



Fred Jensen

The growth regulator ethephon increases color of Cardinal grapes without normal light. First and third clusters from left were treated with ethephon. Two clusters on left had normal light; the other two received no light.

## Growth regulators offer numerous benefits

Robert J. Weaver

Since the 1920s, girdling of Thompson Seedless vines has been used to increase the size of the table grapes. Research on growth regulators started in 1949 when 31 different hormones were tested on Black Corinth and Thompson Seedless grapes. The two most promising regulators of the auxin type (a plant growth hormone regulating cell division) were 4-chlorophenoxyacetic acid (4-CPA) and benzothiazole-2-oxyacetic acid (BOA). For several years 4-CPA was used commercially, but it is no longer registered for use on grapes; BOA has never been used commercially.

Applications of 4-CPA at 2 to 10 ppm made three or four days after full bloom replaced girdling to increase berry size and fruit set in Black Corinth (the dried raisins are called "Zante Currant"). However, 4-CPA sometimes resulted in compact clusters subject to rotting. Also, there was always a possibility of applying too much compound and adversely affecting the vine and fruit. In the 1950s 4-CPA was used at 5 to 15 ppm on Thompson Seedless either to replace or to supplement girdling, but sometimes fruit maturation was delayed.

The first experiments with gibberellic acid (GA<sub>3</sub>) on grapes were made in 1957. By the early 1960s, sprays of GA<sub>3</sub> had replaced 4-CPA as a means of increasing berry size in Black Corinth. To produce the Zante Currants desired by the bakery trade, GA<sub>3</sub> is sprayed from the time of 95 percent capfall until three days later.

GA<sub>3</sub> is now used on all Thompson Seedless grapes for table use. For several years vines were sprayed at 20 to 40 ppm at the fruit-set stage to increase berry size. However, some clusters were quite compact in spite of cluster and berry thinning to prevent over-cropping.

Five years after the first use of GA<sub>3</sub> on Thompson Seedless, it was noted that vines sprayed at bloom were properly thinned, mainly because fruit-set was reduced, so that clusters were not too compact. Soon the recommended method was to use two GA<sub>3</sub> applications, one at full bloom for thinning and increasing size, and the other at fruit-set to further increase size. Girdling is also performed at fruit-set, or shortly afterwards, to further increase berry size and make the berries more uniform and more firmly attached to the cap stem. An additional spray about two weeks after fruit-set will produce even larger berries.

### Delaying maturation

In our early screening work we found BOA would delay maturation of both seeded and seedless *Vitis vinifera* grapes from a few days to several weeks, depending on how much hormone is used. So far growers have not shown much interest in delaying maturation of fruit, but at some future date BOA may be useful for staggering picking dates or meeting late market demands.

In a field trial on thinning of clusters at Davis using several hormones, ethephon increased the color of grapes, although it gave poor thinning results. However, little or no change occurred in the amount of berry sugar.

In a recent California test, ethephon markedly increased the percentage of sugar in Thompson Seedless raisin grapes, as measured by the °Brix test. Berries treated with 250 ppm at Davis at onset of ripening matured 16 days earlier than control berries. An earlier



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Girdling Thompson Seedless grapevines to increase berry size is now being replaced or supplemented by growth hormones.

accumulation of sugar could be beneficial to the raisin industry, because it would allow earlier harvesting and increase the possibility of avoiding fall rain on grapes or on drying clusters on picking trays.

### Fruit-set

Plant growth retardants can markedly increase fruit-set and yield in grape cultivars with clusters that are too loose. For example, University of California researchers found that spraying *Malvasia bianca* grapes at prebloom with chlormequat more than doubled yield. The increase was largely due to improved berry set.

Emperor grapes sometimes are affected by a condition known as berry shrivel. Scattered grapes in the clusters begin to turn soft in August and attain only about half the normal size by harvest because of water loss. If more than about 12 berries per cluster are affected, the cluster must be discarded as a cull. Applications of GA<sub>3</sub> to Emperor at 20 ppm two weeks after the fruit-set stage were found to prevent berry shrivel.

