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Some Studies on the Effect of Putrescine and Paclobutrazol on the Growth and Chemical Composition of *Bougainvillea glabra* L. at Nubaria

Fatma E.M. El-Quesni, Magda M. Kandil and Mona H. Mahgoub

Department of Ornamental Plants and Woody Trees,
National Research Centre, Dokki, Cairo, Egypt

Abstract: A pot experiment was carried out during 2005 and 2006 seasons at Research and Production Station, Nubaria of National Reseach Centre, Dokki, Cairo, Egypt,. The aim of this work is to study the effect of foliar spray of putrescine (0, 100, 200 ppm) and paclobutrazol (0, 250, 500 ppm) and their interaction on vegetative growth and some chemical composition of *Bougainvillea glabra* L. plant. Most criteria of vegetative growth expressed as plant height, number of branches, leaves/plant, stem diameter fresh and dry weight of plant organs were significantly affected by application of the two factors which were used in this study. Foliar application of putrescine and paclobutrazol separately promoted all the aforementioned characters in this study, except plant height was decreased by application of 500 ppm paclobutrazol. Chemical constituents i.e. chl(a), chl(b), carotenoids, total carbohydrates, nitrogen and potassium content were increased compared with untreated control. Foliar application of the two factors under study separately or collectively on *Bougainvillea glabra* L. plant significantly increased number of flowers/plant, as well as fresh and dry weight of the flowers as compared with control plants.

Key words: *Bougainvillea glabra* L. B-glabra putrescine (put) Paclobutrazol (paclo)

INTRODUCTION

Genus Bougainvillea includes eighteen species, native to the tropical and subtropical regions of South America from Brazil west to Peru South to thouthern Argentina. Bougainvilleas are popular ornamental plants in most areas with warm climates, including Australia, the Caribbean, India, Malysia, the Miditerranean region, South Africa, Taiwan and the united states in Arizona, California, Florida, Hawii and Southern Texas Chittendon [1].

Bougainvillea glabra L. Family Nyctaginaceae. Usher [2], commonly known "paper flower" owing to the bracts are thin and papery. They are thorny woody, vines growing anywhere, its length about 1-12 meters tall, scrambling over other plants with their hooked thorns. They are evergreen where rainfall occurs all the year, or deciduous if there is a dry season. The leaves are alternate, simple ovate acuminate, 4-13 cm long. The actual flower of the plant is small and generally white, but each cluster of three flowers is surrounded by three or six bracts with the bright colors associated with the plant, including pink, magenta, purple, red, orange, white or yellow. Polunin and Huxley[3], Usher [2] reported that as indoor houseplants in temperate regions, they can be kept small by bonsai techniques, the bougainvilleas are mostly evergreen or semi-evergreen dropping their leaves for a brief period in winter, their woody, thorn armored canes soar to great heights and then tend to flop over sprawling across whatever is adjacent.

These are several species and hybrids in cultivation, B-glabra is one that is great for container plantings and has smooth leaves and smaller and fewer thorns than its relatives, other species of bougainvilleas huge sprawling plant, that is perfect for arbors and draped a long fences where it creates a security barrier by its thorns and twiggy growth. The bougainvillea's brilliant color displays are enjoyed Florida to California, from the south of France to southeast Asia to Australia and throughout its native tropical America.

Polyamines are (advanced materials) to be considered as a group of plant growth regulators, Evans &

Corresponding Author: Dr. Fatma E.M. El-Quesni, Department of Ornamental Plants and Woody Trees, National Research Centre, Dokki, Cairo, Egypt

Malmberg[4], they are characterized by low molecular mass polycations found in all living organisms. In plants they have been implicated in a wide range of biological processes, including growth, development and abiotic stress response [5], polyamines are small ubiquitous molecules that have been involved in nearly all developmental processes, including the stress response [6]. They are cationic molecules, positively charged under intercellular pH, which are essential for plant growth and differentiation and thus are involved in various physiological processes [7, 8]. They regulated growth, probably by binding to negatively charged macromolecules, Smith[9] and Rowland *et al.* [10], reported that the most common polyamines studied in plants are the diamine putrescine (Put), the tetramine spermidine (Spd) and the tetramine (Spm). They also reported that polyamines are part of the overall metabolism of nitrogenous compounds. Polyamine can influence the transcriptional and translational stages of protein synthesis [11], stabilize membranes [12] an alter intercellular free calcium levels [13]. Smith *et al.* [14] work on peas *(Pisum sativum)* suggested that polyamines might be important in the portion of the GA response that results from cell division, but not in the portion resulting from cell elongation.

