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EFFORTS TO ESCAPE AZALEA FLOWER BUD DORMANCY

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In 1962 the N. C. State studies on year-around flowering were started and it was apparent almost immediately that the big stumbling block to grower acceptance was azalea flower bud dormancy. The cool temperature requirements already were well known, but the installation of cool storage facilities, quite limited in size, was looked upon with disfavor by many growers. The application of some effective chemical to break dormancy seemed like a better idea, if such a chemical existed or looked promising.

The concept of breaking azalea flower bud dormancy with a chemical was reported in 1959 by Boodley and Mastalerz (3). They used the varieties "Hexe" and "Sweetheart Supreme" and successfully broke dormancy with gibberellic acid at concentrations of 1000 parts per million or higher. Martin, Wiggans and Payne (4) had good results with gibberellic acid when "Dorothy Gish" plants were treated during the winter but their results were unsatisfactory in the spring. Success was reported by Barba and Pokorny (2) when they treated "Hinodegiri" plants with 500 or 1000 ppm gibberellic acid. Ballantyne and Link (1) had variable results from one study to another. They tried combinations of cool temperatures and gibberellic acid applications and reported the chemical could replace the latter portion of the cool temperature treatment. Skou (5) had had satisfactory results when plants were exposed to cool temperatures for 3 weeks and then were given 3 applications of gibberellic acid after the plants were placed at a temperature suitable for forcing.

Dormancy studies at N. C. State have involved the complete elimination or reduction of the cool temperature requirement, with gibberellic acid. One of the first studies included 2 gibberellic acid concentrations (500 and 1000 ppm) applied at 4 or 7 day intervals. The material was applied as a foliar spray to "Red Wing" plants with well-developed flower buds. Some plants were also placed at 35°F (unlighted) and 48°F (lighted) for 4 or 6 weeks. The first chemical treatments were applied on the date the plants were placed in the 2 coolers. The plants treated with gibberellic acid were kept in a greenhouse at a 60°F minimum night temperature.

The effectiveness of gibberellic acid in breaking dormancy is shown in Fig. 1. The gibberellic acid-treated plant had received 5 applications at 500 ppm each time and was in flower 40 days from the date of the first application. The plants given the cool temperature treatments were in flower 3 weeks later. Plants kept at 60° but not treated with gibberellic acid did not bloom.

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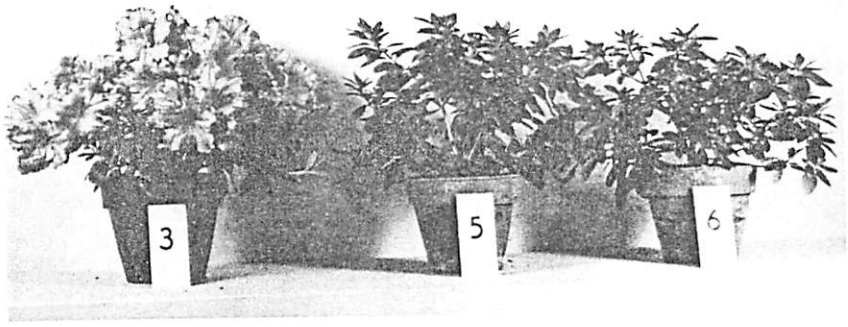

Fig. 1. "Red Wing" azalea plants given Trt. 3, gibberellic acid 500 ppm every 7 days; Trt. 5, 35°F for 4 weeks; Trt. 6, 48°F for 4 weeks. Plants in Trts. 5 and 6 were in flower 3 weeks later. Study conducted at N. C. State, February to May, 1967.

The most floriferous plants were those subjected to the cool temperature treatments. The gibberellic acid treatments were generally acceptable but some deleterious effects were noted, particularly when the chemical was applied every 4 days. The flowers were borne on very long pedicels. Flower color appeared to be slightly faded or bleached. It was noted that if flower buds had not been adequately developed prior to the start of gibberellic acid treatment, the bud scales would be much enlarged and only rudimentary flower parts would be inside the bud scales. This indicated that timing of gibberellic acid treatments was critical, with regard to stage of flower bud development.

Flower size was affected. The largest flowers were produced in the gibberellic acid treatments (3 1/4 to 3 1/2" diameter), while flowers produced on plants in the coolers were approximately 2 1/2".

