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Effect of Pinching and Paclobutrazol (Pbz) on Vegetative Growth of *Russelia equisetiformis* for Using as a Pot Plant

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THE PRESENT experiment was performed at the nursery of Horticulture Research Institute, Agriculture Research centre, Giza, Egypt during two successive seasons 2013 and 2014. It intended to dwarf vegetative growth of *Russelia equisetiformis* for using as a pot plant. Thus, the individual and the combined effects of different pinching treatments (after either one or two months from planting) and various levels of paclobutrazol (0, 100, 150 and 200 mg/l) were applied as a foliar spray, commencing from one month of planting and then at weekly intervals till the experiment termination in (September15th) in both seasons. The results emphasized that using pinching treatment for only one time produced the highest number of secondary shoots/plant and increased fresh and dry weight of shoots/plant as well as flower number/plant. Meanwhile, treating plants with pinching treatment for two times proved its superiority in reducing plant height with increasing number of main shoots, root length and number of roots/plant. Additionally, negligible and insignificant differences were observed for fresh and dry weights of roots due to using pinching treatments in both seasons.

Plant height was gradually decreased by increasing paclobutrazol levels in both seasons, whereas number of roots/plant was progressively increased by increasing paclobutrazol level in the same seasons. Applying paclobutrazol at 100 mg/l revealed a clear increment in either fresh or dry weight of shoots/plant. Moreover, root length was increased due to using the same paclobutrazol level (100 mg/l). Supplying plants with paclobutrazol at 150 mg/l proved its mastery in raising number of main and second shoots/plant. Also, the same treatment proved its superiority for raising fresh and dry weight of roots. Meanwhile, paclobutrazol treatment at 200 mg/g gave rise to the utmost high values of flower number/plant.

Referring to chemical constituents of vegetative growth parts, pinching treatment for two times proved its mastery in raising chlorophyll (a) and carotenoids contents, whereas it slightly increased chlorophyll (b). Meanwhile, the same treatment caused a slight increment in phenols content, but decreased indoles content in the

same organ. Using the moderate Pbz level (150 mg/l) was the best for raising chlorophyll a and b in the leaves in the two seasons, whereas, applying the highest level (200 mg/l) was the best for elevating carotenoids content in the same seasons. Moreover, applying Pbz at 150 mg/l gave the highest phenols value, whereas, the highest level (200 mg/l) gave the lowest record of indoles content.

From the aforementioned results and the interactions, it could be recommended to use pinching treatment for two times with supplying plants with Pbz in the range of 150 – 200 mg/l for producing short plants of good quality.

Keywords: *Russelia equisetiformis,* Pinching, Paclobutrazol.

Russelia (*Russelia equisetiformis*) is a flowering plant belong to Family *Scrophulariacaea*, native to Mexico and Guatemala, The species name refers to this plant resemblance to horse tail. Commonly used to hide unattractive retaining walls or fences because they grow quickly and have dense foliage. Growing to a maximum height of 1.8 m., they are shrubs which tolerate full sun to partial shade. As evergreens they bloom for most of the year freely from late spring to frost, with bright colored flowers (Wikipedia, 2015 and Umberto, 2000). The attractive leaves and the bright flowers encourage many scientists to make this shrub to be used as a pot plant using several treatments such as growth retardants. Plant growth retardants (PGRs) are commonly used to inhibit stem elongation of many ornamental plants, which they act by inhibiting cell division in the sub-apical meristem of the shoots (Grossmann, 1992), Furthermore, PGRs are used as traditional plant breeding and commercially in greenhouses to inhibit stem elongation , enhance foliage color and decrease time of flowering (Dole and Wilkins, 1999). Pbz, a member of tiazole plant growth regulator group, is a broad-spectrum GA biosynthesis inhibitor and used widely in agriculture (Davis and Curry, 1991). The chemical control of plant growth to reduce the size through the use of plant growth regulators is a common practice to make a plant more compact and commercially more acceptable. A number of synthetic compounds are known to manage shoot growth in higher plants without being phytotoxic or causing malformation or damage (Salisbury and Ross, 1994). Some of these substances have been found in agricultural practices, since they reduce the rate of stem elongation and are involved in the regulation of photosynthesis and the movement of photosynthetic products from their site of synthesis in the leaf to the site of accumulation (Mir *et al.*, 2009). Moreover, chemical addition as growth retardants may have effect on the cell division as the reduction of height was due to reduction in cell division frequency of the meristematic tissues in the apical growing regions and reduction in cell elongation (Don *et al.*, 2003), Growth retardants and cytokinins can affect flower size, pedicel length, number of flowers, (Pobudkiewicz, 2008). They can be directly applied on plants to alter structural and modifying hormone balance to increase yield, improve quality or facilitate harvesting (Lamas, 2001). Plant growth retardants (CCC and Pbz) as spraying increased dry matter, starch, reducing sugars, total sugars and chlorophyll contents also helping in increasing