All triazoles compounds, its derivatives (uniconazole, paclobutrazol ... etc.) act as antigibberellin i.e. interfere with the biosynthesis of endogenous gibberellin by preventing the oxidation of entkauren to entkaureonic acid [15-17]. These compounds also reduced the endogenous content of auxins (IAA) but led to increase of endogenous content of abscisic acid (ABA) in treated plants [17]. Plant growth regulators widely used for modifying plant growth and development of many agricultural crops. Paclobutrazol has been found to inhibit, specifically, the three oxidative steps of the gibberellin precursor ent-kaurens to entkaurenoic. Thus paclobutrazol blocks the biosynthes of the active gibberellin and therefore, decreases plant growth and development. The morphological response to paclobutrazol is the reduction in internode length and this effect has been observed in herbaceous[17].

Paclobutrazol has proven its efficiency in the reduction of height and promotion of flowering and fruiting in pear by increasing number of spurs/branch. A part from reduction in plant height, paclobutrazol increased leaf N,P,Ca and Mg content[18]. Paclobutrazol increases number of flowers and their longevity in rose [19].

The aim of this work to evaluate the influence of diamine putrescine and paclobutrazol individually or collectively on vegetative growth parameters and some chemical constituents of *Bougainvillea glabra* L. plant.

MATERIALS AND METHODS

The experimental trails were carried out at National Research Centre (Research and Production Station, Nubaria). On first week of march 2005, 2006 seasons, vegetative uniform cuttings (20-25 cm length) were taken from bougainvillea plants, cuttings were treated for one minute with 1000 mg/L indole butric acid before planting in pots to enhance rooting. Rooted cuttings were planted in black plastic pots 10 cm in diameter (one plant/pot) and grown in shaded greenhouse media formulated by combination of peatmoss and sandy soil (1:1, v/v) with pH 5.5 to 6.5 and humidity about 60-80%, a nutrient solution with (3N: 1 P_2O_5: $2K_2O$) with micronutrients. The seedlings were transplanted on mid April 2005 and 2006 seasons, in plastic pots 30 cm. in diameter filled with 10 kg of peat moss and sandy soil (1:1, v/v).

Each pot were fertilized twice with 1.5 gm nitrogen as ammonium nitrate (33.5% N) and 1.o gm potassium sulphate (48.5% K_2O). The fertilizers were applied at 30 and 60 days after transplanting. Phosphorus as calcium superphosphate (15.5% P_2O_5) was mixed with media before transplanting at a rate of 3.0 gm/pot. Thirty days later, transplants were sprayed with different concentrations of putrescine (0, 100, 200 ppm) and paclobutrazol (0, 250, 500 ppm), interaction treatments of the different concentrations of the two factors had been also carried out, in addition to the untreated plants (control) which were sprayed with tap water. Foliar application of putrescine and paclobutrazol was carried out two times of 30 days intervals, starting at mid may at both seasons. The experiments were sit in a Completely Randomized Design (CRD) with three replicates, two factors putrescine (0, 100, 200 ppm) and paclobutrazol (0, 250, 500 ppm) concentrations and their interactions. Other agricultural processes were performed according to normal practice.

The following data were recorded on 30 November 2005 and 2006 seasons: plant height cm, number of branches, number of leaves and flowers/plant, stem diameter, fresh and dry weight (gm) of plant organs. Photosynthetic pigments: including chlorophyll (a and b) and carotenoids were determined exactly 0.1 g of fresh leaves of bougainvillea plant using the

spectrophotometric method developed by Metzzner *et al.* [20]. Total carbohydrate, were determined in the ground powder of bougainvillea leaves using colorimetric method described by Herbert *et al.* [21]. Total nitrogen was determined by Chapman and Pratt [22] while phosphorus determination was carried out colorimetrically according to King[23]. Potassium was determined photometrically by Flame Photometer Method as described by Brown and Lilland[24]. Data obtained were subjected to standard analysis of variance procedure. The values of LSD were obtained whenever F values were significant at 5% level as reported by Snedecor and Cochran [25].