In another study gibberellic acid at 1000, 1500 and 2000 ppm was applied at 7 and 14 day intervals to "Red Wing" plants which had been pinched, given 9 weeks of 16-hour days and 6 weeks of 9-hour days prior to dormancy-breaking treatments. The results are shown in Table 1.

Table 1. Effects of gibberellic acid on "Red Wing" azalea plants.

Treatments were started May 4, 1967, 15 weeks after the final pinch.

Concentration of GA	Frequency of application	Number of days to 1st bud color	Number of days to 1st open flower	Number of days to Salable	Number of flowers
1. 1000 ppm	7 days	26	39	44	113
2. 1000 ppm	14 days	28	39	47	88
3. 1500 ppm	7 days	25	37	43	104
4. 1500 ppm	14 days	26	39	44	98
5. 2000 ppm	7 days	24	39	43	121
6. 2000 ppm	14 days	26	39	43	110
7. Water control		41	50	-	-
8. 48°F, 6 weeks		57[a]	66[a]	70[a]	147[a]

a) Includes cooler and forcing time.

The 14 day interval was too long and many flower buds never did develop. There was very little difference in flowering time or number of flowers among the 3 concentrations, and plants of the best quality were those given the 1000 ppm treatment.

Several other dormancy studies were conducted and results in one study would be very encouraging and unsatisfactory in the next. A very critical factor was the stage of development of the flower bud when gibberellic acid was first applied. As mentioned previously, application of the chemical to improperly developed flower buds resulted in abnormal flowers and reduction in the number of flowers per plant. A large number of by-passing shoots around the flower bud occurred when the treatments were delayed excessively. An experiment was started in September 1969 to determine the optimum time for application of gibberellic acid. "Red Wing" plants were given 6 weeks of long days following the final pinch, and then 8, 10, 12, 14, 16, 18 and 20 weeks of short days prior to the start of the chemical treatment. The treatments were 500 ppm gibberellic acid every 4 or 7 days, applied to plants kept at 65°F night temperatures, or 6 weeks at 48°F. The results are shown in Table 2 and Figure 2 for plants given 8, 10 and 12 weeks of short days. Plants given longer periods of short days were unsatisfactory.

Table 2. The response of "Red Wing" azalea plants to gibberellic acid and 48°F treatments after 8, 10 and 12 weeks of short days (9 hours). The study was started September 22, 1969.

Treatment	No. days treatment to flower	Per cent of shoots with flowers	By-pass shoots/ plant
1. 8 weeks of short days			
a. 500 ppm GA_3 every 4 days	49	81	0
b. 500 ppm GA_3 every 7 days	48	86	0
c. Water control	-	9	6
d. 48°F, 6 weeks	70[a]	100	1
2. 10 weeks of short days			
a. 500 ppm GA_3 every 4 days	41	99	0
b. 500 ppm GA_3 every 7 days	38	87	0
c. Water control	-	55	13
d. 48°F, 6 weeks	68[a]	99	11
3. 12 weeks of short days			
a. 500 ppm GA_3 every 4 days	28	95	4
b. 500 ppm GA_3 every 7 days	34	94	7
c. Water control	-	73	18
d. 48°F, 6 weeks	65[a]	100	21

[a] Includes cooler and forcing time. Gibberellic acid treatments were started when other plants were placed at 48°. Some gibberellic acid-treated plants were in flower before the 6 weeks cooler treatment was concluded.

Plants exposed to 48°F for 6 weeks forced in the same amount of time whether the plants were given 8, 10 or 12 weeks of short days. Plants treated with gibberellic acid flowered in about 48 days after 8 weeks of short days, 40 days after 10 weeks, and 30 days after 12 weeks of short days. The percentage of shoots with flowers increased when more short days were given. The number of by-passing shoots increased as the short day treatment was prolonged, particularly on plants given the 48°F treatment. These plants were of excellent quality otherwise.

Fig. 2. Response of "Red Wing" azalea plants to gibberellic acid and cooler treatments after 8, 10 and 12 weeks of short days. Trt. 1, gibberellic acid 500 ppm every 4 days; Trt. 2, every 7 days; Trt. 3, water control; Trt. 4, six weeks at 48°F. The photographs were taken when the chemically treated plants were in full bloom. Forcing had not yet started on treatment 4.

