MODERATOR RAUCH: Thank you, Bettie, for that fine discussion on bananas. We have some exotic happenings occuring on the mainland. Our next speaker from the "Evergreen State" also did his graduate work at UCLA and later went to Florida, then returned to the State of Washington. I would like to call on George Ryan to talk on "Chemical Control of Development." George:

CHEMICAL CONTROL OF SOME ASPECTS OF PLANT DEVELOPMENT[1]

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Abstract The use of growth retardants to induce flowering of ornamental plants, especially azaleas and rhododendrons (*Rhododendron* spp.), is reviewed Examples of recent data show approximately 200% increases in number of flower buds on outdoor container grown 'Anna Rose Whitney' rhododendrons treated with Alar, Phosfon or Cycocel in their second season of growth.

The relationship between nutrition and response to growth retardants is discussed Nitrogen levels probably are as important for the growth retardant response as reported for P levels. Data presented show a significant reduction in number of flower buds where N fertilization was reduced or omitted, with only a reduction in leaf N from 1 9 to 1.7%

Results are presented of the use of chemicals to prune and induce branching of *Photinia x fraseri* The number of side branches was increased from 0.6 to 8 4 per plant by treatment with a combination of the pruning agent Off-Shoot-O and the cytokinin SD 8339.

Nurserymen have become skillful in the use of nutrients, water, temperature, and sometimes supplemental light, to grow vigorous plants to marketable size in a minimum of time. This combination of factors for optimum growth rate does not always result in a plant properly developed in terms of shape, branching habit, or presence of flower buds. Much attention has been focused in recent years on the use of growth regulating chemicals to modify these characteristics of plant development.

CHEMICALS TO PROMOTE FLOWERING

Effects of growth retardants on flowering of azaleas and rhododendrons (*Rhododendron* spp.) were first reported by Stuart

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[1]Scientific paper 4114 Project 0085, College of Agriculture Research Center, Washington State University, Pullman, Washington 99163.

(28) and Cathey (2, 3). Rooted cuttings of rhododendrons were grown in a greenhouse with supplemental night lighting and treated by applying soil drenches of Phosfon (2,4-dichlorobenzyl tributyl phosphonium chloride), or Cycocel [(2-chloroethyl) triethylammonium chloride]. or by spraying each growth flush with B-Nine (succinic acid 2,2-dimethyl hydraside). Treated plants usually produced flower buds on the third growth flush. After three months of short photo-period followed by two months at 50°F, flowers were forced in a greenhouse with 65°F night temperature. Untreated plants remained vegetative until the ninth flush, which occurred in the third season of growth.

Cathey and Taylor (6) reported that the stems of Phosfon-treated plants were limber and yellow and the flowers were smaller and paler in color than normal. On Cycocel treated plants the vegetative growth subtending the terminal flowers developed and obscured the flowers. The leaves of Cycocel-treated plants developed brown margins during the forcing period. When further evaluated on 'Roseum Elegans', Cycocel failed to give satisfactory growth and its use was discontinued. B-Nine sprayed at an excessive rate (1.0%) greatly delayed flower development and reduced flower size and color intensity. As a soil drench it was highly toxic to rhododendrons.

Following the procedures of Cathey, Crossley (10) reported development of flower buds on Phosfon-treated 'Anna Rose Whitney' plants in less than 12 months from taking the cuttings. He did not observe a weakening of the stems from Phosfon treatment. He has had response from B-Nine and Alar but considers the results from Phosfon more dependable (11).

A number of other studies of the response of several cultivars to Phosfon and Cycocel drench, B-Nine sprays and supplemental lighting have been reported (8, 9, 12, 20, 27).

Ticknor and Nance (31) were the first to report studies with growth retardants on field grown rhododendrons. They recorded 100 to 300% increases in number of flower buds on 'Roseum Elegans' plants sprayed with B-Nine or Cycocel in the nursery during their third year of growth. No adverse effects on plant color or on flower development were observed. A slight advance in the blooming date of Cycocel-treated plants was reported. Two applications of B-Nine at 0.5% two weeks apart were less effective than Cycocel at 1844 or 3688 ppm. There was very little response from Cycocel at 1844 ppm on the same cultivar in 1967 experiments, even when two additional applications were made on the second growth flush (29).