Rot often occurs in seeded wine grapes that have very compact clusters. As the berries expand during growth, they may break near the area of attachment to the cap stem. The exposed berry flesh attracts insects, which may also introduce yeasts and other spoilage organisms. In 1959 we found that GA<sub>3</sub> sprays applied three weeks before bloom could markedly loosen the clusters, mainly as a result of decreased fruit-set and elongation of berry stems. Elongation of the main stem of the cluster may also be involved. Vines are sprayed when shoots are 14 to 16 inches long at concentrations ranging from 1 to 10 ppm, depending on the grape variety. Unfortunately, the practice of spraying tight-clustered wine varieties with GA<sub>3</sub> has been halted for the present because of some toxic effects observed on the *Chenin blanc* vines.

### Second crop

In some years, one-third of the total yield of wine grapes is made up of a second crop. The second crop matures later than the first, so that it is not a good idea to pick it at the regular harvest season. However, much of the second crop is usually harvested along with the first crop, whether picked by hand or mechanically harvested. We have found that application of auxins such as naphthaleneacetic acid (NAA) applied just before the second crop is beginning to bloom will remove 70 to 100 percent of the second crop. At that time the first (primary) crop is not injured because the berries are larger and resist damage from the NAA.

### Berry size and wine quality

One viticultural theory is that a struggling vine produces better wine than one that has better growing conditions. If this is true, the reason may be that the struggling vine has smaller berries than the vine growing under more favorable conditions. Thus there is more skin (which contains pigments and some flavor and tannins) per ton of grapes and per gallon of wine than when berries are larger. We have found that smaller berries may be obtained by spraying with growth retardants such as daminozide. However, this material is not cleared for use in California.

In 1949 there was only one known class of plant regulators—the auxins. Now there are five main classes—auxins, gibberellins, cytokinins, ethylene, and inhibitors. No doubt this list will lengthen as new hormones are discovered and new growth regulators synthesized. It is quite possible that, in time, all physiological processes in plants will be controlled by application of growth substances.

# Propagation of grapevines

Curtis J. Alley

**G**rapevines are propagated primarily by cuttings just as they have been for years. The use of seeds for propagation is not satisfactory, because the seedling does not resemble the parent vine. Work by F. T. Bioletti in the 1920s indicated that production of new vineyards was the same whether or not the original cuttings arose from vines that bore heavy crops or light crops. The difference was caused by the environment and was not inherited.

The best length and diameter of cuttings for propagation were determined by research. At first, medium-size cuttings 10 to 12 inches long with four to five nodes were recommended, but later, it was found that short cuttings did not grow as well as longer cuttings in sandy areas. Cuttings should be at least 1/8 to 1/2 inch in diameter at the top. Length can vary from 14 to 18 inches, depending on location and soil type; the longer lengths are best for sandy areas.

A. J. Winkler found in 1927 that the earlier the planting, the more successful the rooting. Wood maturity was important: rooting improved with maturity of the cutting. Winkler also developed the iodine color test, which measured stored starch in grading cuttings for wood maturity.

In Fresno County studies, the best rooting resulted when cuttings that had been stored in a sand pit were planted in April and May. At planting time, the cuttings had roots out about 1/8 to 1/4 inch, and the top bud was pushing about 3/4 to 1 inch. Cuttings may also be held in refrigeration but should be removed about two weeks before planting and allowed to warm and start growing. Removing cuttings from refrigeration late in the spring and planting directly into the nursery may be detrimental. In areas where strong winds prevail in the spring and early summer, cuttings root and grow better when the top bud is covered over with a layer of soil. Where there are no winds in the spring, cuttings root and grow better when the top one or two buds are left exposed.

### Rootstocks

When first grape phylloxera and later root-knot nematode infections of grapevines were identified, growers in affected areas had to change their propagation methods. They had to borrow from the experience of French vineyardists and use phylloxera-resistant rootstocks. St. George, MdG 41B and 420A, and Couderc 3306 and 3309 were recommended in the 1920s. Some Lenoir (Jacques) was used, but later St. George became the most popular rootstock, followed by AxR #1. Researchers recently found AxR #1 to be the best for production among the several rootstocks tested.

Rootstocks resistant to root-knot nematodes became important in the sandy soils of California. Couderc 1613 has been the leading resistant rootstock for years. In sandy areas where this rootstock cannot grow satisfactorily, Salt Creek and Dog Ridge have been used. Two new rootstocks, Harmony and Freedom, are now becoming more important, replacing the earlier nematode-resistant rootstocks.

The need for resistant rootstocks has complicated the propaga-

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