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# EFFECT OF MINERAL AND BIOFERTILIZATION TREATMENTS ON: 1- VEGETATIVE GROWTH AND FLOWERING OF GLADIOLUS PLANTS

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**ABSTRACT:** A field experiment was carried out at Nursery of Ornamental Plants, Fac. Agric., Minia Univ., Egypt during the two successive seasons of 2013/2014 and 2014/2015 to investigate the effect of NPK (0, 50, 75 and 100% of recommended dose) and biofertilization (phosphorein and/or E.M.) treatments on growth and flowering of *Gladiolus grandiflorus* cv. White Prosperity.

Results showed that vegetative growth traits (leaf length, number of leaves/plant and leaves dry weight/plant) and flowering parameters (length of spike, rachis length, number of florets/spike, first floret diameter and fresh weight) were gradually increased by increasing the levels of NPK fertilizer. Also, all biofertilization treatments significantly increased all vegetative growth parameters as well as all flowering characters in comparison with the control. Phosphorein plus effective microorganisms (E.M.) treatment was more effective in this concern. It was found that the use of NPK (75% from the recommended dose) plus phosphorein + E.M. improved the growth and flower production of gladiolus plants compared with the other treatments.

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**Key words:** *Gladiolus grandiflorus* cv. White Prosperity, NPK, biofertilization, phosphorein, E.M., vegetative growth, flowering.

## INTRODUCTION

*Gladiolus grandiflorus*, L. is considered one of the most important flowering bulbs grown in Egypt. Gladiolus belongs to family Iridaceae and is propagated by corms. It has decorative spike which carries numerous florets. There is as expands in areas planted with gladiolus in Egypt in order to meet the increase demand for gladiolus flowers for local market and export.

Mineral NPK and biofertilization are among the important agricultural treatments which have been proved to improve and augmented the vegetative growth and flowering aspects of gladiolus plants.

Many authors studied the effect of mineral NPK fertilization on gladiolus plants as Sehrawat *et al*. (2003); Atta-Alla *et al.* (2003); Khan and Iftikhar (2004); Gaurav and Prabhakar (2007) and Taha and Hassan (2008) how found that NPK fertilizer treatments on gladiolus plants gave an increase in plant height, number of leaves/plant, dry weight of leaves/plant, length of spike, rachis, length, number of florets/spike, lowest floret diameter and fresh weight.

Regarding the use of biofertilizers, Kathiresan *et al.* (2002); Abdou *et al.* (2004); Taha and Hassan (2008) and Dubey *et al*. (2008 and 2010) and Abdou *et al.* (2013) on gladiolus reported that

biofertilization treatments improved vegetative growth and flower parameters. Similar results were obtained on other flowering bulbs by Hussein (2004) and Allam and El-Tayeb (2008) on Iris and Koley and Pal (2011) on tuberose.

The aim of this work was to study the effect of NPK and biofertilization treatments on the vegetative growth and flowering of gladiolus cv. White Prosperity.

## MATERIALS AND METHODS

A field experimental was carried out during the two successive seasons of 2013/2014 and 2014/2015 at the Nursery of Ornamental Plants, Fac. Agric., Minia Univ., to figure out the response of *Gladiolus graniflorus* cv. White Prosperity to mineral and biofertilization treatments.

The corms of gladiolus 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, 15$^{th}$ 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 used soil 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). While, 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 cut of flowers.

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 flowers cut.

**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 | | | |

**The following data were recorded:**

1- Vegetative growth characters just before flowering: leaf length (cm), number of leaves/plant and dry weight of leaves/plant (g).

2- Flowering characters: length of spike (cm), rachis length, number of florets/spike, lowest floret diameter (cm) and floret fresh weight (g).

The data of the two experiments 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-Vegetative growth characters:**

Data presented in Table (1) indicated that leaf length, number of leaves/plant and leaves dry weight/plant of *Gladiolus grandiflorus* cv. White Prosperity were significantly increased, in both seasons, due to the use of $N_1P_1K_1$, $N_2P_2K_2$ and $N_3P_3K_3$ fertilization in comparison with those of unfertilized control ($N_0P_0K_0$) plants. The increase was study by the gradual increase in NPK fertilizer levels. So, the high level of NPK ($N_3P_3K_3$) was superior than other used treatments. The increase in vegetative growth traits due to $N_1P_1K_1$, $N_2P_2K_2$ and $N_3P_3K_3$ fertilizer over the control ($N_0P_0K_0$) reached 8.50, 14.14 and 18.40% for leaf length, 23.33, 27.13 and 29.62% for number of leaves and 23.27, 27.21 and 29.84% for leaves dry weight, respectively, in the first season.

Similar results were found by Atta-Alla *et al.* (2003) and Taha and Hassan (2008) on gladiolus, Hussein (2004) on Iris plant and El-Naggar and El-Nasharty (2009) on *Amaryllis* plants.

