Journal of Horticultural Science & Ornamental Plants 4 (3): 340-344, 2012
ISSN 2079-2158

DOI: 10.5829/idosi.jhsop.2012.4.3.265

Effect of Biofertilization on Growth and Chemical Composition of *Gardenia augusta* Ellis. Plant

[1]*Boshra A. El-Sayed,* [2]*S.M. Shahin and* [1]*Amal A. Zaky*

[1]Department of Floriculture Research,
Horticulture Research Institute, Agricultural Research Center (ARC), Giza, Egypt
[2]Botanic Gardens, Research Department Horticulture Research Institute,
Agricultural Research Center (ARC), Giza, Egypt

Abstract: Two pot experiments were conducted under the full sun at the Experimental Farm of Horticulture Research Institute, Agricultural Research Center (ARC), Giza, Egypt during 2010 and 2011 seasons to detect the beneficial effects of both cyriallin (a biofertilizer that contains a special strain of bacteria which fixes atmospheric N_2 and secrets some growth promoting substances and antibiotics) and phosphorein (a commercial product that contains a specific clone of bacteria which changes the unavailable triphosphate to available monophosphate),either individually or in combinations, when applied bimonthly, as a soil drench at the rates of 0, 5 and 10 g/pot on growth and quality of 6-months-old *Gardenia augusta* Ellis transplants cultivated in 15-cm-diameter plastic pots filled with about 2 kg of sand, loam and peatmoss mixture (1:1:1, by volume). The obtained results indicated that all vegetative and root growth parameters were improved with various significant differences as a result of applying the different biofertilization treatments used in such trial. Increasing level of the two biofertilizers used in this study, as well as combining between them at any level mostly caused an additional increment in the rate of growth. Similarly, were those results of chlorophylls a and b, carotenoids, N, P and K concentration in the leaves. In general, cyriallin biofertilizer gave better results than phosphorein one, but the prevalence in the two seasons was for the combined treatment between cyriallin and phosphorein at 5 g/pot from each which gave the utmost high means comparing with either control or other treatments.

Key words: *Gardenia augusta* · Growth parameters · Cyriallin · Phosphorein

INTRODUCTION

Gardenia augusta Ellis, (formerly, *G. jasminoides*), common gardenia (Family: Rubiaceae) is an evergreen shrub to 1.8-2 m height, leaves lanceolate or obviate, flowers often double and fragrant, native to tropics and subtropics of old world. If was formerly very popular greenhouse plant and is now grown indoors for cut flowers and outdoors in mild climates. It requires a warm close house with a night temperature of about 20°C. Propagated by cuttings with 3 or 4 buds kept over bottom heat and with frequent syringing [1]. Nowadays, using of biofertilizers has become one of the most important requirements to protect environments from pollution, besides getting a safe and clean product, especially if this product will be used by man indoors, as pot plant. Biofertilizers contain microorganisms, which may fix atmospheric N_2 in a free living state, e.g. *Azotobacter* and *Azospirillum*. These bacteria secrete some growth promoting factors, e.g. gibberellin, cytokinin-like substances, auxins and some vitamins such as thiamine, riboflavin, pyridoxine, nicotinic and pantothenic acids [2]. *Azotobacter chroococcum* bacteria synthesize antifungal antibiotics, which gave it additional advantage for the use in field of production [3]. Phosphate-solubilizing microorganisms (PSM) release phosphate ions from rocks and organic materials to be available for plants [4]. Other benefits are also mentioned by many investigators. By looking up in the literature, we found a limited body of information about the effect of biofertilizers on growth

Corresponding Author: Boshra A. El-Sayed, Department of Floriculture Research,
Horticulture Research Institute, Agricultural Research Center (ARC), Giza, Egypt.

and quality of Gardenia, while on other ornamentals, there are many efforts such as those indicated on *Hibiscus rosa-sinensis* [5], *Peperomia obtusifolia* cv. Variegata [6], *Ficus binnendikii* cv. Amstel King [7]. *Ficus macrocarpa* var. Hawaii [8], *Nephrolepis exaltata* [9], Dracaena and Ruscus [10, 11] revealed that biogein greatly improved vegetative growth and flowering of *Gladiolus sp.* cultivars white and Rose Prosperity, especially at the rate of 15g/ plant. Similarly, new corm diameter and its fresh and dry weights, as well as number of cormels/plant in both cultivars were also increased. On *Vinca rosea* cv. Major, It was reported that nitrobein and phosphorein at either 5 or l0 g/plant markedly improved vegetative and root growth and caused a progressive increment in the number of inflorescences/plant, number of florets/ inflorescence and stalk length as the rate of bioferbilizer was increased. Moreover, there was an increase in the leaf content of chlorophylls a and b, carotenoids, total carbohydrates, N, P and K.

