

Effect of Pinching and Spraying of Paclobutrazol on Vegetative Growth, Flowering and Chemical Composition of *Zinnia elegans*, Jacq.

Sharaf-Eldien, M. N.¹; Samia Z. El-Bably² and M. R. Magouz²

¹Dept. Veg. & Flori., Fac. Agric., Mansoura Univ., Egypt.

²Hort. Res. Inst., Agric. Res. Center, Giza, Egypt.



ABSTRACT

This investigation was carried out in the Experimental Farm of Sakha Horticulture Research Station, Kafr El- Sheikh, during two successive seasons of 2014 and 2015 to investigate the effect of pinching and foliar spray of paclobutrazol (PBZ) at 0, 50, 100 and 150 ppm as well as interaction with them on growth, flowering and chemical composition of *Zinnia elegans* as pot plant. The obtained results revealed that the pinching increased stem diameter, number of branches and flowers/plant, fresh and dry weights of vegetative parts and flowers/plant, and N, P and K percentages but decreased plant height, leaf area, flower diameter as well as chlorophyll a, b and (a+b) contents. PBZ treatments caused an increase in the stem diameter, number of branches and flowers/plant, chlorophyll a, b and (a+b) as well as P and K percentages, while decreased plant height, fresh and dry weight of vegetative parts and flowers/plant and flower diameter. Concerning the interaction, shortest plant height, the largest number of branches and flowers/plant and the highest amount of chlorophyll content were obtained with pinching and 150 ppm PBZ treatment. It may be concluded that the pinching and treated with PBZ at 100 or 150 ppm gave a good feature for potted *Zinnia elegans* plants.

INTRODUCTION

Zinnia elegans belongs to family Asteraceae, is an annual plant, growing as bedding, cut flowers and can also be used as flowering potted plant. However, production of zinnia as a pot-plant is not short and compact enough to produce high-quality and marketable plant (Andersen and Andersen, 2000 and Pinto *et al.*, 2005). The aesthetic value can only be achieved by the increased number of healthy and beautiful flowers (Wainwright and Irwin, 1987 and Munir and Naz, 2006). Therefore, a technique such as pinching (manual removal of shoot apices) to overcome apical dominance and encourage lateral branching is a commercial recommendation in ornamental plant production (Lee *et al.*, 2006; Ahmad *et al.*, 2007; Shanan and Soliman, 2011; Dorajeero and Mokashi, 2012 and Mutlu and Agan, 2015). Effects of pinching in terms of significant reduction in plant height, delayed flowering and increased number of flowers have been recorded in several commercial floriculture crops (Dorajeero and Mokashi, 2012 and Mutlu and Agan, 2015). Plant growth retardants (PGRs) have been used in the field of floriculture for inducing more acceptable plant characteristics like compact growth, dwarfness and increased number of healthy branches (Cox and Keever, 1988; Banon *et al.*, 2002; Taychasinpitak and Manochai 2003). An important group of commercial plant growth retardants are the triazol compounds such as paclobutrazol (PBZ), which suppresses growth through interference of gibberellic acid biosynthesis, a hormone responsible for cell elongation (Fletcher *et al.*, 2000 and Rademacher, 2000). Therefore, the objective of this study was to evaluate the effects of manual pinching and PBZ on the growth of *Zinnia elegans* and to identify the best procedure for production of zinnia as commercial pot plant.

MATERIALS AND METHODS

This study was carried out in a polyethylene-covered green house, in the Experimental Farm of Sakha Horticulture Research Station, Kafr El- Sheikh, during two successive seasons of 2014 and 2015. Seeds were sown on the March 1st in both seasons in polyethylene plug trays filled with a mixture of peatmoss and vermiculite (2:1 v/v). One month from sowing, the uniform seedlings about 9-10 cm height were transplanted into 16 cm diameter plastic

pot filled by the same medium, single seedling was planted per pot. After one week from transplanting, the plants of *Zinnia elegans* were divided into two groups, in the first group the apical buds were removed (pinched) while in the second group they were without pinching (non-pinched). Both groups were twice sprayed with PBZ ([4chlorophenyl) methyl]-a-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol) at four concentrations (0, 50, 100 and 150 ppm) at 3 and 21 days after pinching. Spray applications were done in early morning till the solution run off, while control plants (0) were sprayed with distilled water only.

