# Effects of Plant Growth Regulators on *Linaria maroccana*©

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***Linaria maroccana* is a small and vigorous annual plant. It is sometimes referred to as toadflax or miniature snapdragon. The Fantasy series has several colors, such as, yellow, white, pink, blue, and rose. Some colors are more vigorous than the others. The goal was to discover if plant growth regulators (PGR) or their combinations could provide acceptable growth control and would produce a plant more proportional to the plant container. Materials used include: B-Nine (daminozide), Bonzi (paclobutrazol), Cycocel (chlormequat chloride), A-Rest (ancymidol), Florel (ethephon), or Sumagic (uniconazole). Tests were conducted for the 1997 and 1998 California Pack Trials. Plants were grown in 4-inch pots. Several materials exhibited acceptable growth control (B-Nine combined with Cycocel at 2500 + 1500 ppm, respectively). However, and more importantly, it was discovered that timing of the application in relationship to plant size is an important factor for obtaining desirable growth control; early treatments must be made when plants are 1½ inches tall.**

## INTRODUCTION

*Linaria maroccana* is a small and vigorous growing annual plant. Sometimes referred to as toadflax, or miniature snapdragon, it is a hardy plant, which, performs well during cool weather. American Takii Seed Inc., Salinas, California, has in the past few years, been developing a new series of *Linaria* for compact growth and fuller canopy growth. The series (Fantasy) consists of many colors, i.e., yellow, white, pink, blue, and rose. Several colors appears to be more vigorous than the others and would benefit from plant growth regulators.

The goal of American Takii Seed and Uniroyal Chemical Co. was to discover what plant growth regulators or their combination could provide acceptable growth control. Products used included: B-Nine (daminozide, Uniroyal Chemical Co.), Bonzi (paclobutrazol, Uniroyal Chemical Co.), Cycocel (chlormequat chloride, Olympic Horticultural Products), A-Rest (ancymidol, SePRO Corp.), Florel (ethephon, Monterey Chemical), or Sumagic (uniconazole, Valent Professional Products). The tests were conducted, in part, for the 1997/1998 California Pack Trials. Several products did exhibit good growth control; however, more importantly, it was discovered thattiming of the applications in relationship to plant size, is a key factor in obtaining any activity from PGRs.

## MATERIALS AND METHODS

Three tests were conducted during the period of winter/spring 1997, and winter/spring 1998. The trials were conducted at American Takii Seed Inc. located in Salinas, California. Weather during this time of year is cool and typically may have

**List 1.** Test 2 treatment list.

| Treatment | Rate (ppm) | Application frequency (1×, 2×, 3×) and letter code |
|---|---|---|
| 1. B-Nine WSG. | 2500 | b. 2 × |
| 2. B-Nine WSG. | 5000 | a. 1 × |
| 3. B-Nine WSG | 5000 | b. 2 × |
| 4. B-Nine WSG | 5000 | c. 3 × |
| 5. Bonzi | 10 | d. 1 × drench |
| 6. Bonzi | 20 | d. 1 × drench |
| 7. Bonzi | 30 | d. 1 × drench |
| 8. Bonzi | 60 | d. 1 × drench |
| 9. Bonzi | 15 | e. 1 × sprench |
| 10. Bonzi | 15 | f. 2 × sprench |
| 11. Bonzi | 30 | e. 1 × sprench |
| 12. Bonzi | 30 | f. 2 × sprench |
| 13. Bonzi | 60 | e. 1 × sprench |
| 14. Bonzi | 60 | f. 2 × sprench |
| 15. Cycocel | 1000 | b. 2 × |
| 16. Cycocel | 1500 | b. 2 × |
| 17. Cycocel | 2000 | a. 1 × |
| 18. Cycocel | 2000 | b. 2 × |
| 19. Cycocel | 3000 | a. 1 × |
| 20. Cycocel | 3000 | b. 2 × |
| 21. A-Rest | 25 | a. 1 × |
| 22. A-Rest | 25 | b. 2 × |
| 23. A-Rest | 50 | a. 1 × |
| 24. A-Rest | 50 | b. 2 × |
| 25. A-Rest | 20 | d. 1 × drench |
| 26. A-Rest | 40 | d. 1 × drench |
| 27. B-Nine + Bonzi | 2500 + 15 | b. 2 × |
| 28. B-Nine + Bonzi | 2500 + 30 | b. 2 × |
| 29. B-Nine + Bonzi | 5000 + 30 | a. 1 × |
| 30. B-Nine + Bonzi | 5000 + 30 | b. 2 × |
| 31. B-Nine + Bonzi | 5000 + 60 | a. 1 × |
| 32. B-Nine + Bonzi | 5000 + 60 | b. 2 × |
| 33. B-Nine + CCC | 2500 + 1000 | b. 2 × |
| 34. B-Nine + CCC | 2500 + 1500 | b. 2 × |
| 35. B-Nine + CCC | 5000 + 2000 | a. 1 × |
| 36. B-Nine + CCC | 5000 + 2000 | b. 2 × |
| 37. B-Nine + CCC | 5000 + 3000 | a. 1 × |
| 38. B-Nine + CCC | 5000 + 3000 | b. 2 × |
| 39. Untreated control | | |