photosynthesis activity (Eyob and Krishnappa, 1999). Pbz is a strong growth retardant used in many plants to control their growth and development (González *et al.,* 1999). The reduction in aerial parts and dry weight by Pbz was found by Ruter (1996) on Lantana, Nasr (1995) on *Pelargonium zonale* and Bañón *et al.* (2001a and b) on *Asteriscus maritimus* and oleander. Plant growth retardants are commonly used to produce short and attractive compact floriferous plants (Andersen and Andersen, 2000). Pbz (0.2, 0.3, 0.4 and 0.5 mg/pot) and ethephon ETH (25, 50, 75 and 100 mg/pot) were applied as a single soil drench on *Reichardia tingitana* where they reduced plant height, plant width, aerial part dry weight, number of flowering stems and number of inflorescences per plant also decreased chlorophyll a and b and flower numbers (Banon *et al.,* 2003).

On *Nerium oleander* seedling, Ochoa *et al*. (2009) applied Pbz as a single liquid drench application to the substrate surface (20 mg/l a. i. per plant) in a nursery dedicated to pot production in SE Spain. Results revealed that Pbz significantly reduced the growth parameters, providing more compact plant of good commercial value and confirming its ability to reduce the vertical growth of native oleander in the nursery. Shanan and Soliman (2011) studied the response of snapdragon plant to pinching and growth retardant treatments. They concluded that pinching the plants at 3 - leaves stage and treating with paclobutrazol (Pbz) caused a remarkable reduction in plant height as Pbz at 150 mg/l exhibited the lowest indole acetic acid (IAA). The plants treated by 50 mg/l Pbz and pinched at 7- leaves stage gave the greatest number of branches/plant. Badgeshalini *et al*. (2014) worked on summer African marigold and concluded that pinching treatment at 15 day was found to be the best for improving vegetative growth parameters Abdul - Razzak *et al*. (2014) studied the effect of pinching treatment on *Pelargonium hortorum* i. e. pinching or without pinching. Results showed that pinching treatment caused a significant increase in the number of side shoots. Priyank *et al*. (2015) on *Barleria cristata* concluded that seedlings recorded maximum number of secondary side shoots when grown in soil from natural and FYM with double pinching and with the application of 75 ppm paclobutrazol.

Therefore, the work embodied in this paper was carried out for achieving the hope of producing short plants of *Russelia equisetiformis* suitable for using as pot plants by studying the individual and combined effects of different pinching treatments and Pbz levels.

Materials and Methods

The experimental trial was performed throughout two successive seasons (2013 and 2014) at the nursery of Horticulture Research Institute, ARC, Giza, Egypt, with the aim of producing short plants of *Russelia equisetiformis* plants for using as a pot plant. Thus, the individual and the combined effects of different pinching treatments and paclobutrazol levels were investigated.

Materials

- Plastic pots (20 cm. diameters) filled with about 2.5 kg of the mixture of sand + clay (1:1, v/v).
- Rooted cuttings of 15-20 cm. height and 12-14 main shoots were selected for planting in the two seasons.
- Different paclobutrazol (pbz) levels (0, 100, 150 and 200 mg/l).

Procedure

On March 15th, the plants were planted in plastic pots (one plant/each). Thereafter, they were divided into three main groups, the first received pinching treatment for one time one month from planting, whereas the second received pinching at two times, after one and two months from planting. The third was for, control plants which was left without pinching. The plants were left to grow under open field conditions. Meanwhile, after one month from planting all the cultivated plants without control plants received foliar spray of different paclobutrazol levels (0, 100, 150 and 200 mg/l) at weekly intervals commencing from April 15th, throughout the growth cycle of the plant till the terminate of the experiment (September 15th).

The experimental design of the two seasons was a factorial experiment in randomized complete block design, with three replicates. The main plots were assigned to pinching treatments, whereas, the sub plots exhibited the different paclobutrazol treatments. Thus, 12 treatments were included in the experiment (3 pinching treatments ×4 paclobutrazol levels). Every experimental unit contained 6 plants and every treatment was represented by 18 plants.

Regular agricultural practices such as weeding, watering and fertilization (with NPK at 1.5g/pot was applied as a soil dressing), were carried out throughout the course of the study.

Data were recorded at the termination of the experiment (September 15th) on:

- Plant height (cm.)
- Number of main shoots/plant
- Number of secondary shoots/plant -Fresh and dry weight of shoots/plant (g)
- Number of flowers/plant
- Root length (cm.)
- Root number/plant- Fresh and dry weight of roots/plan (g)

Chemical determination

- Chlorophyll a, b and carotenoids in the leaves: mg/g f.w. as described by Lichtenthaler and Wellburn (1985).
- Phenols content in the leaves: mg/g f.w. according to A.O.A.C. (1990).
- Indoles content in the leaves: mg/g f.w. as recorded by Larsen *et al*. (1962) and Salim *et al*. (1978) and the concentration were calculated as mg indole acetic acid/100g fresh weight.

Data were statistically analyzed using SAS (1994) computer program and means were compared by L.S.D. test according to Snedecor and Cochran (1990).

