# GROWTH REGULATORS ON POINSETTIAS*

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Short, properly proportioned poinsettias are becoming more numerous with each passing season. The development of new and better growth regulators are largely responsible for this change. More information is required, however, before results are as efficient and consistent as desired in all sections of the country.

Widmer (10) in 1962 recommended controlling the height of poinsettias in Minnesota with soil applications of the growth regulator 2-chloroethyl trimethylammonium chloride (Cycocel) at rates from 1730 to 5200 ppm, depending on time of application. He further stated that soil application to young plants was more effective than was soil application to stock plants or treatment of rooted or unrooted cuttings. In addition to controlling plant height, the treatment resulted in a darker green foliage color and smaller, more compact bract clusters.

Kiplinger (3), Widmer (10, 11) and Gaertner, Wilkins and Coorts (2) found that concentrations of Cycocel greater than the 3000 ppm suggested by the manufacturer were frequently necessary to limit plant height effectively. Widmer (11) in 1963 recommended for application to the variety Barbara Ecke Supreme in Minnesota, a drench of 6000 ppm through August, and 3000 ppm in September and early October. Rothenberger and Rogers (8) found that different poinsettia varieties react differently to applications of Cycocel. They reported further that application of a liquid drench was preferable, and that it should be applied when the young plants begin vigorous growth. Cathey (1) also recommended a soil drench. Lindstrom (5) stated that treated plants showed a tendency to grow out of the effect of the growth regulator after the plants were shifted to untreated soil in the final pans. Rothenberger and Rogers (8) did not find any tendency of the plants to grow out of the effect of treatment after they were shifted to final pans.

Larson and Mc Intyre (4) found that N-dimethylaminosuccinamic acid (B995) provided good height control when foliar sprays of 10,000 and 15,000 ppm were applied to plants of Barbara Ecke Supreme and Indianapolis Red propagated between August 1 and 15. Widmer (11) found that foliar applications of B995 at rates up to 10,000 ppm were not as effective in limiting plant stretch as was a soil drench of 6000 ppm Cycocel.

## Materials and Methods

Detailed studies were conducted, in the University greenhouses on the St. Paul Campus, to determine further the effect of culture and environment on the

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reaction of Barbara Ecke Supreme poinsettia to growth regulators. Soil drench and foliar applications were also compared.

All plants were rooted in soil in pots under intermittent mist, unless otherwise specified. A soil mixture of 2 parts sphagnum peat moss, 1 part loam and 1 part sand was used for rooting. The panning soil was a mixture of 2 parts loam, 1 part sphagnum peat moss and 1 part sand. Both mixtures were steam sterilized. All plants were grown in full light intensity, in the natural photoperiod and at a minimum temperature of 60°F., unless otherwise indicated. The plants were freely watered and fertilized, if the specific treatment did not require otherwise. Quantities of growth regulator solution applied as a soil drench were 17,100 and 250 ml. per 2½, 4 and 6-inch pots respectively.

## Time of Panning-Growth Regulator Relationship

Objective of this study was to determine whether panning immediately after treatment with a Cycocel drench would alter the effectiveness of the growth regulator. Plants propagated on August 15, 1963 were divided into six similar groups of 36 plants each, and treated on September 12. All plants were actively growing in 2½-inch pots when treated. Three groups were planted four to a 6-inch pan immediately following treatment; while the other three groups, similarly treated, were panned on October 11. Plants which remained in 2½-inch pots from September 12 to October 11 were fertilized regularly so that the soil nutrient supply would not be a limiting factor. Treatments and results are shown in Table 1.

