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PRODUCTION OF *Barleria cristata* L. AS A DWARF FLOWERING POT PLANT

BY

Abou-Dahab, T.A.M. and Afaf M.A. Habib
Ornamental Horticulture Department, Faculty of Agriculture, Cairo University

ABSTRACT

This study was conducted in the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during the seasons of 2002/2003 and 2003/2004, to study the effect of pinching height (5 or 10 cm), paclobutrazol (PP-333) foliar spray treatments at 200 or 400 ppm (with or without pinching at a height of 10 cm), and combining pinching at 10 cm with N fertilization at rates of 2 or 4 g/plant (using ammonium sulphate, 20.5% N) on growth, flowering and chemical composition of *Barleria cristata*. All treatments decreased plant height (especially pinching + PP-333 at 400 ppm), but increased stem diameter and branching, with pinching + N fertilization at 4 gm ammonium sulphate/pot giving the highest number of branches /plant. The number of leaves/plant was increased by pinching at a height of 5 cm, and by pinching + N fertilization (especially at 4 gm ammonium sulphate/pot), but was decreased by all other treatments. The number of flowers/plant was increased by pinching (alone or in combination with N fertilization), and by pinching + PP-333 at 200 ppm. The fresh and dry weights of aerial plant parts were decreased by most of the PP-333 treatments, whereas the fresh and dry weights of roots were increased by pinching + paclobutrazol at 200 or 400 ppm. Also, the fresh and dry weights of aerial parts and roots were increased by pinching, especially at a height of 10 cm, and this increase was more pronounced when pinching was combined with N fertilization (especially at 4 gm ammonium sulphate/pot). Pinching at 5 or 10 cm increased the contents of chlorophylls "a" and "b" and carotenoids in the leaves, whereas PP-333 without pinching increased the chlorophyll contents, but decreased the carotenoids content. Pinching + PP-333 increased chlorophyll "a" and carotenoids contents, but decreased chlorophyll "b" content, compared to the control. In most cases, pinching + N fertilization at 2 or 4 gm ammonium sulphate/pot gave the highest chlorophyll contents in leaves, and the highest total carbohydrates contents in leaves and stems, whereas pinching + PP-333 at 200 ppm gave the highest content of total carbohydrates in the roots. In most cases, the contents of N, P and K in the leaves were increased by all the tested treatments, with pinching + N fertilization at 4 gm ammonium sulphate/pot giving the highest values

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Key words: Pinching, Paclobutrazol (pp-333), nitrogen fertilizers, *Barleria cristata*

INTRODUCTION

Barleria cristata (wild bush petunia) belongs to family Acanthaceae. The species grows into a dense shrub with many branches, covered by masses of purple to mauve flowers. *Barleria cristata* grows very well in full sun and semi-shaded conditions. The shrublet can be planted in mixed borders and banks, and can be used as a flowering pot plant. Regular pruning is necessary after the shrub has flowered, for neat and compact growth. To encourage the production of more flowers, the shoots should be nipped-off during spring and early summer. *Barleria cristata* is easily propagated from seeds, cuttings and by layering.

In general, plant growth can be regulated by several means: **genetically** through cultivar selection; **physically** by pinching or pruning and training; **culturally** through management of the crop and its environment; and **chemically** by the application of specific growth regulating chemicals. Regulating stem length while maintaining the other characteristics of quality presents a difficult challenge to the producer of potted plants.

Removing shoot tips (pinching) to promote branching is an example of the physical methods commonly used to regulate the growth of flower crops. The physical methods of control are performed manually and this results in high labor costs. Growth regulating chemicals can be applied to produce the same effect as physical methods. They have the added advantage of saving time and reducing the cost of manual labor.

Several researchers have reported that pinching caused a reduction in plant height, increased lateral branch formation and delayed the flower time in a number of ornamental crops, including *Antirrhinum majus* [Reist and Rey (1976) and Noto and Romano (1989)], *Chrysanthemum* (Sen and Naik, 1977), carnation [Groshkov and Angelov (1981), Khanna *et al.* (1986), and Arafa (1983)]. Omar *et al.* (1997) also found that pinching treatments increased the fruit weight and sepals weight in *Hibiscus sabdariffa* L.

The effects of paclobutrazol (PP-333) on plant growth include a decrease in plant height, increases in the numbers of leaves and branches, and increases in the fresh and dry weights [Scrojny and Kepcznski (1985), Barrett (1982), Haggag (1997), Yewale *et al.* (1998) and Singh *et al.* (1999) on *Chrysanthemum*; Heursel and Witt (1985), Walker (1986), and Wilfret and Barrett (1994) on azalea; Holocomb and Gohn (1995) on poinsettia; El Khateeb *et al.* (1994) on *Hibiscus sadboriffa*; Ahmed (1997) on *Bougainvillea Mrs. Butt* and Auda *et al.* (2002) on *Barleria cristata*]. Application of PP-333 also has an effect on the chemical composition of plant tissues. For example, it was found to increase the leaf contents of chlorophyll and nitrogen, but reduced the carotenoids content [Kandeel *et al.* (1991) on poinsettia; Mao *et al.* (1991) on *Salvia splendens*; El-Tantawy *et al.* (1994) on *Chrysanthemum*; Nasr (1997) on Gerbera]. Moreover, Awad *et al.* (1994) found that PP-333 application reduced total carbohydrates percentage in poinsettia.

