American-Eurasian Journal of Sustainable Agriculture, 5(2): 150-157, 2011
ISSN 1995-0748

ORIGINAL ARTICLES

Response of Snapdragon Plants to Pinching and Growth Retardants Treatments

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Nermeen T.A. Shanan, Amira Sh. Soliman: Response of Snapdragon Plants to Pinching and Growth Retardants Treatments

ABSTRACT

This study was carried out aiming to have compact and well branched snapdragon plants to be used as commercial pot plant. The effect of different growth retardants (PGRs) and leaf pinching stages were taken into consideration.

Results indicated that, pinching the plants at 3-leaves stage and treated with Paclobutrazol (PBZ) caused a remarkable reduction in plant height by (9.27 and 8.88%) than P-chlorophenoxy-iso butyric acid (PCIB). PBZ at 150 mg L-1 or PCIB at 50 mg L-1 was exhibit the lowest gibberellic acid (GA3) and indole acetic acid (IAA) accompanied with the highest abscisic acid (ABA) concentrations. The plants treated by 150 mg L-1 PBZ and pinched at 7-leaves stage, the shortest inflorescence length (11.3 and 10.01 cm) was obtained. At this stage, the greatest number of branches/plant was recorded with 50 mg L-1 PBZ and 150 mg L-1 PCIB. Anatomically, there was a positive relationship between increasing of PGR concentrations and the reduction occurred in the stem diameter, since as the concentrations of PGR increased, the reduction of stem diameter increased.

Key words: Abscissic acid, *Antirrhinum majus*, Anatomy, Gibberellic acid, Indole acetic acid , Paclobutrazol; P-chlorophenoxy-iso butyric acid.

Introduction

Antirrhinum majus L. is commonly known as snapdragon plant used as cut flower crops and pot plants. One of the problems arise when grow the snapdragon as pot plant is become too tall without self-supporting (Wainwright and Irwin 1987). Leaf pinching at certain stages of plant life is one of the techniques that could overcoming this problem and produce compact and well branching plants (Munir and Naz 2006).

Pinching is the removal of the apical bud to release the lower axillary buds from apical dominance, in order to increase branching and stimulate the development of axillary bud. There is a relation between the apical dominance and the concentration of auxins produced in apical bud, which indirectly inhibit the growth of axillary bud . Indole acetic acid (IAA) and Cytokinin concentrantions in axillary buds increased after pinching and then remained constant (Gocal *et al*. 1991; Mader *et al*. 2003).

The application of plant growth retardants (PGRs) as foliar spray or soil drop irrigation is probably the other widely used method for controlling the growth (Lee and Rho 2000; Hwang *et al*.2008). PGRs have been used to manipulate the plant size, shape, flowering period and overall quality of floricultural crops (Richard 1996, Meijon *et al*. 2009; Navale *et al*. 2010).

Paclobutrazol (as antigibberellin) controlling the growth through interference of gibberellic acid biosynthesis (Sebastian *et al*. 2002; Marosz and Matysiak 2005), in addition to improving water use by reducing the rate of transpiration (Eliasson *et al*. 1994; Navarro *et al*. 2007).

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Meanwhile, P-chlorophenoxy-isobutyric acid (PCIB), as a putative antiauxin, inhibit auxin action (Kim *et al*. 2000; Xie *et al*. 2000; Oono *et al*. 2003).

The aim of this study is to produce compact and well branched plants by using growth retardants at different leaf pinching stages.

Materials and methods

Study Species and Site:

This study was carried out in the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during two successive winter seasons 2008 and 2009. Seeds of snapdragon plant (*Antirrhinum majus* L.) were germinated in plug trays on 20th of October in both seasons. Three weeks from sowing, the seedlings (approximately 10 cm in length, with 3 leaves) were transplanted to pots; 20 cm inner diameter containing a mixture of peat moss and sand (1:1 v/v). Single seedling was planted per pot. All recommended agricultural procedures for snapdragon production were followed.

