N-6-Benzyladenine Increases Lateral Offshoots in a Number of Perennial Species

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A study was conducted testing the effects of N-6-benzyladenine (BA) on a number of perennial species. Eighteen perennials were screened for BA's effect on the number of lateral offshoots and overall foliage appearance. Eighty-nine percent of the perennials tested in the screen had significantly more offshoots when treated with 1000 ppm BA (P<.05). In addition, two perennials, *Persicaria amplexicaulus* 'Taurus' and *Veronica gentianoides* 'Barbara Sherwood' were treated with 0, 1000, 2000, and 4000 ppm BA. Mean number of offshoots and overall foliage appearance were analyzed and rooting analyses of offshoots and overall growth were studied. Benzyladenine significantly increased the number of lateral offshoots in both plants tested (P<.001). However, there was no significant difference in the number of lateral offshoots in the 1000, 2000, and 4000 ppm treatments. As concentration of BA increased, leaf size and height decreased in *Veronica gentianoides* 'Barbara Sherwood' while width increased. Petiole length and height decreased as BA concentration increased in *Persicaria amplexicaulus* 'Taurus.' Results suggested that BA releases lateral bud dormancy and increases the number of lateral offshoots in a number of different perennial species. Although increasing concentration of BA had an effect on overall plant growth in *Veronica gentianoides* 'Barbara Sherwood' and *Persicaria amplexicaulus* 'Taurus,' the number of lateral offshoots did not increase significantly above 1000 ppm BA.

INTRODUCTION

There are several perennials sold at Green Leaf Enterprises that are difficult to produce efficiently because of the small number of offshoots the plant produces each year. The minimal number of offshoots produced by some plants is a result of slow growth or the nature of the plant's growth. Therefore, many plants are produced in tissue culture or propagated only once or twice a year. This causes an increase in cost for Green Leaf and our customers. Finding a way to treat these "problem" plants or to significantly increase the number of cuttings for any plants produced at Green Leaf was our goal in this experiment.

In the past, cytokinins have been used to increase lateral breaks in woody plants (Henny, 1986 and Wang, 1987), promote bud formation in woody plants (Mulgrew and Williams, 1985), and induce lateral branching in poinsettias and geraniums (*Pelargonium*) (Carpenter et al., 1971 and Carpenter and Carlson, 1972). In addition, cytokinins such as benzyladenine (BA) are commonly used today in tissue-culture production to induce shoot proliferation during the multiplication stage.

The apical dominance in a plant is determined by the relationship of cytokinins to auxins. Auxins are antagonistic to cytokinins, inhibiting the development of lateral

buds. Benzyladenine allows lateral buds to develop that have been otherwise suppressed by an auxin (Garner et. al., 1997a). Recently, BA has been found to increase the number of offshoots in a number of hosta cultivars when applied exogenously (Keever, 1994; Garner et. al., 1997; and Keever and Brass, 1998). Our interest lies in BA's effect on a number of different perennials that are produced at Green Leaf Enterprises. The objective of the study was to evaluate the effects of BA on lateral offshoots, foliage, and overall growth. Based on previous studies, we expect to see an increase in the number of lateral breaks as the concentration of BA increases. We also expect BA to decrease leaf size and affect overall growth by decreasing height and increasing width (Keever, 1994).

MATERIALS AND METHODS

Plant Materials.

Brunnera macrophylla
Campanula persicifolia 'Chettle Charm'
Coreopsis Flying Saucer™ tickweed
Eryngium 'Sapphire Blue'
Filipendula 'Midwest Dream'
Gaillardia ×*grandiflora* 'Baby Cole'
Geranium ×*cantabrigiense* 'Karmina'
Heuchera micrantha var. *diversifolia* 'Absi', Bressingham Bronze™ alumroot
Hibiscus 'Blue River II'
Iberis sempervirens 'Purity'
Lithodora diffusa 'Grace Ward'
Persicaria amplexicaulus 'Taurus'
Physostegia virginiana subsp. *speciosa* 'Variegata'
Polemonium caeruleum 'Blanjou', Brise d'Anjou™ Jacob's ladder
Pulmonaria 'Little Star'
Stokesia laevis 'Silver Moon'
Tiarella ×*hybrida*
Veronica gentianoides 'Barbara Sherwood'