Because of the early reports of unsatisfactory results with Cycocel and the weakening effect of Phosfon on plant growth, work in western Washington with retardants was initially confined to Alar (succinic acid 2,2-dimethyl hydraside) (25). Two sprays of 1 to 1.5% Alar were applied, the first one as soon as growth buds had expanded enough to expose new leaves, and the second one two weeks later. This treatment has greatly increased the number of flower buds on some cultivars. All of the work has been done with field nursery stock, or container plants outdoors or under lath shade.

'Humming Bird' plants, which had only 3 to 5 buds per plant in their second and third years without treatment, produced 18 to 22 buds with optimum rates of Alar. 'Anna Rose Whitney' plants in containers treated in their second or third season responded by producing up to 8 times as many flower buds as untreated plants. Cycocel sprays at 1844 and 3688 ppm on field-grown 'Anna Rose Whitney' in 1969 and 1970 were less effective than 1.25% Alar. A soil drench with Cycocel or Phosfon gave nearly the same response in 1971 as two sprays of Alar at 1.25% or one spray at 2.5% (Table 1).

In cultivars that respond to growth retardants, the effect apparently is additive to the influence of optimum nutritional status for flower bud formation. Myhre and Mortensen (22) reported that supplying an abundance of phosphorus to the roots of 'Cynthia' plants at the time of planting resulted in large increases in number of flower buds conpared with plants receiving only surface application of phosphorus. It was later reported that the number of flower buds was further increased by application of Alar on plants that received high levels of P (9, 25).

Nitrogen levels probably are as important for the growth retardant response as P levels. In one experiment with field grown 'Anna Rose Whitney', Alar increased flower buds 160% in plants fertilized by pre-plant incorporation of P and annual surface application of N (Table 2). Omitting the N application reduced flowering much more than omitting the P application. These plants were not obviously N deficient. Leaf N was reduced from 1.9% to 1.7%, but plant growth and color were good.

Alar, Phosfon and several other growth retardants increased the number of flower buds on deciduous azaleas (26). Application early in July reduced plant height approximately 20%. Later applications did not significantly affect plant height. Treatment in August, especially at the highest rate (20,000 ppm), delayed flower opening a week to 20 days the following spring.

Accelerated flowering from growth retardant treatment has been reported for various other ornamentals, including *Gardenia* (7), *Camellia* (13), *Bougainvillea* (14), *Begonia* (15), *Pyracantha* (17), *Ilex* (21) and *Impatiens* (23).

CHEMICALS FOR PRUNING AND INDUCING BRANCHING

The use of chemicals for pruning to control plant shape has become an accepted practice with a few kinds of plants, particularly evergreen azaleas and chrysanthemums. The action of methyl esters of C_8 to C_{12} saturated fatty acids and C_8 to C_{12} fatty alcohols on active meristems of a number of kinds of plants was first reported by Cathey, et al. (5). More detailed information on techniques and the response of more than 80 species and cultivars have been reported (4, 18, 19).

For chemical pruning to be effective in producing a well branched plant, growth of more than one axillary bud is essential. Many plants when pruned either mechanically or chemically have a tendency to resume growth from the uppermost axillary bud. Pruning of those plants only temporarily delays the elongation of the main axis or a few branches and does not result in the desired plant shape. One effect of the group of growth regulators known as cytokinins is to reduce apical dominance and promote growth of axillary buds. Cytokinins have been reported to increase branching of a number of floricultural crops, including induction of bottom breaks in greenhouse roses (1, 16, 24).

Branching of *Photinia x fraseri* was greatly increased by 3 applications of 6-benzylamino-9-(tetrahydropyran-2-yl)-9H-purine

Table 1. Effect of growth retardants on flower bud formation and height of 'Anna Rose Whitney' rhododendron[1].