Materials, Characters and Experimental Design:

Pinching was applied when the seedling has 3, 5 and 7 leaves, in addition to the un-pinched seedling (as control). Two plant growth retardants (PGRs) were applied; PBZ and PCIB (secured from Genotech Co., Egypt). PGR applications were twice sprayed at 15 and 30 days after pinching, at three concentrations; 50, 100 and 150 mg L-1 plus control (sprayed with water). The following characters were recorded at blooming stage; plant height (cm), number of branches/plant, endogenous hormone concentrations in the shoot;IAA, abscisic acid (ABA) and gibberellic acid (GA3) (according to the method described by Du and Xu 2000). In anatomical features (specimens have been taken from the middle internode of the stem according to Nassar and El-Sahhar (1998) and the floral characters; inflorescence length (cm), number of days to flowering (day).

The experiment layout was Factariol Experimental in Radomized Complete Blocks design (RCBD) with three replication. Data were recorded on eight random plants per replicate for each treatment as well as the control. Data were statistically analyzed using ANOVA in the MSTATE-C software package (Freed *et al*. 1989). The means were compared using the "Least Significant Difference (L.S.D)" test at the 5% level, as described by Little and Hills (1978).

Results:
Plant Height:

Regardless of the pinching stage, PBZ treatments caused a reduction in plant height. Relative to the control, the reduction percentages were 27.41% and 25.68% for the 1st and 2nd seasons, respectively. Same trend of reduction with a lesser magnitude was observed with PCIB treatments (22.43 and 22.06%) in the same order (Table 1).

Generally, at 3-leaves pinching stage, PBZ treatments were more effective in reducing the plant height than PCIB. The reduction percentages due to PBZ treatments were 9.27% and 6.75 % in the 1st and 2nd seasons, respectively. As the used concentrations of PBZ got higher more reduction in plant height was occurred, which gives more favorable compacted plant, that may highly appreciable for commercial purposes of snapdragon plants.

Inflorescence Length:

Generally, plants pinched at 7-leaves stage produced the shortest inflorescence length compared with the other pinching stages (Table 2). Relative to the control, the average reduction percentages of the plants treated by PBZ concentrations were nearly the same 29.30% in both seasons, respectively. PBZ treatments showed more reduction in inflorescence length as compared with PCIB. Significant differences between the adopted concentrations were noticed, since the highest concentration of both PGRs (150 mg L-1) always produced the shortest inflorescence length. Relative to the control, 150 mg L-1 PBZ treatments resulted in 37.00% reductions in inflorescence length in the 1st and 2nd seasons, respectively. The corresponding reduction percentages recorded with 150 mg L-1 PCIB treatments were (0.17%-0.19%) in both seasons.

The interaction between leaf pinching stages and the growth retardants was significant. So, plants pinched at 7- leaves stage and treated with 150 mg L-1 PBZ showed the shortest and compact inflorescence performance; 11.13 and 10.01 cm in both seasons, respectively. Same trend with a lesser reduction values was

with 150 mg L-1 PCIB treatments.

Number of Days to Flowering:

The un-pinched control plants were flowered earlier (88.04 and 86.18 days) than any other treated by PGRs in the 1st and 2nd seasons, respectively. Generally, plants pinched at 3- leaves stage showed earlier flowering than those pinched at the other stages. The growth retardants produced significant increases in number of days to flowering. Since, PBZ and PCIB treatments delaying flowering compared with their respective controls . Whereas, the average days to flower of pinched plants and received PBZ treatments were prolonged by 13.22-12.94 days than the control in both seasons, respectively. The corresponding average to flower of pinched plants and received PCIB treatments were prolonged by 18.60 and 16.79 days in the 1st and 2nd seasons, respectively. PBZ treatments increasing the number of days to flowering was clear as the used concentrations increased. With both growth retardants, 50 mg L-1 concentration showed the most favorable reduction in number of days to flowering as compared with the other adopted concentrations 100 or 150 mg L-1 (Table 3).

The interaction between pinching and the growth retardants was significant with such trait. So, in both seasons, plants pinched at 3-leaves stage and received 50 mg L-1 PBZ delayed flowering by 2.85 and 2.79 days in both seasons, as compared with their respective controls. The corresponding values due to PICB at 50 mg L-1 treatments were 6.96 and 6.82 days in both seasons in the same order. Generally, PBZ treatments caused a reduction in number of days to flowering as compared with PCIB treatments.