All plants were fertilized with 4 g/plant calcium super phosphate (15.5% P₂O₅) in one dose at the soil preparation before transplanting, 8 g/plant ammonium sulphate (20.5% N) and 4 g/plant potassium sulphate (48.5% K₂O). Nitrogen and potassium fertilizer were divided into two equal doses, the first dose was added after two weeks from transplanting and the second one was added three weeks later according to El Morsy (2011). However, all plants received the usual agricultural practices.

The following data were recorded at the end of production cycle (six to seven open inflorescences per plant); plant height (from main stem base to inflorescence receptacle insertion, cm), stem diameter (cm), leaf area (cm²) was calculated using the formula according to Gardner *et al.*, (1985), number of branches and flowers/plant, fresh and dry weight of vegetative parts and flowers (g)/plant, flower diameter (cm), chlorophyll a, b and chlorophyll (a+b) (the fifth leaf from the top of the plant) according Moran (1982), total nitrogen (% of dry weight) in the leaves was determined using microkjeldahl as described by Black (1965), phosphorus (% of dry weight) in the leaves was estimated colorimetrically as recommended by Jackson (1973), as well as potassium (% of dry weight) in the leaves was determined using flame photometer method described by Cottenie *et al.* (1982). The leaves were dried in an electrical oven at 50 °C till constant dry weight before chemical analysis.

A factorial experiment in a randomized completely block design was applied with two factors: (1) pinched and non-pinched, (2) four concentrations of PBZ. Each of the 8 treatments of the experiment had

three replicates each replicate contained three pots. Data were statistically analyzed by using MSTAT program and means were compared by Duncan's Multiple Range Test at 0.05 level (Snedecor and Cochran, 1980).

RESULTS

1. Vegetative growth plant height

Data in Table (1), reveal that the pinching reduced plant height than unpinched plants by 11.76 and 14.37% in the first and second seasons, respectively. PBZ at different rates showed significant effect on the plant height and 150 ppm concentration produce highly reduction by 23.87 and 43.23% in the first and second seasons, respectively compared to control (sprayed with water). Concerning the combined effects of the pinching and PBZ treatments, it is clear from the data presented in Table (1), that the shortest plants were obtained in pinched plants and treated with PBZ at the high rate (150 ppm) and this decrease was 32.53 and 54.36% in the first and second seasons, respectively compared to unpinched and PBZ untreated plants, which had maximum length.

Stem diameter

It is obvious from the data presented in Table (1), that pinching significantly increased stem diameter than unpinched plants by 4.35 and 6.36% for the first and second seasons, respectively. Stem diameter increased with increasing rate of PBZ spraying and the differences among them were significant. The high concentration of PBZ led to increase this parameter by 14.94 and 14.95%

in the first and second seasons, respectively compared to control. Concerning the effect of interaction, the treatment of PBZ at 150 ppm in pinched plants gave the highest value in this respect. Such increase was 23.53 and 26.96% compared to unpinched and PBZ untreated plants in the first and second seasons, respectively.

Number of branches/plant

Data presented in Table (1), show that the pinching significantly increased number of branches/plant than unpinched plants by 57.63 and 20.18% in the first and second seasons, respectively. All concentrations of PBZ also increased number of branches/plant compared with control. Concerning the effect of interaction, the treatment of PBZ at 100 ppm in pinched plants gave the highest value in this regard. Such increase was 106.22 and 45.86% in the first and second seasons, respectively compared to unpinched and PBZ untreated plants.

Leaf area

Significant reduction in leaf area was recorded in pinched plants (Table 1), reduction reached up to 4.60 and 5.26% compared to unpinched plants in both seasons, respectively. Leaf area was reduced by increasing concentrations of PBZ. At the highest concentration of PBZ, reduction reached up to 12.30 and 20.25% in the both seasons, respectively compared to control. Maximum reduction was recorded in pinched plants and treated with PBZ at 150 ppm, reduction reached up to 42.54 and 25.49% compared to unpinched and untreated plants in both seasons, respectively.

Table 1. Effect of pinching, paclbutrazol (PBZ) treatments and their interaction on plant height, stem diameter, number of branches/plant and leaf area of *Zinnia elegans* during 2014 and 2015 seasons.