Screening Process. Plants were initially screened for a response to BA. Twenty-four juvenile plants without lateral breaks were potted in 3.5-inch pots in March through July 1999. Plants were potted in Fafard 1P potting mix. Twelve plants were treated with no hormone (control) and 12 plants were treated with a 1000 ppm N-6-benzyladenine (BA) solution. A surfactant was added to the solution at 1 ml gal^{-1}. Firstly, the foliage was sprayed with the BA until runoff and then the crown was saturated. After 30 days, the number of lateral breaks and the foliage quality were graded for each plant. The foliage quality was determined by using assigned numbers to describe the appearance of the foliage (0-dead; 1-dying, diseased, or desiccated; 2-chlorotic; and 3-healthy). If there was a significant difference in the number of lateral breaks between treated and non-treated plants, the crop was put into an experiment using various concentrations of BA. After trialing several plants and observing BA's effect on internode length; height measurements were included in the screen. Over the 30-day growing period, plants were watered with a 200 ppm of 20N-10P-20K liquid fertilizer with micronutrients and grown in a double poly greenhouse with glaze.

Experimental Design. Eighteen juvenile plants without lateral breaks were potted up into 3.5-inch pots using Fafard 1P potting mix. Plants for the *E.* 'Sapphire Blue,' *P.* 'Taurus,' and *V.* 'Barbara Sherwood' experiment were taken from the cuttings rooted down in the screening process. Nine plants of each crop were treated with 1000 ppm, 2000 ppm, 4000 ppm, or no treatment (control). Lateral breaks were counted and the foliage quality was rated after 30 days.

In the second part of the experiment, 12 cuttings were taken from the plants in each treatment when available (the control in some crops did not show lateral breaks.) If plants had no lateral breaks, the mother plants were used for rooting success analyses. Cuttings were treated with the appropriate rate of indole 3-butryic acid, potassium salt (IBA-K) that is used during production and stuck in saleable flats. After sticking, cuttings were treated with a Subdue Max/Clearys 3336 FL drench as directed by the label. After 15 days, rooting success was measured. Three factors determined the plantlet's rooting success: root rate, root number, and foliage quality. Root rate was determined by assigning the cuttings numbers (0-dead, 1-no callus, 2-callus, and 3-roots greater than 2 mm). The number of roots was counted and foliage rate was determined by assigning numbers based on foliage appearance (0-dead; 1-dying, diseased, or desiccated; 2-chlorotic; and 3-healthy).

RESULTS

Screen. There was no significant difference in the number of lateral breaks when *C.* 'Chettle Charm' and *L.* 'Grace Ward' were treated with 1000 ppm BA. *Coreopsis* Flying Saucer™ *coreopsis*, *E.* 'Sapphire Blue,' *G.* ×*grandiflora* 'Baby Cole,' *P.* 'Taurus,' *V.* 'Barbara Sherwood,' *H.* 'Bressingham Bronze,' *B. macrophylla*, *G.* ×*cantabrigiense* 'Karmina,' *P. caeruleum* 'Blanjou', Brise d'Anjou™ Jacob's ladder, *S.* 'Silver Moon,' *I. sempervirens* 'Purity,' *F.* 'Midwest Dream,' *H.* 'Blue River II,' *P.* 'Little Star,' *P.* 'Variegata,' and *T.* ×*hybrida* all exhibited significantly more lateral breaks when treated with 1000 ppm BA. Benzyladenine appeared to have an effect on the growth habits in most of the plants screened. Smaller leaves were observed in *E.* 'Sapphire Blue' and *V.* 'Barbara Sherwood' plants that were treated with BA. When *G.* ×*grandiflora* 'Baby Cole' was treated with BA, plants remained in a juvenile stage; BA-treated plants had smooth leaves, nontreated plants had jagged leaves. Overall canopy height of BA-treated *P.* 'Taurus' plants was approximately 20% less than in the control. Petiole length appeared to be shorter in plants that were treated and the breaks of *P.* 'Taurus' were more swollen and thicker at the base than the plants not treated with BA. Again, *H.* 'Bressingham Bronze' and *C.* Flying Saucer™ coreopsis plants treated with BA were shorter and more compact than plants in the control. No plants showed any phytotoxicity to the foliage when treated with BA during the screen. Some cuttings were taken from plants that were "cuttable" after 30 days to qualitatively observe whether rooting might have been affected. There was no difference in rooting between treated and untreated cuttings of *P.* 'Taurus,' *E.* 'Sapphire Blue,' *V.* 'Barbara Sherwood,' and *H.* 'Bressingham Bronze' after 30 days.

