Plant Archives Vol. 19 No. 2, 2019 pp. 2315-2320 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

THE EFFECT OF N P K LEVELS COMBINED WITH PHOSPHOREIN OR FOLIAR NUTRITION (HUMIC ACID OR POTASSEIN) ON FLOWERING OF *IXORA COCCINEA* L. PLANTS

Azza M.S. Arafa[1]*, Mona A. Darwish[2], Boshra A. El-Sayed[2] and Ghada D. Ahmed

[1]Department of Ornamental Horticulture, Faculty of Agriculture, Cairo University, Egypt.
[2]Ornamental Plants and Landscape Gardening Res. Department, Horticulture Res. Institute, ARC, Giza, Egypt.

Abstract

Two pot experiments was consummated in under plastic house at nursery of, Horticulture Research Institute, Agricultural Research Center (ARC), Giza, Egypt throughout the two successive seasons of 2016 and 2017 seasons to find out the effect of NPK (0.0, 1.0, 2.0gm/ pot) combined with some fertilization treatment (phosphrien at 0.0, 2.5 and 5.0 gm/ pot, humic acid at 0.0, 2.5, and 5.0 ml/L, potassien N at 0.0,1.5 and 3.0 ml/L and potassien P at 0.0, 1.5 and 3.0 ml /L concentrations) from flowering of 3 month-old *Ixora* plants grown in 20-cm-diameter plastic pots filled with about 2.5 kg of a mixture of peatmoss, perlit and cocopeat (1:1:1, by volume).

The obtained results indicated that all fertilization treatments significantly improved all flowering growth (number of flower, diameter of flower(mm) and fresh and dry weight (g) of flower of plants used in this study compared to control, especially with spraying the foliage to run-off with (2.0 gm/pot NPK combined with 5.0 ml/L of humic. as well as, the flowers content of anthocyanin was significantly increased in response to the different treatments employed in the present study, with the superiority of (2.0 gm/pot NPK combined with 5.0 ml/L humic acid)

On the other hand, potassien at 1.5 ml alone gave the least results compared with control.

Hence, in order to get the best growth of flowering it is recommended to treat the plants were grown in 20-cm diameter plastic pot with spraying the foliage to run-off with (2.0 gm/pot NPK combined with 5.0 ml humic acid ml/L) 6 times with 1 month interval.

Key words : *Ixora*, flowering, anthocyanin, NPK, humic acid and fertilization.

Introduction

Ixora coccinea L.*,* a flowering shrub, belong to Family Rubiaceae; native to tropic Asia and Africa, extending to Australia. It is a handsome plant in cultivation with bright coloured flowers and attractive foliage. It is grown in the greenhouse and in the open in warm climates. Propagated by cuttings, preferably with 3 or 4 joints, in spring and kept over bottom heat; also by seeds. (Bailey, 1976).

Fertilization is still the most important agricultural process necessary for improving growth and quality of plants, especially flowering and foliage pot plants, among of them Ixora.

Humic substances can affect plants indirectly though their positive effect on soil physical, chemical and microbial properties. Humic substances stabilize soil structure and increase soil water holding capacity; they are important components of the soil radix systems, and they increase the soil caution exchange capacity (Jiang and Kappler 2008). Many investigators as., Ali *et al.,* (2015) found that, humic acid (1.25ml of 8% Humic acid) along with NPK application (10 g/m^2 NPK) helps to improve the uniform crop stand, plant, plant growth and flower quality of Tulip. And, Ali *et al.,* (2017) on gladiolus plants found that, maximum number of florets per spike in Megma red variety was recorded at 350ppm Humic Acid, while maximum plant height in pink rose supreme variety was recorded at 500ppm humic Acid per plant.

Nowadays, using of biofertilizers, as natural preparations containing one or more of beneficial microorganisms that can release nutrients from rocks and

organic matter in the soil to become available for plants, has become one of the most important requirements to protect environments from pollution, besides getting a safe and clean product.

Phosphorene (a commercial product which contains a special clone of bacteria which changes the unavailable triphosphate to available monophosphate). In this. respect, inoculation with phosphrene may cause increasing phosphorus content in the soil as a result of application of phosphate dissolving bacteria as well as producing growth promoting substances such as indole acetic acid and gibberellins by organism used.

