorein	91.0	113.6	127.5	137.0	117.3	92.1	115.7	130.0	140.0	119.5
E.M.	88.5	110.4	125.1	135.6	114.9	90.2	111.8	127.4	137.8	116.8
Phos. + E.M.	93.1	115.8	138.9	141.8	122.4	94.5	118.9	140.1	145.6	124.8
Mean (A)	85.9	107.5	125.2	133.5		87.3	110.2	126.9	136.1	
L.S.D. at 5 %	A: 5.9		B:2.9		AB: 5.8	A: 6.8		B: 4.0		AB: 8.0
Corm total sugars content (mg/g d.w.)										
Control	42.1	47.2	50.1	52.6	48.0	43.7	48.4	51.3	53.5	49.2
Phosphorein	43.9	48.8	51.3	53.8	49.5	44.9	50.1	52.9	54.9	50.7
E.M.	44.9	50.8	53.6	55.9	51.3	46.4	52.2	54.8	56.5	52.5
Phos. + E.M.	47.8	53.5	59.1	63.8	56.1	49.5	55.8	59.5	65.9	57.7
Mean (A)	44.7	50.1	53.5	56.5		46.1	51.6	54.6	57.7	
L.S.D. at 5 %	A: 2.8		B: 3.9		AB: 7.8	A: 3.1		B: 4.6		AB: 9.2

Phos.= Phosphorein , E.M.= Effective microorganisms
$N_0P_0K_0$= 0%, $N_1P_1K_1$= 50%, $N_2P_2K_2$= 75%, $N_3P_3K_3$= 100%

chlorophyll content. Similar results were obtained by Abdou *et al.* (2004) and Taha and Hassan (2008) on gladiolus.

The interaction between main and sub plot was significant in both seasons with the highest values being obtained with either $N_3P_3K_3$ or $N_2P_2K_2$ in combination with phosphorein + E.M.

b. Corms nitrogen, phosphorus, potassium and total sugars content:

Data presented in Tables (2 and 3) revealed that increasing the levels of NPK fertilizers linearly enhanced the contents of N, P, K and total sugars in the corms of gladiolus. The treatment with high level NPK ($N_3P_3K_3$) gave the highest contents. These results are in agreement with those obtained Atta-Alla *et al.* (2003), Abdou *et al*. (2004) and Taha and Hassan (2008) on gladiolus.

Supplying gladiolus with additional NPK fertilizer dose after flowering had been ceased could stimulate and increase the dry matter production in storage organs of flowering bulbs (Mengel and Kirkby, 1987). Moreover, the NPK fertilizers increased the root system, which became more capable of absorption of more amounts of N, P and K elements (Gabra, 2004).

Data also, showed that N, P, K and total sugars contents of corms were significantly increased in the two seasons, as a result of treating gladiolus plants with biofertrilizer treatments in comparison with control (Tables, 2 and 3). The highest contents were obtained when phosphorein and E.M. were used together. The stimulatory effect of biofertilizer on N, P and K contents may be due to the increment of these elements in the root zone from inoculation with phosphorein and/or E.M., that improved the uptake of such elements (Yadav *et al.*, 2011).

The interaction between main and sub plots treatments (A×B) was significant, in both seasons, for corm contents of N, P, K and total sugars (Tables, 2 and 3). The highest contents for the four constituents were obtained due to $N_3P_3K_3$ or $N_2P_2K_2$ in combination with phosphorein + E.M.

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تأثير معاملات التسميد المعدني والحيوي على :
٢- إنتاج الكورمات والكريمات والمحتوى الكيماوي لنباتات الجلاديولس صنف White Prosperity

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تم إجراء تجربة حقلية بمشتل الزينة، كلية الزراعة، جامعة المنيا في موسمي ٢٠١٣/٢٠١٤ و ٢٠١٤/٢٠١٥ بغرض استقصاء تأثير التسميد المعدني (٤ مستويات) والتسميد الحيوي (٤ مستويات) على إنتاجية الكورمات والكريمات وكذلك المحتوى الكيماوي لنباتات الجلاديولس صنف وايت بروسبيرتي.

أوضحت النتائج أن قطرالكورمة والوزن الجاف للكورمة وعدد الكريمات للنبات والوزن الجاف للكريمات للنبات وكذلك المكونات الكيماوية (المحتوى للنتروجين والفوسفور والبوتاسيوم والسكريات الكلية في الكورمات والصبغات الكلية في الأوراق) قد زاد معنوياً مع كل مستويات التسميد المعدني ن فو بو مقارنة بمعاملة الكنترول مع أن أعلى القيم نتجت عن المستوى العالي من التسميد المعدني.

كل معاملات التسميد الحيوي أدت إلى زيادة معنوية في قراءات إنتاجية الكورمات والكريمات وكذلك المحتوى الكيماوي مقارنة بمعاملة الكنترول معاملة الفوسفورين + الميكروبات الدقيقة النشطة (E.M.) كانت أكثر فاعلية في هذا الشأن.

تأثير معاملات التفاعل كان معنوياً مع أحسن القيم تم الحصول عليها مع استخدام التسميد المعدني ن فو بو بالمستوى المتوسط مع خليط من الفوسفورين والميكروبات الدقيقة النشطة.