Optimal BA Rate. There was a significant difference in the number of lateral breaks when *P.* 'Taurus' was treated with 0, 1000, 2000, and 4000 ppm BA ($P<.001$). A large increase in the number of lateral breaks from the control to the 1000 ppm treatment was found. After 1000 ppm, the number of lateral breaks leveled off and

started to decrease at 4000 ppm (Fig. 1). However, there was no significant difference between the 1000, 2000, and 4000 ppm treatments. In addition, there was no significant difference in foliage quality between treatments. We qualitatively observed a decrease in petiole length and leaf size as the concentration of BA increased.

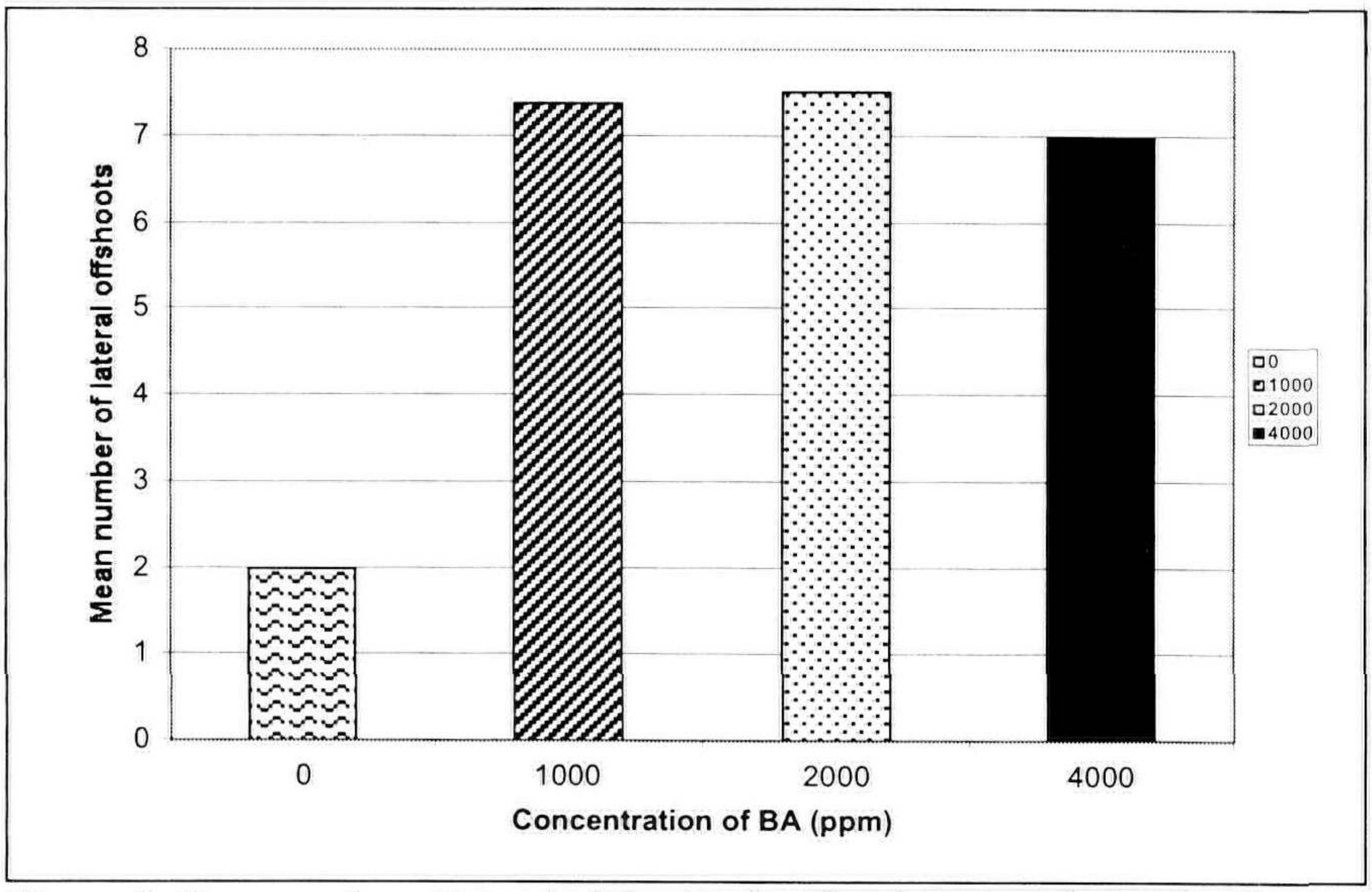

Figure 1. Mean number of lateral offshoots when *Persicaria amplexicaulus* 'Taurus' was treated with various concentrations of benzyladenine.

Veronica gentianoides 'Barbara Sherwood' performed similarly when treated with 0, 1000, 2000, and 4000 ppm BA. There was a significant effect of BA on the number of lateral breaks in eachtreatment ($P<.001$). From the control to 1000 ppm, there was a sharp increase in the number of lateral breaks. After 1000 ppm, the number of lateral breaks leveled off (Fig. 2). There was no significant difference in the number of lateral breaks between the 1000, 2000, and 4000 ppm treatments, nor was there a significant difference in foliage quality between all of the treatments. Plants became more compact and had decreased leaf size as the concentration of BA increased. Cuttings were not immediately taken when the data was collected because there was not enough of a conversion zone present after 30 days for successful rooting. Currently, cuttings in each treatment under mist do not appear to be rooting differently.

Gaillardia ×*grandiflora* 'Baby Cole,' *P. caeruleum* 'Blanjou', Brise d'Anjou™ Jacob's ladder, and *H.* 'Bressingham Bronze' which were treated with 1000, 2000, and 4000 ppm BA during July and August did not perform well. High temperatures caused leaf burn and eventually death in all treated plants while plants in the control had normal growth. *Persicaria amplexicaulus* 'Taurus' plants treated with BA had approximately 25% to 50% smaller root masses than nontreated plants. Phytotoxicity to the foliage and a reduction in root mass was not observed in the *G.*