RESULTS AND DISCUSSION

Effect of putrescine and paclobutrazol on vegetative growth: Data presented in Table 1 and 2 elucidate that foliar application of putrescine on bougainvillea plants significantly increased all growth parameters at 100 and 200 ppm. The highest values of plant height, number of branches and leaves/plant, stem diameter, fresh and dry weights of stem, leaves and roots were obtained at 200 ppm putrescine as compared with control plants. These results are in accordance with those obtained by Talaat *et al.* [26] on *Catharanthus roseus* L. The increase in shoot growth could be due to enhanced cell division activity, as it observed that increased putrescine level accompanies higher cell division in plants polyamines are currently considered to be regulators of plant growth and development owing to their effects on cell division and differentiation [27]. Paschalidis and Roubelakis-Angelakis[28] reported that, polyamines, their precursors and their biosynthetic enzymes along with correlation with cell division, expansion, differentiation and vascular development in tobacco plant. Data presented in Table 2 show that number of flowers, fresh and dry weight of flowers were significantly increased by putrescine application, as it observed that increased putrescine level accompanies with increases of flowers and fruit setting in tomatoes[29]. Pritsa and Voyiatzis [30] showed that a direct relationship in terms of polyamine fluctuations with developmental processes such as shoot growth, floral differentiation, anthesis fertilization and fuit development in olive.

Table 1: Effect of foliar application of putrescine and paclobutrazol on vegetative growth of *Bougainvillea glabra* L. plants (means of the two seasons 2005 and 2006)

Treatments	Plant height (cm)	Number of branches/ plant	Number of leaves/ plant	Fresh weight of leaves gm	Dry weight of leaves gm	Fresh weight of stem gm	Dry weight of stem gm
	Effect of putrescine						
Control	44.40	7.38	203.68	25.41	10.23	41.76	25.61
Put 100 ppm	55.56	7.67	211.33	32.81	12.78	47.88	30.44
Put 200 ppm	66.79	9.50	242.56	32.97	15.50	51.53	34.12
LSD at 5% level	0.83	0.43	3.51	0.91	0.84	1.78	1.41
	Effect of paclobutrazol						
Control	55.0	7.07	201.93	27.59	11.89	45.52	28.74
Paclo 250 ppm	59.67	9.61	240.61	33.22	13.68	48.77	31.54
Paclo 500 ppm	52.08	7.87	215.02	30.38	12.93	46.89	29.88
LSD at 5% level	0.83	0.43	0.52	0.91	0.84	1.78	1.41
	Effect of interaction						
Control	40.300	5.50	170.50	23.50	9.17	38.70	23.61
Put 100 ppm	72.70	7.00	200.97	30.47	11.72	46.25	28.75
Put 200 ppm	63.00	8.70	234.33	28.80	14.79	51.60	33.88
Paclo 250 ppm	48.700	10.23	253.50	27.56	11.06	44.40	27.17
Paclo 500 ppm	44.20	6.40	187.03	25.17	10.47	42.18	26.04
Put 100 ppm + Paclo 250 ppm	60.00	8.30	215.00	36.00	13.75	49.40	31.86
Put 100 ppm + Paclo 500 ppm	53.97	7.70	218.02	31.97	12.86	48.0	30.72
Put 200 ppm + Paclo 250 ppm	70.30	10.30	253.33	36.10	16.25	52.500	35.60
Put 200 ppm + Paclo 500 ppm	67.07	9.50	240.00	34.00	15.47	50.50	32.88
LSD at 5% level	1.44	0.75	6.09	1.58	N.S	N.S	N.S

1Putrescine: Put.Paclobutrazol: Paclo.

Table 2: Effect of foliar application of putrescine and paclobutrazol on vegetative growth of *Bougainvillea glabra* L. plants (means of the two seasons 2005 and 2006)