Table 1. Effect of Cycocel applied to the soil on September 12, in relation to time of panning.

| Treatment | Mean height (inches) | | Bract diameter (inches) | |
|---|---|---|---|---|
| | panned Sept. 12 | panned Oct. 11 | panned Sept. 12 | panned Oct. 11 |
| Check | 19.2 | 15.7 | 14.9 | 14.1 |
| 3000 ppm Cycocel | 15.6 | 14.1 | 14.7 | 14.0 |
| 6000 ppm Cycocel | 14.5 | 11.5 | 13.1 | 14.3 |

Delayed panning resulted in shorter plants in each treatment. The differences in plant height between check and treated plants were greater for the plants panned September 12. With early panning there was also a tendency for greater reduction in bract diameter. These results are in agreement with those obtained by Widmer (11) in 1962. Such results lead to the conclusion that treated plants shifted to untreated soil in the final pans grew taller because of a greater water supply in the greater soil volume, rather than because the roots grew into untreated soil.

## Fertilizer-Growth Regulator Relationship

Plants propagated on August 14, 1962 were divided into six similar groups of 30 plants, and treated with growth regulators on September 13. Cycocel was applied as a soil drench and B995, with Tween 20 wetting agent, as a foliar spray. Although all plants were a healthy green color on October 3, they received no additional fertilizer prior to transfer from 2½-inch pots to 6-inch pans on November 3. Therefore, foliage color at time of panning was greenish-yellow and the plants were "hard". Normal foliage color returned gradually following panning and supplemental applications of fertilizer. The effect on anthesis (time of appearance of pollen) is shown in Table 2.

Table 2. Effect of growth regulators on anthesis of under-fertilized poinsettias in 1962.

| Treatment | Percent of plants showing pollen | | | Comments |
|---|---|---|---|---|
| | Dec.3 | Dec. 10 | Dec. 17 | |
| Check | - | - | 10 | More advanced than Cycocel plants |
| Cycocel 6000 ppm | - | - | - | Some did not show pollen by December 28. |
| B995 1225 ppm | - | 10 | 20 | |
| B995 2500 ppm | 3 | 30 | 70 | |
| B995 5000 ppm | 17 | 53 | 70 | |
| B995 10,000 ppm | 33 | 57 | 90 | |

A severe deficiency of nutrients delayed maturity of the flowers and bracts by approximately two weeks. Plants treated with Cycocel were even slower in developing than were the untreated check plants. Quite to the contrary, treatment of plants with B995 accelerated bract and flower development in direct proportion to the concentration used.

A follow-up study was conducted with Cycocel in 1963. Plants propagated on September 4 were divided into eight similar groups of 15 each on October 9 and treated with Cycocel soil drenches. Four groups received regular applications of a complete fertilizer and four were unfertilized for the duration of the study. All plants were grown in 2½-inch pots throughout the study. Results are presented in Table 3.

Fertilized and unfertilized check plants were similar in date of maturity. Size of bract cluster was smaller on unfertilized plants. Unfertilized plants treated with Cycocel were slower to mature than were unfertilized check plants. Fertilized plants treated with 3000 and 6000 ppm Cycocel matured earlier than fertilized check plants. Fertilized plants treated with 1500 ppm Cycocel were slower to mature during the period from December 16 to 24. This sudden "slow down" in development may have resulted from root injury and leaf abscission caused by accidental over-fertilization of plants in this treatment.

Table 3. Effect of growth regulators on anthesis of poinsettias grown in two fertilizer treatments in 1963.

| Treatment | Percent of plants showing pollen | | | | | |
|---|---|---|---|---|---|---|
| | Dec. 11 | Dec. 13 | Dec. 16 | Dec. 18 | Dec. 20 | Dec. 24 |
| No fert - check | 13 | 20 | 60 | 67 | 73 | 87 |
| No fert - Cycocel 1500 ppm | 7 | 13 | 20 | 33 | 47 | 67 |
| No fert - Cycocel 3000 ppm | 7 | 13 | 33 | 40 | 67 | 93 |
| No fert - Cycocel 6000 ppm | 13 | 20 | 40 | 47 | 67 | 73 |
| Fert. check | 13 | 13 | 47 | 60 | 73 | 100 |
| Fert. Cycocel 1500 ppm | 7 | 13 | 47 | 47 | 60 | 60 |
| Fert. Cycocel 3000 ppm | 27 | 33 | 67 | 73 | 93 | 93 |
| Fert. Cycocel 6000 ppm | 33 | 53 | 87 | 93 | 100 | 100 |

Studies for both years indicate that severe under-fertilization of Cycocel-treated poinsettias will delay flower development up to several weeks.

