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Effect of various doses of chemical fertilizer (kristalon) individually or in combination with different rates of bio-fertilizer on growth, flowering, corms yield and chemical constituents of *Gladiolus grandiflorus*

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Abstract: The present investigation was carried out in the green house at the Research and production Station of the National research Center (NRC) in Nubaria during the two successive seasons of 2012 and 2013. The aim of this study was to investigate the effect of various doses of Chemical fertilizer (Kristalon) individually or in combination with different rates of bio-fertilizer on growth, flowering and corms yield of *Gladiolus grandiflorus* L. Results showed that treatments increased all growth parameters in both seasons compared with untreated plants. Kristalon at 80 mg/m ^{2}+ 80 ml/ m^{2}gave the maximum values of corms/plant and spike length, while the untreated plant growth gave the minimum values. Additionally, carbohydrates, nitrogen,phosphorous and potassium content increased by all fertilizers treatments in the two seasons. The highest value of carbohydrates percentage was obtained by 80 gm/m^{2}Kristalon + 80 ml/ m^{2}biofertlizer followed by 60 gm/ m^2 + 60 ml/ m^2 bio-fertilizer. Kristalon at 80 gm/ m^2 gave the highest nitrogen, phosphorous and potassium percentage followed by 60 gm/ m^{2}Kristalon. So, in this experiment, biofertilizer enhances the effect of chemical fertilizer which increases soil fertility and crop production in sustainable farming.
Keywords: *Gladiolus grandiflorus* L**,** Kristalon**,** nitrogen, phosphorous, potassium**,** biofertlizer.

Introduction

Gladiolus (*Gladiolus grandiflorus*), generally called “Glad” is from the family Iridaceae and sub-family Ixiodeae, the plant originates from South Africa, it is a bulbous cut flower plant known as the Sword Lily or Corn Lily, due to its sword shaped leaves. As a prominent bulbous ornamental plant, Gladiolus occupies a significant position among commercial crops of flowers which are of high demand in the markets both domestically and internationally. The plant comes in eighth position in the world's cut flower trade and has a global history [1]. The major gladiolus producing countries are Poland, the United States (Florida and California), Brazil, France, Italy , Australia, Holland, Bulgaria, India, and Israel. The plant possesses astonishing spike that bears a great number of florets with different sizes and shapes that ruffle smoothly of deeply crinkled sepals. In India, the area under bulbous crop currently is about 3500 ha of which gladiolus possesses more than 1200 ha. The main places gladiolus grow are placed to the north Indian lands. It is grown in the plains as well as hills up to elevation of 2400 m from mean sea levels [2]. Gladiolus is also known as "Queen" of the bulbous flowers, it is one of the important ornamental flowering crops in the world. It is popular for its cut flowers owing to its versatile colours and varieties having higher keeping quality of flower. It is of great economic value for the cut flower trade and the aesthetic world regards it highly for its beauty and elegance 15[3]. The criterion for the quality of flowers is based on the number of days a flower remains fresh in acceptable condition. Flower crops

respond very well to fertilizers. It is quite capable of exhausting a large number of nutrients from the soil. So, it requires a higher amount of chemical fertilizer in balanced proportions for ensuring the highest flower production. Gladiolus requirements of fertilizer have a significant role to play in growth, quality, corn and cormel production. Many countries have reported requirements of Nitrogen (N), phosphorus (P), potassium (K) and other fertilization. Nitrogen, phosphorus, potassium as major nutrients along with zinc markedly increase the number of flowers, florets/spike, length of spike and flowering stem of gladiolus[4]. The plant nutrients' availability determines the plants' ability to produce more yield, because cultivation of high yielding varieties of crop along with intensive cropping systems has depleted the fertility of the soil which resulted in deficiencies of multi-nutrients in soil-plant system. Using balanced fertilization is athe main component of the technology of crop production. Nitrogen is a vital plant nutrient as it is an essential constituent of protein. An adequate supply of nitrogen is usually accompanied with rapid vegetative growth of plants and deep green colour of leaves. Application of Phosphorus increases the root growth which helps in absorbing different plant nutrients. Phosphorous has to do with the meristmatic tissue formation and has a fundamental role in number of enzymatic reactions. Phosphorous is an important component of DNA, RNA, which is needed for the synthesis of protein. Moreover, it possesses a significant role in energy transfer system (ADP, ATP). Phosphorus is very important for a lot of metabolic processes. Phosphorous (P) is one of the most important macro nutrients that limit the growth of plant as it has low bio-availability in soils [5,6]. The last component is Potassium which possesses a very important role in forming proteins and carbohydrates, regulating water condition in the plant cell and water loss by photosynthesis and transpiration [7]. Bio-fertilizers are potential sources of plant nutrients. It is a substance which contains living microorganisms that colonizes the rhizosphere or the plant's interior and promote growth by increasing the availability or supply of primary nutrients to the host plant when applied to seed, plant surfaces, or soil. Bio-fertilizers provide nutrients through the natural processes of solubilizing phosphorus, nitrogen fixation, and inducing plant growth through the synthesis of substances that promote growth. Bio-fertilizers are microbial culture, which make availability of certain plant nutrients to crops by various actions. Rhizobium, Azotobacter and Azospirillum fix atmospheric nitrogen while certain bacteria/ fungal culture viz; Bacillus polymyxa/, Aspergillusawamori help in phosphate solublization of both native and applied sparingly soluble phosphate [8,9]. The experimental trials presented in this paper are concerned with studying the effect of different doses of chemical fertilizers individual or in combination with different rates of bio- fertilizer on growth , yield and quality of *Gladiolus grandiflorus*.