On *Helianthus annuus* L., Ekin (2010). Found that Bacillus M-13 alone, or in combination with P fertilizer, has a great potential to increase oil yield and yield components of sunflower and to improve the usage efficiency of chemical fertilizers as in many other crops previously tested. PSB Bacillus M-13 strain as plant growth promoting bacteria can be used as an economic input to increase crop productivity.

Kumari and Prasad (2016). concluded that in respect of cultivation of petunia (*Petunia hybrida*) under Allahabad condition, the application of *Azotobactor* + PSB +PMB + 100% doses of NPK was effective in enhancing vegetative growth and quality of petunia (*Petunia hybrida*).

On african marigold, Rolaniya, *et al.,* (2017) concluded that application of 100 % RDF of NPK + Azotobacter + PSB along with 60 cm × 45 cm spacing exhibited significantly maximum average weight of flower, yield of flowers per plot as well as per hectare.

On china aster, Sowmya and Prasad (2017) found that, the best floral attributes, days taken for 1st flowering, days taken for 50% flowering, flower stalk, flower diameter were recorded on the treatment which containing 100% NPK + Azospirillum + PSB [phosphate-solubilizing bacteria]

Potassein is a foliar fertilizer containing 30% K, produced by Ministry of Agric., Egypt. This fertilizer is available in tow forms: one fortified with nitrogen (Potassein-N) a liquid fertilizer which contains 30% K_2O and 8% N. and the other with phosphorus (Potassein-P) a liquid fertilizer which contains 30% K_2O and 10% P_2O_5. Many investigators as., Shahin, *et al.,* (2007). stated that, it could be recommended to spray the foliage of the young *Hibiscus rosasinensis* L. transplants grown in 25-cm-diameter clay pots thrice with a combination of 5ml/L. potassein-N + 5 ml/L. potassein-P with one month interval to get the best growth and flowering.

On *Dhalia pinnata*, El-Shakhs *et al.,* (2002) found that increasing K level significantly improved height, number of branches/ plant, leaf No./ plant, flower diameter, flower stem length and dry weight of the cut flowers. Sultana *et al.,* (2006) revealed that NPK fertilizer at 400kg/ha greatly reduced number of days to first floret opening in tuberose plants, and recorded the highest values of vegetative and floral characters. El-Sayed *et al.,* (2012) found that, NPK at 2gm/pot was the best treatment for growth and flowering of *Ixora* plants

This work, however, was done to investigate the individual effect of some fertilizers on flowering of *Ixora* pot plants.

Materials and Methods

The two experiments were carried out under plastic house at nursery of Horticulture Research Institute, Agricultural Research Center (ARC), Giza, Egypt throughout the successive seasons of 2016 and 2017. to find out the effect of some fertilization treatments on flowering of *Ixora coccinea* L. plants. The fertilization treatments consist of the fertilizer NPK (20:20:20) at (0.0, 0.1 and 2gm/pot) combined with phosphorein at (2.5 and 5gm/pot) as soil application (Phos.) a commercial product which contains a special clone of bacteria which changes the unavailable triphosphate to available monophosphate or foliar nutrition (humic acid at 2.5 and 5ml/l (HA) , potassein-N at 1.5 and 3ml/l (Pot. N) or potassein-P at 1.5 and 3ml/l (Pot. P)) as a foliar spray 6 times with one month interval. The treatments consist twenty seven combination of fertilizer (3 level NPK combined with either phos., HA, Pot. N or Pot. P (each at 2levels) were recorded 24 treatments and 3 treatments as control (0.0,0.1 and 0.2 NPK gm/pot).

Therefore, three-month-old of *Ixora plants* (a local variety) bearing of about 12±1 cm height and carrying about 5-6 leaves were planted on 15th March, for both seasons in 20-cm-diameter plastic pots (one transplant/ pot) filled with about 2.0 kg of an equal mixture of peatmoss, perlite and cocopeat (1:1:1, by volume). After two weeks from planting (on 1st April), the transplants received the previously mentioned treatments. The physical and chemical properties of the cocopeat and perlite used in the two seasons are shown in Table 1, while those of peatmoss are shown in Table 2.