many days of overcast skies. Day temperatures average at 60°F and night temperatures average 48°F. Plants were grown in 4-inch pots, outside, using standard commercial growing practices.

**Test 1.** Five colors of *Linaria* were tested for growth control, applications used were: Bonzi, B-Nine, Cycocel, Sumagic, Florel, A-Rest, and an untreated control. Plants were sown on 6 Jan. 1997 into 276-plug trays. Developed plugs were then transplanted into 4-inch pots, allowed to establish, and then pruned back to 2 inches. All plants were pruned to uniform size, providing for a consistent starting point for all treatments. Treatments were applied on 14 Feb. 1997 using: untreated control, B-Nine at 5000 ppm, Cycocel at 1500 ppm, Bonzi at 20 ppm, A-Rest at 20 ppm, Sumagic at 20 ppm, and Florel at 500 ppm. All sprays were made to runoff (2 qt 100 $ft^{-2}$).

**Test 2.** The goal for this trial was to simply find a product or combination of products, that would elicit a response from the treatment. Having no activity from the previous year's work. The trial ended up having a total of 39 treatments (List 1, treatment list). Some of the applications had one application, 1X; or two applications, 2X; etc. Plants were produced from plugs (sow date of 26 Jan. 1998) then transplanted (transplant date of 19 Feb. 1998) into 4-inch pots and allowed to establish for 1 week. The first applications were made when the plants had 1 to 2 side-shoots averaging ½ inches long. In addition, they had 10 to 12 leaves and were approximately 1½ inches tall. Sprays were applied using 2 qt 100 $ft^{-2}$, drenches at 840 gal $acre^{-1}$, and drenches at 2 oz per pot. Plants were grown outside, during the months of February and March 1998.

Weather was normal for the Salinas, California, area; cool with some overcast days.

**Test 3.** The last test was designed to produce plants for the Ohio Short Course, as a demonstration plot. In this experiment, six treatments were evaluated for growth control; they were: B-Nine at 7500 ppm, 2X; Bonzi at 50 ppm, 2X drench; Bonzi 5 ppm, 1X drench; B-Nine + Cycocel at 2500 + 3000 ppm, 1X; B-Nine + Bonzi at 2500 + 50, 1X; and an untreated control. Seeds were sown on 13 May 1998 in 276-plug trays. Plants were transplanted on 2 June 1998 into 4-inch pots. Applications were on 5 June 1998 to 1½ inches tall plants, having a diameter of 2 inches. Spray volume was 2 qt 100 $ft^{-2}$, drench volume was 840 gal $acre^{-1}$, and the drench volume was 2 oz per pot. Plant height measurements were taken 32 days after treatment. B-Nine + Cycocel attained the desired goal of 5.5 inches for a 4-inch pot versus the untreated control at 7.4 inches. B-Nine + Cycocel produced the most proportionate plant for the size container.

**Table 1.** Test 1: Mean plant height (inches), first application.

| | A-Rest | UTC | CCC | B-Nine | Florel | Sumagic | Bonzi |
|---|---|---|---|---|---|---|---|
| Fantasy White | 10.5 | 10.5 | 11.0 | 11.0 | 11.0 | 10.5 | 10.5 |
| Fantasy Pink | 10.0 | 10.5 | 9.75 | 10.5 | 10.0 | 9.5 | 9.5 |
| Fantasy Rose | 10.25 | 10.5 | 10.5 | 10.75 | 10.75 | 10.5 | 10.5 |
| Fantasy Blue | 10.5 | 10.0 | 8.0 | 8.75 | 11.0 | 10.0 | 10.5 |
| Fantasy Yellow | 9.0 | 9.25 | 9.25 | 9.0 | 9.0 | 9.0 | 8.0 |