The increase of vegetative growth resulting from using mineral NPK might be due to the enhance of cell division and/or cell enlargement. These elements might participate directly or indirectly in plant anabolism resulting in more plant materials (Lambers *et al.,* 2000).

Data presented in Table (1) showed that, leaf length, number of leaves/plant and leaves dry weight of gladiolus were significantly increased, in both seasons, due to the use of each phosphorein, effective microorganisms (E.M.) and phosphorein + E.M. treatments in comparison with control (non-biofertilizer). The mixed treatment of phosphorein plus E.M. seemed to be more effective than either biofertilizer alone. Similar results were obtained by Abdou *et al*. (2004) and Taha and Hassan (2008) on gladiolus.

The role of effective microorganisms (E.M.) as a biofertilizer (containing photosynthetic bacteria + yeast + lactic acid) in promoting vegetative might be attributed to the increase in soil available nitrogen, vitamins amino acids and plant growth regulators. Consequently, increasing the formation of metabolities which encourage the vegetative growth and enhance meristematic activity of cell and tissues to improve leaf production (Sperenat, 1997; Hassan, 1997 and Ali, 2013). Phosphorein (containing phosphate solubilizing bacteria) increases in phosphorus uptake (Hauka, 2000 and Gabra, 2004).

The interaction between mineral NPK and biofertilization treatments was significant for the three traits in both seasons. The maximum leaf length, number of leaves and leaves dry weight, in both seasons, were obtained due to fertilizing gladiolus cv. White Prosperity with either $N_3P_3K_3$ or $N_2P_2K_2$ in combination with phosphorein + E.M.

**2- Flowering parameters:**

Data presented in Tables (2 and 3) showed that all NPK fertilizer treatments caused significant increase in length of spike, rachis length, number of florets/plant, lowest floret diameter and fresh weight, in the two seasons, in comparison with control ($N_0P_0K_0$). High level of NPK ($N_3P_3K_3$) recorded the highest values of flowering parameters. These results are in agreement with those obtained by Sehrawat *et al.* (2003);

**Table 1. Effect of mineral NPK fertilization and biofertilization treatments on leaf length, number of leaves/plant and leaves dry weight/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) |
| **Leaf length (cm)** | | | | | | | | | | |
| **Control** | 50.11 | 54.35 | 57.81 | 59.98 | 55.56 | 51.88 | 55.91 | 59.11 | 61.25 | 57.04 |
| **Phosphorein** | 52.22 | 56.75 | 59.89 | 62.00 | 57.72 | 53.99 | 58.05 | 61.22 | 63.35 | 59.15 |
| **E.M.** | 54.33 | 59.00 | 61.19 | 64.10 | 59.66 | 55.95 | 60.20 | 63.45 | 65.41 | 61.25 |
| **Phos. + E.M.** | 56.41 | 61.11 | 64.30 | 66.18 | 62.00 | 57.81 | 62.29 | 65.81 | 67.55 | 63.37 |
| **Mean (A)** | 53.27 | 57.80 | 60.80 | 63.07 | | 54.91 | 59.11 | 62.40 | 64.39 | |
| **L.S.D. at 5 %** | A: 2.11 | | B: 0.95 | | AB: 1.90 | A: 2.04 | | B: 0.88 | | AB: 1.76 |
| **Number of leaves/plant** | | | | | | | | | | |
| **Control** | 7.11 | 8.86 | 9.11 | 9.38 | 8.62 | 7.18 | 8.99 | 9.25 | 9.66 | 8.77 |
| **Phosphorein** | 7.60 | 9.37 | 9.67 | 9.91 | 9.14 | 7.69 | 9.49 | 9.81 | 10.17 | 9.29 |
| **E.M.** | 7.81 | 9.59 | 9.89 | 10.01 | 9.33 | 7.88 | 9.69 | 10.03 | 10.36 | 9.44 |
| **Phos. + E.M.** | 7.99 | 9.81 | 10.11 | 10.25 | 9.54 | 8.01 | 9.90 | 10.45 | 10.53 | 9.72 |
| **Mean (A)** | 7.63 | 9.41 | 9.70 | 9.89 | | 7.69 | 9.52 | 9.89 | 10.13 | |
| **L.S.D. at 5 %** | A: 0.16 | | B: 0.11 | | AB: 0.22 | A: 0.17 | | B: 0.17 | | AB: 0.34 |
| **Leaves dry weight/plant (g)** | | | | | | | | | | |
| **Control** | 2.84 | 3.54 | 3.64 | 3.75 | 3.44 | 2.88 | 3.69 | 3.71 | 3.87 | 3.54 |
| **Phosphorein** | 3.04 | 3.75 | 3.87 | 3.97 | 3.66 | 3.08 | 3.80 | 3.92 | 4.07 | 3.72 |
| **E.M.** | 3.13 | 3.84 | 3.96 | 4.00 | 3.73 | 3.15 | 3.88 | 4.01 | 4.06 | 3.78 |
| **Phos. + E.M.** | 3.20 | 3.92 | 4.05 | 4.10 | 3.82 | 3.21 | 3.96 | 4.18 | 4.21 | 3.89 |
| **Mean (A)** | 3.05 | 3.76 | 3.88 | 3.96 | | 3.08 | 3.83 | 3.96 | 4.05 | |
| **L.S.D. at 5 %** | A: 0.07 | | B: 0.04 | | AB: 0.08 | A: 0.08 | | B: 0.07 | | AB: 0.14 |

