Effects of Paclobutrazol and Pinching on Ornamental Pepper

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ADDITIONAL INDEX WORDS. *Capsicum annuum*, floriculture, plant growth regulators, H/D ratio, anti-gibberellin

SUMMARY. Pinching, manual removal of shoot apices, and/or plant growth regulators (PGRs) are used to create commercially preferred compact and well-branched ornamental plants. The influence of paclobutrazol (PB) with and without pinching on the growth and fruit characteristics of a tall ornamental pepper (*Capsicum annuum*) was assessed 2, 4, 6, and 8 weeks after the initial treatment. PB was sprayed on pinched or nonpinched whole plants at 5, 10, or 15 ppm a.i. Pinching and PB reduced the plant height between 25% and 50% and the canopy diameter up to 8% and 17%, respectively. Height/diameter ratio (H/D) ranged from 1.0 for 10 and 15 ppm PB applied to pinched plants to 2.3 for control plants. Paclobutrazol increased the SPAD chlorophyll value and total fruit number, delayed fruit set, and decreased fruit diameter and dry weight. The relationship between PB and plant height and diameter, SPAD chlorophyll value, dry weight, and fruit number was best explained by a third-order polynomial ($r^2 = 0.83\text{--}0.99$). Paclobutrazol may substitute costly pinching treatment for height control and may offer an economic advantage for commercial greenhouse operators.

Peppers (*Capsicum* sp.) are well recognized as vegetable, spice, and ornamental crops (Rubatzky and Yamaguchi, 1997). Pepper plants bearing small, brightly colored fruit with dense foliage can make decorative displays indoors and outdoors. Ornamental peppers range in size and shape from short, compact plants with piquin-sized fruit to plants as tall as 1 m with full-sized fruit (Stommel and Bosland, 2006). However, for commercial purposes, ornamental pepper plants must be compact and well branched. 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 (Meijon et al., 2009) including pepper (Larson, 1980; Nau, 1989; Vasudevan et al., 2008).

Effects of pinching in terms of significant reduction in plant height, delayed flowering, and increased number of flowering stems have been reported in many commercial flower crops (Debra and Lewis, 1986;

Dorajeero and Mokashi, 2012; Kumar and Singh, 2003; Malleshappa, 1984). However, information as to any effects of pinching alone on growth and fruiting characteristics of ornamental pepper is limited (Mousa, 2012). Pinching is a very labor-intensive process and the need for pinching is one drawback of growing ornamental pepper (Ball, 1985; Hammer, 1980). The use of PGRs for height control offers the opportunity of reducing labor costs (Meijon et al., 2009). Traditional tall cultivars with well-displayed fruit may also be adapted to new commercial demands through the application of PGRs (Basra, 2000; Halmann, 1990). The majority of PGRs used in ornamental plant culture are inhibitors of gibberellin (GA) biosynthesis (Basra, 2000). Triazoles, represented by PB and uniconazole, are among the PGRs with this mode of action. Paclobutrazol has been reported to be effective in controlling vegetative growth, promoting compactness and flower bud

initiation, and is used extensively in the production of many ornamental crops (Davis et al., 1988; Gent 2004; Jiao et al., 1986; Larson, 1985), with varying degrees of success in ornamental pepper (Grossi et al., 2005; Whipker et al., 2000). However, information on the effects of PB on growth and fruiting characteristics with or without pinching treatments are limited.

The main objective of this work was to understand the influence of PB with and without pinching on the growth and fruit characteristics of a tall ornamental pepper line. The effectiveness of the foliar application of PB at different doses on the pinched and nonpinched ornamental pepper growth was evaluated in relation to commercial acceptability represented by both plant growth and fruit set.

Materials and methods

'M402' is a tall ornamental pepper line (Bircan Seed Co., Antalya, Turkey). The unique variegated foliage color with hues of green to purple and nonpungent attractive fruit of this line make it suitable for ornamental applications. Seeds were sown on 13 Feb. 2013 in bedding plant flats (72-cell size, 82 mL volume) containing a mixture of peat, perlite, and vermiculite (6:2:1 by volume) and placed under intermittent mist until emergence. The seedlings were kept in trays until first true leaves were fully expanded, fertilized at 75 mg·L⁻¹ nitrogen using 20N-4.4P-16.6K, and then transplanted into 15-cm-diameter (2.7-L volume) plastic pots filled with peat, perlite, and vermiculite (3:2:1) on 13 Mar. 2013. Plants were grown in a greenhouse at a temperature of 28/20 ± 4 °C (day/night) with monthly means of 12.1, 14.7, and 17.2 mol·m⁻²·d⁻¹ daily light integral in March, April, and May at Akdeniz University, Antalya, Turkey, and were irrigated as needed. All