## Temperature-Growth Regulator Relationship

Roberts and Struckmeyer (7) found that the poinsettia remained vegetative when grown at a minimum temperature of 70°F in a short photoperiod. Stuart (9) reported that several azalea cultivars responded to the application of growth retardants, such as Cycocel and B995, by stopping shoot growth and initiating flowers. Objective of this study was to determine whether the growth regulator would override the effects of a high night temperature. If so, Christmas poinsettias could be propagated later, grown warmer and produced in a shorter period of time.

Actively growing plants which had been propagated on July 30, 1962 were planted four plants per 6-inch pan on October 8. They were divided into six similar groups of eight pans each on November 5. Three groups were grown at a 63°F night temperature, and the other three, at 73°F. Treatments applied on November 9 were 0, 1500 and 3000 ppm Cycocel soil drenches at each temperature.

An additional lot of plants propagated on August 21, 1962 was panned on October 31, divided into groups and treated on November 5. Treatments and plant number were the same as those listed in the preceding paragraph.

In both studies, the plants at 73°F failed to bloom properly and only a few pale bracts developed by December 17. There were no differences in bract and flower development between check and treated plants at the high temperature. Bracts and flowers developed normally at 63°F and treated plants were only slightly shorter than untreated plants.

Because poinsettias usually initiate flower buds in late September or early October in Minnesota, the temperature-growth regulator study was repeated in 1963 with earlier application of the growth regulator. Actively growing plants which had been propagated on September 4 were graded into eight similar groups of 15 plants each and treated on September 30. Four groups were treated with 0, 1500, 3000 and 6000 ppm Cycocel and grown at a night temperature of 60°F. The other four groups were treated similarly and grown at 70°F. All plants remained in 2½-inch pots until Christmas.

Once again, regardless of treatment, bract and flower development was normal at the lower temperature and limited as well as abnormal at the higher temperature. Bract and flower development was slightly better at 70°F in 1963 than at 73°F in 1962. The growth regulator did not override the effects of a high night temperature.

## Photoperiod-Growth Regulator Relationship

Post (6) reported that poinsettia bud initiation occurred when the daylength was not more than 12 hours. The objective of this study was to determine whether or not the use of a growth regulator would alter the effect of long days on the poinsettia. Actively growing plants which had been propagated on September 4 were divided into eight similar groups of 15 plants each and treated on September 30. Four groups were treated with a soil drench of 0, 1500, 3000 and 6000 ppm Cycocel and grown in natural daylength. A second group of four were given the same Cycocel treatments and lighted for 3 hours in the middle of each night thereafter.

Plants subjected to a long photoperiod failed to initiate flower buds until the lights were discontinued in December. The growth regulator did not visibly nullify or modify the effect of long days on the plants.

## Temperature-Photoperiod-Growth Regulator Relationship

As reported under the section on Fertilizer-Growth Regulator Relationship, a foliar spray of B995 accelerated flowering when the plants were severely under-fertilized. This experiment was conducted to determine whether or not B995 applied as a foliar spray would alter the effect of a high night temperature or a long photoperiod.