Number of Branches/plant:

Number of branches per plant was increased by delaying the pinching stage. The average values of number of branches for the plants pinching at 7-leaves stage exceeded the control by 3 to 4 Fold over the control with PBZ treatment in both seasons, respectively. The corresponding values with PCIB were 111.83% and 114.40% in the same order. It was also noticed that as the used concentrations increased the number of branches/plant decreased either with PBZ or PCIB treatments. So, it could be stated that the snapdragon plants received 50 mg L-1 PBZ or 150 mg L-1 PCIB and pinching at 7-leaves stage were produced more number of branches/plant than any of the other treatments (Table 4).

Regardless the pinching stage, the effects of PCIB treatments caused a remarkable increase in branches number. Relative to the control, the increasing percentages were 99.82% and 172.48% in the 1st and 2nd seasons, respectively. While with PBZ treatments these values were; 31.22% and 66.48% in the same order (Table 4).

Shoot Endogenous Hormones Concentrations:

ABA concentrations of the control plants were lower than those treated by any concentrations of either PBZ or PCIB. PBZ treatments showed gradual decrease in the GA3 and IAA concentrations in shoot of snapdragon plants. These decrements were increased by increasing the growth retardant concentrations. The lowest endogenous hormone concentrations of GA3 and IAA was obtained by using 150 mg L-1 PBZ at 3-leaves pinching stage among the other doses of growth retardants. On the contrary, the later dose of PBZ at the same stage produced the highest ABA concentration. As the concentrations of the PGRs increased the ABA concentrations increased too. This result confirmed the reduction occurred in the plant height and inflorescence length by increasing the concentrations of the growth retardants (Table 5).

PCIB at 50 mg L-1 concentrations and at 3-1eaves pinching stage reduced the concentrations of GA3 and IAA, in the same time increasing the ABA concentrations (Table 5). This result again confirmed the reduction occurred in the plant height and inflorescence length.

Anatomical Features:

The morphological study proved that the stem features of snapdragon plant was greatly affected by both PBZ and PCIB treatments. Generally, plant height was greatly reduced due to different concentrations of growth retardants. Measurements in microns and counts as seen in the transverse sections of the 3rd internodes are presented in (Table 6 and Figure 1). It is clear that PBZ and PCIB treatments caused severe reduction in stem diameter. Relative to the control, plants received 150 mg L-1 PBZ or 50 mg L-1 PCIB showed the thicker stems. The average reduction in the stem diameter due to such treatments was 27.8 or 21.8%, respectively. This reduction occurred in most tissues shared in stem structure with different limits.

Whilst epidermis cells were significantly reduced in size as the used concentrations of PGRs increased, except with 50 mg L-1 PCIB, where this size was quietly exceeded the control plants. The epidermal cells of

the later were barrel in shape with relatively long tangential thin walls. While those of the treated plants were isometric in shape with more thin and short wall. Relative to the control, the highest average reduction in epidermis thickness among all other treatments was 36.3% at 100 mg L-1 PBZ.

Concerning the anatomical of cortical cells, 50 mg L-1 PBZ treatments showed a comparable thicker cortex as compared with either the control or PCIB treatment. This increasing in cortex thickness was due to the increasing occurred in the average cortical parenchyma cell size. In addition, the plants treated by PGRs had very short and stocky cells, while the control plants had long cells. This indicates that the suppression of stem length after PGR treatments was actually due to the shortened in length of cell units.