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
29.5735	fl oz	mL	0.0338
3.7854	gal	L	0.2642
2.54	inch(es)	cm	0.3937
25.4	inch(es)	mm	0.0394
28.3495	oz	g	0.0353
1	ppm	mg·L ⁻¹	1
(°F - 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

plants were fertilized twice a week using the same fertilizer at 140 mg·L⁻¹ N until fruit set and then fertilizer concentration was reduced by half.

Half of the plants were pinched to four nodes from bottom, 6 weeks after sowing on 29 Mar. 2013. Plants were treated with PB (Cultar®; Syngenta Crop Protection, Basel, Switzerland) as a spray to the foliage 8 weeks after sowing (i.e., 2 weeks after pinching). Concentrations of PB were 0, 5, 10, and 15 ppm and the mean spray volume was 6.7 mL per pot. The handheld sprayer was calibrated to deliver 6.7 mL of solution for each eight full depressions of the trigger mechanism. The spray volume was monitored by spraying into a 10-mL erlenmeyer flask before and after PB application to every five pots. Control plants were sprayed with tap water. The study was ended at 8 weeks after PB application. Treatments were arranged as 2 × 4 factorial with two pinching treatments (pinched and nonpinched) and four PB concentrations in a randomized complete block design with three replications. Each replication contained five pots per treatment, 120 pots in total.

The plant height and diameter, relative leaf chlorophyll content, fruit number and diameter, and plant dry weight were collected. The plant height was measured weekly beginning 2 weeks after PB application

from the bottom of the pot to the top of the plant, and pot height was subtracted from the total measurement. Canopy diameter was measured weekly beginning at 4 weeks after PB application across the top of the plant using the widest diameter and the two perpendicular measurements were averaged for each plant. To assess aesthetic value, H/D was calculated using plant height and average diameter according to Meijon et al. (2009). Relative leaf chlorophyll content was measured weekly beginning 2 weeks after PB application using a handheld chlorophyll meter (SPAD-502; Spectrum Technologies, Plainfield, IL). The chlorophyll meter provided rapid and nondestructive measurements that correlate well to actual chlorophyll content of leaf (Azia and Stewart, 2001; Richardson et al., 2002). SPAD measurements were taken weekly from the center of three youngest fully expanded leaves of each plant. The fruit was counted on each plant weekly from 4 to 8 weeks after PB application. Fruit diameter was determined on three randomly selected mature fruit on each pot using digital calipers at 8 weeks after PB application. Plants were harvested from soil surface 8 weeks after PB application and oven dried at 70 °C for 72 h and dry weights were recorded. For the presentation of results regarding growth suppression and fruit yield, the equation used was percent

change = [(response_x - response₀) / (response₀)] × 100. In this equation, response₀ denotes control plants, which are nonpinched and received no PB treatment, and response_x denotes the treatments. Analysis of variance was used in data analysis (SAS version 9.0; SAS Institute, Cary, NC). Means were separated using Fisher's protected least significant difference procedure when the F test indicated significance at *P* < 0.05. Data for plant height and diameter, SPAD chlorophyll value, dry weight difference as a function of PB rate, and fruit number as a function of time were fitted to cubic polynomial models using SPSS (version 17; IBM Corp., Armonk, NY).

Results and discussion

There were no significant interactions between pinching and PB rates at most of the evaluation dates, except plant height. However, the main effects were highly significant for the canopy diameter, H/D ratio, SPAD chlorophyll value, fruit number and diameter, and dry weight (Tables 1–4). The relationship between PB and plant height and diameter, SPAD chlorophyll value, dry weight, and fruit number was best explained by a third-order polynomial [*r*² = 0.83–0.99, *n* = 120 (Fig. 1A–E)].

Height control is important for ornamental plants to improve commercial quality and adaptability to shipping and transplanting operations

Table 1. Means, percent reduction, and analysis of variance for plant height and height/diameter (H/D) ratio of 'M402' ornamental pepper as influenced by pinching (P) and paclobutrazol (PB) treatments.