Results and Discussion

Effect on vegetative growth parameters

Plant height

According to data presented in Table 1, it is evident that using pinching treatment for two times proved its superiority in reducing plant height than that gained from other treatments used in both seasons. Meanwhile, considerable influence on the same trait was detected due to supplying plants with the different Pbz levels, where plant height was progressively decreased by increasing Pbz level, giving the lowest means by applying the highest level (200 mg/l), Fig. 1. The interactions indicated the prevalence of using pinching treatment for two times, with supplying plants with the highest Pbz level (200 mg/l) in producing the shortest plant in the two seasons. In this connection, the reduction on plant height due to Pbz treatment was attributed by Don *et al*. (2003) to reduction in cell division frequency of the meristematic tissues in the apical growing regions and reduction in cell elongation. Meanwhile, Banon *et al*. (2003) reported Pbz at 0.2, 03, 0.4 and 0.5 mg/pot applied as a single soil drench on *Reichardia tingitana* reduced plant height. Moreover, Warner and Erwin (2003) added that Pbzat 20 – 40 mg/l inhibited stem elongation of various species of Hibiscus (*H. trioonum, H. coccineus and H.radiata*). Likewise, Shanan and Soliman (2011) studied the effect of pinching and growth retardant treatments on snapdragon and found that pinching the plants at 3 – leaves stage and treating with Pbz caused a remarkable reduction in plan height.

Number of the main and secondary shoots/plant

The significantly highest number of main shoots/plant was observed in plants treated with pinching treatment for two times in both seasons (Table 1), whereas, the highest number of secondary shoots/plant was noticed where, pinching treatment for one time was applied in the two seasons. Meanwhile, the significantly highest number of either main or secondary shoots/plant was a result of supplying plants with Pbz at 150 mg/l in both seasons. The interactions revealed the prevalence of supplying plants treated with pinching treatment for two times with Pbz at 150 mg/l in raising number of main shoots/plant. Meanwhile, the highest records of number of secondary shoots/plant were obtained due to receiving plants treated with pinching treatment for one time Pbz at 150 mg/l in both seasons.

In this regard, the increment in number of either main or secondary shoots/plant due to pinching or Pbz treatments was also ascertained by various workers. Abdul-Razzak *et al*. (2014) on *Pelargonium hortorum* concluded that pinching treatment caused a significant increase in the number of side shoots. Shanan and Soliman (2011) found that the greatest number of branches/plant of *Antirrinum majus* was recorded with 50 mg/l Pbz. Priyanka *et al*. (2015) on

Barleria cristata claimed that seedling recorded maximum number of secondary side shoots when grown in soil from natural habitat and FYM with double pinching and with the application of 75 ppm paclobutrazol.

TABLE 1. Effect of paclobutrazole (Pbz) and pinching treatments on plant height (cm.), number of main shoots/plant, number of secondary shoots/plant, fresh weight of shoots/plant (g.) and dry weight of shoots/plant (g.) of *Russelia equisetiformis* in two seasons.

Characters	Plant height (cm.)									
	First season					Second season				
Levels (pbz)mg/l / Pinching	Control	100	150	200	Mean (A)	Control	100	150	200	Mean (A)
Control	59.5	36.1	34.3	25.0	38.7	54.0	39.5	37.8	27.3	39.7
One	45.6	33.0	26.5	21.0	31.5	46.0	36.4	31.8	23.9	34.8
Two	39.4	28.5	25.0	19.7	28.2	40.8	28.3	27.5	20.2	29.2
Mean(B)	51.0	32.5	28.1	21.9		46.9	34.3	31.9	23.5	
L.S.D.	A= 3.2		B= 4.5		A×B= 6.9	A= 3.5		B= 4.9		A×B= 7.0
	Number of main shoots/plant									
Control	11.7	13.0	17.3	14.7	14.1	13.3	14.7	16.7	14.0	14.7
One	13.7	15.0	18.0	17.3	16.0	13.7	15.7	17.0	15.3	15.4
Two	14.0	16.7	23.0	15.3	17.3	14.3	16.0	18.3	16.7	16.3
Mean(B)	13.1	14.9	19.4	15.8		13.4	15.3	17.0	15.5	
L.S.D.	A=0.6		B= 0.9		A×B=1.2	A= 0.7		B= 0.9		A×B=1.1
	Number of secondary shoots/plant									
Control	220.4	236.1	352.7	170.0	244.8	229.3	241.8	356.7	160.0	247.0
One	233.1	286.2	424.0	181.0	281.1	240.0	293.0	404.7	182.2	279.9
Two	227.7	247.6	374.2	145.0	248.6	234.8	250.8	353.8	128.5	244.2
Mean(B)	243.7	256.6	383.3	165.3		234.7	261.9	181.0	281.1	
L.S.D.	A= N.S.		B= 48.6		A×B= 62.2	A=N.S.		B= 63.4		A×B=101.8
	Fresh weight of shoots/plant (g.)									
Control	32.9	26.0	19.5	17.6	24.0	33.3	23.7	20.6	19.3	24.2
One	19.4	30.9	27.2	22.0	24.9	20.7	32.7	25.1	22.3	25.2
Two	18.6	29.1	21.1	22.0	22.7	20.0	32.6	21.9	20.8	23.8
Mean(B)	23.6	28.7	22.6	20.3		24.7	29.7	22.5	20.8	
L.S.D.	A= 0.8 B=1.1 A×B=1.6					A=0.9	B=1.3		A×B=1.8	
	Dry weight of shoots/plant (g.)									
Control	18.4	10.3	9.7	6.5	11.2	19.0	8.5	8.3	7.7	10.9
One	9.7	13.1	11.3	9.3	10.9	9.5	14.5	10.7	10.1	11.2
Two	9.3	11.7	8.5	8.4	9.5	9.1	14.6	9.0	9.2	10.5
Mean(B)	9.5	12.4	9.9	8.9		9.3	14.6	9.9	9.7	
L.S.D.	A= 0.8		B=1.0		A×B=1.5	A=N.S. B=1.1 A×B=1.6				
	Number of flowers/plant									
Control .	47	133	180	166	131.5	39	144	198	185	141.5
One	55	155	221	209	160	40	160	225	213	159.5
Two	35	136	58	94	80.8	32	144	63	100	84.7
Mean(B)	45.7	141.3	153	156.3		37	149.3	165.3	167.7	
L.S.D.	A= 14.3		B= 20.2		A×B=28.6	A= 15.7		B=22.2 A×B=31.4		