Treatments	Stem diameter mm	Fresh weight of roots gm	Dry weight of roots gm	Flowers growth		
				Flowers number/ plant	Flower fresh weight gm	Flower dry weight gm
	Effect of putrescine					
Control	1.74	16.64	9.11	23.30	27.50	8.08
Put 100 ppm	2.03	22.03	13.44	34.43	36.20	9.99
Put 200 ppm	2.70	27.35	16.29	39.41	44.72	12.95
LSD at 5% level	0.13	1.08	1.49	0.84	1.23	0.75
	Effect of paclobutrazol					
Control	2.00	19.98	12.05	26.91	33.30	9.60
Paclo 250 ppm	2.67	23.90	14.0	36.33	38.70	11.06
Paclo 500 ppm	2.41	22.13	12.75	33.90	36.42	9.82
LSD at 5% level	0.13	1.08	1.49	0.84	1.23	0.75
	Effect of interaction					
Control	1.50	15.30	8.42	21.20	23.40	7.37
Put 100 ppm	2.20	20.10	13.17	30.60	33.80	8.96
Put 200 ppm	2.30	54.55	14.57	28.94	42.70	12.47
Paclo 250 ppm	1.90	18.10	10.24	25.70	30.50	9.78
Paclo 500 ppm	1.83	16.50	8.65	23.00	28.60	7.09
Put 100 ppm + Paclo 250 ppm	3.10	23.40	13.75	39.00	39.30	11.08
Put 100 ppm + Paclo 500 ppm	2.60	22.60	13.40	33.70	35.50	9.94
Put 200 ppm + Paclo 250 ppm	3.00	30.20	18.12	44.30	46.30	13.94
Put 200 ppm + Paclo 500 ppm	2.80	27.30	16.19	45.00	45.17	12.45
L.S.D. at 5% level	0.22	N.S	N.S	1.46	N.S	N.S

Putrescine: Put. Paclobutrazol: Paclo.

Data presented in Table 1 and 2 indicate that foliar application of 500 ppm paclobutrazol treatment decreased plant height compared with control plants, whereas plants received 250 ppm increased plant height at the two seasons,as well as number of branches and leaves/plant stem diameter, fresh and dry weight of stem, leaves and roots were increased significantly by 250 and 500 ppm paclobutrazol application as compared with control plants. These results were in line with those obtained by Bekheta and Amany Ramadan [31] on cotton, the remarkable inhibition of plant height may be attributed to the effect of these growth retardants on gibberellins biosynthesis which are antigibberellin, i.e. prevent the conversion of Kaurene to Kaurenoic acid which leads to the formation of gibberellin [16, 17], paclobutrazol tend to reduce the synthesis and action of auxins in plants through enhancing the activity of IAA-oxidase as well as reducing the rate transformation of tryptophan to IAA [32]. Number of leaves, branches/plant, fresh and dry weight of plant organs were increased significantly due to the application of paclobutrazol (250 and 500 ppm). These results are in line with those obtained by El-Kady [32] on wheat who reported that using uniconazol caused a significant increase in numbers of both leaves and branches/plant. The increase in the number of branches as a result of foliar application of growth retardants may be attributed to the high level of cytokinins, accompanied by reducing levels of indole acetic acid and gibberellins which lead to inhibition of main stem apical dominance [19,32]. The highest values of flower number/plant, fresh and dry weight of flowers were significantly increased by 250 and 500 ppm paclobutrazol as compared with control plants. As regarding the interaction treatments, foliar application of putrescine and puclobutrazol, the data show that significantly increased all growth parameters under study. The highest values of growth parameters were obtained by put 200 ppm combined with paclobutrazol 250 ppm followed by put 200+paclo 500 ppm, put 100 ppm+paclo 250 ppm and put 100+paclo 500 ppm as compared with control plants. Data emphasized that the interactions effects were significantly affected all growth parameters i.e. plants height, number of branches and consequantly leaves fresh and dry weight of *Bougainvillea glabra* L. plants.

Table 3: Effect of foliar application of putrescine and paclobutrazol on chemical composition of *Bougainvillea glabra* L. plants (means of two seasons 2005 and 2006)