Nitrogen seems to have the quickest and the most pronounced effect on the growth of plants. It regulates to a considerable degree the utilization of potassium and phosphorus and other constituents (Brady, 1974). Barman *et al.* (1997a) on *Chrysanthemum morifolium*, Singh and Uma (1996), and Barman *et al.* (1997b) on *Polianthes tuberosa*, reported that increasing nitrogen levels resulted in increased plant height and improved the flower quality. Cabrera (2000) found that the highest flower quality and dry biomass yield were consistently observed in Roses cv. "Royalty" grown in containers receiving 90 mg N/litre. Sita *et al.* (1997) noticed that leaf N content increased corresponding with nitrogen application rate on *Polianthes tuberosa*. Yadav *et al.* (1999) on *Tagetes erecta*, found that leaf N content increased consistently with N application rate and leaf chlorophyll contents increased with N application rate.

As far as the available literature is concerned, a few studies have been reported on the effect of pinching height, PP-333 treatments and nitrogen fertilizers on the growth and flowering of *Barleria cristata* L. plants. Therefore, this study aimed to investigating the effect of height of pinching, PP-333 treatments and N fertilization rates on the growth, flowering and chemical composition of *Barleria cristata* L., in order to control plant height and to produce it as a dwarf flowering pot plant.

MATERIALS AND METHODS

This study was conducted in the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, during the years of 2002/2003 and 2003/2004, to study the effect of pinching height, paclobutrazol [PP-333] treatments and N fertilization rates on growth, flowering and chemical composition of *Barleria cristata* L., with the aim of producing it as a flowering pot plant in a neat and compact shape.

Barleria cristata seedlings, with an average height of 10-15 cm, were obtained from the nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, and were transplanted on 25th of December, 2002 and 2003 (in the first and second seasons, respectively) into plastic pots (20 cm diameter) filled with a mixture of peat moss and perlite [2:1, v/v], which were then placed in a sunny area.

The following treatments were applied to the plants:

1- Untreated plants (control).
2- Pinching at a height of 5 cm from soil surface.
3- Pinching at a height of 10 cm from soil surface.
4- Foliar spray of PP-333 at 200 ppm
5- Foliar spray of PP-333 at 400 ppm
6- Pinching at a height of 10 cm + PP-333 at 200 ppm
7- Pinching at a height of 10 cm + PP-333 at 400 ppm
8- Pinching at a height of 10 cm + N fertilization at 2 gm ammonium sulphate /plant
9- Pinching at a height of 10 cm + N fertilization at 4 gm ammonium sulphate /plant

Plants receiving the pinching treatments were cut after one month from transplanting (25th of January, 2003 and 2004) at the above-mentioned heights. Plants receiving the pinching + PP-333 treatments were sprayed till run-off after two weeks from pinching, and the spray treatments were repeated 5 more times at two-week intervals. Plants treated with PP-333 without pinching were sprayed at the same times as plants treated with pinching + PP-333. Plants receiving the nitrogenous fertilization treatments were supplied with ammonium sulphate [$(NH_4)_2SO_4$, 20.5% N] at the rates of 2 or 4 gm ammonium sulphate/plant, applied as a soil top dressing. The fertilization treatments were applied six times, at three-week intervals. The first dose was applied after 15 days from pinching.

Each treatment was replicated three times, with 5 plants in each replicate. After pinching, normal agricultural practices, including irrigation (as needed). An organic fertilizer (farm yard manure) was added prior to planting at the rate of 2 gm/pot.

Data recorded:

At the end of August (in both seasons), data were recorded on the growth and flowering characteristics, including plant height (cm), number of branches/plant, number of leaves /plant, number of flowers /plant, as well as, the fresh and dry weights (g/plant) of the aerial parts and roots of the plant. Also, chemical analysis of fresh leaf samples was conducted to determine their contents of pigments (chlorophylls a, b and carotenoids) using the method recommended by Saric *et al.* (1976). In addition, samples of leaves, stems and roots were oven-dried at 70° C, and their content (%) of total carbohydrates was determined, using the colorimetric method described by Smith *et al.* (1956). The contents of nutrients in dried samples of leaves were extracted using the method described by Piper (1947), then the nutrient extract was chemically analyzed to determine the percentages of nitrogen [by distillation in a micro-Kjeldahl apparatus, according to Black (1956)], phosphorus [colorimetrically, using the ascorbic acid method described by John (1970)] and potassium [using a flame photometer, as recommended by Dewis and Freitas (1970)] in the plant tissues.

Experimental design and statistical analysis of data

The layout of the experiment was a "Randomized Complete Blocks Design", with 3 replicates (blocks), each consisting of 5 plants/treatment (i.e., a total of 15 plants/treatment). The recorded data were subjected to statistical analysis of variance, and the means were compared using the "New Least Significant Difference (New L.S.D.)" value at the 5% level, as recommended by Snedecor and Cochran (1972).

RESULTS AND DISCUSSION

I- Effect on vegetative growth and flowering

1- Plant height (cm)

The data presented in Table (1) show that in both seasons, all of the tested treatments caused significant reductions in plant height, compared to the untreated control plants (which had heights of 49.00 and 65.67 cm in the first and

second seasons, respectively). Among the different treatments that were tested, using paclobutrazol at 200 or 400 (with or without pinching at 10 cm) was generally more effective in reducing plant height, compared to pinching alone, or pinching + N fertilization at 2 or 4 gm ammonium sulphate/pot. Also, paclobutrazol was generally more effective when applied at 400 ppm than at 200 ppm. Moreover, the most effective treatment in both seasons (i.e. giving the shortest plants) was pinching at a height of 10 cm + applying paclobutrazol at 400 ppm. In most cases, this treatment gave significantly shorter plants (15.33 and 13.26 cm in the two seasons, respectively) than the control plants, or plants receiving the other treatments. The percentages of reduction in height of plants receiving this treatment (compared to the control) were 68.7% and 79.8% in the first and second seasons, respectively. These results are in agreement with the findings of Barman *et al.* (1997a) on chrysanthemum, and Ahmed (1997) on *Bougainvillea* Mrs. Butte. They reported that PP-333 treatments decreased plant height.