Fresh and dry weight of shoots/plant

Highest records on either fresh or dry weight of shoots/plant were observed due to plants treated with pinching treatment for only one time or for untreated ones in both seasons (Table, 1). Meanwhile, the lowest scores were a result of treating plants two times for both traits in both seasons. Meantime, Pbz treatment at 100mg/l, revealed a clear increment in either fresh or dry weight of shoots/plant in both seasons. In the matter of the interaction, it is evident from data presented in Table 1, the prevalence of untreated plants with either pinching or Pbz treatments, followed with significant difference by plants treated with pinching treatment for only one time and supplied with Pbz at the lowest level (100 mg/l) for raising fresh and dry weight of shoots/plant in both seasons, as well as for plants which received pinching treatment two times and treated with Pbz at 100 mg/l in the second season only.

Flower number/plant

Flowers number/plant was significantly affected by treating plants with either pinching or treating with Pbz treatments in both seasons (Table 1). In this connection, great influence was detected on such trait due to treating plants with pinching for only one time in elevating number of flowers/plant followed by that gained from untreated plants (control) in both seasons. In contrast, the lowest scores in the same parameter was a result of treating plants with pinching treatment for two times in the two seasons as it is clear from data registered in Table 1. Concerning the effect of Pbz level, it is obvious from data the great influence of using the different pbz levels in raising number of flowers/plant as it progressively increased in both seasons by raising Pbz levels, scoring the highest values by using the highest levels (200 mg/l). Referring to the interaction, receiving plants treated with pinching for only one time Pbz at 150 mg/l gave the utmost high number flowers/plant in the two seasons. In contrast, the lowest records were concomitant to plants treated with pinching for two times and untreated with Pbz in both seasons.

The previous results revealed the great influence of using the different Pbz levels in raising number of flowers/plant. However, Davis *et al*. (1988) stated that Pbz is a synthetic plant growth regulator, which has been used to control vegetative growth and to enhance flowering. Gowda and Jaynthi (1991) reported that the increase in number of flowers of *Tagete serecta* L. per plant and yield of flowers/plant might be attributed to the development of large number of axillary shoots as a result of cessation of terminal growth. Pobudkiewicz (2008) reported that growth retardants and cytokinins can affect number of flowers.