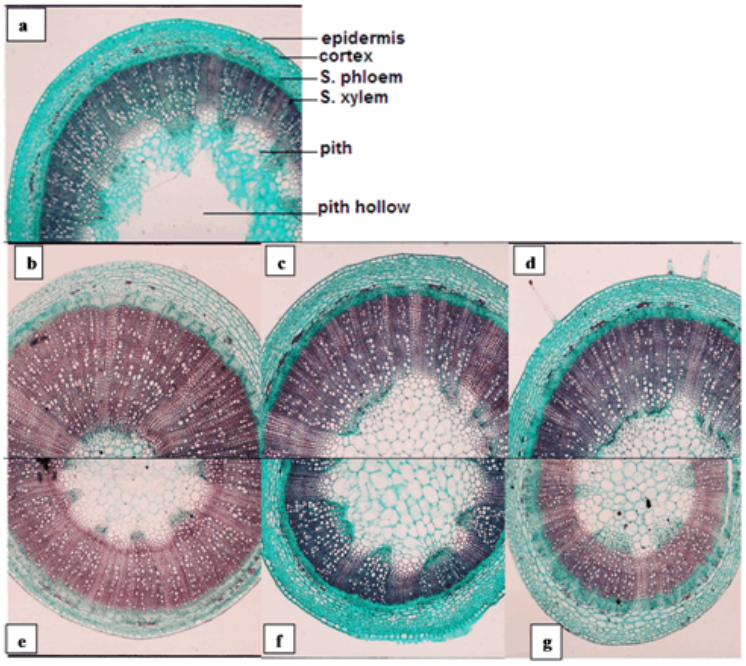

Fig. 1: Graphs of transverse sections in the 3rd internode of the main stem of snapdragon plants treated with different concentrations of PBZ and PCIB.
Details: (a) Control, PBZ: (b) 50 ppm, (c) 100 ppm, (d) 150 ppm. PCIB: (e) 50 ppm, (f) 100 ppm, (g) 150 ppm. 40 X

Table 1: Influence of growth retardants and pinching stages on the average plant height (cm) of snapdragon plants during the two seasons (2008 and 2009).

Growth Retardants (PGRs)	Plant height (cm)									
	1st season					2nd season				
	Pinching stage (leaves)				Mean	Pinching stage (leaves)				Mean
	0	3	5	7		0	3	5	7	
					PBZ					
Control	71.33	48.67	58.00	64.00	60.50	67.00	47.67	55.33	61.67	57.92
50 mg L-1	56.33	42.67	53.67	57.33	52.50	53.00	39.67	51.67	53.33	49.42
100 mg L-1	52.00	39.00	50.00	45.33	46.58	50.00	36.67	45.67	43.33	43.92
150 mg L-1	47.00	35.67	43.33	42.00	42.00	46.00	34.33	39.33	38.33	39.50
Average PBZ	51.78	39.11	49.00	48.22	47.03	49.67	36.89	45.56	45.00	44.28
					PCIB					
50 mg L-1	52.00	39.67	48.67	47.33	46.92	50.00	36.00	47.00	44.00	44.25
100 mg L-1	58.00	46.00	56.00	48.33	52.08	55.67	43.00	53.67	46.67	49.75
150 mg L-1	56.00	43.67	52.00	58.67	52.58	51.00	39.67	49.33	56.00	49.00
Average PCIB	55.33	43.11	52.22	51.44	50.52	52.22	39.56	50.00	48.89	47.66
					$LSD_{5\%}$					
PGRs		3.74						2.86		
P		2.76						2.85		
PGRs × P		7.49						5.72		
PBZ vs PCIB		1.22						1.21		

Table 2: Influence of growth retardants and pinching stages on the average inflorescence length (cm) of snapdragon plants during the two seasons (2008 and 2009).

Growth Retardants (PGRs)	Inflorescence length (cm)									
	1st season					2nd season				
	Pinching stage (leaves)				Mean	Pinching stage (leaves)				Mean
	0	3	5	7		0	3	5	7	
					PBZ					
Control	24.65	23.05	19.27	17.54	20.89	22.19	20.75	17.34	15.78	19.02
50 mg L-1	20.06	20.98	18.54	13.60	18.29	18.05	18.88	16.68	12.24	16.46
100 mg L-1	18.39	19.12	17.31	12.47	16.82	16.55	17.20	15.58	11.22	15.14
150 mg L-1	16.75	17.06	15.27	11.13	15.04	15.08	15.35	13.75	10.01	13.55
Average PBZ.	18.40	19.05	17.04	12.40	16.72	16.56	17.14	15.34	11.16	15.05
					PCIB					
50 mg L-1	21.82	22.47	21.15	18.84	21.07	19.64	20.23	19.03	16.95	18.96
100 mg L-1	20.97	20.41	18.90	17.85	19.53	18.87	18.37	17.01	16.07	17.58
150 mg L-1	20.26	20.28	18.33	17.57	19.11	18.23	18.25	16.50	15.81	17.20
Average PCIB.	21.02	21.05	19.46	18.09	19.90	18.91	18.95	17.51	16.28	17.92
					$LSD_{5\%}$					
PGRs			1.11					1.33		
P			1.07					1.59		
PGRs × P			2.12					2.56		
PBZ vs PCIB			2.92					3.10		