As previously mentioned, pinching alone was generally less effective than using paclobutrazol (with or without pinching). However, pinching (especially at the height of 10 cm) was still quite effective in reducing plant height, giving significantly shorter plants than the control. The effect of pinching in reducing plant height was also observed by Reist and Rey (1976) on snapdragon, Sen and Naik (1977) on chrysanthemum and Arafa (1983) on carnation. They all reported that pinching caused a reduction in plant height. However, supplying the plants with N fertilization at 2 or 4 gm ammonium sulphate/pot after pinching at a height of 10 cm partly counteracted the retarding effect of pinching, giving significantly taller plants than those pinched at 10 cm without N fertilization (which gave values of 26.67 and 39.67 cm in the first and second seasons, respectively). In fact, plants treated with pinching at 10 cm + N at 4 gm ammonium sulphate/pot was the least effective treatment for reducing plant height, i.e. plants receiving this treatment were taller (with heights of 46.33 and 54.77 cm in the first and second seasons, respectively) than those receiving any other treatment. Accordingly, it can be mentioned that if the purpose of the pinching treatment is to produce compact plants, the use of N fertilization after pinching should be avoided since it results in relatively tall plants. Similar increases in plant height due to N fertilization treatments were also observed in *Polianthes tuberosa* [Singh and Uma (1996), and Barman *et al.* (1997b)] and roses (Cabrera, 2000).

2- Number of branches / plant:

The data recorded in the two seasons (Table 1) show that pinching *Barleria cristata* plants at heights of 5 or 10 cm caused a slight (insignificant) increase in the number of branches/plant, compared to the unpinched control plants (which had 3.50 and 4.00 branches/plant in the first and second seasons, respectively). This increase in the number of branches (although statistically insignificant) confirms the results reported by Groshkov and Angelov (1981) on carnation plants, and Noto and Romano (1989) on *Antirrhinum majus* plants. They found that pinching the plants increased the formation of lateral branches.

Table (1) : Effect of pinching , paclolutrazol ($PP_{.333}$) and nitrogen fertilization on growth and flowering parameters of *Barleria cristata* shrubs as a flowering pot plants during the two seasons 2003 and 2004.

Treatments	Plant height (cm)		No.of branches/plant		No.of leaves/plant		Stem diameter (mm)		No of flowers/plant	
	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.
Control	49.00	65.67	3.50	4.00	78.00	80.00	6.33	7.57	7.00	7.33
Pinching (1) at 5cm	44.33	48.33	4.50	5.33	84.33	88.33	8.53	9.06	17.00	19.00
Pinching (2) at 10cm	26.67	39.67	4.33	4.32	59.33	62.33	9.33	9.23	18.00	20.67
$PP_{.333}$ (200ppm)	23.33	29.32	5.66	5.00	58.67	53.33	8.70	8.60	8.00	8.00
PP_{333} (400ppm)	16.00	20.00	4.66	3.33	47.08	60.67	9.56	8.50	7.00	7.66
Pinching (2)+ $PP_{.333}$ (200ppm)	21.67	20.67	5.93	6.00	67.08	64.00	9.53	9.33	12.00	11.00
Pinching 2+ $PP_{.333}$ (400ppm)	15.33	13.26	5.86	5.00	68.67	67.67	9.23	9.13	7.33	7.33
Pinching 2+2gm fertilizer /pot	35.33	42.33	5.66	6.00	88.33	101.00	8.68	9.50	16.00	18.00
Pinching 2+4gm fertilizer /pot	46.33	54.77	6.66	9.00	119.7	129.70	9.40	9.60	18.67	20.33
L.S.D. at 5 %	2.26	2.15	1.48	1.49	15.00	9.60	1.40	0.65	1.48	3.30

F.S.: First season **S.S.: Second season**

Regarding the effect of paclobutrazol on branching, the data in Table (1) show that application of paclobutrazol at 200 ppm (without pinching) significantly increased branching in the first season (giving 5.66 branches/plant), compared to the control, but in the second season the effect of this treatment was less pronounced, giving insignificantly more branches (5.00 branches/plant) than the control (4.00 branches/plant). The high paclobutrazol concentration (400 ppm) was generally less effective than the low concentration, causing no significant difference in the number of branches, compared to that of control plants (in both seasons). The favourable effect of the low paclobutrazol concentration (200 ppm) on branching was more pronounced when it was combined with pinching of the plants at a height of 10 cm. However, the values obtained from plants receiving this treatment (pinching at 10 cm + paclobutrazol at 200 ppm) were significantly higher (5.93 and 6.00 branches/plant in the first and second seasons, respectively) than the those of the control, but not significantly higher than those obtained from plants receiving paclobutrazol alone at 200 ppm. The effect of paclobutrazol at 400 ppm on branching was also more pronounced when the treatment was combined with pinching at 10 cm.

The promotion of branching in *Barleria cristata* plants receiving pinching and PP-333 treatments may be attributed to an interference with the supply of auxins from the shoot apex. This results in overcoming apical dominance, which is commonly explained by inhibition of lateral bud growth by auxin emanating from the apical bud (Horgan, 1984). These results are in agreement with the findings of Barman *et al.* (1997a) and Singh *et al.* (1999), who found that treatment of chrysanthemum with PP-333 increased the number of branches/plant.