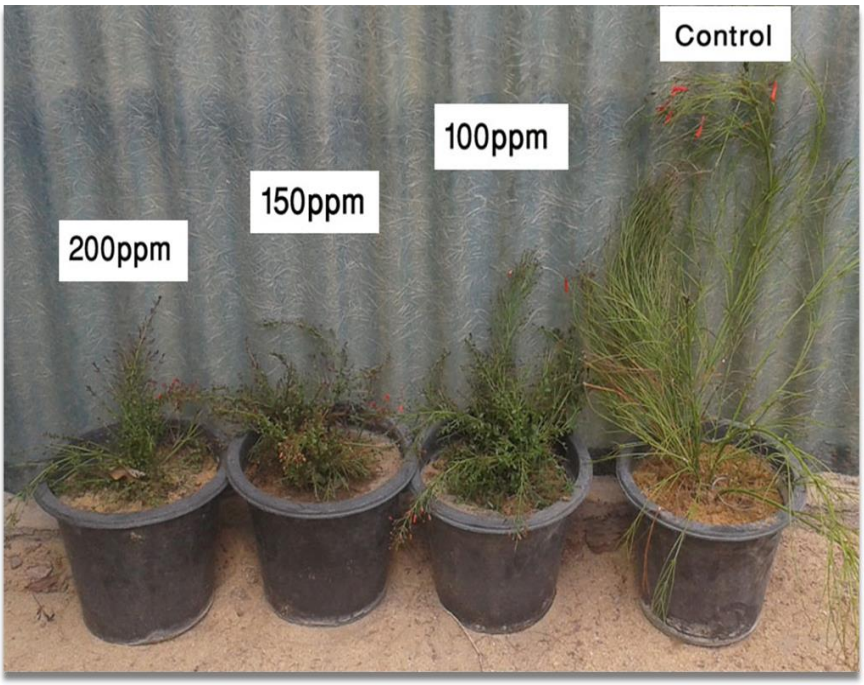

Fig. 1. Effect of different concentrations of Pbz without pinching on the vegetative growth of *Russelia equisetiformis.*

Effect on root parameters

Root length

As shown from data registered in Table 2, the utmost high values of root length were a result of plants treated with pinching for two times. Meanwhile, the lowest records in both seasons were obtained due to treating plants with pinching for only one time in both seasons. On the other hand, the highest records of the same trait were gained due to untreated plants with Pbz, followed with significant difference by those which received the lowest level of Pbz (100 mg/l). Meantime, the lowest means were obtained due to supplying plants with the highest Pbz level (200 mg/l). In the matter of the interactions, highest records were obtained for the same trait due to untreated plants with either pinching or Pbz treatments as well as with plants treated with pinching treatment for two times and untreated with Pbz in the first season. However, the highest records in the second one were a result of plants treated with pinching treatment for either one or two times and untreated with Pbz. In contrast, the lowest scores were obtained as a result of plants treated with pinching for one time and supplied with the highest Pbz level (200 mg/l) in the two seasons.

The after mentioned results revealed the beneficial effect of pinching treatment for two times in raising root length, whereas, using the highest Pbz

level (200 mg/l) caused a clear decrement in the same trait. However, such effects were in agreement with those of Dessouky (1994) who concluded that root length/plant of *bird of paradise* was noticeably increased with pinching treatment. Also, the highest Pbz level (200 mg/l) caused a clear decrement in the same trait.

TABLE 2. Effect of paclobutrazol (pbz) and pinching treatments on root length (cm), root number/plant, fresh weight of roots/plant (g) and dry weight of roots/plant (g) of *Russelia equisetiformis*.

Characters	Root length (cm)									
	Season one					Season two				
Levels (pbz)mg/l / Pinching	Control	100	150	200	Mean (A)	Control	100	150	200	Mean (A)
Control	31.4	26.5	27.0	21.0	26.5	29.0	25.8	25.5	21.7	25.5
One	30.7	27.8	26.3	18.5	25.8	31.7	26.7	21.2	18.3	24.5
Two	31.0	30.8	27.2	20.3	27.3	30.9	31.0	27.3	20.2	27.3
Mean (B)	31.0	28.4	26.8	19.8		30.5	27.8	24.7	20.0	
L.S.D.	A=0.8		B=1.0A×B=1.6			A=0.9		B=1.1	A×B=1.7	
Root number/plant										
Control	12.1	12.4	12.9	14.3	12.9	11.4	12.0	14.0	15.1	13.26
One	11.0	11.3	12.0	12.7	11.8	11.7	13.0	14.0	14.3	13.3
Two	11.7	13.0	12.7	15.3	13.2	11.9	13.3	13.3	19.3	14.5
Mean (B)	11.6	12.2	12.5	14.1		11.7	12.8	13.8	16.2	
L.S.D.	A=0.8		B=1.1	A×B=1.6		A= 0.9		B= 1.2	A×B=1.8	
Fresh weight of roots/plant (g)										
Control	4.7	5.7	6.5	5.4	5.5	6.0	6.9	7.3	6.2	6.6
One	4.6	5.9	6.7	5.1	5.6	6.1	8.1	7.9	7.3	7.4
Two	4.2	5.0	5.5	4.9	4.9	5.7	7.9	7.5	7.1	7.1
Mean (B)	4.5	5.5	6.2	5.1		5.9	7.6	7.6	6.7	
L.S.D.	A= N.S.		B= 1.1	A×B=1.8		A= N.S		B= 1.2	A×B=1.8	
Dry weight of roots/plant (g)										
Control	2.4	2.2	3.3	2.6	2.6	3.3	3.1	3.4	2.3	3.0
One	2.0	2.5	2.9	2.3	2.4	2.5	3.5	3.3	3.3	3.2
Two	1.9	2.1	2.4	2.1	2.2	2.3	3.4	3.2	3.1	3.0
Mean (B)	2.1	2.3	2.9	2.3		2.4	3.3	3.3	3.2	
L.S.D.	A=N.S.		B= 1.1	A×B=1.6		A=N.S.		B=1.1	A×B=1.6	

Number of roots/plant

In both seasons, the significantly greatest number of roots/plant belonged to plants treated with pinching for two times, followed with significant difference in the second season, but not in the first one by plants untreated with pinching (Table 2). In contrast, the lowest means were a result of plants which received pinching treatment for only one time in the two seasons. On the other hand, number of roots/plant was progressively increased by increasing Pbz level in

both seasons. The interaction, indicated the mastery in raising number of roots/plant due to treating plants with pinching treatment for two times, with supplying plants with the highest Pbz level (200 mg/l) in the two seasons. In contrast, the lowest values belonged to plants treated with pinching for only one time and untreated with Pbz in the first season as well as for untreated plants with either pinching or Pbz in the second one (control).