Treatments		Time after PB application (weeks)							
Pinching	PB rate (ppm) ^a	2		4		6		8	
		Ht (cm) ^y	Change (%)	Ht (cm)	Change (%)	Ht (cm)	Change (%)	Ht (cm)	H/D (ratio)
Pinched	0	36.5	-25	45.7	-22	47.6	-22	48.4	1.9
	5	22.0	-55	22.8	-61	23.5	-61	24.2	1.1
	10	20.6	-58	21.2	-64	21.6	-64	22.3	1.0
	15	20.2	-59	20.6	-65	21.1	-65	21.7	1.0
Nonpinched 0 (control)	0	48.9	—	58.7	—	60.8	—	61.5	2.3
	5	26.4	-46	27.2	-54	28.2	-54	29.4	1.3
	10	24.8	-49	26.0	-56	27.4	-55	29.2	1.3
	15	24.5	-50	25.4	-57	26.7	-56	28.0	1.2
LSD (0.05) ^y		1.6		2.0		2.0		1.9	0.1
Source ^x									
P		***		***		***		***	***
PB		***		***		***		***	***
PB × P		**		**		**		*	NS

^a1 ppm = 1 mg·L⁻¹, 1 cm = 0.3937 inch.

^yLeast significant difference values indicate significant means separation at *P* = 0.05.

^xNS, *, **, ***Nonsignificant or significant at *P* < 0.05, 0.01, or 0.001, respectively.

Table 2. Means, percent reduction and analysis of variance for canopy diameter of 'M402' ornamental pepper as influenced by pinching (P) and paclobutrazol (PB) treatments. Canopy diameter was measured across the top of the plant using the widest diameter and the two perpendicular measurements were averaged for each plant.

Treatments		Time after PB application (weeks)											
Pinching	PB rate (ppm) ^z	4			5			6			7		
		Diam (cm) ^y	Change (%)	Diam (cm)	Diam (cm)	Change (%)	Diam (cm)	Diam (cm)	Change (%)	Diam (cm)	Diam (cm)	Change (%)	Change (%)
Pinched	0	20.6	-9	22.7	23.5	-8	24.1	24.9	-7	24.1	24.9	-8	-8
	5	19.7	-12	20.7	21.1	-16	21.7	22.3	-17	21.7	22.3	-18	-18
	10	19.7	-13	20.4	21.2	-17	21.7	21.9	-17	21.7	21.9	-19	-19
	15	19.3	-14	20.2	20.9	-18	21.3	21.7	-18	21.3	21.7	-20	-20
Nonpinched	0 (control)	22.5	—	24.6	25.5	—	26.1	27.1	—	26.1	27.1	—	—
	5	20.3	-10	21.0	21.6	-15	22.2	22.6	-15	22.2	22.6	-16	-16
	10	20.1	-11	20.7	21.3	-16	21.9	22.6	-16	21.9	22.6	-16	-16
	15	19.9	-11	20.4	21.0	-17	21.8	22.5	-16	21.8	22.5	-17	-17
LSD (0.05) ^y		1.15		1.18	1.16		1.21	0.95		1.21	0.95		
Source ^x													
P		**		*	*		*	***		*	***		***
PB		***		***	***		***	***		***	***		***
PB × P		NS		NS	NS		NS	NS		NS	*		*

^z1 ppm = 1 mg L⁻¹, 1 cm = 0.3937 inch.

^yLeast significant difference values indicate significant means separation at $P = 0.05$.

^xNS, *, **, ***Nonsignificant or significant at $P < 0.05$, 0.01, or 0.001, respectively.