Treatments	Chlorophylls as (mg gm^{-1}, F.W)			Carotenoids	Total carbohydrates	Mineral ions content (%)		
	Chl.(a)	Chl.(b)	Total Chl.(a+b)	mg gm^{-1} F.W	D.W %	N	P	K
	Effect of Putrescine							
Control	2.19	1.26	3.45	1.14	23.28	2.87	0.31	0.81
Put 100 ppm	2.46	1.4	3.86	1.23	25.89	3.02	0.21	0.97
Put 200 ppm	2.81	1.56	4.37	1.33	31.16	3.3	0.34	1.14
LSD at 5% level	0.04	0.03	-	0.03	2.26	-	-	-
	Effect of Paclbutrazol							
Control	2.38	1.35	3.73	1.19	23.98	2.87	0.31	0.81
Paclo 250 ppm	2.58	1.47	4.05	1.27	29.83	2.99	0.21	0.93
Paclo 500 ppm	2.5	1.4	3.9	1.23	26.51	2.95	0.2	0.86
LSD at 5% level	0.04	0.03	0.04	0.031	2.26	-	-	-
	Effect of interaction							
Control	2.15	1.22	3.37	1.1	19.4	2.87	0.31	0.81
Put 100 ppm	2.34	1.34	3.68	1.2	24.74	3.02	0.21	0.97
Put 200 ppm	2.66	1.5	4.16	1.28	27.78	3.3	0.34	1.14
Paclo 250 ppm	2.23	1.3	3.53	1.17	48.48	2.99	0.21	0.93
Paclo 500 ppm	2.2	1.27	3.47	1.14	21.95	2.95	0.2	0.86
Put 100 ppm + Paclo 250 ppm	2.58	1.46	4.04	1.26	27.24	3.23	0.25	1.07
Put 100 ppm + Paclo 500 ppm	2.46	1.4	3.86	1.23	25.68	3.02	0.22	1.02
Put 200 ppm + Paclo 250 ppm	2.94	1.66	4.6	1.38	33.79	3.8	0.51	1.4
Put 200 ppm + Paclo 500 ppm	2.84	1.54	4.38	1.32	31.89	3.63	0.45	1.17
L.S.D. at 5% level	0.08	0.05	0.07	N.S	N.S	-	-	-

Putrescine: Put, paclobutrazole: Paclo, Fresh weight: F.W, Dry weight: D.W

Effect on flowering growth: Data in Table 2 reveal that foliar application of paclobutrazol and putrescine treatments separately or collectively on bougainvillea plants significantly increased number of flowers/plant, fresh and dry weight of flowers g/plant compared with control plants. Hence only through interaction like those reported above putrescine is essential for plant growth and differentiation and thus are involved in various physiological processes[7,8] and enhancement the growth, in addition to paclobutrazol has proven its efficiency in the reduction of height and promotion of flowering[20], the highest increases in number of flowers/plant were found in plant treated by put 200+paclo 500 followed by put 200 + paclo 250, put 100+paclo 250 and put100 + paclo 500 which exceeded by 112.26, 108.96, 83.96 and 58.96% respectively than the corresponding values of the control plants. These results agreement with those obtained by Singh and Bist [19] on rose.

Chemical constituents: Data presented in Table 3 indicate that foliar application of putrescine and paclobutrazol separately to bougainuvillea plants significantly increased Chl(a), Chl(b) content, total carotenoids as well as total carbohydrate at the two seasons. The putrescine induced effects on the previous parameters by increasing its concentration, Table 3. Polyamines have been found to affect protein synthesis and nitrogenous compounds metabolism[10]. Polyamines effects may be attributed to their binding to negatively charged macromolecules[9]. In the present work, it is obvious that the results recorded in Table 3 using paclobutrazol, alone or in combination with putrescine resulted in the highest contents of photosynthetic pigments as compared with their respective control. It should be mentioned here that carotenoids provide photosynthetic system with a method of photoprotection by prevent the formation of free radical oxygen by quenching the triple states of the chlorophyll molecules [33]. These results are in line with those obtained by Bekheta *et al.* [17].

Data presented in Table 3 revealed that spraying bougainvillea plants with paclobutrazol 250 ppm or 500 ppm respectively combined with putrescine resulted insignificant increases in the total carbohydrates compared with control plant. These results are in agreement with those obtained by Bekheta *et al.* [17] and El-Kady[32].