Material and Methods

The field experiments was conducted on sandy soil at the experimental station of National Research Centre (Research and Production Station, Nubaria during the two successive growing seasons of 2012/ 2013 and 2013/2014 .It was intended to find out the effect of different rates of chemical and bio-fertilizers on growth, flowering properties and chemical constituents of *Gladiolus grandiflorus* plant. The physical and chemical properties of soil were determined according to Black *et al*. [10] as shown in Table (1)

Table (1): Physical and Chemical Properties of El-Nubaria soil:

Particle size distribution				**Field capacity (%)**
Sand (%)	**Silt (%)**	**Clay (%)**	**Soil Texture**	
70.8	25.6	3.6	Sandy loam	20.1

Chemical properties				
EC dsm^{-1}	**PH (1:2.5)**	**$CaCO_3$ (%)**	**O.M (%)**	**Soluble Cobalt (ppm)**
1.26	7.9	3.57	0.23	0.49

Soluble Cations (meq L^{-1})				**Soluble Anions (meq L^{-1})**			
Ca^{++}	**Mg^{++}**	**K^{+}**	**Na^{+}**	**CO_3^{-}**	**HCO_3^{-}**	**Cl^{-}**	**SO_4^{--}**
2.4	2.0	0.162	1.87	-	1.50	0.65	4.28

Total N (mg/100g)	**Available (mg/100g)**		**Available micronutrients (ppm)**			
	P	**K**	**Fe**	**Mn**	**Zn**	**Cu**
15.1	13.0	21.0	4.47	2.61	1.44	4.0

Gladiolus corms were supplied by ornamental plants research, Institute of Agriculture, Giza, Egypt . For cultivation gladiolus bulbs were planted on the 1st of December in plots (1m^2), each plot consists of four rows. The bulbs were planted at 20 cm, distance. Irrigation water was supplied through a drip irrigation system and the drips were 20 cm apart. After one month from transplanting the plants received the first application of (Kristalon) NPK fertilizers. The *Gladiolus grandiflorus* seedlings were fertilized with different rates (0, 40,60 and 80gm / m^2) of Kristalon (NPK ,19:19:19), produced by Phayzon company, Holland. Plants were fertilized 4 times during the growing season starting from January15thuntil April 15th at 30 days intervals. The fertilizers were applied as top dressing to the field then irrigation water was added. The biofertilizer which contains nitrogen fixing bacteria "*Azotobacter sp.*, *Azospirillum* sp. and *Pseudomonas sp*." As well as phosphate dissolving bacteria "*Bacillus megaterium* " was added to soil as fresh inocula mainly prepared by General Organization for agricultural Equalization Fund (G.O.A.E.F.) under control of Agricultural Research Centre, Ministry of Agriculture, Giza, Egypt. Its concentrations were used in combination with Kristalon in the following treatments (40ml/m^2+40gm/m^2), (60ml/m^2+60gm/m^2) and (80ml/m^2+80gm/m^2) respectively.