The previous results showed favourable effects on number of roots/plant in both seasons due to receiving plants paclobutrazol treatments, with the mastery of using the highest level (200 mg/l). However, many scientists confirmed such result on some plants. Geneve (1990) stated that Pbz treatment enhanced adventitious root formation in English ivy (*Hedra helix*). Symons *et al.* (1990) reported that Pbz improved root formation of avocado, which may be attributed to increase assimilate partitioning to the roots due to reduced demand in the shoot. DeResende and DeSouza (2002) proved that, Pbz treatment led to increase assimilation partitioning to the underground parts. Abdi and Ascari-Raburi (2009) concluded that number of roots was increased when the cuttings of *Delonix regia* were treated with Pbz at 5 g/l + 300 mg/l IBA.

Fresh and dry weight of roots

Negligible and insignificant differences were observed in fresh and dry weight of roots due to using pinching treatments in both seasons (Table 2). On the other hand, highest records were obtained on the same traits due to receiving plants Pbz at 150 mg/l in the first season and at either 100 or 150 mg/l in the second one. The interaction proved the superiority of receiving plants treated with pinching treatment for only one time, Pbz at150 mg/l in the first season and at 100 mg/l in the second one, for raising the recorded values for both traits.

The improving of fresh and weight of roots due to Pbz treatments might be understood in the light of the following findings of many authors on different plant species Yim *et al.* (1997) reported that Pbz treated rice seedlings had higher root dry and greater ability to produce new roots. Tsegaw (2006) concluded that spraying of Pbz at 45, 67 and 90 mg/l increased fresh and dry weight of potato. Kucharska and Orlikowska (2008) found that Pbz at 0.5, 1.0 and 3.0 mg/l increased fresh weight of roots of chrysanthemum plants.

Effect on chemical constituents

Pigment content in the leaves

Chlorophyll (A)

It is evident from data registered in Table 3 that pinching treatment caused an increment in chlorophyll (a) content in the leaves comparing with that gained from control plants in both seasons, with the mastery of applying pinching treatment for two times. Also, all Pbz levels revealed a positive significant effect on the same constituent, with the prevalence of applying the moderate level (150 mg/l) in the two seasons. Referring to the interaction, plants which treated with pinching treatment for two times and treated with Pbz at the moderate level

(150 mg/l) recorded the utmost high values in both seasons. In contrast, the lowest score was obtained due to untreated plants with either pinching or Pbz treatments.

TABLE 3. Effect of paclobutrazol (pbz) and pinching treatments on chlorophyll a, b and carotenoids, phenols and indoles mg/g f.w. of *Russelia equisetiformis* in leaves.

Characters	Chlorophyll a mg/g f.w..									
	First Season					Second Season				
Levels (pbz)mg/l / Pinching	Control	100	150	200	Mean (A)	Control	100	150	200	Mean (A)
Control	0.34	0.43	0.47	0.44	0.42	0.37	0.44	0.45	0.45	0.43
One	0.44	0.45	0.47	0.45	0.45	0.44	0.46	0.54	0.45	0.47
Two	0.45	0.46	0.54	0.45	0.48	0.46	0.51	0.61	0.57	0.54
Mean(B)	0.41	0.45	0.49	0.45		0.42	0.47	0.53	0.49	
L.S.D.	A= 0.02		B=0.04		A×B=0.05	A= 0.02		B= 0.03		A×B=0.04
Chlorophyll b mg/g f.w.										
Control	0.16	0.21	0.25	0.20	0.21	0.18	0.27	0.32	0.17	0.24
One	0.21	0.22	0.29	0.17	0.22	0.21	0.29	0.33	0.19	0.25
Two	0.20	0.29	0.31	0.19	0.25	0.22	0.31	0.36	0.25	0.29
Mean(B)	0.19	0.24	0.28	0.19		0.20	0.29	0.34	0.20	
L.S.D.	A=0.02		B=0.03		A×B=0.05	A=0.02		B=0.03		A×B=0.04
mg/g f.w. Carotenoids										
Control	0.04	0.03	0.05	0.07	0.05	0.03	0.04	0.05	0.07	0.05
One	0.05	0.06	0.06	0.09	0.07	0.04	0.05	0.06	0.08	0.06
Two	0.06	0.07	0.08	0.1	0.08	0.05	0.05	0.07	0.09	0.07
Mean(B)	0.05	0.05	0.06	0.09		0.04	0.05	0.06	0.08	
L.S.D.	A=0.01		B= 0.02		A×B= 0.03	A= 0.01		B= 0.02		A×B= 0.03
Phenols mg/g f.w.										
Control	1.5	2.1	2.2	2.2	2.0	1.3	2.2	2.3	2.2	2.0
One	1.6	2.2	2.3	2.2	2.1	1.5	2.3	2.4	2.2	2.1
Two	1.7	2.3	2.4	2.3	2.2	1.7	2.4	2.5	2.4	2.3
Mean(B)	1.6	2.2	2.3	2.2		1.5	2.3	2.4	2.3	
L.S.D.	A=0.09		B=0.1		A×B=0.2	A= 0.08		B= 0.1		A×B=0.2
Indoles mg/g f.w.										
Control	22.0	11.0	10.8	3.5	11.8	22.1	10.7	6.4	3.0	10.6
One	21.2	10.7	10.7	3.3	11.5	21.4	9.8	5.9	2.0	9.8
Two	20.8	10.5	3.2	3.4	9.5	20.9	10.3	3.1	1.8	9.0
Mean(B)	21.3	10.7	8.2	3.4		21.5	10.3	5.1	2.3	
L.S.D.	A=1.6		B=2.0		A×B=2.5	A= N.S.		B= 2.1		A×B=2.7