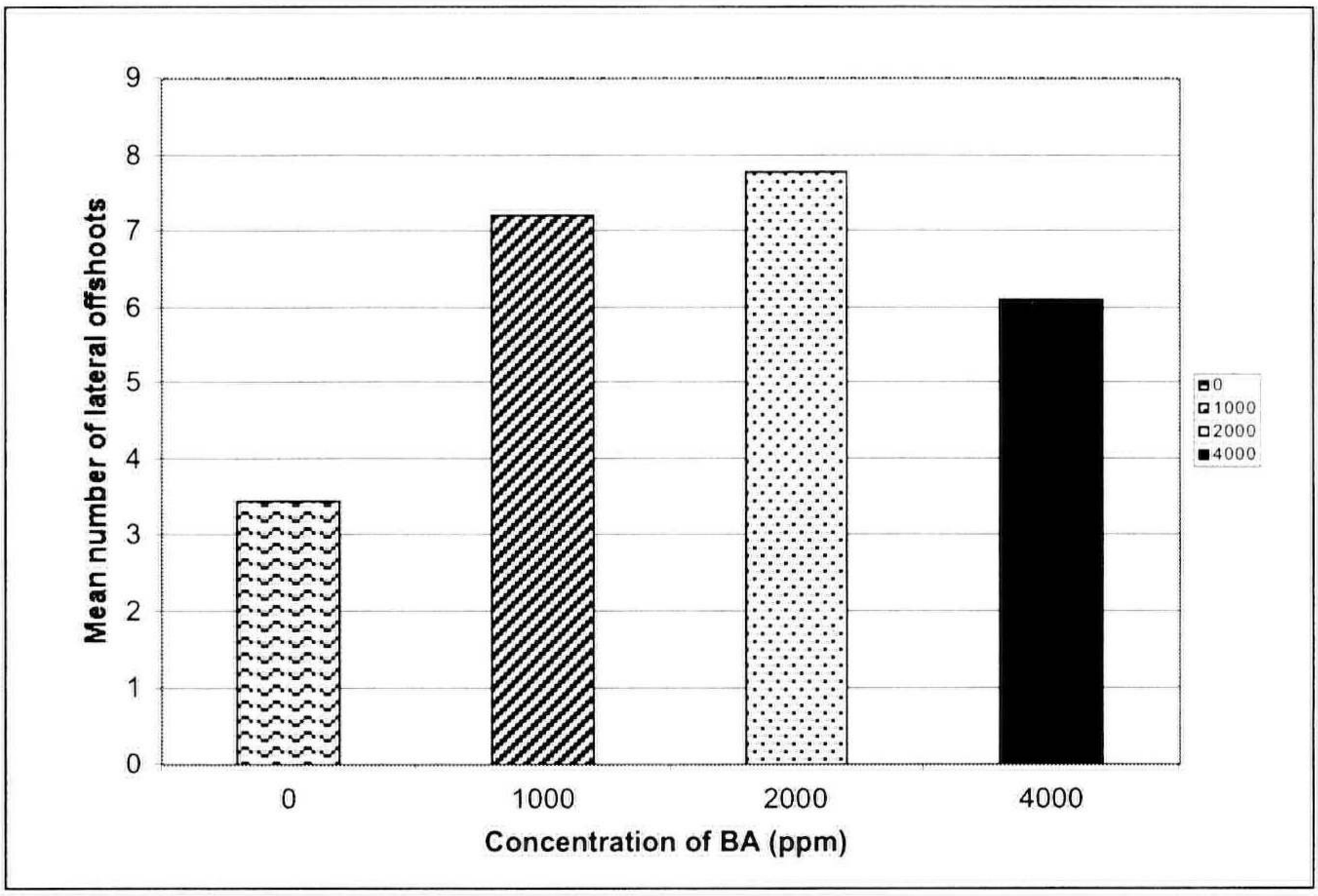

Figure 2. Mean number of lateral offshoots when *Veronica gentianoides* 'Barbara Sherwood' was treated with various concentrations of benzyladenine.

×*grandiflora* 'Baby Cole', *P. caeruleum* 'Blanjou', Brise d'Anjou™ Jacob's ladder, *H.* 'Bressingham Bronze,' and *P.* 'Taurus' screen in Sept. 1999.

DISCUSSION

Screen. As expected, BA had an effect on the number of lateral offshoots for the majority of the plants tested (Garner et al., 1997b). All plants that naturally break from the ground except *C.* 'Chettle Charm' had significantly greater offsets when treated with BA. The 1000 ppm treatment was effective in releasing lateral buds from apical dominance for *E.* 'Sapphire Blue,' *C.* Flying Saucer™ coreopsis, *G.* ×*grandiflora* 'Baby Cole,' *P.* 'Taurus,' *V.* 'Barbara Sherwood,' *H.* 'Bressingham Bronze,' *B. macrophylla*, *G.* ×*cantabrigiense* 'Karmina,' *P. caeruleum* 'Blanjou', Brise d'Anjou™ Jacob's ladder, *S.* 'Silver Moon,' *I. sempervirens* 'Purity,' *F.* 'Midwest Dream,' *P.* 'Little Star,' *H.* 'Blue River II,' and *P.* 'Variegata.' Not only were there significantly more offshoots when treated with BA, the lateral breaks were more uniform than in the control treatment. This could mean less production time spent grading cuttings and improving cell flat uniformity. Petiole length was decreased in *P.* 'Taurus' making the plants more attractive and easier to hold (would require less mechanical pruning). In addition to the increased number of lateral breaks in BA-treated plants, the cuttings when placed under intermittent mist rooted without any noticeable differences (Keever, 1994).

Optimal BA Treatment. According to our initial studies, the lowest concentration of BA, which was effective at releasing lateral bud dormancy and increasing the number of lateral offshoots was 1000 ppm. We hope to continue studies at lower concentrations of BA since the chemical is relatively expensive. As in other studies,

phytotoxicity was observed in the foliage when temperatures were unusually high (Keever, 1994). From our experience applying BA during the summer, we have observed that many plants are temperature sensitive to BA. Plants that were treated grew best when BA was applied at temperatures 30°C or below. In addition, plants treated with 4000 ppm BA appeared over treated. Lateral buds had begun to develop but offshoots were so small plants required more growing time before cuttings were available.

Based on the screening process, there is a great potential for increasing production by applying BA to stock plants. We hope to continue our studies to find optimal rates of application that cost Green Leaf the least amount of money.

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