The previous treatments were applied at 30,60 and 90 day after planting (DAP).All the normal culture practices of growing gladiolus corms were applied in a usual manner. At the flowering stage a sample of three representative replicates was taken randomly for each treatment, and the following parameters were determined that included the following data that, plant height (cm), fresh and dry weights of leaves (g/), No. of corms, fresh and dry weight of corms (g) as well as spike length (cm) ,No. of flowers/ plant and fresh and dry weight of flowers (g). Experimental design and statistical analysis**:** The experiment was laid out to statistical analysis as factorial experiment in randomized complete block design having three replicates. The recorded data (means of the two growing seasons**)** was taken according to the procedure of[11] Means were compared by least significant differences(LSD 5% levels of probability). The chemical analysis:total carbohydrates were determined using colorimetric method as described by[12]**.** Total nitrogen was determined by the methods of [13]while phosphorus determination was carried out calorimetrically according to[14]. Potassium was determined photo metrically by flame photometer method as described by [15]**.**

Results and Discussions

1-Vegetative growth:

Data on vegetative growth of *Gladiolus grandiflorus* as affected by different rates of Kristalon individual or in combination with bio-fertilizer, are presented in Table (2). The average ranged from (56.67 to 81.00 cm) for plant height, (99.07 to 23.77 gm)for leaves fresh weight and (1.67 to 4.65 gm)for leaves dry weight. The plants fertilized by 80 gm/m^2 Kristalon +80 mL/m^2 bio-fertilizer were the tallest (81.00 cm) , with the heaviest leaves fresh weight (23.77 gm) and the heaviest leaves dry weight (4.65 gm) ones. Whereas, the shortest height and the lightest fresh and dry weight of leaves were recorded with unfertilized plants (control). The rise in the height of plant was because of the readily available form of nitrogen .Bio-fertilizers increase the absorption of the macro and micro nutrients of plant. Inoculation of seeds with bio-fertilizing enhanced growth factors such as plant height ,fresh and dry weight of leaves in Jasmine and Tuberose plants as shown by [16,17]. Migahed *et al*.,[18]and [19,20] showed that biofertilizers caused an increase in plant height through nitrogen content and photosynthesis rate enhancement..

2-Flowering :

The flower parameters as affected by NPK alone or combined with bio-fertilizer treatments are shown in Table (2).The maximum values of spike length, fresh and dry weight of flowers were obtained from the plants treated with 80 gm/m^2 Kristalon +80mL/m^{2}biofertilizer. While, the lowest values occurred by untreated plants. Numerically, spike length, fresh and dry weight were increased by (44.05,66.2 and 82.11%) as a results of treated with 80 gm /m^2 Kristalon +80mL/m^{2}biofertilizer in comparison with untreated plants. On the other hand,60 gn/m^{2}Kristalon +60mL/m^{2}biofertilizer gave the highest number of flowers/plant (16.00) followed by 40gm/m^{2}Kristalon (14.00) then 80 gm/m^2+80mL/m^2 bio-fertilizer(13.00) compared with the control (8.67). The rise in spike length could be attributed to nutrition' availability and cteristic 's elevation. Almost the same findings were revealed by ([21]) who advised that the treatment of Azospirillumsp + phosphate solubilizing bacterium+vermincompost+NPK(25% of recommended dose)enhanced the quality of flowers and multiplied

the flower yield of *Petunia hyprid* flower . The fresh weight increased as a result of the biological fixation of phosphorous and nitrogen in the portion of roots in the plants which resulted in better absorption of more nutrients and better utilization of them as well. In addition, Azospirilium plays a role in the fixation of nitrogen and is also a part of the production of GA,IAA and Cytokinin like substances which improves the growth of plants. These results are on the same page with the results of [22] who said that applying bio-fertilizers like phosphate solubilizing bacterium and Azospirillum increased the fresh weight of flowers in carnation .

Production of corms:

The results obtained in Table (2) showed that NPK individual or combination with bio-fertilizers increased all corms parameters compared with the control plants which gave the lowest values .The maximum values of corms number /plant and the heaviest fresh and dry weight of corms/plant were produced from the treatment of 80gm/m^2Kristalon + 80 mL/m^2 bio-fertilizer compared with the control and other treatments .The increments were (211.64%) number of corms /plant, (154.20%)fresh weight of corms/ plant and (314.29%) dry weight of corms/plants compared with the control . A noticeable rise in corms number /plant and fresh and dry weight of corms/ plant might be because of the better availability of phosphorous which is particularly needed for growth of corms .The better production of corms could be a result of the inoculation of corms with bio-fertilizers that led them to store more carbohydrates through an effective photosynthesis process. As for the increment of corms weight, that could be a result of carbohydrates and nitrogen compound storage in the corms. Soluble nitrogen compounds and carbohydrates are translocated from the leaves to the corms. Corms play the role of a sink source for food storage as explained by [23].