Nitrogenous fertilization of *Barleria cristata* plants using amonium sulphate at the rates of 2 or 4 gm/plant (after pinching the plants at a height of 10 cm) also caused significant increases in the number of branches/plant, compared to the control plants. Moreover, N fertilization was more effective in this respect when it was applied at the rate of 4 gm ammonium sulphate/plant, which gave a higher number of branches (especially in the second season) than those formed on plants receiving any other treatment. Similar results have been reported by Singh and Uma (1996) on *Polianthes tuberosa.*

3- Number of leaves / plant:

The data on the number of leaves/plant (Table 1) showed that pinching the plants to a height of 5 cm caused a slight (insignificant) increase in the number of leaves/plant, compared to the control. This increase in the number of leaves may be due to the increase in number of branches formed on plants pinched to a height of 5 cm. Increases in the number of leaves as a result of pinching treatments have been reported by Reist and Rey (1976) on chrysanthemum and Noto and Romano (1982) on *Antirhinum majus* plants. In contrast, pinching the plants to a height of 10 cm had an unfavourable effect on leaf formation, giving significantly fewer leaves (59.33 and 62.33 leaves/plant) than the control. In plant which were pinched to a height of 10 cm, the

percentages of decreases in number of leaves (compared to the control) were 23.9% and 22.1% in the first and second seasons, respectively.

The paclobutrazol (PP-333) treatments also significantly reduced the number of leaves/plants, compared to the control. However, no significant difference was detected (in both seasons) between the values recorded with paclobutrazol concentrations of 200 or 400 ppm. This reduction effect may be due to the retardation effect of PP-333 on cell division and cell elongation. Combining paclobutrazol application (at 200 or 400 ppm) with pinching resulted in the formation of a number of leaves that was intermediate between those formed by control plants, and those formed on plants receiving paclobutrazol without pinching, i.e. the effect of paclobutrazol on decreasing the number of leaves was more pronounced when the plants were left unpinched.

Nitrogen fertilization significantly increased the number of leaves/plant and this effect increased by increasing the fertilization rate. In both seasons, the best treatment in terms of increasing the number of leaves/plant was pinching the plants to a height of 10 cm, and supplying them with 4 gm ammonium sulphate/plant. This treatment increased the number of leaves/plant by 53.5% and 62.1% over the control plants in the first and second seasons, respectively.

4- Stem diameter (mm):

The data Table (1) indicated that pinching *Barleria cristata* plants to a height of 5 or 10 cm resulted in significantly thicker stems (i.e. higher stem diameter), compared to control plants. In the first season, the percentages of increase in stem diameter were 34.8% and 47.4% in plants pinched at heights of 5 cm and 10 cm, respectively. However, in the second season the percentages of increase were 19.7 and 21.9% with pinching at heights of 5 and 10 cm, respectively.

Results recorded in the two seasons (Table 1) also showed that paclobutrazol treatments (with or without pinching) significantly increased stem diameter, compared to the control. In general, paclobutrazol was more effective in increasing stem thickness when the paclobutrazol treatments were combined with pinching at a height of 10 cm. However, in most cases no significant difference was detected between stem diameter of plants receiving the different paclobutrazol treatments.

Nitrogen fertilization also significantly increased the stem diameter, and this effect was more pronounced with the high fertilization rate (4 gm ammonium sulphate/plant). The percentages of increase due to N fertilization at the rate of 2 gm/plant (compared to the control) were 37.1% in the first season and 25.5% in the second season. However, in plants receiving the high fertilization rate (4 gm/plant) the percentages of increase were 48.5% and 26.8% in the first and second seasons, respectively.

Among the different treatments that were tested, paclobutrazol at 400 ppm (without pinching) gave the thickest stems in the first season (9.56 mm),

whereas the thickest stems in the second season (9.60 mm) were those of plants pinched at a height of 10 cm and supplied with 4 gm ammonium sulphate/plant.

In general one can say that pinching the plants at 5 or 10 cm, or treating the plants with paclobutrazol (PP-333) at the rates of 200 and 400 ppm (with or without pinching), or pinching the plants and fertilizing them with 2 or 4cm / ammonium sulphat/plant, significantly increased stem diameter.

5- Number of flowers /plant:

The data presented in Table (1) revealed that pinching *Barleria cristata* plants at heights of 5 or 10 cm significantly increased the number of flowers/plants. With pinching at 5 cm, the percentages of increase in this character over the unpinched plants reached 142.9 and 159.2% in the first and second seasons, respectively. Pinching at 10 cm was even more effective, with percentages of increase reaching 157.1 and 182.0% in the first and second seasons, respectively.

Regarding the effect of paclobutrazol (PP-333) treatments, the data showed that application of PP-333 at the rate of 200 ppm in combination with pinching at a height of 10 cm resulted in a significant increase in the number of flowers (giving 12.00 and 11.00 flowers/plant in the first and second seasons, respectively), compared to the control (with values of 7.00 and 7.33 flowers/plant in the two seasons, respectively). All other paclobutrazol treatment (paclobutrazol at 200 or 400 ppm without pinching, or paclobutrazol at 400 ppm with pinching) had no significant effect on the number of flowers produced by *Barleria cristata* plants (compared to the control).

Combining manual pinching at 10 cm with nitrogenous fertilization at 2 or 4 gm ammonium sulphate/plant significantly increased the number of flowers/plant, compared to the control. However, values obtained with these treatments were nearly the same as those obtained with pinching alone, i.e. pinching alone (without fertilization) was sufficient to cause a significant increase in flowering, and N fertilization did not have any additional advantage in this respect.