Treatments pinching PBZ (ppm)	Plant height (cm)			Stem diameter (cm)		
	Pinched	Unpinched	Mean	Pinched	Unpinched	Mean
First season (2014)						
0	67.42 c	83.25 a	75.33 a	0.89 cd	0.85 d	0.87 c
50	62.56 d	73.17 b	67.86 b	0.93 bc	0.92 bc	0.93 b
100	57.35 f	60.97 de	59.16 c	0.96 b	0.95 b	0.96 b
150	56.17 f	58.53 ef	57.35 c	1.05 a	0.96 b	1.00 a
Mean	60.87 b	68.98 a		0.96 a	0.92 b	
Second season (2015)						
0	58.67 a	61.11 a	59.89 a	1.09 b	1.04 b	1.07 b
50	51.11 bc	53.22 b	52.17 b	1.13 b	1.08 b	1.11 b
100	37.00 e	49.56 c	43.28 c	1.15 b	1.13 b	1.14 ab
150	27.89 f	40.11 d	34.00 d	1.31 a	1.16 b	1.23 a
Mean	43.67 b	51.00 a		1.17 a	1.10 b	
Number of branches/plant						
First season (2014)						
0	7.55 c	4.50 f	6.03 b	21.36 bc	33.03 a	22.19 a
50	8.03 bc	5.08 ef	6.56 b	20.85 cd	21.54 b	21.19 b
100	9.28 a	5.50 de	7.39 a	19.98 e	20.68 d	20.33 c
150	8.61 ab	6.17 d	7.39 a	18.98 f	19.93 e	19.46 d
Mean	8.37 a	5.31 b		20.29 b	21.29 a	
Second season (2015)						
0	7.56 abc	5.56 d	6.56 b	20.83 ab	21.93 a	21.38 a
50	7.78 ab	6.89 bc	7.33 a	19.72 bc	20.59 b	20.16 b
100	8.00 a	6.67 c	7.34 a	18.07 d	18.84 cd	18.45 c
150	8.11 a	7.06 bc	7.58 a	16.34 e	17.76 d	17.05 d
Mean	7.86 a	6.54 b		18.74 b	19.78 a	

Values in the same column (for both pinching and paclbutrazol) and between columns (for their interaction) that are followed by the same letters do not differ significantly according to Duncan's Multiple Range Test at the 5% level.

Fresh and dry weight of vegetative parts/plant

Data in Table (2) show that pinching treatment increased fresh and dry weights of vegetative parts/plant than unpinched plants by 6.52 and 8.00% for fresh weight in the first and second seasons, respectively and 6.47% for

dry weight in second season, whereas the increasing for dry weight in the first season was non-significant. Fresh and dry weight of vegetative parts/plant decreased with increasing rate of PBZ, the high concentration of PBZ (150 ppm) decreased this parameter by 19.37 and 26.36% for

fresh weight and 33.95 and 40.27% for dry weight in the first and second seasons, respectively compared to control. Concerning the effect of interaction, the treatment of PBZ at 150 ppm on unpinched plants gave the lowest value for fresh weight. Such decrease was 18.54 and 26.84% in the first and second seasons, respectively compared to unpinched and PBZ untreated plants. While the lowest value for dry weight was resulted from PBZ at 150 ppm on pinched plants. The reduction was about 37.29 and 39.56% in the first and second seasons, respectively compared to unpinched and PBZ untreated plants.

2. Flowering

Number of flowers/plant

Data in Table (2) show that the pinching significantly increased number of flowers/plant than unpinched plants by 6.19 and 5.17% in first and second seasons, respectively. PBZ increased number of flowers/plant with all rates and 100 ppm rate gave the highest value. Such increase was 38.31 and 12.58% in the first and second seasons, respectively compared with control. Concerning the effect of

interaction, the treatment of PBZ at 100 ppm in pinched and unpinched plants gave the highest value in this concern. This increase was 43.39 and 20.14% in pinched plants and 41.67 and 17.42% in unpinched plants in the first and second seasons, respectively compared to unpinched and PBZ untreated plants.

Flower diameter

Data presented in Table (2) reveal that the pinching decreased flower diameter than unpinched plants by 5.78 and 1.74% for the first and second seasons, respectively. PBZ at different rates show decreased flower diameter, the highest PBZ concentration (150 ppm) decreased this parameter by 8.34 and 7.12% in the first and second seasons, respectively than control. Concerning the effect of interaction, the treatment of PBZ at 150 ppm in pinched plants gave the lowest value in this respect. Such decrease was 12.51 and 9.22% in the first and second seasons, respectively compared to unpinched and PBZ untreated plants.