Chlorophyll (b)

Chlorophyll (b) content was not significantly affected by applying pinching treatment for only one time in the two seasons, whereas it slightly increased it over control, by using pinching treatment for two times. Meanwhile, receiving plants the moderate Pbz level (150 mg/l) gave the highest record of chlorophyll (b), followed with significant difference by plants treated with the lowest level

(100 mg/l) and occupied the second rank in this concern. On the contrary, the lowest scores were a result of untreated plants or those which received the highest Pbz level (200 mg/l) in the two seasons. In the matter of the interaction, the highest records were obtained in chlorophyll (b) content in the leaves resulting from plants treated with pinching treatment for two times and received Pbz at either (100 or 150 mg/l). On the contrary, the lowest mean was a result of untreated plants with either pinching or Pbz treatments in both seasons.

Carotenoids

Carotenoids content in the leaves was progressively increased by increasing number of pinching time, where the highest score was gained due to using pinching for two times. On the other hand, using the highest Pbz level (200 mg/l) showed a clear increment in carotenoids content in both seasons. The interaction, revealed marked increment in the same constituents due to receiving plants which treated with pinching treatment for two times, Pbz at the highest level, where the utmost high values were obtained. In contrast, the lowest record was a result of untreated plants with pinching with receiving either Pbz at the lowest level (100 mg/l) or untreated one in both seasons.

The previous results revealed the excellence of applying Pbz at the moderate level (150 mg/l) for raising chlorophyll a and b contents in the leaves parts. However, the great influence of Pbz for improving chlorophyll content was also reported by a lot of workers. Pan and Luo (1994) on *Cymbidium sinense*, Wang *et al*. (1994) on Lolium, Kim *et al*. (1999) on *Dicentra spectabilis* stated that 0.3 mg/l Pbz increased chlorophyll contents and have the darkening leaves. Fletcher *et al*. (2000) claimed that Pbz as one in triazol group stimulates cytokinin synthesis that enhances chloroplast differentiation, chlorophyll biosynthesis and prevents chlorophyll degradation. Berova and Zlative (2000) stated that densely packed of chlorophyll content may be ascribed to higher cytokinin content that stimulated chlorophyll biosynthesis and reduced chlorophyll catabolism Tsegaw (2006) stated that spraying of Pbz at 45, 67 and 90 mg/l increased chlorophyll a and b of potato. Kucharska and Orlikowska (2008) found that Pbz at 0.5, 1.0 and 3.0 mg/l increased chlorophyll a and b of chrysanthemum.

Phenols content in the leaves

Results of Table 3 show slight increment in phenols content in the leaves due to treating plants with pinching for either one or two times, where the latter was the best in this regard. Pbz treatments, on the other hand, significantly increased phenols content over the control in the two seasons. However, supplying plants with Pbz at 150 mg/l was the best in raising such constituent in the two seasons. The interaction indicated that treating plants with pinching treatment for two times with supplying plants with Pbz at 150mg/l gave the utmost values in the two seasons. Meanwhile, the lowest record was a result of untreated plants with either pinching or Pbz (control) in both seasons.

The previous results indicated that Pbz treatments significantly increased phenols content over the control in both seasons. However, such finding is in accordance with Henrique *et al*. (2006), reported that Pbz at 100 mg/l with IBA or NAA increased total phenols of *Pinus caribaea* var hondurensis.