This study, however was carried out to explore the role of both cyriallin and phosphorein, each alone or in combination in improving growth and chemical composition of common gardenia plant [12].

MATERIALS AND METHODS

Two pot experiments were consummated under the full sun at the Experimental Farm of Horticulture Research Institute, Agricultural Research Center (ARC), Giza, Egypt during the seasons of 2010 and 2011 to examine the positive effects of both cyriallin and phosphorein biofertilizers, individually or in combinations on growth and chemical composition of common gardenia plant. Therefore, the 6-months-old uniform transplants of Gardenia augusta Ellis, (initial height about 8 cm and carries about 8 leaves) were planted on April, 1st for the two seasons in 15-cm-diameter plastic pots (one transplant/pot) filled with about 2 kg of an equal mixture of sand, loam and peatmoss by volume (1:1: 1, v/v/v). Some physical and chemical properties of the sand and loam used in both seasons are shown in Table 1, while those of peatmoss are illustrated in Table 2.

After two weeks from planting (on April, 15th), the plants received the following treatments:

- No fertilization, referred to as control.
- Biofertilization with either cyriallin (a biofertilizer that contains a specific strain of bacteria which fixes atmospheric N_2 and secrets some growth promoting substances and some antibiotics) or phosphorein (a commercial product that contains a special clone of bacteria which changes the unavailable triphosphate to available monophosphate) at the rates of 5 and 10 g/pot for each. They were applied bimonthly, as a soil drench, 4 times till October, 15th.
- Cyriallin was combined with phosphorein at either the low or high level to form 2 interaction treatments as follows:

Cyriallin + Phosphorein, each at 5g/pot.
Cyriallin + Phosphorein, each at 10g/pot.

During the course of this study, transplants received the regular agricultural practices recommended for such plantation whenever needed and they were set at in a complete randomized design, with three replicates, as each

Table 1: Some physical and chemical properties of sand and loam during 2010 and 2011 seasons

		Particle size distribution (%)							Cations (meq/l)				Anions (meq/l)		
Soil type	Seasons	Coarse sand	Fine sand	Silt	Clay	S.P	E.C. (dS/m)	pH	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{--}
Sandy	2010	89.03	2.05	0.40	8.52	23.00	3.31	7.50	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	2011	90.10	1.95	0.50	7.45	22.63	3.58	7.82	19.42	8.33	7.20	0.75	1.60	7.00	27.10
Loamy	2010	10.18	46.17	19.53	24.12	35.00	3.46	8.27	17.50	9.42	20.00	0.79	3.80	10.00	33.91
	2011	10.30	46.54	18.88	24.28	33.68	3.51	8.18	18.00	8.95	20.50	0.85	3.65	10.20	34.45

EC and soluble ions were determined in the soil paste extract

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

Variables	Value	Variables	Value
Organic matter %	90-95%	P %	0.23
Ash %	8-10%	K %	1.77
Density (vol. dry) mg/L	80-90	Fe ppm	421
pH value	3.4	Mn ppm	27
Water relation capacity%	60-75	Zn ppm	41
Salinity g/l	0.3	Cu ppm	8.8
N %	1.09	Mg ppm	3.3

replicate contained four transplants [13]. At the end of each season (December, 15th), plant height (cm), stem diameter at the base (cm), number of branches and leaves/ plant, leaves fresh and dry weights (g), number of roots/ plant and the longest root length (cm) were determined. The plants did not flower during the course of study. So, no data were recorded about flowering. In fresh leaf samples taken from the middle parts of the plants, photosynthetic pigments (chlorophyll a, b and carotenoids as mg/g F.W.) were measured according to the method described by Moran [14], while in dry samples, the percentages of nitrogen using micro-Kjeldahle method [15], phosphorus colorimetrically as the method explained by Luatanab and Olsen [16] and potassium [17] were measured.