At the end of each season (30th Sept.), the following data were recorded flower number, flower diameter (mm), its fresh and dry weights (g/flower) and anthocyanin % were measured. In fresh flower samples taken of the plant, photosynthetic pigment anthocyanin (mg/g F.W.) was determined according Du and Francis (1973).

Data were then tabulated and subjected to analysis

Table 1: Some physical and chemical properties of the used cocopeat and perlite in the two seasons substrates.

Substrates	C/N (%)	BD (g/cm3)	pH	EC (ds/m)	CEC (Cmol/kg)	Porosity (%)	WHC (%)	N (mg/L)	P (mg/L)	K (mg/L)
Coco peat	48.47	0.16	6.7	2.9	138.7	58	90.5	1.96	1.32	477.7
Perlite	0.0	0.13	7.8	1.6	0.0	68	96.7	0.27	0.57	0.1

Definitions: WHC = Water Hold Capacity, BD = Bulk Density.

Table 2: Some physical and chemical properties of the used peatmoss in the two seasons.

Organic matter............ 90-95%	P...................0.23%
Ash........................... 5-10%	K....................7% 1.7
Density (Vol. Dry) 80-90	Fe..................421 ppm
pH value......................3 .4	Mn.................27 ppm
Water relation capacity... 60-75%	Zn..................41 ppm
Salinity......................0.3 g/l	Cu..................8.8 ppm
N..............................1.09%	Mg ....3.3 ppm

of variance according to SAS program (1994) using Duncan's Multiple Range Test (1955) for detecting the significancy level among the means of various treatments. The layout of the experiments in both seasons was a complete randomized design in factorial (Mead *et al.,* 1993) with three replicates, as each replicate contained five plants.

Results and Discussion

Data presented in Table (3and 4) showed that, raising NPK levels caused gradual increase of mean flower number/plant and flower diameter (mm) of *Ixora coccinea* L plants in two seasons.

Regarding the effect of different fertilization treatments data observed that, all treatments significantly increased mean flower number /plant and flower diameter (mm) of *Ixora coccinea* L. plants, when compared to control in the two seasons.

The highest mean flower number /plant 5.78 and 6.78 in the first and second seasons, respectively were recorded significantly by the treated with 5.0 ml of humic acid. Whereas, flower diameter was significantly as a result of either humic acid at 5.0ml or phosphorien at 2.5 and 5 gm/pot compared with other treatments.

The interaction between NPK and different fertilizer levels reflected significant effect on flower number /plant and flower diameter. The interaction treatment of 2gm/pot NPK, when combined with 5.0 ml humic acid found significantly superior to the rest of combination treatments regarding flower number /plant, it recorded the highest number of flowers (6.67 and 7.67) in the first and second seasons respectively). The largest diameter of flower was observed when 2gm/pot NPK with either HA at 5.0 ml (11.57 and 12.19 mm) or phos. at 5 gm/pot (11.50 and 12.42mm) and 2.5 gm/pot (11.23 and 12.06mm) were applied in the first and second seasons, respectively. These results are in line with findings of Ahmad, *et al.,*. (2013) proved that, on *Gladiolus grandiflorus* L. three applications of HA and NPK was best for earlier spike emergence, greater number of florets per spike, longer stems and spikes, and greater diameter of a spike, higher flower quality.

Data in (Table 5, 6) revealed that the response of fresh, dry weights and of *Ixora coccinea* L plants, to treatments of NPK combined different fertilization in the two seasons had the same trend of number flower and flower diameter.

In the two seasons,, increasing the levels of NPK from 0.0,1.0 to 2.0 gm/pot caused significant increasing in mean fresh weights of flower (gm) . which recorded 2.43, 3.44 and 4.03 gm mean fresh weights of flower , in the first season and 2.59, 3.69 and 3.69 (gm) mean fresh weights in the second season respectively.