**Table 2.** Test 1: Mean plant height (inches), second application.

| | UTC | CCC | B-Nine | B-Nine+Bonzi | Sumagic | Bonzi |
|---|---|---|---|---|---|---|
| Fantasy White | 7.5 | 8.0 | 7.5 | 6.75 | 7.0 | 6.75 |
| Fantasy Pink | 8.0 | n/a | n/a | n/a | n/a | 6.5 |
| Fantasy Rose | 7.25 | n/a | n/a | 7.5 | 7.0 | 7.0 |
| Fantasy Blue | 7.5 | 6.0 | 8.5 | n/a | n/a | n/a |
| Fantasy Yellow | 6.5 | 6.25 | 7.0 | n/a | 7.25 | n/a |

## RESULTS AND DISCUSSION

**Test 1.** Plants were evaluated 28 DAT (days after treatment) on 14 March 1997. No treatments produced a significant difference versus the untreated control. All plants were similar to the untreated control (Table 1). Because of no response from this first test the blocks were split and a second application was made to some of the colors. The plants were again pruned down to 3 inches, treated and measured on 11 April 1997, 28 DAT. Applications made were: Cycocel at 3000 ppm, B-Nine at 5000 ppm, B-Nine + Bonzi at 5000 + 20 ppm, Sumagic at 100 ppm, and Bonzi at 100 ppm. Again, no significant difference was observed from any of the second applications (Table 2).

**Test 2.** Plants were evaluated on 11 April 1998 for height control. Plants of acceptable size were those treated with: B-Nine + CCC at 5000 + 3000 ppm, 1× spray (5.4 inches); B-Nine + CCC at 2500 + 1500 ppm, 2× spray (5.5 inches); A-Rest at 20 ppm, 1× drench (5.5 inches). Other treatments that looked very good were: B-Nine + Bonzi at 2500 + 30 ppm, 2× spray (5.0 inches); Bnine + CCC at 2500 + 1000 ppm, 2× spray (5.1 inches); Bonzi at 60 ppm, 2× sprench (5.2 inches). All other treatments were considered unacceptable for commercial sale. It became very clear that *Linaria* was a plant that can respond to PGRs; however, it must receive these applications early in the crop cycle for optimum effect. Some of the treatments that would be considered aggressive, i.e., B-Nine at 5000 ppm (3×), resulted in no significant difference compared to the untreated control. (7.0 inches versus 7.3 inches, respectively). It did appear that combination treatments performed better than stand alone applications, for example, B-Nine at 5000 ppm, 1× (9.1 inches); or CCC at 3000 ppm, 1× (7.2 inches) versus the two combined 1× (5.4 inches).

**Test 3.** Plant height measurements were taken 32 DAT (Table 3). B-Nine + Cycocel attained the desired goal of 5.5 inches for a 4-inch pot versus the untreated control at 7.4 inches. B-Nine +Cycocel produced the most desirable plant for the size container. All other treatments were unacceptable for commercial sale. It appeared that B-Nine sprayed alone, was not effective on *Linaria*, but when combined with Cycocel or Bonzi it was. The Bonzi drench rate of 5 ppm 1× produced a similar looking plant (4.9 inches) versus the B-Nine+Cycocel plant (5.5 inches). This may warrant further investigation into refining the rate down, for example 2 or 4 ppm 1× and 2×.

**Table 3.** Test 3: Mean plant height 32 days after treatment (inches).

| | UTC | B-Nine WSG | Bonzi sprench | B-Nine + Bonzi | Bonzi | B-Nine + Cycocel |
|---|---|---|---|---|---|---|
| Fantasy Yellow | 7.45 | 6.46 | 4.0 | 4.65 | 4.98 | 5.5 |

* A sprench application is a heavy spray allowing for significant run off from the leaves into the soil. Applications made in this test were made at 840 $ac^{-1}$.

## CONCLUSIONS

It appeared from the above tests that one can achieve proper height control on *L. maroccana* Fantasy series. The success of any plant growth regulator applied to this plant must be done early in the crop cycle, preferably, when the young transplants are 1.5 inches to no more than 2 inches tall. Plants of this size should have a couple of side shoots, ½ inch long. Spray applications made to larger plants will probably not respond to the treatment, even if used at aggressive rates. Two sprays appear to work better than one spray. Two products combined (B-Nine + Cycocel) performed better than as separate applications. With appropriate height control, *Linaria* can be grown in 4-inch pots and results in a plant well proportioned to the container.