Statistical Analysis: Data were then tabulated and subjected to analysis of variance according to program of SAS [18], while Duncan's Multiple Range Tests [19] was used to verify the significant between means of the different treatments.

RESULTS AND DISCUSSION

Effect of Biofertilization Treatments and Their Combinations On

Vegetative and Root Growth: As shown in Table 3, It is clear that vegetative and root growth parameters expressed as plant height (cm), stem diameter (cm), No. branches and leaves/plant, No. roots/plant and root length (cm) were significantly increased in response to the different bioferlization treatments used in such trial comparing with control in the two seasons. However, the mastery was for the combination between cyriallin and phosphorien at 5g/pot for each, as this combination gave the highest means over other treatments in both seasons. Cyriallin at 10g/pot improved some vegetative growth traits giving averages closely near to those of the combination mentioned above, while phosphorein at 10g/pot improved root growth characters taking the second grade immediately after the prevalent combination.

A similar trend was also gained regarding the leaves and roots fresh and dry weights (g) as indicated in Table 4, where the heaviest fresh and dry weights in the two seasons were also obtained by the combination of cyriallin + phosphorien at 5g/pot for each, followed by the same combination, but at the rate of 10g/pot for both biofertilizers indicating that increasing the rate of biofertilizer application in the combined treatment did not correspond by additional increase in growth. That was not true for the individual application, as the rising rate of each biofertilizer alone induced an additive increment in the rate of growth.

Increasing growth of biofertilized plants may indicate the role of cyriallin in fixing more atmospheric N_2 and secreting some growth promoters and antibiotics, besides increasing root system growth and improving soil properties [5]. Moreover, phosphorein plays a vital role in releasing the unavailable triphosphate to available monophosphate [4].The previous results concur with those claimed by Shahin *et al.* [5] on *Hibiscus rosa-sinensis*, El-Sayed *et al.* [8] on *Ficus macrocarpa* var. Hawaii, Abdel-Fattah *et al.* [10] on Dracaena and Ruscus and El-Sayed *et al.* [11] on gladiolus.

Chemical Composition: Data in Table 5 exhibit that the individual treatments of either cyriallin or phosphorein caused a gradual increment in the leaf content of chlorophyll a, b and carotenodis (mg/g F.W.) as the level of each was increased in the two seasons. However, the combining between cyriallin and phosphorein at any rate induced a cumulative increase in content of the previous pigments to reach the maximum values compared to the values scored by the individual applying. Similar observations were also gained concerning the percentages of N, P and K (Table 6). However, the highest

Table 3: Effect of biofertilization treatments on vegetative and root growth of *Gardenia augusta* Ellis. plants during 2010 and 2011 seasons

	Plant height (cm)		Stem diameter (cm)		No. branches/plant		No. leaves/plant		No. roots/plant		Root length (cm)	
Biofertilization treatments	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Control	10.0d	11.0d	0.20c	0.23c	1.0d	1.0c	10.0d	10.6d	8.3e	9.1f	17.1d	16.5f
Cyriallin at 5g/pot (A)	15.0b	18.0b	0.29b	0.27b	1.5c	2.0b	12.7bc	15.0c	12.0d	13.5e	26.0c	25.0d
Cyriallin at 10g/pot (B)	20.1a	23.2ab	0.30b	0.40a	2.0b	2.0b	10.9d	11.5d	16.0c	14.0de	25.0c	26.9c
Phosphorein at 5g/pot (C)	15.0b	17.0bc	0.30b	0.26b	1.3c	1.9b	13.0bc	15.0c	18.0b	15.0d	29.0b	31.5cb
Phosphorein at 10g/pot (D)	13.5c	17.5b	0.31b	0.38a	2.0b	2.0b	14.9b	18.1b	19.2ab	20.3b	28.3b	33.4b
A + C	20.0a	25.0a	0.40a	0.41a	2.8a	3.0a	18.0a	20.0a	21.9a	25.0a	35.6a	36.2a
B + D	15.3b	16.7c	0.28b	0.30b	2.0b	2.0b	12.3c	14.6c	18.1b	17.3c	18.7d	19.3e

Means within a column having the same letters are not significantly different at 5% level according to Duncan's Multiple Range Test (DMRT)

Table 4: Effect of fertilization treatments on leaves and roots fresh and dry weights of *Gardenia augusta* Ellis. plants during 2010 and 2011 seasons.