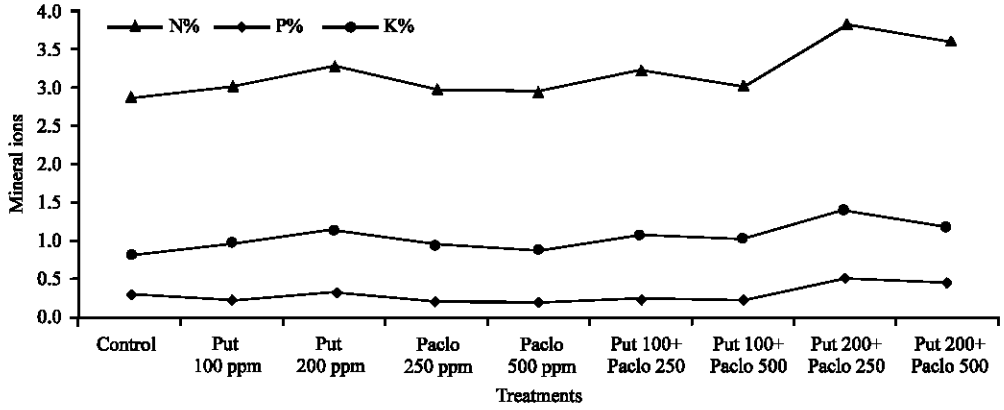

Fig. 1: Effect of putrescine (Put.)and paclobutrazol (Paclo.) on mineral ions content of *Bougainvillea glabra* L. plant

Mineral ions content: As regarding to Table 3 and Fig. 1 that foliar application of putrescine and/or paclobutrazol, mostly increased the total amounts of nitrogen and potassium ions content in most cases as compared with a mounts obtained from the untreated plants. On the other hand application of put 100 ppm, paclo 250, 500 ppm and put 100+paclo 250 and put 100 combined with paclo 500 ppm decreased in phosphorus ions content compared with control plants, whereas putrescine 200 ppm alone or combined with paclobutrazol at the two concentrations under study gave the highest values of phosphorus ions content than control plants.

From the above mentioned results, it could be concluded that foliar application of putrescine 200 ppm+paclobutrazol 250 ppm and put 200+paclo 500 ppm might be play a role in many metabolic and physiological process, through affecting the metabolism of photosynthesis process which led to increase in carbohydrates content which influences and promoted all vegetative growth and number of flowers as indication for foliage and flower quality.

REFERENCES

1. Chittendon, F., 2001. RHS Dictionary of plants supplement. Oxford Univ. Listing of Species and How to Grow Them.
2. Usher, G., 1974. Dictionary of plants used by Man. Constable ISBN 0094579202. Lists a very extensive range of useful plants from a round the world with very brief details of the uses.
3. Polunin, O. and A. Huxley, 1987. Flowers of the Mediterranean. Hogarth ISBNO-7012-0784-1. Avery readable pocket flora that is well illustrated. Gives some information on plant uses.
4. Evans, T.P. and R.L. Malmberg, 1989. Dopolyamines have roles in plant development. Ann. Rev. Plant Physio. Plant Mol. Biol., 40: 235.
5. Galston, A.W. and Kaur-Sawhney, 1990. Polyamines in plant physiology. Plant Physiol., 94: 406.
6. Perez-Adamor, M.A., J. Lean, P.J. Green and J. Carbonell, 2002. Induction of the arginine decarboxilase ADC2 gene provides evidence for the involvement of polyamines in the wound response in Arabidopsis. Plant Physiol., 130: 1454-1463.
7. Flores, H.E. and A.W. Galston, 1982. Polyamines and plant stress: Activation of putrescine biosynthesis by osmotic shock. Science, 217: 1259-1261.
8. Friedman, R., A. Altman and N. Levin, 1989. The effect of salt stress on polyamine biosynthesis and content in mung bean plants and halophytes. Physiol. Plant, 76: 295-302.
9. Smith, T.A., 1985. Polyamines. Annu. Rev. Plant Physiol., 36: 117-143.
10. Rawland, A.J., A.M. Borland and P.J. Lea, 1988. Changes in amino acids, amines and proteins in response to air pollutants. In: Schulte-Hostede, S.; N.M. Darrell, L.W. Blank and A.R. Wellburn. Pro. 2nd Int. Symp. On Air Pollution and plant metabolism, pp: 189-222.
11. Pegg, A.E., 1986. Recent advances in the biochemistry of polyamines in eukaryotes. Biochem. J., 234: 249-62.
12. Schuber, F., 1989. Influence of polyamines on membrane functions. Biochem. J., 260: 1-10.
13. Khan, N.A., A. Sezan, V. Quemener and J.P. Moulinoux., 1993. Polyamine transport regulation by calcium and calmodulin: role of Ca^{2+} - ATPase. J. Cell Physiol., 157: 493-501.