Cuttings taken September 19 were maintained at 70°F until the intermittent mist was discontinued on October 19. All plants were subjected to a long photoperiod from October 2 to 21. On October 21 the plants were divided into eight treatements of 30 plants each as follows:

| | | | | |
|---|---|---|---|---|
| 1 | Natural photoperiod | 60°F nights | | |
| 2 | Short " | 60°F " | | |
| 3 | Natural " | 70°F " | | |
| 4 | Short " | 70°F " | | |
| 5 | Natural " | 60°F " | 5000 ppm, B995 | |
| 6 | Short " | 60°F " | " " | " |
| 7 | Natural " | 70°F " | " " | " |
| 8 | Short " | 70°F " | " " | " |

Black cloth applied from October 21 to November 12 was used to provide the short (8 hour) photoperiod. The B995 was applied with Dreft (1 tbsp. per 2 gal) as a wetting agent. Plants were grown to maturity in 2½-inch pots.

Unfortunately the 70°F greenhouse dipped below 70° at irregular intervals. Therefore, fairly normal bracts and flowers formed at both temperatures for

check and treated plants. At the lower temperature, B995 delayed bract and flower development by approximately one-half week. At the higher temperature B995 did not alter flowering time. Short-day plants were approximately one week earlier in blooming regardless of other treatments. The use of B995 on the properly fertilized plants in this experiment did not significantly alter the flowering date.

## Spray Applications

Most of the foregoing studies were based on soil applications of Cycocel. The person making the application must be cautious to apply equal quantities of solution to each pot for fairly uniform results. Foliar sprays, if equally effective, provide much more efficient use of growth retardant and manpower. The foliar sprays were applied to run off.

Cycocel Objective of these trials was to determine the effectiveness of Cycocel applied as a foliar spray with Dreft (1 tbsp. per 2 gal.) as a wetting agent. Plants propagated July 25 were treated on August 20 and September 19 as shown in Table 4. A soil drench of 6000 ppm was considered to be a Cycocel check. There were 10 plants per treatment. All plants were transferred to 4-inch pots on October 3.

As seen in Table 4, all treated plants were shorter than the untreated check, and the 6000 ppm rate was the most effective. The second foliar application was of questionable value, but caused no plant injury. Bract cluster size was reduced more by a soil drench than by spray applications. Results of this limited trial do not provide sufficient basis for definite recommendations, but several Minnesota commercial growers have reported good results with spray applications of Cycocel. Therefore, this method of application should be considered on a trial basis for the 1964 poinsettia crop.

B995 Objectives of these trials were to determine the effectiveness of foliar applications of B995 at higher rates than those used in 1962, and to determine whether fertilization practices influence the effect of the growth retardant. Dreft ( 1 tbsp. per 2 gal.) was used as a wetting agent.

Plants propagated on July 22 were divided into six similar lots of 24 plants each and treated on August 13. Half of the plants treated with B995 received a second application on September 19. A soil drench of 6000 ppm Cycocel was considered to be a growth regulator check treatment. Treatments are shown in Table 5. All plants were transferred from 2½-inch to 4-inch pots on October 2.

Results are presented in Table 5. All plants treated with B995 were shorter than the untreated check and Cycocel check plants. A second application made little difference in plant height but increased foliar injury. Foliar injury was evident a few days after application. Bract cluster size was reduced but a fuller center resulted in neater appearing clusters. No significant differences in time of anthesis were evident. All factors con-

Table 4. Effect of foliar spray and soil drench applications of Cycocel to poinsettias in 2½-inch pots. Prop. July 25

| Treatment | Plant height (inches) | | Bract diameter (inches) |
|---|---|---|---|
| | Sept. 10 | Dec. 20 | Dec. 20 |
| Untreated check | 10.3 | 21 | 15.8 |
| Cycocel, 6000 ppm soil | 7.7 | 15.3 | 13.8 |
| Cycocel, 1000 ppm spray | | | |
| Aug. 20 | 9.7 | 20.1 | 15.8 |
| Aug. 20 & Sept. 19 | | 22.- | 15.7 |
| Cycocel, 2000 ppm spray | | | |
| Aug. 20 | 9.3 | 20.5 | 15.4 |
| Aug. 20 & Sept. 19 | | 20.1 | 15.5 |
| Cycocel, 3000 ppm spray | | | |
| Aug. 20 | 8.5 | 19.1 | 15.5 |
| Aug. 20 & Sept. 19 | | 16.2 | 14.3 |
| Cycocel, 6000 ppm spray | | | |
| Aug. 20 | 7.5 | 15.8 | 14.4 |
| Aug. 20 & Sept. 19 | | 14.- | 14.6 |