	Fresh weight (g)				Dry weight (g)			
	Leaves		Roots		Leaves		Roots	
Biofertilization treatments	2010	2011	2010	2011	2010	2011	2010	2011
Control	3.00c	4.50b	2.20c	3.00c	1.60d	2.02c	1.00c	1.07d
Cyriallin at 5g/pot (A)	3.50bc	4.90b	3.00b	3.50bc	2.10c	2.81b	1.50b	1.38c
Cyriallin at 10g/pot (B)	3.58bc	4.99b	2.99b	3.70b	2.31bc	2.90b	1.50b	1.97b
Phosphorein at 5g/pot (C)	3.24cb	5.00b	3.00b	4.00b	2.33b	2.93ab	1.60b	2.03b
Phosphorein at 10g/pot (D)	4.00b	5.20ab	3.21a	4.11ab	2.58b	2.95ab	1.71ab	2.07ab
A + C	5.31a	6.67a	3.50a	4.56a	2.97a	3.32a	1.85a	2.33a
B + D	5.23a	6.20a	2.99b	3.61b	2.76ab	2.98ab	1.56b	1.92b

Means within a column having the same letters are not significantly different at 5% level according to Duncan's Multiple Range Test (DMRT)

Table 5: Effect of bioertilization treatments on chlorophyll a, b and carotenoids (mg/g f.w.) of *Gardenia augusta* Ellis. plants during 2010 and 2011 seasons

	Chlorophyll a		Chlorophyll b		Carotenoids	
Biofertilization treatments	2010	2011	2010	2011	2010	2011
Control	0.42d	0.39d	0.09d	0.10d	0.13d	0.17d
Cyriallin at 5g/pot (A)	0.51c	0.65bc	0.12d	0.22c	0.17d	0.20d
Cyriallin at 10g/pot (B)	0.81ba	0.72b	0.15d	0.24c	0.27c	0.30c
Phosphorein at 5g/pot (C)	0.48dc	0.47c	0.26c	0.25c	0.29bc	0.35bc
Phosphorein at 10g/pot (D)	0.78b	0.69bc	0.35b	0.40b	0.35b	0.40b
A + C	0.80ba	0.72b	0.60a	0.63a	0.78a	0.76a
B + D	0.90a	0.85a	0.62a	0.61a	0.71a	0.80a

Means within a column having the same letters are not significantly different at 5% level according to Duncan's Multiple Range Test (DMRT)

Table 6: Effect of bioertilization treatments on N, P and K % of *Gardenia augusta* Ellis. plants during 2010 and 2011 seasons.

	N%		P%		K%	
Biofertilization treatments	2010	2011	2010	2011	2010	2011
Control	1.46c	1.58d	0.23c	0.19c	1.56c	1.39c
Cyriallin at 5g/pot (A)	2.39b	2.51c	0.31b	0.26b	1.67b	1.50bc
Cyriallin at 10g/pot (B)	2.78ab	3.00b	0.39b	0.29b	1.63b	1.58b
Phosphorein at 5g/pot (C)	1.53c	1.62d	0.46a	0.37ab	1.60bc	1.43c
Phosphorein at 10g/pot (D)	1.56c	1.67d	0.48a	0.41a	1.58cb	1.50bc
A + C	2.98a	3.39a	0.53a	0.46a	2.00a	1.97a
B + D	2.83a	2.91bc	0.50a	0.44a	1.69b	1.63b

Means within a column having the same letters are not significantly different at 5% level according to Duncan's Multiple Range Test (DMRT)

values of all previous constituents in the two seasons were resulted due to the combining between cyriallin and phsophorein, each at the rate of 5 g/pot. These results could be interpreted and discussed as done before in case of vegetative and root growth.