Table 3: Influence of growth retardants and pinching stages on the average number of days to flowering of snapdragon plants during the two seasons (2008 and 2009).

Growth Retardants (PGRs)	Number of days to flowering (day)									
	1st season					2nd season				
	Pinching stage (leaves)				Mean	Pinching stage (leaves)				Mean
	0	3	5	7		0	3	5	7	
					PBZ					
Control	88.04	93.10	98.80	101.96	95.48	86.18	91.14	96.72	99.82	93.47
50 mg L-1	89.61	95.95	99.75	103.86	97.30	87.73	93.93	97.65	101.68	95.25
100 mg L-1	95.31	100.39	102.29	108.94	101.74	93.31	98.27	100.13	106.64	99.59
150 mg L-1	99.75	103.24	105.76	110.20	104.74	97.65	101.06	103.54	107.88	102.53
Average PBZ.	94.89	99.86	102.60	107.67	101.26	92.90	97.75	100.44	105.40	99.12
					PCIB.					
50 mg L-1	94.36	100.06	103.86	107.66	101.49	92.38	97.96	101.68	105.40	99.35
100 mg L-1	101.01	104.50	110.51	113.69	107.43	98.89	102.30	108.19	111.29	105.17
150 mg L-1	97.85	102.29	108.3	118.11	106.64	95.79	100.13	106.02	115.63	104.39
Average PCIB.	97.85	102.29	108.3	118.11	106.64	95.69	100.13	105.30	110.77	102.97
					$LSD_{5\ \%}$					
PGRs			2.17					2.75		
P			2.47					1.79		
PGRs × P			2.35					3.49		
PBZ vs PCIB			2.08					2.87		

Furthermore, comparing to the control, 50 mg L-1 PBZ treatment produced among all the other treatments a remarkable increase in the average thickness of the secondary xylem (25.7%). This increase was associated with 8.30% reduction in the average vessel diameter. So, the increase occurred in the thickness of the secondary xylem was rather due to the increase in number of vessels rows. However, the other adopted PBZ or PCIB concentrations caused an appreciable decrease in the average thickness of the secondary xylem that was associated with decreased average vessels diameter.

Treated plants by PGRs caused denser vascular cambium cells (VC), as compared to the control. With all PGR treatments, the rate of reduction in cell size was higher in phloem (P) than in xylem (X). The average thickness of secondary phloem showed remarkable reduction, This reduction was greater with PBZ than with PCIB. The average reduction percentages ranged between (23.1% and 53.9%) and (6.6 % and 19.3%) at 50 and 150 mg L-1 PBZ and PCIB treatments, respectively. All PGR treatments caused a remarkable reduction in the average of pith thickness. The highest reductions; 44.3% and 66.1% were recorded at 150 mg L-1 PBZ or PCIB treatments, respectively.

Table 4: Influence of growth retardants and pinching stages on the average number of branches per plant of snap dragon plants during the two seasons (2008 and 2009).