Ballantyne and Link (1) had tried combinations of cooler treatment and gibberellic acid, and similar attempts were made at N. C. State. Sporadic results were discouraging and the idea was dropped until positive results were reported by Skou (5). The 3-week cooler treatment does not eliminate the "bottleneck" of refrigerated storage for year-around flowering but twice as many plants can be given the cooler treatment in a year's time as when a 6-week cooler treatment is used. A large study on "Red Wing" azaleas was started in the spring, 1970 in which combinations of cooler-chemical treatments were compared with a 6 weeks cooler treatment. The treatments and results are shown in Table 3.

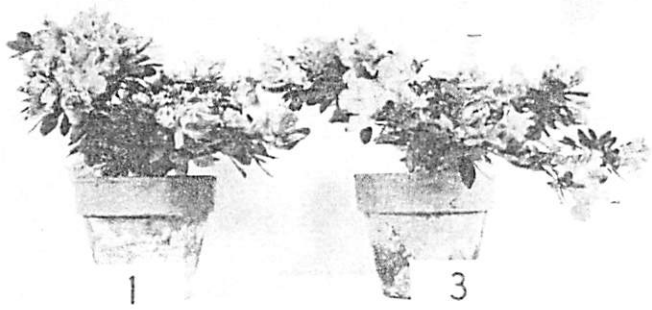

Fig. 3. "Red Wing" azalea plants given 3 weeks at 48°F., Trt. 1, three applications of 500 ppm GA_3, Trt. 3, three applications of gibberellins A_4 A_7. Study was started May 21, 1970 and photograph was taken July 17.

Table 3. Comparison of cooler-chemical combination treatments with cool temperature storage alone. The treatments were started on "Red Wing" azalea plants May 21, 1970, 11 weeks from the final pinch date.

	Temperature		Chemical treatment[a]	Date of flower	Number of flowers/ plant	Quality
1.	3 weeks	48°F	250 ppm GA_3	July 21	49	Very good
2.	"	"	500 " "	" 17	77	Excellent
3.	"	35°F	250 " "	" 24	50	Good
4.	"	"	500 " "	" 22	62	Fair
5.	"	48°F	500 " GA_4A_7	" 17	73	Excellent
6.	"	35°F	500 " "	" 23	75	Good
7.	"	48°F	-----	---	--	---
8.	"	35°F	-----	---	--	---
9.	6 weeks	48°F	-----	July 31	88	Excellent
10.	"	35°F	-----	August 4	90	Excellent

[a] The chemical treatments were first applied 4 days after the plants were removed from the coolers, and then 2 more applications were made at weekly intervals.

A comparison of the gibberellic acid (GA_3 potassium salt) and gibberellins A_4 A_7 (Pro-Gibb 47) treatments are shown in Fig. 3.

The greatest numbers of flowers were obtained in the 6-week cooler treatments but flowering occurred as much as 2 1/2 weeks after the chemically-treated plants.

The majority of azalea dormancy studies have involved the use of gibberellic acid (GA_3 potassium salt) but in this experiment the chemical treatment Gibberellins A_4 A_7 (Pro-Gibb) was effective.

Several experiments are now underway at N. C. State to see if there is a correlation between flower bud diameter and stage of development, and to determine the optimum diameter and stage for the initiation of the dormancy-breaking treatments. Initiation of treatments based on shoot apex characteristics should be more meaningful than weeks from final pinch.

SUMMARY

1. Gibberellic acid (GA_3 potassium salt) treatments generally have been satisfactory substitutes for cool temperature to break azalea flower bud dormancy but the results are often variable.

2. Flowering is hastened with the chemical treatment but excessively long pedicels, faded flower color and reduced keeping quality occur when excessive amounts of gibberellic acid are used.

3. Combination treatments of cool temperatures and chemicals look very promising. Some of the disadvantages of the chemical treatment are overcome, but the need for refrigerated storage is not eliminated.

4. Almost all of the dormancy studies have involved the use of GA_3, but the Gibberellins A_4 A_7 treatment was very effective in one study.

5. The optimum stage of flower bud development for the initiation of dormancy-breaking treatments is now being studied. The varieties used in one large experiment are "Alaska, California Sunset, Dark Rose Queen, Gloria, Red American Beauty".

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