Table 5. Effect of B995 and Cycocel on poinsettias in 2½-inch pots propagated July 22.

| Treatment | Plant height (inches) Dec. 18 | Bract Diameter (inches) Dec. 18 | Foliage injury* |
|---|---|---|---|
| Untreated check | 20.7 | 15.6 | None |
| Cycocel, 6000 ppm soil | 19.8 | 15.3 | None |
| B995, 5000 ppm spray | | | |
| Aug. 13 | 16.4 | 15.2 | None |
| Aug. 13 & Sept. 19 | 15.9 | 14.8 | An occasional leaf |
| B995, 10,000 ppm spray | | | |
| Aug. 13 | 13.7 | 14.8 | Slight on 2 plants |
| Aug. 13 & Sept. 19 | 12.3 | 14.0 | Slight puckering & necrosis on a few plants. |
| B995, 15,000 ppm spray | | | |
| Aug. 13 | 13.5 | 14.9 | Occasional on margin |
| Aug. 13 & Sept. 19 | 13.0 | 14.4 | Slightly more than with 2 applications of 10,000 ppm. |
| B995, 20,000 ppm spray | | | |
| Aug. 13 | 13.0 | 13.6 | Excessive |
| Aug. 13 & Sept. 19 | 11.3 | 12.6 | Excessive |

*Symptoms included yellowing of marginal areas, slight crinkling or puckering and some necrosis starting at the margins.

sidered a single application of 10,000 or 15,000 ppm B995 provided the most satisfactory results. Surprisingly, the soil application of 6000 ppm Cycocel was relatively ineffective. Observations made one month after application were similar to the final impressions. Therefore, the relative ineffectiveness of the Cycocel in this instance could not be attributed to a break down or using up of the chemical before the end of the study. The actual cause is not known.

Plants in the second study were propagated on July 31 and placed in five different fertilizer treatments. Within each fertilizer treatment there were three groups of 18 plants, each of which were treated with 0, 5000, and 10,000 ppm B995 on September 19. All plants were planted three to a 6-inch pan on September 27, with the same fertilizer treatments continued. Treatments are shown in Table 6. Unfertilized check plants made moderate growth because the potting soil contained a moderate supply of nutrients.

Results are presented in Table 6. Effectiveness of B995 in altering plant height and bract cluster diameter was inconsistent. The shortest plants were those in the check treatment which received no supplemental fertilizer. Little difference was noted among treatments in blooming time. In both studies the darker green foliage color which resulted from the use of B995 was still noticeable at Christmas time. The darker green foliage color of Cycocel treated plants was usually no longer evident at Christmas.

Reasons for the inconsistent results with B995 are not definitely known. Larson and Mc Intyre (4) in 1962 found that B995 provided good poinsettia height control with plants propagated between August 1 and 15, but only limited control with plants propagated between August 31 and September 14. Widmer (11) reporting on 1962 work, found fair to good height control with plants propagated July 20 and treated August 24, when B995 was applied at rates up to 10,000 ppm. With plants propagated August 14 and treated September 13, he reported fair height control at 10,000 ppm B995. The results of Larson and Mc Intyre coupled with Widmer's findings appear to indicate that B995 is most effective and consistent when applied prior to September.