**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 length of spike, rachis length and number of florets/spike 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) |
| **Length of spike (cm)** | | | | | | | | | | |
| **Control** | 48.1 | 55.6 | 59.8 | 62.1 | 56.4 | 49.2 | 56.8 | 60.2 | 63.8 | 57.5 |
| **Phosphorein** | 51.2 | 58.8 | 62.8 | 64.9 | 59.4 | 52.1 | 59.7 | 63.3 | 66.7 | 60.5 |
| **E.M.** | 53.1 | 60.9 | 64.8 | 65.9 | 61.2 | 54.0 | 61.8 | 65.2 | 67.8 | 62.2 |
| **Phos. + E.M.** | 56.0 | 63.7 | 67.8 | 68.0 | 63.9 | 57.1 | 64.7 | 68.9 | 70.3 | 65.3 |
| **Mean (A)** | 52.1 | 59.8 | 63.8 | 65.2 | | 53.1 | 60.8 | 64.4 | 67.2 | |
| **L.S.D. at 5 %** | A: 1.2 | | B: 1.0 | AB: 2.0 | | A: 1.5 | | B: 1.2 | AB: 2.4 | |
| **Rachis length (cm)** | | | | | | | | | | |
| **Control** | 28.9 | 33.4 | 35.9 | 37.2 | 33.9 | 29.5 | 34.1 | 36.1 | 38.3 | 34.5 |
| **Phosphorein** | 30.7 | 35.3 | 37.7 | 38.9 | 35.7 | 31.3 | 35.8 | 38.0 | 40.0 | 36.3 |
| **E.M.** | 31.9 | 36.5 | 38.7 | 39.5 | 36.7 | 32.4 | 37.1 | 39.1 | 40.7 | 37.3 |
| **Phos. + E.M.** | 33.6 | 38.2 | 40.9 | 41.8 | 38.6 | 34.1 | 38.8 | 41.3 | 42.4 | 39.2 |
| **Mean (A)** | 31.3 | 35.9 | 38.3 | 39.4 | | 31.8 | 36.5 | 38.6 | 40.4 | |
| **L.S.D. at 5 %** | A: 0.6 | | B: 1.1 | AB: 2.2 | | A: 0.9 | | B: 0.8 | AB: 1.6 | |
| **Number of florets/spike** | | | | | | | | | | |
| **Control** | 8.14 | 8.49 | 9.44 | 9.59 | 8.92 | 8.25 | 8.64 | 9.59 | 9.90 | 9.10 |
| **Phosphorein** | 8.50 | 8.98 | 9.99 | 10.10 | 9.39 | 8.73 | 9.15 | 10.10 | 10.41 | 9.60 |
| **E.M.** | 9.01 | 9.49 | 10.40 | 10.61 | 9.88 | 9.24 | 9.67 | 10.65 | 10.93 | 10.12 |
| **Phos. + E.M.** | 9.50 | 9.95 | 10.95 | 11.13 | 10.38 | 9.73 | 10.18 | 11.14 | 11.45 | 10.63 |
| **Mean (A)** | 8.79 | 9.23 | 10.20 | 10.36 | | 8.99 | 9.41 | 10.37 | 10.67 | |
| **L.S.D. at 5 %** | A: 0.30 | | B: 0.25 | AB: 0.50 | | A: 0.35 | | B: 0.25 | AB: 0.50 | |