14. Smith, M.A., P.J. Davies and J.B. Reid, 1985. Role of polyamines in gibberellin induced internode growth in peas. Plant Physiol., pp: 78-92.
15. Izumi, K., S. Nakagawa, M. Kobayashi, H. Oshio, A. Sakurai and N. Takahashi, 1988. Levels of IAA, Cytokinins, ABA and Ethylene in rice plants as affected by gibberellin biosynthesis inhibitor uniconazole. Plant Cell Physiol., 29: 97-104.
16. Rademacher, W., H. Fritch, E.J. Graebe, H. Sauter and J. Jung, 1987. Tetcyclacis and triazole type plant growth retardants, their influences on the biosysenthesis of gibberellins and other metabolic processes. Pestic Sci., 21: 241-252.
17. Bekheta, M.A., A.H. El-Ghourab and M.H. Mahgoub, 2003. Influence of stigmasterol and uniconazole on growth, endogenous hormones, chemical composition and radical scaving activity of Thyme (*Thymus syrpyllum* L.) Egypt, J. Res. NRC, 1: 523-545.
18. Bist, L.O., 1990. Influence of paclobutrazol, a lar, CCC and promalin on macronutrient status of pear leaf. Acta Hort., 274: 43-50.
19. Singh, A.K. and L.D. Bist, 2003. Effect of paclobutrazol on growth and flowering in rose cv. Gruss-an-Teplitz J. Hort., 60: 188-191.
20. Metzzner, H., H. Rava and H. Senger, 1965. Unter suchungen zur synchronis iebekiety pigments mangel von chlrella. Planta, 65: 186-190.
21. Herbert, D.P., P. Phlipps and R. Strangle, 1971. Determination of carbohydrates. Method in Microbial, 58: 209-344.
22. Chapman, H.D. and P.F. Pratl, 1961. Methods of Analysis for Soils, Plants and Waters. Univ. California, Div. Agric. Sci. Berkely, USA, pp: 445.
23. King, E.J., 1951. Microanalysis in Medical Biochemistry. 4th E'dn. J. and Ehar Chill. L., London.
24. Brown, J.D. and O. Lilliland, 1946. Rapid determination of K and Na in plant material and soil extract by flame photometer. Proc. Am. Hort. Sci., 48: 341-346.
25. Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 7th Edn. Iowa State, Press, USA.
26. Talaat, I., M.A. Bekheta and M.H. Mahgoub, 2005. Physiological response of Periwinkle plants (*Catharanthus roseus* L.) to tryptophan and Putrescine. Int. J. Agric. Biol., 7: 210-213.
27. Galston, A.W., 1983. Polyamines as modulators of plant development. Bioscience, 33: 382.
28. Paschalidis, A.K. and Roubelakis, A.K. Angelakis, 2005. Sites and regulation of polyamine catabolism in the tobacco plant. Correlation with cell division/expansion, cell cycle progression and vascular development. Plant Physiol., 138: 2174-2184.
29. Jainyang, Li., Gan lu and Yan, Ren, 2005. Advances in research on effect of polyamines on fruit growth and development of fruit trees. J. Fruit. Sci., 3: 256-260.
30. Prista, T.S. and D.G. Voyiatzis, 2004. Seasonal changes in polyamine content of vegetative and reproduction olive organs and fruit development. Aust. J. Agric. Res., 55: 1039-1046.
31. Bekheta, M.A. and Amany, A. Ramadan, 2005. Influence of bioregulators uniconazal and coumarin on some moropholgical, physiological aspects and fiber quality of cotton plants. J. Agric. Sci. Mansoura Univ., 30: 3683-3696.
32. El-Kady, F.M.A., 2002. Some studies on the effect of growth regulator uniconazol on the growth, some metabolic changes, levels endogenous hormones and productivity of wheat plants. M. Sc. Thesis, Bot. Dept. Fac. Sci., Al-Azhar Univ.
33. Fyfe, P., R.J. Cogdell, C.N. Hunter and M.R. Jones, 1995. Study of the carotenoid binding pocket of photosynthesis reaction center from the purple bacterium *Rhodobacter sphaeroides* p. Mathis (Ed.), photosynthesis: from light to Biosphere. In Proc. of 10h Intl. Photosynthesis Congress, Montpelleir, France, 20-25 August, 4: 47-50.