(Agehara and Leskovar, 2014). Plant height varied with pinching and PB treatments (Table 1). Up to 25% reduction in plant height was achieved with pinching alone. Several studies also reported that apical bud pinching caused significant reduction in plant height of many ornamental plants (Dorajeerao and Mokashi, 2012; Jhon and Paul, 1995; Kumar and Singh, 2002; Malleshappa, 1984). The interaction revealed that PB rates of 5, 10, and 15 ppm produced similar suppression on nonpinched plants, whereas the 15 ppm PB yielded a greater suppression than 5 ppm on the pinched plants (21.6 vs. 24.2 cm) through the 8-week period. The results indicate that the difference in growth suppression rates between 5 vs. 10 and 15 ppm PB does not justify the use of higher doses. Suppression in plant height by PB ranged from 55% to 65% and 46% to 57% for pinched and nonpinched plants, respectively (Table 1; Figs. 1A and 2). Growth suppression by PB was reported in earlier studies on various plant species (Berova and Zlatev, 2000; Larcher et al., 2011; Maloupa et al., 2000; Wilkinson and Richards, 1987), including pepper (Aloni and Pashkar, 1987; Grossi et al., 2005; Whipker et al., 2000). Grossi et al. (2005) also reported similar growth suppression when PB applied on to nonpinched pepper plants. However, the degree of height control by PB achieved in our study was higher than that of Whipker et al. (2000). Another triazole-type PGR, uniconazole, reduced the pepper plant height linearly as dose-dependent manner and as much as 50% with 15 ppm (Starman, 1993). The effectiveness of the PGR may vary depending on the cultivar, plant age and health, nutritional status, environmental conditions, and method of application or timing (Basra, 2000; Halmann, 1990; Smit et al., 2005). Elongations during the 6-week period were 21% for nonpinched and 25% for pinched control plants. Relatively little elongation occurred between weeks 2 and 8 after PB application where 13% and 8% elongations were measured for nonpinched and pinched groups, respectively.

The effects of each PB doses at pinched and nonpinched plants on canopy diameter are presented

Table 3. Means and analysis of variance for SPAD chlorophyll value and dry weight of 'M402' ornamental pepper as influenced by main effects of pinching (P) and paclobutrazol (PB) treatments. SPAD values are averages of three readings from each plant, the numbers in pinching treatment represent means of 180, and in PB treatments of 90 readings.

Treatments	SPAD chlorophyll value							Dry wt (g) ^z
	Time after PB application (weeks)							
	2	3	4	5	6	7	8	
Pinching								
Pinched	60.1 A ^y	58.8 A	57.7 A	56.2 A	53.5 A	49.7 A	42.3 B	20.2 A
Nonpinched	62.3 B	56.4 B	57.4 A	56.3 A	52.6 A	51.4 A	45.7 A	19.8 A
PB rate (ppm) ^z								
0	57.6 c	51.9 c	50.5 c	48.9 c	45.9 c	43.8 b	38.9 b	26.5 a
5	61.5 b	58.7 b	58.5 b	57.0 b	53.7 b	51.8 a	45.7 a	18.4 b
10	62.5 a	60.7 a	59.8 ab	58.8 ab	55.7 ab	52.5 a	45.9 a	17.7 c
15	63.1 a	61.0 a	60.8 a	60.3 a	56.8 a	54.0 a	46.3 a	17.5 c
Source ^x								
P	***	**	NS	NS	NS	NS	*	NS
PB	***	***	***	***	***	***	***	***
PB × P	NS	NS	NS	NS	NS	NS	*	NS

^z1 g = 0.0353 oz, 1 ppm = 1 mg·L⁻¹.

^yValues in the same column that are followed by same letter do not differ significantly according to least significant difference ($P = 0.05$).

^xNS, *, **, ***Nonsignificant or significant at $P < 0.05$, 0.01, or 0.001, respectively.

separately in Table 2. The pinching without PB application reduced the plant diameter 8% throughout the evaluation dates. This is the first study reporting the effect of pinching to canopy diameter relative to non-pinched control group in pepper. When 15 ppm PB applied to non-pinched and pinched plants, reduction reached up to 17% and 20% 8 weeks after PB application, respectively. On the pinched pepper plants, Whipker et al. (2000) reported a 13% reduction in canopy diameter with PB and Starman (1993) reported a 33% reduction with uniconazole treatments. Modification of plant architecture by means of pinching and PB was shown in several ornamentals, but little information is available as to any effects on H/D ratio or compactness of ornamental pepper. Maintaining height proportional to the container would improve quality. Although in ornamental plants, it is a difficult aspect to define, an H/D ratio around one yielded compact plants with high commercial quality on highly branched azalea [*Rhododendron* sp. (Bird and Conner, 1999)]. The results demonstrated that pinching alone significantly increased compactness of pepper plants by 17%, reducing the H/D ratio from 2.3 to 1.9 (Table 1). The enhanced compactness obtained by pinching may not be sufficient for commercial potted ornamental pepper. But it may be acceptable as bedding plants in landscape settings. The PB applications to

pinched and nonpinched plants reduced the H/D ratios down to a range of 1.0 to 1.3, pointing to a more compact plant type for potted ornamental pepper while control plants had leggy appearance. The pinching and PB ratios should be tested for each pepper cultivar considering market needs and demands.