6- Fresh and dry weights of aerial parts (gm/plant):

The data in Table (2) indicated that in both seasons, manual pinching at heights of 5 or 10 cm increased the fresh and dry weights of aerial parts in *Barleria cristata* plants. Pinching at a height of 10 cm was generally more effective than pinching at 5 cm for increasing the fresh and dry weights of aerial parts. These results are in the agreement with the findings of Omar *et al.* (1997) on *Hibiscus subdraiffa* plants. Moreover, the favourable effect of the pinching treatments was more pronounced when pinching was combined with N fertilization, especially at the relatively high rate of 4 gm ammonium sulphate/plant. In fact, pinching the plants at a height of 10 cm and supplying them with the high N fertilization rate (4 gm ammonium sulphate/plant) gave the highest values for fresh and dry weights of aerial parts in both seasons (with fresh weights of 170.90 and 180.30 gm/plant in the first and second seasons,

respectively, and dry weights of 83.24 and 74.67 gm/plant in the two seasons, respectively). These values represent increases of 293.1% and 382.1% in the fresh weight in the first and second seasons, respectively, and increases of 362.7% and 364.9% in the dry weight in the two seasons, respectively.

In contrast, the recorded values were decreased by paclobutrazol at 200 or 400 ppm (without pinching) and by paclobutrazol at 400 ppm with pinching, compared to the control. The only paclobutrazol treatment that increased the recorded values (compared to the control) was the low PP-333 rate (200 ppm) combined with pinching at a height of 10 cm. However, this treatment was generally less effective than pinching alone (at heights of 5 or 10 cm), or pinching at a height of 10 cm in combination with N fertilization at 2 or 4 gm ammonium sulphate/plant.

7- Fresh and dry weights of roots (gm/plant):

The results recorded in the two seasons (Table 2) show that pinching *Barleria cristata* plants at heights of 5 or 10 cm increased the fresh and dry weights of roots, compared to those of control plants. This favourable effect was clearer with pinching at a height of 10 cm, which gave significantly higher values than the control (in both seasons). In fact, pinching at a height of 10 cm was the most effective treatment for increasing the fresh and dry weights of roots in the first season. However, in the second season the highest fresh weight of roots was obtained from plants pinched at a height of 10 cm and treated with PP-333 at 200 ppm, while the highest dry weight of roots was obtained from plants pinched at a height of 10 cm and treated with PP-333 at 400 ppm.

Paclobutrazol (PP-333) treatments also had a considerable effect on the fresh and dry weights of roots. In most cases, PP-333 at the concentration of 200 ppm (without pinching) increased the recorded values, but the high PP-333 concentration (400 ppm) decreased them, compared to the control. The only exception to this trend was detected in the second season, with PP-333 at 200 ppm giving a lower dry weight of roots (7.21 gm/plant) than that of control plants (9.29 gm/plant). However, when the use of PP-333 was combined with pinching, both concentrations (200 and 400 ppm) resulted in increases in the fresh and dry weights of roots, compared to the control.

Regarding the effect of combining pinching with N fertilization, the data in Table (2) show that these treatments increased the fresh and dry weights of roots (compared to the control), and this effect was more pronounced when the high fertilization rate (4 gm ammonium sulphate/plant) was used.

From the above results, it can concluded that, in general, most of the tested treatments increased the fresh and dry weights of roots in *Barleria cristata* plants. In the first season, only one treatment (PP-333 at 400 ppm, without pinching) insignificantly decreased the fresh and dry weights of roots, whereas all other treatments increased the recorded values, compared to the control. Also in the second season, all treatments gave higher fresh weights than the control. Moreover, only two treatments (PP-333 at 200 or 400 ppm without pinching)

gave lower dry weights than the control in the second season, whereas pinching at heights of 5 or 10 cm (with or without PP-333 or N fertilization) increased root dry weight in the second season.

II- Effect on chemical composition

1- Photosynthesis pigments:

The data in Table (3) showed that, in most cases, the contents of the three studied photosynthesis pigments (chlorophyll a, b and carotenoids) were increased by pinching at heights of 5 or 10 cm (in both seasons). The only exception to this general trend was recorded in the second season, with plants pinched at a height of 10 cm having a slightly lower carotenoids content (1.172 mg/gm F.W.) than that of control plants (1.273 mg/gm F.W.). In both seasons, no significant difference was detected (for the three pigments) between values recorded in plants pinched at a height of 5 cm and those recorded in plants pinched at a height of 10 cm.

The results recorded in the two seasons also show that, in most cases, treatment of *Barleria cristata* plants with PP-333 at 200 or 400 ppm (without pinching) increased the chlorophyll "a" and chlorophyll "b" contents, but decreased the carotenoids content, compared to the control. When PP-333 treatments were combined with pinching at a height of 10 cm, the chlorophyll "a" content was slightly increased, compared to values obtained when PP-333 was used without pinching, whereas the chlorophyll "b" was decreased (in most cases, especially with the low concentration of 200 ppm). Also, combining pinching with PP-333 increased the carotenoids content (in most cases), compared to the control.

Regarding the effect of combining pinching with N fertilization, the data presented in Table (3) show that in general, pinching the plants at a height of 10 cm and supplying them with N fertilization was generally more effective than the other tested treatments for increasing the contents of photosynthetic pigments (chlorophyll "a", chlorophyll "b" and carotenoids) in leaves of *Barleria cristata* plants. Moreover, application of the high N fertilization rate (4 gm ammonium sulphate/plant) was more effective in most cases than using the low N rate (2 gm ammonium sulphate/plant). In fact, plants pinched at a height of 10 cm and supplied with 4 gm ammonium sulphate/plant gave the highest value for chlorophyll "a" in the second season, and the highest values for total chlorophyll in both seasons. Also, plants treated with pinching + N fertilization at 2 or 4 gm ammonium sulphate/plant gave the two highest values for chlorophyll "b" in the second season (0.493 and 0.473 mg/gm F.W., for the two treatments, respectively), and the two highest values for the carotenoids content in the first season (1.288 and 1.286 mg/gm F.W., for the two treatments, respectively). However, in the second season, these two treatments gave lower carotenoids contents, compared to most of the other treatments that were tested. The general increase in the photosynthetic pigments due to the use of pinching plus nitrogen fertilization is in agreement with the findings of Hassanein *et al.* (2003) on *Calendula officinalis* and Abdou (2003) on chrysanthemum plants.