Treatment	Number of flower buds[2]	Plant height[2] (cm)
Check	2.6 a	43.7 a
Alar 12,500 ppm 1 application	2.7 a	40.9 abc
Alar 12,500 ppm 2 applications	9.0 c	37.6 bcde
Alar 25,000 ppm 1 application	8.9 c	35.6 de
Phosfon L drench 0.4 g/plant	7.3 bc	41.7 ab
Phosfon L drench 0.8 g/plant	7.8 bc	35.8 cde
Cycocel drench 0.8 g/plant	3.6 ab	40.4 abcd
Cycocel drench 1.6 g/plant	7.7 bc	38.4 abcde

[1]Plants started from cuttings August, 1969; growing outdoors in 2 gal. cans; treated May, 1971.

[2]Treatments followed by the same letter are not significantly different at the 5% level

Table 2. Effect of nitrogen and phosphorus applications on response of 'Anna Rose Whitney' rhododendron to Alar[1].

Fertilizer rate[2] (lb/A)			
N	P	Alar application[3]	Number of flower buds[4]
40	105	—	5.9 bcd
20	105	—	4.0 ab
0	105	—	3.1 a
40	0	—	5.9 bcd
40	105	+	15.3 f
20	105	+	11.2 e
0	105	+	5.7 abc
40	0	+	11.2 e

[1] Rooted cuttings planted in Puyallup loam soil June, 1969.

[2] Nitrogen was applied annually as ammonium sulphate; P was applied by pre-plant incorporation of treble phosphate; K was applied annually in all treatments

[3] Two applications at 12,500 ppm May 28 and June 12, 1970.

[4] Treatments followed by the same letter are not significantly different at the 5% level.

Table 3 Effect of pinching, Off-Shoot-O and SD 8339 on branching of *Photinia x fraseri*[1]

Treatment[2]	Number of side branches per plant[4]
Check	0.6 a
Hand pinch[3]	1.1 a
Off-Shoot-O	1.3 a
Hand pinch + SD 8339	3.5 bc
Off-Shoot-O + SD 8339	8.4 d
SD 8339	1.9 abc

[1] Rooted cuttings in 1 gal cans.

[2] Treated July 9 SD 8339 at 1000 ppm; second and third applications of SD 8339 July 16 and 23; Off-Shoot-O applied only July 9, at 4.2% fatty acids.

[3] Soft tips removed July 9.

[4] Treatments followed by the same letter are not significantly different at the 5% level

(SD 8229). The greatest response was in combination with the chemical pruning action of the methyl esters of C_6 to C_{12} fatty acids (Off-Shoot-O) (Table 3). Leaves on one or two growth flushes following treatment were smaller, especially in length, than normal. Later growth was normal in appearance, resulting in an attractive, well-branched plant.

Chemicals such as these can help to eliminate some of the hand labor required to properly shape a developing plant. As they become available commercially, and as experience in their use increases, they should find a place in nursery practice.

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MODERATOR RAUCH: Thank you, George. I am now going to call on Clyde Elmore, Agriculture Extension Specialist, University of California, Davis, to talk on pollution by weeds. Clyde:

WEED POLLUTION

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Plants are a necessary complement of our environment and lend much beauty and pleasure to man. Plants may also be detrimental in many ways to the health, wealth and well being of man and animals.

Much physical harm and discomfort arise from man and animals contacting thorny bushes and trees such as thistles, starthistle, gorse, or *Opuntia sp.*, cactus, as well as plants with lesser armament. Others of this type include members of the families *Cactaceae* and *Euphorbiaceae*, generally of the desert regions of America, Africa and Asia. Plants also are poisonous to man and animals. In the western United States sheep losses from feeding on halogeton are great. In one reported case in Idaho 1,620 sheep were lost in a single day.

The expenditure of funds and lack of crop return for the control of weeds cost the people of California over 374 million dollars for a year (over 1 million/day). In the U.S. a staggering 2.5 billion figure was suggested in 1968.

Although the total costs of weed control in ornamentals (Table 1) appear small in proportion to large acreage crops such as corn, the dollar per acre figure is one of the highest of any crop. As in other crops, costs increased considerably during a period from 1959 to 1968. With increased labor costs, costs have undoubtedly continued to rise.

Plants are not always weeds. They are considered to be weeds when they interfere with land or water resource utiliza-