Increasing NPK levels in two seasons caused significant progressive increments in mean dry weights of flower (gm). the heaviest mean fresh weight was found with 2mg / pot NPK treatment, which formed 2.00 and 2.13 gm mean dry weights of flower in the first and second seasons, respectively. The effect of different fertilization treatments on the mean fresh weights, data in table (5and 6) recorded that the heaviest mean fresh weights (5.35 and 5.64gm) and mean dry weights (2.37 and 2.48) were observed with 5ml of HA treatment in the two seasons, followed by the mean fresh weights (4.09 and 4.37 gm) and mean dry weights (2.06 and 2.22) were obtained by phosphorein at 5 g/pot treatment in the first and second seasons, respectively and also the significant difference between the two treatments were recorded.

Regarding the combined treatments of the different levels of NPK and different fertilization treatments on flowers fresh weight of *Ixora coccinea* L. plants, in the first and second seasons, the treatment (2gm/pot NPK combined with 5.0 ml humic acid) showed the highest fresh weight of flowers 6.37 and 6.58 gm/pot with significant difference with all other treatments. The

Table 3: The effect of NPK levels combined with phosphorein or foliar nutrition (humic acid , potassein –N or potassein –P) on flower number of *Ixora coccinea* L. during 2016 and 2017 seasons.

NPK / Phos.or fn	1st Season				2nd season			
	NPK 0	NPK 1	NPK 2	Mean	NPK 0	NPK 1	NPK 2	Mean
Control	0.67 o	1.33 n	1.67 m	1.22 i	1.33 o	2.33 n	2.67 m	2.11 i
Phos 2.5 g	3.33 h	3.67 g	4.00 f	3.67 d	4.33 h	4.67 g	5.00 f	4.67 d
Phos 5 g	3.67 g	4.00 f	4.33 e	4.00 c	4.67 g	5.00 f	5.33 e	5.00 c
HA 2.5 m/l	4.00 f	4.33 e	4.67 d	4.33 b	5.00 f	5.33 e	5.67 d	5.33 b
HA 5 m/l	5.00 c	5.67 b	6.67 a	5.78 a	6.00 c	6.67 b	7.67 a	6.78 a
Pot N 1.5m/l	2.00 l	2.00 l	2.67 j	2.22 h	3.00 l	3.00 l	3.67 j	3.22 h
Pot N 3m/l	2.33 k	2.67 j	3.00 i	2.67 g	3.33 k	3.67 j	4.00 i	3.67 g
Pot P 1.5m/l	2.67 j	3.00 i	3.33 h	3.00 f	3.67 j	4.00 i	4.33 h	4.00 f
Pot P 3 m/l	3.00 i	3.33 h	3.67 g	3.33 e	4.00 i	4.33 h	4.67 g	4.33 e
Mean	2.96 c	3.33 b	3.78 a		3.93 c	4.33 b	4.78 a	

Means having the same letters within a column are not significantly different according to Duncan's multiple range test (DMRT) at 5% level.

Table 4: The effect of NPK levels combined with phosphorein or foliar nutrition (humic acid, potassein –N or potassein –P) on flower diameter (mm) of *Ixora coccinea* L. during 2016 and 2017 seasons.

NPK / Phos.or fn	1st Season				2nd season			
	NPK 0	NPK 1	NPK 2	Mean	NPK 0	NPK 1	NPK 2	Mean
Control	4.67 o	6.33 n	6.63 mn	5.88 d	5.05 n	6.79 m	6.96 m	6.27 e
Phos 2.5 g	10.53 cd	10.73 b-d	11.23 a-c	10.83 a	11.45 bc	11.49 b	12.06 a	11.67 a
Phos 5 g	10.87 a-d	10.63 cd	11.50 ab	11.00 a	11.62 b	11.06 cd	12.42 a	9.18 c
HA 2.5 m/l	8.37 i-k	8.50 g-k	8.87 f-j	8.58 c	8.95 j	9.21 h-j	9.37 g-i	11.54 a
HA 5 m/l	10.40 de	11.20 a-d	11.57 a	11.06 a	10.84 d	11.58 b	12.19 a	8.73 d
Pot N 1.5m/l	7.17 lm	8.27 jk	8.98 f-j	8.14 c	7.62 l	9.07 ij	9.51 gh	8.95 cd
Pot N 3m/l	7.40 lm	8.57 g-k	9.30 fg	8.42 c	7.80 l	9.02 ij	10.04 ef	9.10 c
Pot P 1.5m/l	7.97 kl	8.47 h-k	9.23 f-h	8.56 c	8.44 k	9.14 h-j	9.72 fg	10.02 b
Pot P 3 m/l	9.13 f-i	9.57 f	9.67 ef	9.46 b	9.69 fg	10.17 e	10.19 e	10.27 a
Mean		8.50 c	9.14 b	9.66 a		9.05 c	9.73 b	