CONCLUSION

Hence, to get the best growth and quality, from commercial point of view, it is recommended to fertilize 6-months-old common gardenia transplants grown in cyriallin and phosphorein at 5g/ pot for each, 4 times with 2 months interval.

REFERENCES

1. Bailey, L.H., 1976. Hortus Third. Macmillan Publishing Co., Inc., 866 Third Avenue, New York, N.Y. 10022, pp: 1290.
2. Darwish, F.M., 2002. Effect of different fertilizer sources and levels on growth, yield and quality of tomato. Ph.D. Thesis, Fac. Agric, Cairo Univ., Egypt.

3. Subba Rao, N.S., 1993. Biofertilizers in Agriculture. 3rd Ed., Oxford and IBH publishing Co. Ltd., New Delhi, Bombay, Calcutta, pp: 242.
4. Bhatia, S. and Y.C. Gupta, 2007. Studies on use biofertilizer in carnation (*Dianthus caryophyllus* L.) flower production. J. Ornam. Hort., 10(2): 131-132.
5. Shahin, S.M., Naglaa Y.L. Eliwa and Boshra 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.
6. El-Sayed, B.A., S.M. Shahin and Naglaa Y.L. Eliwa, 2007. How far nitrobein and gibberellic acid can improve growth and chemical composition of *Peperomia obtusifolia* (L.) A. Dietr. cv. Variegata transplants? J. Biol. Chem. and Environ. Sci., 2(4): 167-179.
7. El-Sayed, B.A. and A.H. El-Feky, 2007. Effect of biofertilizers on growth of *Ficus binnendikii* L. (Amstel King) Plant. Egypt. J. Appl. Sci., 22(10A): 157-170.
8. El-Sayed, B.A., Aml S.A. El-Fouly and A.H. El-Feky, 2008. Response of *Ficus macrocarpa* L. Var. Hawaii transplants to some fertilization treatments. Egypt. J. Appl. Sci., 23(1): 224-231.
9. El-Sayed, Boshra A., Hanan A. El-Din and S.M. Shahin, 2009 Response of *Nephrolepis exaltata* Schott. plant to medium type and nitrobein biofertilization. J. Biol. Chem. and Environ. Sci., 4(1): 705-707.
10. Abdel-Fattah, G.H., Boshra A. El-Sayed and Soad A.M. Khenizy, 2009 Response of Dracaena and Ruscus plants to humic acid and biofertilizer supply. Ann. Agric. Sci., Moshtohor, 47(1): 111-119.
11. El-Sayed, B.A., Azza M. Abdel-Moniem and S.M. Shahin, 2010a. Response of *Gladiolus sp.* cvs. White and Rose Prosperity plants to some fertilization treatments. J. Biol. Chem. and Environ. Sci., 5(2): 205-222.
12. El-Sayed, B.A., Samira S. Ahmed and S.M. Shahin, 2010b. Response of *Vinca rosea* cv. Major plant to chemical and biofertilization treatment. J. Biol. Chem. And Environ. Sci., 5(4): 25-38.
13. Mead, R., R.N. Curnow and A.M. Harted, 1993. Statistical Methods in Agriculture and Experimental Biology. 2nd Ed., Chapman and Hall Ltd., London, pp: 335.
14. Moran, R., 1982. Formula for determination of pigments extracted with N,N-dimethyl formamide. Plant Physiol., 69: 1376-1381.
15. Pregl, F., 1945. Quantitative Organic Micro-Analysis. 4th Ed., J. and A. Churchill Ltd., London, pp: 203-209.
16. Luatanab, F.S. and S.R. Olsen, 1965. Test of an ascorbic acid method for determining phosphorus in water and Na HCO_3 extracts from soil. Soil Sci. Soc. Amer. Proc., 29: 677-678.
17. Jackson, M.L., 1973. Soil Chemical Analysis. Prentice-Hall of India Private Limited M-97, New Delhi, India, pp: 498.
18. SAS Program, 1994. SAS/STAT User's Guide Statistics. Vers. 6.04, 4th Ed., SAS Institute Inc., Cary, N.C., USA.
19. Duncan, D.B., 1955. Multiple Range and Multiple F Tests. J. Biometrics, 11: 1-42.