Growth Retardants (PGRs)	Number of branches/plant									
	1st season					2nd season				
	Pinching stage (leaves)				Mean	Pinching stage (leaves)				Mean
	0	3	5	7		0	3	5	7	
					PBZ					
Control	5.67	5.89	10.00	14.00	8.89	3.67	5.67	9.00	10.33	7.17
50 mg L-1	9.33	5.10	16.33	19.00	12.44	7.67	5.33	14.33	16.33	10.92
100 mg L-1	7.00	5.77	14.00	15.67	10.61	5.67	5.63	12.67	13.33	9.33
150 mg L-1	6.00	5.98	11.00	13.00	9.00	5.00	6.00	10.33	11.67	8.25
Average PBZ.	7.44	5.62	13.78	15.89	10.68	6.11	5.65	12.44	13.78	9.50
					PCIB.					
50 mg L-1	9.67	5.30	17.67	19.67	13.08	8.33	5.33	13.67	16.33	10.92
100 mg L-1	13.00	5.88	25.33	23.00	16.80	11.33	5.91	22.33	21.00	15.14
150 mg L-1	11.33	6.00	20.67	29.33	16.83	10.33	6.00	18.33	27.00	15.42
Average PCIB.	11.33	5.73	21.22	24.00	15.57	10.00	5.75	18.11	21.44	13.82
					$LSD_{5\ \%}$					
PGRs			2.29					1.68		
P			2.50					1.08		
PGRs × P			3.58					3.35		
PBZ vs PCIB			3.22					4.13		

Table 5: Effect of growth retardants and pinching stages on the endogenous hormones concentrations (mg/100g FW) in shoot of snapdragon plants.

Growth Retardants (PGRs)	Pinching stage (P)*														
	0	3	5	7	Mean	0	3	5	7	Mean	0	3	5	7	Mean
			GA3					IAA					ABA		
								PBZ							
Control	0.348	0.182	0.215	0.300	0.261	0.840	0.466	0.604	0.781	0.673	0.008	0.028	0.015	0.009	0.015
50 ppm	0.308	0.111	0.165	0.209	0.198	0.672	0.379	0.484	0.594	0.476	0.033	0.092	0.048	0.045	0.055
100 ppm	0.219	0.079	0.106	0.138	0.135	0.484	0.161	0.234	0.376	0.314	0.057	0.153	0.105	0.071	0.096
150 ppm	0.167	0.051	0.063	0.088	0.092	0.178	0.049	0.074	0.104	0.101	0.081	0.237	0.111	0.108	0.134
Average PBZ	0.231	0.081	0.111	0.145		0.445	0.196	0.264	0.358		0.057	0.161	0.088	0.075	
								PCIB							
50 ppm	0.252	0.056	0.121	0.162	0.147	0.353	0.163	0.254	0.286	0.264	0.063	0.178	0.089	0.067	0.099
100 ppm	0.337	0.136	0.191	0.249	0.228	0.798	0.406	0.531	0.461	0.549	0.023	0.062	0.040	0.057	0.045
150 ppm	0.324	0.108	0.163	0.271	0.216	0.748	0.245	0.412	0.656	0.515	0.505	0.116	0.065	0.029	0.065
Average PCIB	0.304	0.100	0.158	0.227		0.633	0.271	0.399	0.467		0.048	0.118	0.069	0.054	
								$LSD_{5\%}$							
PGRs			0.180					0.220					0.011		
P			0.330					0.170					0.023		
Grs×P			0.360					0.440					0.021		
PBZ vsPCIB			0.350					0.610					0.004		

Table 6: Measurements (µ) of different anatomical features in the transverse sections of the 3rd internode of snapdragons plants treated by PBZ and PCIB.

Treatments	PBZ							PCIB					
Concentrations	control	50 ppm	± %	100 ppm	± %	150 ppm	± %	50 ppm	± %	100 ppm	± %	150 ppm	± %
Ave. stem diameter	2474	1446	-41.5	1681	-32.0	1784	-27.8	1935	-21.8	1619	-34.6	907	-63.3
Epidermis Thick	24.5	22.3	-9.0	15.6	-36.3	18.9	-22.9	26.7	9.0	18.9	-22.9	18.9	-22.9
Cortex thick	218.1	264.7	21.4	220.2	0.96	215.7	- 1.10	204.7	-20.7	142.4	-44.8	115.7	-55.2
S. xylem thick	449.5	565.2	25.7	427.2	-5.0	240.3	-46.5	440.6	-2.0	432.8	3.0	405.3	-16.3
Vessel diameter	28.9	26.5	-8.3	24.5	-15.2	20.7	-28.4	20.5	-29.1	21.3	-26.3	17.8	-38.4
S. Phloem thick	57.9	44.5	-23.1	35.6	-38.5	26.7	-53.9	54.1	- 6.6	52.3	- 9.7	46.7	- 19.3
Ave. Pith thick	1023.5	733.5	-28.3	738.7	-27.8	569.6	-44.3	898.9	-12.2	471.7	-53.9	347.1	-66.1

Discussion:

The present results indicated that the shortest plant height was achieved when the plants treated by 150 mg L-1 PBZ and 50 mg L-1 PCIB and pinching at 3-leaves stage. With these concentrations the lowest GA3 and IAA and the highest ABA concentrations were noticed.