Means having the same letters within a column are not significantly different according to Duncan's multiple range test (DMRT) at 5% level.

lowest fresh weight of flowers registered (1.02 g and 1.55 gm/pot) in the first season and (1.12 g and 1.68 gm/pot) in the second season resulted by control (0.0 NPK) and (0.0 NPK with potassein-N at 1.5ml/l) treatments, respectively.

Concerning interaction between NPK levels and different fertilization treatments on flowers dry weight of *Ixora coccinea* L., it appears from Table 6 that the lowest dry of flowers recorded (0.22 and 0.88 gm/pot) in the first season and (0.23 and 0.92 gm/pot) in the second season resulted by (0.0 NPK) and (0.0 NPK with potassein-p at 1.5ml/l) treatments, respectively Whilst, the heaviest were in a descending order: (2.89, 2.64,2.63 and 2.57 gm/pot) in the first season and (3.01, 2.88, 2.87 and 2.74 gm/pot) in the second season respectively. These results due to (2gm/pot NPK with 5.0 ml humic acid), (2gm/pot NPK with potassein-p at 3 ml/l, (2gm/pot NPK with phosphorein at 5 g/pot) and (2gm/pot NPK with phosphorein at 2.5 g/pot) consecutively. Differences between this treatments were insignificant. Similar results were reported by Bashir, *et al.,* (2016). depicted that humic acid (3.0 mL) in combination with NPK (17:17:17) produced higher spike length, spike diameter, stem length and flower characteristics of gladiolus than all other treatments. However, plants grown without application of humic acid (only NPK) showed relatively poor floral. It could be concluded that humic acid application can increase fresh and dry weight of floret.

Data in Table 7 showed that the highest mean anthocyanin % registered (8.49 and 9.01) resulted by 2.0 gm/pot NPK treatment in the two seasons.

The effect of different fertilization treatments on anthocyanin %,data showed that, the humic acid 5.0 and 2.5 ml/l treatments significantly produced the largest mean anthocyanin % (16.37 and 12.00) in the first season and (15.25 and 11.31) in the second season respectively.

Regarding the NPK levels with different fertilization treatments on anthocyanin % of *Ixora coccinea* L, data indicated that, the highest anthocyanin % were (16.13, 15.27 and 14.30) in the first season and (17.53, 16.24 and 15.35) in the second season. These results occurred due to the combined treatments of humic acid at 5 m/l with 0.0, 1.0, 2.0 g/pot NPK, respectively. The differences between these treatments were significant.

As shown in Table 7, it is a clear that humic acid with high level increased content of flower from anthocyanin, Parandian and Samavat (2012). Reported that spraying humic acid at high concentration was efficient for increasing anthocyanin content in *Lilium* petals. Abdel-Salam (2016), illustrated that treated Ruby Seedless Grapevine by humic acid achieved an increment in total anthocyanin content, but the least increasing anthocyanin content of from potassien treatment.

Table 5: The effect of NPK levels combined with phosphorein or foliar nutrition (humic acid, potassein –N or potassein –P) on fresh weight of flowers (g) of *Ixora coccinea* L. during 2016 and 2017 seasons.