Indoles content in vegetative growth

Data exhibited in Table 3 exert that pinching treatments caused a decrement in indoles content in the leaves in the two seasons, giving the lowest means due to applying pinching treatment for two times. Moreover, indoles content was progressively decreased by increasing pbz level, giving the lowest record by using Pbz at the highest level (200 mg/l) in the two seasons. The interaction cleared a considerable increment in indoles content in the leaves due to plants untreated with either pinching or Pbz treatments in both seasons, as well as for plants treated with pinching for one and two times and untreated with Pbz in the same seasons. All of them gave means closely near together in the two seasons. In contrast, the same constituent much decreased for plants untreated with pinching or treated with pinching for one or two times and supplied with the highest Pbz level (200 mg/l) in the two seasons, as indicated in Table 3.

In this connection, the reduction in indole content due to applying Pbz treatments was also found by other authors. Shanan and Soliman (2011) mentioned that Pbz at 150 mg/l decreased IAA (indole acetic acid) and GA_3 leaves content of *Antirrhinum majus*.

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تأثير التطويش والباكلوباتـرازول على النمو الخضرى لنبـــات الروسيليا لإستخدامه كنبات أصص

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إجريت التجربة بمشتل معهد بحوث البساتين - مركز البحوث الزراعية - محافظة الجيزة - مصر خلال موسمين متتاليين بهدف تقزيم النمو الخضرى لنبات *Russelia equisetiformis* لإستخدامه كنبات أصص. وعلى هذا تم دراسة العوامل المنفردة والعوامل المتجمعة لمعاملات تطويش مختلفة (بعد شهر وشهرين من الزراعة) وتركيزات مختلفة من الباكلوباترازول (صفر – ١٠٠ - ١٥٠ - ٢٠٠ ملجم/لتر) والتى تم إستخدامها عن طريق الرش على النباتات بعد شهر من تاريخ الزراعة ثم على فترات إسبوعية إلى نهاية التجربة (١٥ سبتمبر) فى كلا الموسمين وأوضحت النتائج أن إستخدام معاملة التطويش لمرة واحدة أدى إلى الحصول على أعلى عدد من الفروع الثانوية/نبات كما أدى إلى زيادة الوزن الطازج والجاف للأفرع/نبات بالإضافة إلى زيادة عدد الآزهار/نبات. فى نفس الوقت كان لمعاملة النباتات بالتطويش لمرتين أثراً متفوقا فى خفض إرتفاع النبات مع زيادة عدد الفروع الرئيسية وطول الجذور وعدد الجذور/نبات كذلك تم الحصول على نتائج غير معنوية يمكن إهمالها بالنسبة للوزن الطازج والجاف للجذور كنتيجة لإستخدام معاملات التطويش فى كلا الموسمين.

تم ملاحظة إنخفاض تدريجى بالنسبة لإرتفاع النبات وذلك بزيادة تركيز الباكلوباترازول المستخدم بينما حدثت زيادة تدريجية بالنسبة لعدد الجذور/نبات وذلك بزيادة تركيز الباكلوباترازول الذي تم إستخدامة فى كلا الموسمين. أوضحت النتائج كذلك أن إستخدام الباكلوباترازول بتركيز ١٠٠ ملجم/لتر أدى إلى زيادة واضحة بالنسبة للوزن الطازج والجاف لأفرع النبات كذلك إزداد طول الجذر كنتيجة لإستخدام نفس التركيز (١٠٠ ملجم/لتر).

أظهر إمداد النباتات بالباكلوباترازول بتركيز ١٥٠ ملجم/لتر تفوقاً واضحاً فى زيادة عدد الأفرع الرئيسية والثانوية/نبات بالإضافة إلى ذلك أظهرت نفس المعاملة تفوقاً فى زيادة الوزن الطازج والجاف للجذور. فى حين أدى إستخدام الباكلوباترازول بتركيز ٢٠٠ ملجم/لتر إلى الحصول على أعلى القيم بالنسبة لعدد الأزهار/نبات.

أوضحت النتائج كذلك أن إستخدام معاملة التطويش لمرتين أظهرتفوقاً واضحاً فى زيادة محتوى الاوراق من الكلورفيل (ا) والكاروتينويدات بينما أدت نفس

المعاملة إلى زيادة بسيطة فى المحتوى من الكلورفيل (ب) فى نفس الوقت أدت نفس المعاملة إلى زيادة بسيطة فى محتوى الاوراق من الفينولات لكنها أدت إلى خفض محتواها من الأندولات. هذا وقد كان إستخدام المستوى المتوسط من الباكلوباترازول (١٥٠ ملجم/لتر) هو الأفضل فى زيادة محتواها من الكلورفيل ا ، ب فى كلا الموسمين، بينما كان إستخدام المستوى المرتفع (٢٠٠ ملجم/لتر) هو الأفضل فى زيادة المحتوى من الكاروتينويدات و الأندولات.

من النتائج السابقة ومن التفاعلات يمكن النصح بإستخدام معاملة التطويش لمرتين مع معاملة النباتات بالباكلوباترازول بتركيز ١٥٠-٢٠٠ ملجم/لتر للحصول على نباتات مقزمة ذات جودة عالية.