Table 2. Effect of pinching, paclobutrazol (PBZ) treatments and their interaction on fresh and dry weight of vegetative parts/plant, number of flowers/plant and flower diameter of *Zinnia elegans* during 2014 and 2015 seasons.

Treatments pinching	Fresh weight of vegetative parts/plant (g)			Dry weight of vegetative parts/plant (g)		
	Pinched	Unpinched	Mean	Pinched	Unpinched	Mean
PBZ (ppm)						
First season (2014)						
0	127.33 a	118.67 b	123.00 a	61.71 a	58.57 b	60.14 a
50	117.00 b	107.33 c	112.17 b	57.57 b	51.61 c	54.59 b
100	105.33 c	101.00 d	103.17 c	49.37 d	52.65 c	51.01 c
150	101.67 d	96.67 e	99.17 d	36.73 f	42.70 e	39.72 d
Mean	112.83 a	105.92 b		51.35 a	51.38 a	
Second season (2015)						
0	119.00 a	112.03 b	115.52 a	58.26 a	51.54 b	54.90 a
50	109.72 b	98.02 c	103.87 b	48.60 c	41.90 e	45.25 b
100	90.80 d	85.50 ef	88.15 c	45.09 d	44.11 de	44.60 b
150	88.17 de	81.96 f	85.07 c	31.15 g	34.42 f	32.79 c
Mean	101.93 a	94.38 b		45.77 a	42.99 b	
	Number of flowers/plant			Flower diameter (cm)		
First season (2014)						
0	6.82 c	6.43 c	6.63 c	8.54 bc	8.95 a	8.75 a
50	8.40 ab	7.83 b	8.12 b	8.20 d	8.91 a	8.56 a
100	9.22 a	9.11 a	9.17 a	8.02 de	8.55 b	8.29 b
150	9.20 a	8.30 ab	8.75 a	7.83 e	8.20 cd	8.02 c
Mean	8.41 a	7.92 b		8.15 b	8.65 a	
Second season (2015)						
0	7.78 ab	7.00 b	7.39 c	8.70 b	9.00 a	8.85 a
50	7.89 ab	7.44 b	7.67 b	8.57 bc	8.67 bc	8.62 b
100	8.41 a	8.22 a	8.32 a	8.43 cd	8.53 bc	8.48 b
150	7.66 ab	7.50 b	7.58 b	8.17 e	8.27 de	8.22 c
Mean	7.93 a	7.54 b		8.47 b	8.62 a	

Values in the same column (for both pinching and paclobutrazol) and between columns (for their interaction) that are followed by the same letters do not differ significantly according to Duncan's Multiple Range Test at the 5% level.

Fresh and dry weight of flowers/plant

It is obvious from the data presented in Table (3), that pinching significantly increased fresh weight by 6.01 and 5.23% and dry weight by 5.92 and 5.57% than unpinched plants for the first and second seasons, respectively. Increasing PBZ doses significantly reduced fresh and dry weight of flowers/plant compared to control in both seasons. However, 150 ppm dose had the greatest reducing effect in both seasons, reduction reached up to 25.42 and 8.18% for fresh weight and 27.32 and 9.76% for dry weight in both seasons, respectively. The interaction

revealed that PBZ at the highest dose produced similar reduction on pinched and unpinched plants.

3. Chemical composition

Chlorophyll (a), (b) and chlorophyll (a+b) content (mg/cm²)

Data in Table (3 and 4) show that pinching decreased chlorophyll (a) by 22.99 and 17.19%, chlorophyll (b) by 22.22 and 30.30% and chlorophyll (a+b) contents by 22.72 and 21.65% in the first and second seasons, respectively compared to unpinched plants. It is clear from Table (3 and 4) that PBZ increased chlorophyll (a), (b) as well as chlorophyll (a+b) contents with all rates

Nitrogen percentage in the leaves

Data presented in Table (4) show that pinched plants had significantly increased nitrogen percentage in both seasons. This increase was 12.80 and 21.27% in the first and second seasons, respectively compared to unpinched plants. It is clear from Table (4) that nitrogen percentage significantly decreased with increasing rate of PBZ spraying except 50 ppm, which was statistically similar with control in both seasons. Concerning the combined effects of the pinching and PBZ treatments, it is clear from the data in Table (4), that the highest value was obtained from pinched plants and treated with PBZ at 50 ppm rate and such increase was 13.91 and 19.75% in the first and second seasons, respectively compared to unpinched and PBZ untreated plants.