NPK / Phos.or fn	1st Season				2nd season			
	NPK 0	NPK 1	NPK 2	Mean	NPK 0	NPK 1	NPK 2	Mean
Control	1.02 r	2.35 o	2.48 no	1.95 h	1.12 n	2.59 l	2.60 kl	2.10 h
Phos 2.5 g	2.96 j-l	3.89 fg	4.50 d	3.79 c	3.16 ij	4.09 ef	4.79 cd	4.01 c
Phos 5 g	3.15 jk	4.24 de	4.89 c	4.09 b	3.35 h-j	4.61 d	5.16 c	4.37 b
HA 2.5 m/l	2.78 l-n	2.87 k-m	2.90 kl	2.85 ef	2.97 j-l	3.09 i-k	3.06 i-l	3.04 ef
HA 5 m/l	4.11 ef	5.56 b	6.37 a	5.35 a	4.36 de	5.99 b	6.58 a	5.64 a
Pot N 1.5m/l	1.55 q	2.53 m-o	3.60 g-i	2.56 g	1.68 m	2.67 kl	3.83 f-h	2.73 g
Pot N 3m/l	1.96 p	3.27 ij	3.76 gh	2.99 e	2.05 m	3.50 g-i	3.96 e-g	3.17 e
Pot P 1.5m/l	1.81 pq	2.68 l-o	3.54 hi	2.68 fg	1.98 m	2.86 j-l	3.73 f-h	2.86 fg
Pot P 3 m/l	2.50 no	3.60 g-i	4.27 de	3.46 d	2.61 kl	3.79 f-h	4.60 d	3.67 d
Mean	2.43 c	3.44 b	4.03 a		2.59 c	3.69 b	4.26 a	

Means having the same letters within a column are not significantly different according to Duncan's multiple range test (DMRT) at 5% level.

Table 6 : The effect of NPK levels combined with phosphorein or foliar nutrition (humic acid, potassein –N or potassein –P) on dry weight of flowers (g) of *Ixora coccinea* L. during 2016 and 2017 seasons.

NPK / Phos.or fn	1st Season				2nd season			
	NPK 0	NPK 1	NPK 2	Mean	NPK 0	NPK 1	NPK 2	Mean
Control	0.22 l	1.06 i-k	1.13 i-k	0.80 f	0.23 l	1.12 jk	1.19 i-k	0.85 d
Phos 2.5 g	1.76 cd	1.88 c	2.57 b	2.07 b	1.88 b-e	1.97 bc	2.74 a	2.19 b
Phos 5 g	1.64 c-e	1.93 c	2.63 ab	2.06 b	1.73 b-f	2.05 b	2.87 a	2.22 b
HA 2.5 m/l	1.19 h-j	1.25 g-j	1.20 h-j	1.21 e	1.27 h-k	1.38 f-j	1.25 h-k	1.30 c
HA 5 m/l	1.69 c-e	2.53 b	2.89 a	2.37 a	1.81 b-e	2.64 a	3.01 a	2.48 a
Pot N 1.5m/l	0.97 jk	1.44 e-h	1.77 cd	1.39 d	1.02 jk	1.52 e-i	1.90 b-d	1.48 c
Pot N 3m/l	1.06 i-k	1.51 d-g	1.45 e-h	1.34 de	1.12 jk	1.60 c-h	1.54 d-i	1.42 c
Pot P 1.5m/l	0.88 k	1.56 d-f	1.69 c-e	1.38 de	0.92 k	1.65 c-g	1.80 b-e	1.46 c
Pot P 3 m/l	1.27 f-i	1.70 c-e	2.64 ab	1.87 c	1.34 g-j	1.80 b-e	2.88 a	2.01 b
Mean	1.19 c	1.65 b	2.00 a		1.26 c	1.75 b	2.13 a	

Means having the same letters within a column are not significantly different according to Duncan's multiple range test (DMRT) at 5% level.

Table 7: The effect of NPK levels combined with phosphorein or foliar nutrition (humic acid, potassein-N or potassein-P) on anthocyanin % of *Ixora coccinea* L. flowers during 2016 and 2017seasons .