The SPAD chlorophyll value was similar between pinched and non-pinched plants while PB treatment increased it between 7% and 24% throughout the 8-week period (Table 3; Fig. 1D). The relative chlorophyll content, relative to the untreated control, was 24% greater at 6 weeks after PB application. The 15 ppm PB rate enhanced the SPAD chlorophyll value better than 5 ppm until 6 weeks posttreatment and thereafter PB doses yielded similar results. Increase in relative chlorophyll content with PB measured in this study may be attributed to more densely packed chloroplasts per unit leaf area as a result of reduced leaf elongation and/or enhanced chlorophyll biosynthesis (Davis et al., 1988; Khalil, 1995). The higher chlorophyll content in PB-treated pepper leaves may also be related to the influence of PB on endogenous cytokinin level. Triazoles have been proposed to stimulate cytokinin synthesis that enhances chloroplast differentiation, chlorophyll biosynthesis, and prevents chlorophyll degradation (Fletcher et al., 2000). Increased cytokinin contents were reported after the application of

GA biosynthesis inhibitors (Grossman, 1992; Sebastian et al., 2002). Enhanced chlorophyll synthesis in pepper, carnation (*Dianthus caryophyllus*), madagascar periwinkle (*Catharanthus roseus*), and tomato (*Solanum lycopersicum*) were reported (Aloni and Pashkar, 1987; Berova and Zlatev, 2000; Grossi et al., 2005; Jaleel et al., 2007; Sebastian et al., 2002). Phytotoxicity was not observed in the present study. Grossi et al. (2005) did not observe phytotoxicity with 6 ppm PB canopy spray. However, 9- and 18-ppm PB drenches caused chlorosis in ornamental pepper (Grossi et al., 2005). Because soil or stem applications of triazoles are more effective in retarding growth than foliar application (Davis et al., 1988), phytotoxicity might be caused by extended exposure to and a higher uptake of PB by plants.

The pinching did not affect plant dry weight while PB treatment reduced it up to 34% (Table 3). Increasing PB rates decreased the plant dry weight and fit cubic polynomial models [$r^2 = 0.98$ – 0.99 (Fig. 1C)]. However, Grossi et al. (2005) reported a dose-dependent linear reduction up to 52% with 6.0 ppm PB. Reduction in plant dry weight with PB was also reported for other ornamental species (Banon et al., 2002; Hammid and Williams, 1997).

In addition to growth habit and foliar characteristics, ornamental peppers have been primarily developed based on unique fruit characteristics (Bosland and Votava, 2000; Stommel

Table 4. Means, percent reduction and analysis of variance for fruit number (per plant) and fruit diameter of 'M402' ornamental pepper as influenced by pinching (P) and paclobutrazol (PB) treatments.

Treatments		Time after PB application (weeks)											
		4		5		6		7		8		8	
Pinching	PB rate ^z (ppm)	Fruit (no.)	Change (%)	Fruit (no.)	Change (%)	Fruit (no.)	Change (%)	Fruit (no.)	Change (%)	Fruit (no.)	Change (%)	Fruit diam (mm) ^z	Change (%)
Pinched	0	2.0	20	6.8	17	7.5	24	7.7	16	7.8	11	23.0	-4
	5	0.0	NA ^y	4.0	-31	7.2	19	7.9	19	8.5	22	19.3	-19
	10	0.0	NA	3.9	-33	6.7	10	7.7	15	8.4	20	19.3	-19
	15	0.0	NA	3.8	-34	6.7	10	7.7	16	8.4	20	19.1	-21
Nonpinched	0 (control)	1.7	—	5.8	—	6.1	—	6.7	—	7.0	—	24.0	—
	5	0.3	-80	3.0	-48	5.0	-18	6.8	2	7.3	4	20.3	-15
	10	0.3	-80	2.8	-53	4.8	-21	6.6	-2	7.2	2	19.6	-18
	15	0.4	-76	2.8	-52	4.8	-21	6.5	-3	7.1	1	19.4	-19
LSD (0.05) ^x		1.15		1.18		1.16		1.2		0.9		0.73	
Source ^w													
P		*		***		***		***		***		**	
PB		***		***		***		NS		**		***	
PB × P		**		NS		NS		NS		NS		NS	

^z1 ppm = 1 mg·L⁻¹, 1 mm = 0.0394 inch.^yNot applicable.^xLeast significant difference values indicate significant means separation at $P = 0.05$.^wNS, *, **, ***Nonsignificant and significant at $P < 0.05$, 0.01, or 0.001, respectively.