Phosphorus and potassium percentages in the leaves

It is obvious from the data presented in Table (4), that pinching significantly increased phosphorus and potassium percentages in both seasons, as increment reached 5.26 and 4.76% for phosphorus and 18.03 and 16.20% for potassium in the first and second seasons, respectively. Plants showed an increase in the phosphorus and potassium percentages as PBZ concentrations increased. The highest PBZ concentration increased these parameters by 41.18 and 38.89% for phosphorus and 32.54 and 36.20% for potassium in the first and second seasons, respectively compared to the control. The interaction revealed that, the maximum contents of the P% were obtained in plants sprayed with all doses of PBZ regardless pinch treatment. For content of K% it was clear that pinched plants and treated with the highest dose of PBZ gave the highest potassium percentage, with increase 54.71 and 60.74% in the first and second seasons, respectively compared to unpinched and PBZ untreated plants. However, this result was parallel with the data obtained on the effect of these factors on most vegetative and flowering characters as shown in Table (1 and 2).

DISCUSSION

It is obvious from the aforementioned results (Table, 1-4) that pinching reduced plant height, leaf area, flower diameter and chlorophyll content, while stem diameter, number of branches/plant, fresh and dry weight of vegetative parts/plant, number of flowers/plant and fresh and dry weight of flowers/plant increased. Several studies also reported that apical bud pinching induced significant reduction in plant height and increased number of branches and flowers/plant (Jhon and Paul, 1995; Garner *et al.*, 1997; Pathania *et al.*, 2000; Kumar and Singh, 2002 and Dorajeero and Mokashi, 2012).

Pinching is commonly practiced to overcome apical dominance and promote lateral branching, resulting in a large number of inflorescences and make the pot plant well shaped, more compact and attractive (Munir and Naz, 2006; Shanan and Soliman, 2011 and Mutlu and Ağan, 2015).

The results indicated that PBZ at highest rate increased number of branches/plant to 66.20 and 31.41% for pinched and unpinched plants, respectively (mean of both seasons) while, pinching plants without PBZ application increased it to 50.10% (mean both seasons). Moreover, number of branches was directly proportional to

the concentration of the PBZ. It is also clear from the results that number of flowers/plant are correlated with number of branches/plant, but flower diameter was small. Armitage *et al.*, (1981) and Chen *et al.*, (1993) also found that daminozide (5.0 g L⁻¹) and PBZ (0.25 or 0.75 g L⁻¹) reduced inflorescence diameter of *Zinnia elegans* cultivars.

In data cleared that all used concentrations of PBZ caused a decrease fresh and dry weight of vegetative parts and flowers/plant. The obtained results show similarity to findings by Gibson and Whipker, (2003) and Hojjati *et al.*, (2009), who reported that PBZ treatments reduced the growth of *Osteospermum* and *Zinnia elegans*, respectively. However, higher PBZ rate induced more branching but size of these branches remained small, with reduced leaf area, they cause some decrease in the photosynthesis rate in the plant, which decrease plant fresh and dry weight. This result may be attributed to the PBZ treatments decreased the nitrogen content that led to decrease in protein content. However, these results are in accordance to those of Kim and Suzuki (1989) who found that treatments of growth retardants reduced sink activity in side branches and inhibit assimilated ¹³C translocation from leaves to other zinnia organs. Plant growth retardants (like PBZ) are mainly applied for decreasing the plant height of ornamental plants. These compounds decrease the internodes length and eliminate the apical dominance and inhibit the gibberellic acid biosynthesis. However, when the apical bud is removed or eliminate, the lateral buds have relatively high indole acetic acid concentrations which induce their elongation (Davis *et al.*, 1988 and Rademacher, 2000). The increase in chlorophyll content with PBZ treatments in this study may be attributed to more densely packed chloroplasts per unite leaf area as a result of reduced leaf elongation and enhanced chlorophyll biosynthesis. However, triazol have been proposed to stimulate cytokinin synthesis that enhances chloroplast differentiation, chlorophyll biosynthesis, and prevents chlorophyll degradation (Fletcher *et al.*, 2000).