**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 first floret diameter (cm) and first floret fresh weight (g) 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) |
| **First floret diameter (cm)** | | | | | | | | | | |
| **Control** | 7.11 | 7.63 | 8.17 | 8.65 | 7.89 | 7.15 | 7.66 | 8.20 | 8.68 | 7.92 |
| **Phosphorein** | 7.50 | 8.10 | 8.65 | 9.11 | 8.34 | 7.52 | 8.15 | 8.61 | 9.21 | 8.37 |
| **E.M.** | 7.83 | 8.51 | 9.14 | 9.52 | 8.75 | 7.90 | 8.56 | 8.91 | 9.68 | 8.76 |
| **Phos. + E.M.** | 8.21 | 8.93 | 9.58 | 10.05 | 9.19 | 8.31 | 8.97 | 9.85 | 9.99 | 9.28 |
| **Mean (A)** | 7.66 | 8.29 | 8.89 | 9.33 | | 7.72 | 8.34 | 8.89 | 9.39 | |
| **L.S.D. at 5 %** | A: 0.10 | | B: 0.25 | AB: 0.50 | | A: 0.14 | | B: 0.15 | AB: 0.30 | |
| **First floret fresh weight (g)** | | | | | | | | | | |
| **Control** | 3.45 | 4.56 | 4.69 | 5.10 | 4.45 | 3.67 | 4.85 | 4.89 | 5.21 | 4.66 |
| **Phosphorein** | 4.59 | 4.68 | 4.80 | 5.31 | 4.85 | 4.79 | 4.99 | 5.05 | 5.38 | 5.05 |
| **E.M.** | 4.89 | 4.99 | 5.15 | 5.65 | 5.17 | 5.01 | 5.28 | 5.36 | 5.69 | 5.34 |
| **Phos. + E.M.** | 5.08 | 5.29 | 5.91 | 6.31 | 5.65 | 5.25 | 5.49 | 5.99 | 6.24 | 5.74 |
| **Mean (A)** | 4.50 | 4.88 | 5.14 | 5.59 | | 4.68 | 5.15 | 5.32 | 5.63 | |
| **L.S.D. at 5 %** | A: 0.22 | | B: 0.30 | AB: 0.60 | | A: 0.17 | | B: 0.27 | AB: 0.54 | |

**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%**

Atta-Alla *et al*. (2003) and Taha and Hassan (2008) on gladiolus plants.

The positive effect of NPK fertilizer treatments might be attributed primarily to their stimulative effect on the different vegetative growth parameters (Table, 1). Better vegetative growth should be directly reflected on various flowering aspects.

Data presented in Tables (2 and 3) indicated that all biofertilization treatments significant increased length of spike, rachis length, number of florets/spike, lowest floret diameter and floret fresh weight compared with non-biofertilized plants. The highest values for all studied flowering parameters were obtained by phosphorein + E.M. treatment. Similar results were found by Abdou *et al*. (2009) on borage and Ali (2013) on *Calendula officinalis* using E.M. and Taha and Hassan (2008) on gladiolus using phosphorein.

These results may be attributed to the direct and indirect role of stimulating substances (nutrients, amino acids, vitamins and plant growth regulators) which came as a result from inoculation of bacteria, all those have better effects on the plant growth, consequently improving enzymatic systems that reflect on the flowers.

The interaction between NPK and biofertilization treatments was significant for the five studied flowering characters in both seasons as clearly shown in Tables (2 and 3). The best overall results were obtained due to supplying gladiolus plants with either medium or high level of NPK in

combination with phosphorein + E.M. It is mention that there are no significant differences between phosphorein + E.M. in combination with $N_2P_2K_2$ and $N_3P_3K_3$ treatments on vegetative growth and flowering characters in both seasons. So, $N_2P_2K_2$ with phosphorein + effective microorganisms (E.M.) are economically and environmentally required and beneficial.

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## تأثير معاملات التسميد المعدني والحيوي على:
## ١- النمو الخضري والتزهير لنباتات الجلاديولس

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تم إجراء تجربة حقلية خلال موسمين متتاليين هما ٢٠١٣/٢٠١٤ و ٢٠١٤/٢٠١٥ وذلك لدراسة تأثير معاملات التسميد المعدني ن فو بو (صفر، ٥٠، ٧٥ و ١٠٠ % من الكمية الموصى بها) والتسميد الحيوي (فوسفورين و/أو الميكروبات الدقيقة النشطة) على نمو وتزهير نبات الجلاديولس صنف وايت بروسبيرتي.

أظهرت النتائج أن صفات النمو الخضري (طول الورقة وعدد الأوراق للنبات والوزن الجاف للأوراق للنبات) وصفات التزهير (طول الشمراخ وطول الجزء الحامل للزهيرات وعدد الزهيرات للشمراخ وقطر الزهيرة الأولى والوزن الطازج) أزداد تدريجياً بزيادة مستوى التسميد الكيماوي. كل معاملات التسميد الحيوي زادت معنوياً كل صفات النمو الخضري وقياسات الأزهار مقارنة بالكنترول. ووجد أن استعمال التسميد المعدني (ن فو بو) بنسبة ٧٥ % من الجرعة الموصي بها مع الفوسفورين + الميكروبات الدقيقة النشطة (E.M.) تحسن صفات النمو الخضري وإنتاج الأزهار لنباتات الجلاديولس مقارنة بالمعاملات الأخرى.