NPK / Phos.or fn	1st Season				2nd season			
	NPK 0	NPK 1	NPK 2	Mean	NPK 0	NPK 1	NPK 2	Mean
Control	0.60 u	1.60 t	3.10 s	1.77 i	0.65 s	1.75 r	3.21 q	1.87 i
Phos 2.5 g	7.00 k	7.77 ij	9.20 g	7.99 d	7.51 j	8.27 i	9.66 g	8.48 d
Phos 5 g	7.87 i	8.63 h	9.90 f	8.80 c	8.55 i	9.06 h	10.56 f	9.39 c
HA 2.5 m/l	11.53 e	9.00 g	13.40 d	11.31 b	12.27 e	9.43 g	14.29 d	12.00 b
HA 5 m/l	14.30 c	15.27 b	16.13 a	15.23 a	15.35 c	16.24 b	17.53 a	16.37 a
Pot N 1.5m/l	2.93 s	4.37 q	5.17 o	4.16 h	3.14 q	4.62 o	5.31 n	4.36 h
Pot N 3m/l	4.30 q	5.10 op	6.43 l	5.28 f	4.60 o	5.30 n	6.79 k	5.56 f
Pot P 1.5m/l	3.60 r	4.87 p	5.53 n	4.67 g	3.81 p	5.08 n	5.95 m	4.95 g
Pot P 3 m/l	5.83 m	6.27 l	7.50 j	6.53 e	6.26 l	6.56 kl	7.80 j	6.87 e
Mean	6.44 c	6.99 b	8.49 a		6.91 c	7.37 b	9.01 a	

Means having the same letters within a column are not significantly different according to Duncan's multiple range test (DMRT) at 5% level.

Conclusion

In regard to the fertilization treatments, the best results of (flower number, fresh and dry weight of flowers, flower diameter and anthocyanin %) due to the treatment (2.0 gm/ pot NPK combined with 5.0 ml humic acid), on the other hand, the least results due to the treatment control (0.0 NPK) and (0.0 NPK with potassein – N at 1.5ml/L).

Acknowledgement

First and foremost, I would like to express my gratitude to Allah, my God, for protecting me and being with me and my family, enabling me to do this study and this work, and giving us the life we enjoy. May his guidance be with us and his peace envelops the world.

I wish to express my sincere thanks, deepest gratitude and appreciation to Dr., Azza Mohamed Said Arafa and Dr., Mona Ahmed Drwish Professors of Ornamental Horticulture, Faculty of Agriculture, Cairo University for suggesting the problem, supervision, continued assistance and their guidance through the course of study and revision of the manuscript of this thesis. Sincere thanks to Dr. Boshra Abd Allah El -sayed

Head Researcher of Ornamental Plants, Hort. Res. Inst., A.R.C., Giza for sharing in supervision and revising the manuscript of this thesis and Dr. Tarek Mohamed Noor EL-deen Ahmed

Grateful appreciation is also extended to all staff members of Tissue Culture Laboratory as well as to Ornamental Plants and Landscape Design Department, Hort. Res. Inst., A.R.C., Giza.

References

Abdel-Salam, M.M. (2016). Effect of Foliar Application with Humic Acid and Two Antioxidants on Ruby Seedless Grapevine. *Middle East J.*, **5(2):** 123-131.

Ahmad, I., R.U. Saquib, M. Qasim, M. Saleem, A.S. Khan and M. Yaseen (2013). Humic acid and cultivar effects on growth, yield, vase life, and corm characteristics of gladiolus. *Chilean Journal of Agricultural Research*, **73(4):** 339-344.

Ali, A. , S.U. Rehman, S.U. Allah and S. Raza (2015). Combined effect of humic acid and NPK on growth and flower development of Tulipa gesneriana in Faislabad, Pakistan. *IJAVMS*, **9(1):** 18-28.

Ali, B., J. Ali, S.W.A. Bacha, M. Ilyas, W. Khan and M.B.A. Shah (2017). Effect nitrogen and humic acid levels on plant height and number of florets per spike of gladiolus cultivars. International. *Journal of Environmental Sciences & Natural Resources*, **7(1):** 1-5.

Bailey (1976). Ornamental plants. University of Florida IFAS. Central Florida Research and education center, 15-90.