As a conclusion, application PBZ as a foliar spray at the rate of 150 ppm on pinched plants is recommended to improve production of potted *Zinnia elegans*.

REFERENCES

- Ahmad, Iftikhar; K. Ziaf; M. Qasim and M. Tariq (2007). Comparative evaluation of different pinching approaches on vegetative and reproductive growth of carnation (*Dianthus caryophyllus*). Pak. J. Agri. Sci., 44 (4): 563-570.
- Andersen, A.S. and L. Andersen (2000). Growth regulation as a necessary prerequisite for introduction of new plants. Acta Hort., 541: 183-192.
- Armitage, A.M.; R.E. Bass; W.H. Carlson and L.C. Ewart (1981). Control of plant height and flowering zinnia by photoperiod and growth retardants. HortScience 16: 218-220.
- Banon, S.; A. Gonzales; E.A. Cano; J.A. Franco and J.A. Fernandez (2002). Growth, development and colour response of potted *Dianthus Caryophyllus* cv. Mondriaan to paclobutrazol treatment. Scientia Horticulturae, 94: 371-377.

- Black, C.A. (1965). Methods of Soil Analysis. Amer. Soc. Agron. Inc. Publishers, Madison, USA.
- Chen, C.L.; G.L. Keever and C.F. Deneke (1993). Growth and flowering of triazol treated zinnia (*Zinnia elegans*) and marigold (*Tagetes erecta*). PGR Soc. Amer. Quarterly, 21: 169-179.
- Cottenie, A.; M. Verloo; M. Velghe and R. Camerlynck (1982). Chemical Analysis of Plant and Soil. Laboratory of Analytical of Agroc. Stated Univ. Ghent-Belgium.
- Cox, D.A. and G.J. Keever (1988). Paclobutrazol inhibits growth of zinnia and geranium. HortScience, 23: 1029-1030.
- Davis, T.D.; G.L. Steffans and N. Sankhla (1988). Triazole plant growth regulators. Hort. Rev., 10: 63-105.
- Dorajerao, A.V.D. and A.N. Mokashi (2012). Growth analysis as influenced by pinching time in garland chrysanthemum (*Chrysanthemum coronarium* L.). Global J. Bio-Sci. Biotechnol. 1: 242-247.
- El Morsy, Noha, A.A. (2011). Use of ornamental annual plants for aesthetization of green areas. M.Sc. Thesis, Fac. Agric., Kafr El-Sheikh Univ., Egypt.
- Fletcher, R.A.; A. Gilley; N. Sankhla and T.D. Davis (2000). Triazoles as plant growth regulators and stress protectants. Hort. Rev. 24: 55-138.
- Gardner, F.P.; R.B. Pearce and R.L. Mitchell (1985). Physiology of Crop Plants. Iowa State Univ. Press, Ames.
- Garner, J.M.; S.A. Jones and A.M. Armitage (1997). Pinch treatment and photoperiod influence flowering of *Delphinium* cultivars. HortScience, 32 (1): 61-63.
- Gibson, J.L. and B.E. Whipker (2003). Efficacy of plant growth regulators on growth on vigorous *Osteospermum* cultivars. Hort. Tech., 13: 132-135.
- Hojjati, M.; N. Etemadi and B. Baninasab (2009). Effect of paclobutrazol and cycocel on vegetative growth and flowering of zinnia (*Zinnia elegans*). Agric. Sci. Technol. Nat. Resour., 47: 649-656.
- Jackson, M.L. (1973). Soil Chemical Analysis. Prentice-Hall of India, Private Limited, New Delhi.
- Jhon, A.Q. and T.M. Paul (1995). Influence of spacing and pinching treatments on growth and flower production in chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Flirt. Prog. Hort. 27: 57-61.
- Kim, H.Y. and Y. Suzuki (1989). Changes in assimilated ¹³C distribution and soluble acid invertase activity of *Zinnia elegans* induced by uniconazol, an inhibitor of gibberellin biosynthesis. Plant Physiol., 90: 316-321.
- Kumar, R. and K. Singh (2002). Effect of growth regulator and shoot tip pinching on carnation. J. Orna. Hort., 6: 134-136.
- Lee, J.H.; K.S. Kim and C.Y. Song (2006). Effects of pinching and retardants on growth and flowering of *Celosia argentea* native to Korea. Korean J. Plant Res., 19 (5): 573-579.
- Moran, R. (1982). Formula for determination chlorophyllous pigments extracted with N, N-dimethylformamid. Plant Physiol., 69: 1376-1381.
- Munir, M. and F. Naz (2006). Growth and flowering response of snapdragon after release apical dominance. J. App. Hort., 8: 25-28.
- Mutlu, S.S. and E. Agan (2015). Effects of paclobutrazol and pinching on ornamental pepper. HortTechnology, 5 (25): 657-664.
- Pathania, N.S.; O.P. Sehgal and Y.C. Gupta (2000). Pinching for flower regulation in Sim Carnation. J. Orna. Hort., 3: 114-117.
- Pinto, A.C.R.; T.D.D. Rodrigues; I.C. Liete and J.C. Barbosa (2005). Growth retardants on development and ornamental quality of potted Lilliput *Zinnia elegans* Jacq. Sci. Agric., 62: 337-342.
- Rademacher, W. (2000). Growth retardants: Effect on gibberellin biosynthesis and other metabolic pathways. Annu. Rev. Plant physiol. Plant Mol. Biol., 51: 501-531.
- Shanan, Nermeen, T.A. and Amira, Sh. Soliman (2011). Response of snapdragon plants to pinching and growth retardants treatments. Am.-Eurasian J. Sustain. Agric., 5 (2): 150-157.
- Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods, 7th ed. Iowa state Univ. Press, Ames, Iowa, U.S.A.
- Taychasinpitak, T. and B. Manochai (2003). Use of growth retardant on classic zinnia (*Zinnia angustifolia* Kunth) to make commercial pot plant. Kasetsart J. (Nat. Sci.), 37: 243-246.
- Wainwright, H. and H.L. Irwin (1987). The effects of paclobutrazol and pinching on *Antirrhinum* flowering pot plants. J. Hort. Sci., 62: 401-404.