Table (2) : Effect of pinching , paclolutrazol ($PP._{333}$) and nitrogen fertilization on fresh and dry weights of aerial parts and roots of *Barleria cristata* shrubs as a flowering pot plants during the 2002/2003 and 2003/2004 seasons.

Treatments	Fresh Weight				Dry weight			
	Foliage		Roots		Foliage		Roots	
	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.
Control	43.47	37.40	21.63	17.38	17.99	16.06	10.86	9.28
Pinching (1) at 5cm	83.42	87.07	34.12	31.47	33.30	36.51	18.96	13.56
Pinching (2) at 10cm	125.20	122.20	47.81	37.20	45.28	49.12	24.29	14.12
$PP._{333}$ (200ppm)	25.53	23.73	32.24	29.07	9.69	10.96	12.60	7.21
$PP._{333}$ (400ppm)	16.21	22.79	14.16	18.67	8.58	9.94	7.55	7.19
Pinching (2)+ $PP._{333}$ (200ppm)	74.24	58.38	45.54	42.48	36.84	19.65	16.59	15.36
Pinching 2+ $PP._{333}$ (400ppm)	39.27	28.09	27.37	25.62	17.53	14.79	17.32	16.11
Pinching 2+2gm fertilizer /pot	164.10	134.40	32.17	23.07	52.04	45.38	13.45	10.30
Pinching 2+4gm fertilizer /pot	170.90	180.30	40.56	35.46	83.24	74.67	17.99	15.28
L.S.D. at 5 %	19.12	27.44	17.51	9.62	13.00	2.71	1.21	1.47

Table (3) : Effect of pinching , paclolutrazol (PP.333) and nitrogen fertilization on chlorophyll- a,b,total and carotenoids contents (mg/gm % F.W.) in leaves of Barleria cristata shrubs as a flowering pot plants during the 2002/2003 and 2003/2004 seasons.

Treatments	Chl-a		Chl-b		Total chl.		Carotenoids	
	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.
Control	1.640	1.555	0.324	0.352	1.964	1.907	1.146	1.273
Pinching (1) at 5cm	1.880	1.819	0.329	0.415	2.209	2.234	1.230	1.281
Pinching (2) at 10cm	1.871	1.822	0.325	0.448	2.196	2.270	1.175	1.172
$PP._{333}$ (200ppm)	1.707	1.461	0.531	0.439	2.238	1.900	1.134	1.233
$PP._{333}$ (400ppm)	1.821	1.753	0.325	0.372	2.146	2.125	1.115	1.251
Pinching (2)+ $PP._{333}$ (200ppm)	1.885	1.826	0.332	0.343	2.217	2.169	1.225	1.291
Pinching 2+ $PP._{333}$ (400ppm)	1.891	1.859	0.321	0.406	2.212	2.265	1.106	1.305
Pinching 2+2gm fertilizer /pot	1.959	2.100	0.362	0.493	2.321	2.593	1.288	1.174
Pinching 2+4gm fertilizer /pot	1.933	2.316	0.455	0.473	2.388	2.789	1.286	1.194
L.S.D. at 5 %	0.029	0.670	0.198	0.252	-------	-------	0.078	0.529

2- Total carbohydrates percentage:

Chemical analysis of dried leaf samples has revealed that in both seasons, the total carbohydrates percentage in the leaves and stems of *Barleria cristata* plants (Table 4) was significantly increased by all the tested treatments. On the other hand, only two treatments (viz. pinching at a height of 10 cm, with or without paclobutrazol at 200 ppm) decreased the total carobhydrates percentage in the roots, whereas all other treatments increased it significantly, compared to the control.

The general increase in the total carbohydrates percentage in different parts of the plant as a result of the tested treatments may be due to the effect of these treatments on increasing the number of leaves and the number of branches. Among the different treatments that were used, combinations of pinching at a height of 10 cm with N fertilization at 2 or 4 gm ammonium sulphate/plant were generally the most effective treaments for increasing the percentages of total carbohydrates the leaves and stems, giving significantly higher values than any other treatment. The only exception to this general trend was observed in the first season, with leaves of plants pinched at a height of 10 cm (without PP-333 or N fertilization) giving an insignificantly higher value (38.91%) than those obtained from plants pinched at a height of 10 cm and supplied with 2 or 4 gm of ammonium sulphate/plant (which gave values of 37.95% and 38.61%, respectively). On the other hand, the highest percentages of total carbohydrates in the roots (46.60% and 48.61% in the first and second seasons, respectively) were obtained in plants pinched at a height of 10 cm and treated with PP-333 at a concentration of 200 ppm.

In conclusion, one can say that, in general, the different treatments that were tested (pinching, PP-333 or nitrogen fertilization) had a significant effect on increasing the total carbohydrates percentages in different parts of *Barleria cristata* plants, (especially the leaves and stems), whereas only a few treatments caused a slight reduction in the carbohydrates percentage in the roots.

3- Nitrogen percentage:

The results recorded in the two seasons (Table 5) show that, in most cases, the nitrogen percentage in the leaves of *Barleria cristata* plants (Table 5) was significantly increased by the different treatments. In the first season, only one exception to this trend was detected, with plants treated using PP-333 giving an insignificantly higher value (1.545%) than the control (1.529%). In the second season, PP-333 at 200 or 400 ppm significantly reduced the N percentage (giving values of 1.293% and 1.295%, respectively), compared to the control (1.369), while all other treatments gave higher values than the control.