Bashir, M., R.W.K. Qadri, I. Khan, M. Zain, A. Rasool and U. Ashraf (2016). Humic acid application improves the growth, floret and bulb indices of gladiolus (*Gladiolus grandiflorus* L.). *Pakistan Journal of Science*, **68(2):** 121-127.

Duncan, D.B. (1955). Multiple range and multiple F-tests. *J. Biometrics*, 111-42.

Du, C.T. and F.J. Francis (1973). Anthocyanins of roselle (Hibiscus sabdariffa L.) *J. Food Sci.*, **38(5):** 810-812.

Ekin, Z. (2010). Performance of phosphate solubilizing bacteria for improving growth and yield of sunflower (*Helianthus annuus* L.) in the presence of phosphorus fertilizer. *African Journal of Biotechnology*, **9(25):** 3794-3800.

El-Sayed, B.A. and A.A. Zaky (2012). Effect of Chemical Composition of *Ixora amabilis* L. plant.

El-Shakhs, M.H., M.S. Auda and A.K.H. Ahmed (2002). Effect of potassium sulphate and soil moisture on water use, growth and flowering of Dhalia pinnate Cav. *J. Agric. Res*., Tanta Univ., **28(1):** 132-156.

Jiang, J. and A. Kappler (2008). Kinetics of microbial and chemical reduction of humic substances: Implications for electron shuttling. *Environmental Science and Technology*, **42:** 3563-3569.

Mead, R., R.N. Curnow and A.M. Harted (1993). Statistical Methods in Agriculture and Experimental Biology, 2nd ed., Chapman & Hall Ltd., London, pp: 335.

Moran, R. (1982). Formula for determination of pigments extracted with N, N-dimethyl formamide. *Plant Physiol*., **69:** 1376-1381.

Parandian, F. and S. Samavat (2012). Effects of fulvic and humic acid on anthocyanin, soluble sugar, amylase enzyme and some micro nutration elements in Lilium. *Intl. Res. J. Appl. Basic. Sci*., **3(5):** 924-929.

Rolaniya, M.K., S.K. Khandelwal, A. Choudhary and P.K. Jat (2017). Response of african marigold to NPK, biofertilizers and spacings. *Journal of Applied and Natural Science*, **9(1):** 593-597.þ

Russo, R.O. and G.P. Berlyn (1999). The use of organic biostimu-lants to help low input sustainable agriculture. *Journal of Sustainable Agriculture*, **1:**19-42.

SAS Institute (1994). SAS/STAT User's Guide: Statistics. Vers. 6.04, 4th Ed., SAS Institute Inc., Cary, N.C., USA.

Shahin, S.M. (2005). Effect of different fertilizers combinations on growth and quality of Paspalum turf grown in sandy and loamy soils. *Egypt. J. Agric. Res*., **2(2):** 581-597.

Shahin, S.M. and M.A. Khalaf (2002). Effect of N fertilization on the growth and flowering parameters of *Dahlia pinnata* Cav. plants grown in some soils of Egypt. *Fayoum J. Agric. Res. of Dev*., **16(1):** 125-135.

Shahin, S.M., N.Y. Eliwa and B.A. El-Sayed (2007). Growth, flowering and chemical composition of *Hibiscus rosa sinensis* L. transplants as affected by foliar spray with two forms of potassein. *J. Biol. Chem. and Environ. Sci*., **2(4):** 151-165.

Sowmya, K.A. and V.M. Prasad (2017). Effect of NPK and bio-fertilizers on growth, yield, quality of china aster (*Callistephus chinensis*) cv. Shashank for cut flower production under agro climatic conditions of Allahabad, India. *Int. J. Curr. Microbiol. App.Sci.*, **6(10):** 3204-3210.

Sultana, S., F.N. Khan, M.A. Haque, S. Akhter and S. Noor (2006). Effect of NPK on growth and flowering in tuberose. *J. Subtropical Agric. Res. Dev*., **4(2):** 111-113.

Sunita, K. and V.M. Prasad (2016). Effect of different nitrogen doses, Azotobactor, PSB and PMB on plant vigour, flowering and yield of petunia (Petunia hybrida) var. Picotee. *Hort Flora Research Spectrum*, **5(2):** 161-164.