تأثير التطويش والرشد بالباكلوباترازول على النمو الخضري والزهري والتركيب الكيماوي لنبات الزينيا *Zinnia elegans*

محمد نزيه شرف الدين^١، ساميه زهير النيابلي^٢ و محمد رفعت معجوز^٢

^١ قسم الخضار والزينة - كلية الزراعة - جامعة المنصورة

^٢ معهد بحوث البساتين - مركز البحوث الزراعية - الجيزة

أجري هذا البحث بالمزرعة البحثية لمحطة بحوث بساتين سخا في موسمي ٢٠١٥/٢٠١٤ لدراسة تأثير التطويش والرشد بالباكلوباترازول بأربع تركيزات (٠، ١٠٠، ١٥٠ جزء في المليون) على نمو وإزهار نبات الزينيا *Zinnia elegans* كنبات أصص مزهر. وأوضحت النتائج مابلي: أدى التطويش إلى زيادة قطر الساق وعدد الأفرع والأزهار للنبات والوزن الطازج والجاف للمجموع الخضري والأزهار وكذلك النسبة المئوية لكل من النيتروجين والفوسفور والبوتاسيوم بينما أدى إلى نقص ارتفاع النبات والمساحة الورقية وقطر الأزهار بالإضافة إلى محتوى الأوراق من كلوروفيل أ، ب وأب. أدت المعاملة بالباكلوباترازول إلى زيادة قطر الساق وعدد الأفرع والأزهار للنبات ومحتوى الأوراق من كلوروفيل أ، ب وأب والنسبة المئوية للفوسفور والبوتاسيوم بينما أدى إلى نقص في ارتفاع النبات والوزن الطازج والجاف للمجموع الخضري والأزهار وقطر الأزهار والنسبة للتفاعل أعطت النباتات المطوشة والمعاملة بأعلى تركيز من الباكلوباترازول (١٥٠ جزء في المليون) أقل ارتفاع للنبات وأكبر عدد للأفرع والأزهار ومحتوى الكلوروفيل. من النتائج يمكن الحصول على أفضل شكل لنمو نبات الزينيا كنبات أصص بالتطويش مع الرشد بالباكلوباترازول بتركيز ١٠٠ أو ١٥٠ جزء في المليون.