The reduction occurred in the plant height is mainly due to reducing the internodes length (Berova and Zlatev, 2000; Navarro *et al*. 2007). PBZ inhibits gibberellin biosynthesis convinced the significant role of gibberellin and auxin phytohormones in the process of stem elongation (Rademacher 2000; Hwang *et al*.2008). PCIB inhibited auxin action (GA3 and IAA) and increased the concentration of ABA which in turn affect the plant height by competing with auxin at the binding site of the auxin receptor (Basiouny 1994; Oono *et al*. 2003). Foliar sprays by PBZ significantly affected the main inflorescence length. PBZ led to a linear reduction by increasing concentrations due to the consumption of PBZ absorbed via leaves first mainly for reducing plant height and length of the main inflorescence in the relatively short time (Sesbastian *et al*. 2002; Karaguzel *et al*. 2004).

PBZ treatment generally delayed flowering as compared either with PCIB or with the control plants. Plants pinched at any stage achieved flowering later than the control plants. Plants pinched at 3-leaves stage and treated by 50 mg L-1 PBZ delayed the flowering by 2.85 and 2.79 days in both seasons than their respective control. Delaying flowering seems to be a result of returning the plant back to the juvenile status or may be referring to that the axillary shoots being in a less advanced physiological situation than the apical shoot and begin to develop after pinching and treated by PGRs (Munir and Naz 2006). Another possible reason for delaying flowering after PGR treatments is their effect on the inhibition of GA3 and IAA and increase the ABA concentrations affecting general growth which in turn increasing or decreasing the flower formation (Al-Khassawneh *et al*. 2006; Navale *et al*. 2010).

As the used concentrations of PGRs increased the number of branches/plant decreased. So, it could be stated that the plants received 50 mg L-1 PBZ or 150 mg L-1 PCIB and pinching at 7- leaves stage were produced more number of branches/plant than any of the other treatments. The plant treated by Alar (which is the same mode of action of PCIB) also reduced the endogenous content of auxins (IAA) and increase of the ABA content. Increasing number of branches per plant as result of foliar application of PGRs may be attributed to the high level of these retardants accompanied by reducing the level of IAA and GA3 which lead to inhibition of main stem apical dominance (Jindal and Dalbro, 1977; Singh and Bist 2003; Singh 2004; Abdelgadir *et al*. 2009).

The present results indicated that, by using different PGR treatments, the lowest GA3 and IAA and the highest ABA concentrations could be achieved. The reason for that may be due to increasing the acitivity of peroxidase and IAA oxidase which inhibit the biosynthesis of gibberellin. On the other hand, gibberellin promoted the biosynthesis of auxin and increase the amount of auxin in different tissues (Magalene *et al*.1996).

Regarding the suppression of stem length after PGR treatments was actually due to the shortened in cell length. The effect of foliar spray on the stem diameter reduction was related to PGRs transported through xylem tissues (Thetford *et al*. 1995 a,b; Hwang *et al*. 2008). The xylem thickness of *Prunus persica* was reduced with application of PBZ (Aguirre and Blanco 1992) and that of *Catharanthus roseus* (Jaleel *et al*. 2007). This reduction may be due to inhibition on cell elongation by reducing GA3 (Murti *et al*. 2001). The present results indicated that PGR treatments also significantly reduced the diameter of xylem vessels, while the diameter of phloem elements increased. The epidermis and cuticle thickness of plants treated by PCIB significantly increased compared to those treated by PBZ.

Pinching earlier when the seedling was in the juvenile stage at three pairs of leaves accompanied with specific concentration of the previous growth retardants is the favorable technique to achieve compact and well branched snapodragon plants.

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