Table 6. Effect of B995 and fertilizer treatments on poinsettias propagated July 31 and treated September 19.

| Treatment | Plant height (inches) Dec. 17 | Bract diameter (inches) Dec. 17 |
|---|---|---|
| Unfertilized Check 0, B995 | 17.6 | 11.5 |
| Unfertilized Check 5000 ppm B995 | 18.0 | 12.2 |
| Unfertilized Check 10,000 ppm B995 | 16.2 | 12.4 |
| 20-20-20 applied regularly 0, B995 | 23.0 | 12.6 |
| 20-20-20 applied regularly 5000 ppm B995 | 24.7 | 13.8 |
| 20-20-20 applied regularly 10,000 ppm B995 | 25.4 | 14.0 |
| 14-14-14 Low* 0, B995 | 22.8 | 13.4 |
| 14-14-14 Low* 5000 ppm B995 | 21.5 | 12.7 |
| 14-14-14 Low* 10,000 ppm B995 | 18.0 | 10.8 |
| 14-14-14 Med.* 0, B995 | 25.0 | 12.5 |
| 14-14-14 Med.* 5000 ppm B995 | 18.9 | 12.3 |
| 14-14-14 Med.* 10,000 ppm B995 | 19.8 | 11.9 |
| 14-14-14 High* 0, B995 | 23.8 | 13.4 |
| 14-14-14 High* 5000 ppm B995 | 22.2 | 14.1 |
| 14-14-14 High* 10,000 ppm B995 | 21.6 | 13.9 |

*The 14-14-14 fertilizer used was a heavy-coated, slow release material incorporated in the soil at the rates of 0.4, 0.8 and 1.6 grams per 2½-inch pot, and 4, 8, and 16 grams per 6 inch pan for the low, medium and high rates, respectively.

## Discussion

Widmer (11) recommended 6000 ppm Cycocel prior to September 1, and 3000 ppm Cycocel after September 1. The higher rate was used frequently after September 1 in the aforementioned studies with no adverse effects. In fact, the higher rate was needed in some instances to get the desired limitation of plant height. The reason for this was the unusual fall, 1963 weather. According to the official weather bureau records taken at International Airport in Minneapolis, September, October and November were 1.7, 9.7 and 7.8°F above average, respectively. Total possible sunshine was 1, 12 and 6 percent above normal for the same respective months.

Two factors must be considered when B995 is used. (1) This material should not be applied with a sprayer in which the chemical contacts any metal parts, as it corrodes the metal. (2) The B995 regulator was available commercially in 1963 under the trade name B-Nine which had a wetting agent incorporated. The commercial preparation caused severe foliage injury to poinsettias when used at rates in excess of 5000 ppm. Cause of the injury was the wetting agent, not the growth regulator. The manufacturer has stated that the wetting agent has been changed for the 1964 season.

The commercial grower should bear in mind that foliar sprays are most effective when they contain a wetting agent. On the other hand, soil drenches should not contain a wetting agent as plant injury may result. Commercial preparations of growth regulators are sometimes available with or without a wetting agent included. The right preparation must be used to prevent unnecessary injury.

## Conclusions and Summary

Studies were conducted to determine the effect of culture and environment on the reaction of Barbara Ecke Supreme variety to applications of growth retardants. The following conclusions resulted.

1. Shifting of poinsettias from 2½-inch pots to final pans shortly after treatment with a Cycocel soil drench did not lessen the effectiveness of the growth regulator.

2. Delayed panning resulted in shorter plants because of the more limited soil-water supply available to plants in the small pots.

3. Anthesis on severely underfertilized plants was as follows:
   a. Untreated check - delayed
   b. Cycocel soil drench - delayed more than check
   c. B995 foliar spray - accelerated in proportion to concentration applied

4. Anthesis was not significantly altered by the application of growth regulators to plants fertilized properly or slightly under-fertilized.

5. The application of Cycocel did not alter the effect of a high night temperature or a long photoperiod in preventing flowering.

6. Preliminary trials indicated that soil drenches and foliar applications of Cycocel provided similar plant responses.

7. Foliar applications of B995 provided variable results. Best results were obtained when the growth regulator was applied prior to September 1.

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