It can also be seen from the data in Table (5) that combining pinching at a height of 10 cm with PP-333 at 400 ppm gave higher values (1.845% and 1.640% in the first and second seasons, respectively) than those obtained with pinching alone (1.780% and 1.638% in the two seasons, respectively), or PP-333 alone at 200 ppm (giving values of 1.638% and 1.293% in the two seasons, respectively) or at 400 ppm (with values of 1.545% and 1.295% in the two seasons, respectively). Also, combining pinching with N fertilization was more effective than the other tested treatments (in both seasons) for increasing the N percentage in leaves, especially when the high N fertilization rate (4 gm

ammonium sulphate/plant) was used. In fact, plants that were pinched at a height of 10 cm and supplied with 4 gm ammonium sulphate/plant had significantly higher N percentages in their leaves, compared to those found in leaves of plants receiving any other treatment.

Table (4): Effect of pinching , paclolutrazol ($PP_{.333}$) and nitrogen fertilization on the total carbohydrates percentage in leaves,stems and roots of *Barleria cristata* shrubs as aflowering pot plants during the 2002/2003 and 2003/2004 seasons.

Treatments	Leaves		Stems		Roots	
	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.
Control	23.26	25.46	28.51	28.32	41.23	37.97
Pinching (1) at 5cm	29.01	29.97	44.70	44.11	42.90	44.02
Pinching (2) at 10cm	38.91	38.16	45.31	46.21	35.96	37.92
$PP_{.333}$ (200ppm)	31.46	31.19	33.81	41.09	38.99	37.72
$PP_{.333}$ (400ppm)	27.37	30.82	38.05	43.00	46.06	41.61
Pinching (2)+ $PP_{.333}$ (200ppm)	32.03	32.38	45.19	46.90	46.60	48.61
Pinching 2+ $PP_{.333}$ (400ppm)	29.15	31.59	44.25	45.71	45.96	47.78
Pinching 2+2gm fertilizer /pot	37.95	44.41	51.39	51.04	43.41	42.85
Pinching 2+4gm fertilizer /pot	38.61	45.44	49.08	52.16	42.92	45.31
L.S.D. at 5 %	2.688	2.220	1.633	3.870	4.358	3.385

Table (5): Effect of pinching , paclolutrazol ($PP_{.333}$) and nitrogen fertilizer on nitrogen ,phosphours and Potassium contents in leaves of *Barleria cristata* shrubs as aflowering pot plants during the 2002/2003 and 2003/2004 seasons.

Treatments	Nitrogen		Phosphours		Potassium	
	F.S.	S.S.	F.S.	S.S.	F.S.	S.S.
Control	1.529	1.368	0.378	0.383	1.343	1.470
Pinching (1) at 5cm	1.593	1.575	0.430	0.484	2.557	2.463
Pinching (2) at 10cm	1.780	1.638	0.557	0.573	2.690	2.937
$PP_{.333}$ (200ppm)	1.638	1.293	0.390	0.416	2.647	2.603
$PP_{.333}$ (400ppm)	1.545	1.295	0.411	0.436	2.600	2.553
Pinching (2)+ $PP_{.333}$ (200ppm)	1.748	1.371	0.452	0.457	2.763	2.247
Pinching 2+ $PP_{.333}$ (400ppm)	1.845	1.640	0.492	0.522	2.567	2.547
Pinching 2+2gm fertilizer /pot	1.848	1.652	0.520	0.554	3.253	3.843
Pinching 2+4gm fertilizer /pot	1.969	1.783	0.635	0.662	3.433	3.937
L.S.D. at 5 %	0.041	0.025	0.1619	0.1063	0.2002	0.0988

F.S. First seasons. S.S. Second seasons.

In conclusion, it can be stated that most of the treatments increased the N percentage in the leaves, and that combining pinching with N fertilization (especially at the rate of 4 gm ammonium sulphate/plant) gave the highest values in both seasons.

4- Phosphorus percentage:

The data presented in Table (5) show that pinching *Barleria cristata* plants increased the P percentage in the leaves, and that pinching at a height of 10 cm gave higher values (0.557% and 0.573% in the first and second seasons, respectively) than those obtained with pinching at a height of 5 cm (0.430% and 0.484% in the two seasons, respectively).

Regarding the effect of PP-333 treatments, the results recorded in the two seasons (Table 5) show that treating *Barleria cristata* plants with PP-333 at concentrations of 200 or 400 ppm (with or without pinching) also increased the P percentage in the leaves, and that the recorded values were increased by raising the PP-333 rate from 200 to 400 ppm.

The data in Table (5) also show that combining pinching with N fertilization was more effective than other pinching and PP-333 treatments for increasing the P percentage in the leaves, especially when the high N fertilization rate (4 gm ammonium sulphate/plant) was used. In fact, plants pinched at a height of 10 cm and fertilized with ammonium sulphate at the rate of 4 gm/plant gave the highest P percentages recorded in the two seasons (0.635% and 0.662% in the first and second seasons, respectively). These results are in harmony with those reported by El-Shaer (1989) on fennel, Ibrahim (2001) on *Althaea rosea*, and Badran *et al.* (2003) on anise.

From the above results, it can be concluded that all the tested treatments increased the P percentage in leaves of *Barleria cristata*, and that the highest values were obtained as a result of pinching the plants at a height of 10 cm, and fertilizing them with 4 gm ammonium sulphate/plant.

5- Potassium percentage:

The data on the potassium percentage of the leaves (Table 5) revealed that all the tested treatments (pinching at heights of 5 or 10 cm, PP-333 at 200 or 400 ppm, as well as combinations of pinching and PP-333, or pinching and N fertilization) caused significant increases in the potassium percentage in the leaves of *Barleria cristata* plants (in both seasons). The most effective treatment in this respect was pinching the plants at a height of 10 cm and supplying them with N fertilization using ammonium sulphate at the rate of 4 gm/plant. This treatment gave the highest K percentage in both seasons.