Table 2: Effect of various doses of chemical fertilizer (kristalon) individually or in combination with different rates of bio-fertilizer on growth, flowering and corms yield of *Gladiolus grandiflorus* (average of two seasons)

Treatment	Plant height cm.	F.w of leaves	D.w of Leaves	Spike length cm	No. of flowers	F.w of flowers	D.w of flowers	No. of Corms / plant	F.w of Corms / plant	D.w of Corms/ plant
control	56.67 (E)	9.07 (C)	1.67 C	36.33 (D)	8.67 C	15.0 D	3.41 D	5.67 B	14.15 (C)	3.15 D
Kris. 40 gm/m^2	71.33 (C)	15.27 B	2.92 B	35.33 (C)	14.00 AB	22.48 b	5.23 b	7.67 B	16.97 C	4.62 CD
Kris. 60 gm / m^2	78.00 AB	17.20 B	3.13 B	49.67 AB	9.00 C	16.63 C	3.80 C	17.00 A	26.32 B	8.55 B
Kris 80 gm/m^2	65.50 (D)	14.40 B	2.52 B	43.00 (C)	11.67 BC	16.36 C	3.51 D	7.00 B	14.65 C	3.73 CD
40.Kris+ 40 gm/m^2 Bio	72.00 (C)	15.90 B	2.96 B	45.33 (C)	9.00 C	16.61 C	3.93 C	15.33 (A)	18.00 C	5.25 CD
60Kris+ 60 gm/m^2Bio	75.33 BC	16.77 B	3.05 B	46.00 BC	16.00 A	24.31 A	6.03 A	15.67 (A)	26.13 B	6.25 BC
80Kris+80 gm/m^2 Bio	81.00 (A)	23.77 (A)	4.65 A	52.33 (A)	13.00 AB	24.93 A	6.21 A	17.67 (A)	35.97 (A)	13.05 A

Kris = Kristalon
Bio= Biofertilizer

Table 3: Effect of various doses of chemical fertilizer (kristalon) individually or in combination with different rates of bio-fertilizer on Nitrogen, Phosphorous, Potassium and total carbohydrates percentage of *Gladiolus grandiflorus* (average of the two seasons).

Treatments	N	P	K	Carbohydrates%
control	1.53	0.63	6.32	10.41
Kris. 40 gm/m^2	2.89	0.89	8.46	12.35
Kris. 60 gm / m^2	3.93	1.21	16.24	21.43
Kris 80 gm/m^2	4.84	1.63	18.35	23.53
40.Kris+ 40 gm/m^2 Bio	2.87	0.74	9.25	25.61
60Kris+ 60 gm/m^{2}Bio	2.59	0.93	11.44	27.30
80Kris+80 gm/m^2 Bio	3.48	1.21	12.53	29.11

Kris = Kristalon
Bio= Biofertilizer

Chemical composition:

Concerning the effect of Kristalon individual or in combination with bio-fertilizers,it increased carbohydrates percentage compared with the control . Data presented in Table(3) revealed that carbohydrates % gave the same results that had been obtained with corms production. Kristalon at 80 gm/m^2 +80mL/m^2 gave the highest value of carbohydrates percentage (29.11%)over the control .While, the lower value of carbohydrates percentage (10.41%) was obtained by untreated plants .

The presence of nitrogen phosphorus and potassium content in *Gladiolus grandiflorus* to the different rates of Kristalon fertilizer alone or combined with bio-fertilizers is presented in Table (3) Data mentioned that all fertilizers treatments increased percentage of N,P and K compared with the control .Plants treated with 80 gm/m^{2}Kristalon gave the maximum value of N,P and K% (4.84 ,1.63 and 18.35 %) respectively followed by 60 gm/ m^{2}Kristalon (3.93, 1.21 and 16.24 %) respectively and then 80gm /m^2 +80 mL/m^2 (3.48,1.21 and 12.53 %) respectively.

Compound fertilizers, which contain N, P, and K, can often be produced by mixing straight fertilizers. In some cases, chemical reactions occur between the two or more components.

The application of these treatments increased content of nitrogen which could be a result of the rapid absorption of these elements by the surface of plant and their translocation in the plant[24]. Similar results were presented by[25] on chrysanthemum and [26]on cauliflower. The role of phosphate solubilizing bacteria is stimulated in the availability of phosphorus in soil through phosphatase enzyme's secretion which transfers organic phosphorus to their available forms[27,28]. Consequently, it instigates phosphorus absorption and accumulation in plant tissues. The rise in "K" percentage might be because of the effect of different strain groups and nutrients mobilizing microorganism which help in availability of metals and their forms in the composted material and increased levels of extracted minerals [29].

In conclusion, this experiment proves that biofertilizer improves the effect of chemical fertilizer which increases soil fertility and crop production in sustainable farming.

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