and Griesbach, 2008). Pinching delayed flowering and increased number of flowering stems in ornamental plants (Basavaraj, 1984; Malleshappa, 1984; Maloupa et al., 2000; Pathania et al., 2000; Thakur et al., 2006; Ubukata, 1999). Pinching alone increased the fruit set from 6.1 to 7.5 fruit/plant, a 24% increase 6 weeks after PB application (Table 4). However, PB application delayed the fruit set for 2 to 3 weeks on pinched and nonpinched plants, respectively (Table 4). Then, PB treatment enhanced the fruit set from 7.8 to 8.5 and from 7.0 to 7.3 in pinched and nonpinched plants, respectively, 8 weeks post-treatment. Enhancement of fruit yield by PB was more significant among pinched plants with no significant difference between PB doses (Fig. 1E). Over time, change in fruit number of pinched and nonpinched plants with or without PB treatments fit cubic polynomial models [$r^2 = 0.98$ – 0.99 (Fig. 1E)]. Enhanced fruit yield due to pinching can be attributed to increased number of branches per plant (Malleshappa, 1984). Pinching alone decreased fruit diameter slightly while PB reduced it by 15% to 21% (Table 4). Contrary to our results, pinching applied at 8 weeks after sowing did not influence fruit yield and fruit size of the pepper 'NM 6-4' (Mousa, 2012). Time of pinching might be the reason for the conflicting results as shown in chrysanthemum (*Dendranthema grandiflorum*) with significant differences in number of flowers per plant (Singh and Baboo, 2003). Reduction in fruit size by pinching and PB might be the result of competition between increased fruit. Similar to our findings in pepper, increasing PB concentrations decreased fruit diameter but increased the number of fruit in ornamental tomato (de Moraes et al., 2005), where the number of cluster per plant and the number of cluster with fruit also increased linearly by increasing drench PB concentrations. Increased fruit yield may be attributed to the allocation of more carbohydrates to the fruit, probably by redistributing assimilates and directing the majority of assimilates toward reproductive growth (Arzani and Roosta, 2004; Katz et al., 2003) or to the enhanced cytokinin content promoted by PB (Rademacher, 2000). Involvement of cytokinins in both floral stimulus and

Fig. 1. Change in plant height (A), plant diameter (B), and dry weight (C) 8 weeks after treatment (WAT); SPAD chlorophyll values (D) three WAT in response to paclobutrazol (PB) rates. 'M402' ornamental pepper plants received a foliar spray of 0, 5, 10, or 15 $\text{mg}\cdot\text{L}^{-1}$ PB 8 weeks after sowing (2 weeks after pinching). Each point represents mean of five replicates. The solid and broken lines represent regression lines generated for the entire population data using cubic polynomial models for pinched (P) (●) and nonpinched (NP) plants (▲), respectively. Increase in fruit number over time (E) of P only (◆), P + PB (●), control (■), and NP + PB (▲) plants; 1 cm = 0.3937 inch, 1 g = 0.0353 oz, 1 ppm = 1 $\text{mg}\cdot\text{L}^{-1}$.

development has been reported (Chang et al., 1999; Corbesier et al., 2003; Dello Loio et al., 2008; Dewitte et al., 1999; Meijon et al., 2010).

Conclusions

Ornamental peppers have become a profitable crop for pot plant and transplant production and may provide added value for greenhouse

growers. The plants of 'M402' ornamental pepper used in this study grew out of proportion to their commercially accepted pots unless they were treated with PB. Pinching alone recognizably increased branching and fruit number, but failed to provide marketable size potted ornamental pepper (Sachs et al., 1976). Although, PB substituted pinching at

5-ppm concentrations for growth suppression and produced compact ornamental pepper plants that were proportional to their pot size, pinching seemed necessary for enhanced branching. Paclobutrazol may offer an economic advantage for commercial greenhouse operators in producing small, commercially acceptable, compact plants that can be spaced

Fig. 2. Image of 'M402' ornamental peppers 4 weeks after paclobutrazol (PB) treatments applied at 5, 10, or 15 ppm with (P) and without (NP) pinching; 1 ppm = 1 mg·L⁻¹.

closer. The absence of phytotoxicity and enhanced fruit yield on pinched plants were advantages of PB. Hence, for ornamental peppers, 5 ppm PB applied to pinched plants is strongly recommended to improve production.

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