The results recorded on the different growth characteristics of *Barleria cristata* plants in the two seasons clearly indicate that nitrogenous fertilization caused a general increase in plant growth, as well as, the contents of different important chemical constituents. To explain the effects of nitrogen fertilization on the different vegetative growth and chemical characters recorded in the present

study, it is necessary to refer to the physiological roles of nitrogen in plant growth and development. Nitrogen is essential for plant growth as a constituent of all amino acids, proteins, many enzymes and energy transfer materials, as well as physiologically active compounds such as chlorophyll. Nitrogen is essential for plants to grow and form new cells, and the rate of growth is very nearly proportional to the rate at which nitrogen is supplied. Photosynthesis can produce sugars from CO_2 and H_2O but the process cannot go on to the production of proteins. Thus, a severe shortage of nitrogen will halt the processes of growth and reproduction (Bidwell, 1974). Supplying the plants with adequate quantities of N at the right time tends to increase cell number and cell size with an overall increase in vegetative growth (Thompsond and Troeh, 1975).

The relation between the promotion in the different growth characters caused by nitrogenous fertilization, and the stimulating effect on the synthesis and accumulation of photosynthetic pigments, as well as the uptake of nitrogen, phosphorus and potassium by *Barleria cristata* plants could be explained by recognizing the fundamental involvement of these chemical constituents in a very large number of enzymatic reactions that depend on an adequate supply of nitrogen. Accordingly, it can be stated that the increases in the contents of chlorophyll a, b and carotenoids, as well as percentages of carbohydrates, N, P and K in the leaves (which were caused directly by nitrogenous fertilization) were indirectly the cause for enhancing all other vegetative growth characters, as well as the chemical composition of *Barloria cristata* plants.

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إنتاج البارلاريا كرستاتا كنباتات أصص مزهرة مقزمه

طارق أبو دهب محمد ، عفاف محمودالسيد حبيب
قسم بساتين الزينة – كلية الزراعة– جامعة القاهرة

أجرى هذا البحث فى مشتل التجارب بقسم بساتين الزينة بكلية الزراعة – جامعة القاهرة خلال الموسمين ٢٠٠٢/٢٠٠٣ ، ٢٠٠٣/٢٠٠٤ وذلك بهدف دراسة تأثير ارتفاع التطويش (٥ ، ١٠ سم) أو الرش السورقى بمادة الباكلو بترازول بتركيزات ٢٠٠ ، ٤٠٠ جزء فى المليون (مع التطويش على ارتفاع ١٠سم أو بدون تطويش) وكذلك تأثير الجمع بين التطويش على ارتفاع ١٠سم مع التسميد النتروجين) بمعدل ٢ أو ٤ جرام / نبات (سماد سلفات الامونيوم ٢٠,٥% نتروجين) على النمو والتزهير والمحتوى الكيماوى لنباتات البارلاريا .

وقد أظهرت النتائج أن جميع المعاملات أدت إلى تقصير فى ارتفاع النبات خصوصا معاملة التطويش مع الرش بـ pp-333 بتركيز ٤٠٠ جزء فى المليون . وإلى زيادة فى قطر الساق وعدد الأفرع على النبات . زاد عدد الأوراق / النبات نتيجة التطويش على ارتفاع ٥سم أو بالتطويش مع التسميد النتيروجينى بمعدل ٤ جرام سلفات أمنيوم / للنبات) إلا أن عدد الأوراق انخفض عند استخدام باقى المعاملات.

زاد عدد الأزهار / النبات نتيجة التطويش (بمفردة أو بالاشتراك مع التسميد النتروجينى) كذلك التطويش مع الرش pp333 بتركيز ٢٠٠ جزء فى المليون. وانخفضت الأوزان الطازجة والجافة للأجزاء الهوائية نتيجة معظم معاملات الرش PP-333، فى حين زادت الأوزان الطازجة والجافة للجذور نتجة التطويش واستخدام PP-333 بتركيزات ٢٠٠أو٤٠٠ جزء فى المليون. كذلك زادت الأوزان الطازجة والجافة للأجزاء الهوائية والجذور عند التطويش خصوصا على ارتفاع ١٠سم. هذه الزيادة كانت اكبر عند الجمع بين التطويش والتسميد النتروجين (خاص بمعدل ٤ جرام سلفات أمونيوم/ أصص) . أدى التطويش على ارتفاع ٥ أو ١٠سم إلى زيادة محتوى الكورفيل "أ" والكلورفيل "ب" الكاروتينويدات فى الأوراق فى حين أن المعاملة بـ pp-333 بدون تطويش أدت إلى زيادة محتوى الكلورفيل "أ" والكاروتينويدات ولكنه خفض محتوى كلورفيل "ب" بمقارنه بالكنترول . وفى اغلب الحالات أدى استخدام

التطويش + التسميد النتروجين بمعدل ٢ أو ٤ جرام سلفات أمونيوم/ نبات إلى أعطاء أعلى محتوى من الكلوروفيل فى الأوراق ، وأعلى محتوى من الكربوهيدرات فى الأوراق والسيقان بينما التطويش مع الرش PP-333 بتركيز ٢٠٠ جزء مع المليون اعطى اعلى معدل من الكربوهيدرات فى الجذور.

وبصفة عامه ارتفعت محتويات النتروجين والفوسفور و البوتاسيوم فى الأوراق نتيجة استخدام جميع المعاملات محل الدراسة وأعطى التطويش + التسميد النيتروجينى بمعدل ٤ جرام/ سلفات أمونيوم / نبات اعلي القيم لمحتوى العناصر الثلاثة.