# Integrated control of botrytis bunch rot of grape

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Cluster area after leaf removal.

***Botrytis bunch rot of grape was significantly reduced by canopy management in this study. Integrating leaf removal with chemical control may reduce the need for multiple fungicide applications.***

Botrytis bunch rot of wine grapes is especially severe in California's cooler coastal areas in years with late-season rains, but serious losses may also occur without rain moisture. In those instances, infection by the causal fungus, *Botrytis cinerea* Pers, commonly is found in cultivars with dense canopies or tight berry clusters. In California, the first symptoms of disease on susceptible cultivars are usually evident by mid to late August, when fruit sugar levels begin to increase (veraison).

Research has shown that canopy management by hedging or by trellis systems can moderately reduce bunch rot incidence and severity. Changes in the canopy microclimate have also improved yields and fruit quality when *Botrytis* is present.

This study showed that leaf removal, combined with one fungicide application at bloom or when berries are pea-size (preclose), provides adequate protection against botrytis bunch rot.

## Methods

We conducted a field trial in 1984 in a 14-year-old Chenin blanc commercial vineyard in Monterey County, California. The vines were moderately vigorous, cordon-trained, spur-pruned, and planted on a spacing of 8 x 12 feet (vine x row). We used a 2 x 5 split-plot design with four replicates to study subplot effects of hedging, a movable wire trellis system, shoot removal, leaf removal, and no canopy management (control).

In each of the canopy treatments, vines were either not sprayed or sprayed with iprodione (Rovral) 50W at 2 pounds per acre at bloom, preclose, and veraison. Applications were made with a commercial over-the-vine boom sprayer delivering 200 gallons per acre.

All canopy management treatments were performed at late bloom:

Hedging. Shoots about 40 inches long were cut back 12 to 18 inches with hedge trimmers. This reduced the curtain effect that results when shoots "fall" with increased growth.

Movable wire. Wire was attached to the end posts and strung on either side of the canopy at a height of 52 inches to keep shoots oriented upward.

Shoot removal. All interspur and crown shoots were removed, and spurs were thinned to two shoots.

Leaf removal. Leaves and laterals located opposite, one node above, and one node below each flower cluster were removed by hand, resulting in a "window" of exposed clusters.

At maturity, four vines from each treatment in each replicate were hand-harvested and evaluated for incidence of bunch rot and yield. Severity ratings were based on diseased berry weights per cluster per vine.

In 1985, we initiated two spray trials. One used the same vines as the year before in Monterey County, but the treatments differed slightly from those in 1984. We used a 2 x 4 split-plot design with four replicates. Canopy management (subplot) treatments included hedging, prebloom shoot removal, leaf removal, and a control. Main plot treatments included fungicide spray or no spray.

Hedging in 1985 was performed with a commercial sickle-bar hedger at preclose to remove 6 to 12 inches of terminal shoot growth.

Shoots were removed about 4 weeks before bloom. All interspur shoots were removed, and spur shoots were thinned to three.

Leaves were removed at cluster set as in the previous trial.

Management and control treatments were conducted on two vine rows in each replicate. One of the rows served as the nonsprayed control. The other was treated with iprodione at the same concentration and at the same times as in the 1984 trial.

We ran the second trial in 1985 in a vigorous 11-year-old Chenin blanc vineyard in Napa County, in which vines were cordon-trained, spur-pruned, and planted on a spacing of 8 x 12 feet. The plot design was a 2 x 4 split plot with four replicates.

Canopy management in this trial was divided into two categories: (1) normal cultural practice, in which the grower conducted crown-suckering on the entire vineyard (this practice involves removing all shoots arising from noncount buds and is done annually in this vineyard when shoots become 12 to 18 inches long); and (2) leaf removal, performed at cluster set by removing leaves and laterals from above, opposite, and below each grape cluster.

Fungicide applications (subplot) also were tested in this trial. Sprays were timed according to growth stages of the grapevine. Treatments included: benomyl (Benlate) 50W at 1.5 pounds per acre plus captan 50W at 4 pounds per acre applied once at (1) bloom or (2) preclose; (3) a spray of the combination at each of the two timings described; and (4) a nonsprayed control. Sprays were applied to the two inside rows of a four-row block with a commercial air-blast sprayer at 200 gallons per acre. In each treatment, one of the paired rows had the leaf removal treatment and the other was the intact control.

At harvest, four randomly selected vines from each treatment and replicate were picked, and yields were determined by weighing clusters. Bunch rot incidence was evaluated by counting diseased clusters per vine. Severity ratings were based on the percent of rotted berries per cluster.

## Results

**Monterey County, 1984.** Botrytis bunch rot was relatively low in both incidence and severity, but there were significant differences among the various treatments (table 1).

Bunch rot was reduced from 8.7% in the control to 1.7% in the leaf removal treatment. Shoot removal reduced disease incidence by only 3.1%. Disease increased slightly in the hedging and movable wire treatments to 10.7% and 9.6%, respectively. Fungicides did not reduce bunch rot further in the leaf removal treatment but did in all other treatments.

Disease severity, in terms of percent rot by weight, also was influenced by leaf removal in the subplot and by fungicides in the main plot. Bunches on the nonmanaged, nonsprayed control vines had an average of 1.22% rot; those on vines with leaves removed averaged 0.2%. Other canopy management treatments did not significantly reduce rot severity.

**TABLE 1. Effects of canopy management and fungicide applications on botrytis bunch rot and Chenin blanc grape yield, Monterey County, 1984**

| Fungicide treatment° | Hedged | Leaf removal | Shoot removal | Movable wire | Control | Mean |
|---|---|---|---|---|---|---|
| | *Incidence (percent diseased clusters)* | | | | | |
| Sprayed | 7.3 | 1.6 | 2.0 | 4.6 | 5.6 | 4.22** |
| Nonsprayed | 14.2 | 1.8 | 9.2 | 14.6 | 11.9 | 10.34 |
| Mean | 10.7 | 1.7* | 5.6 | 9.6 | 8.7 | |
| | *Severity (percent rot by weight)* | | | | | |
| Sprayed | 0.63 | 0.10 | 0.22 | 0.41 | 0.66 | 0.41* |
| Nonsprayed | 2.31 | 0.30 | 1.58 | 1.31 | 1.78 | 1.46 |
| Mean | 1.48 | 0.20* | 0.90 | 0.86 | 1.22 | |
| | *Yield (tons per acre)* | | | | | |
| Sprayed | 8.55 | 5.96 | 5.30 | 6.65 | 6.87 | 6.66NS |
| Nonsprayed | 7.13 | 6.10 | 5.07 | 6.96 | 8.00 | 6.65 |
| Mean | 7.84 | 6.03* | 5.19* | 6.80 | 7.43 | |

NOTE: Results are expressed as an average of four replicates. Mean differences were determined with orthogonal contrasts. Figures followed by an asterisk denote a significant effect from that treatment at: $*=P<0.05$ and $**=P<0.01$.
° Sprayed treatment: iprodione 50W at 2 lb/acre at bloom, preclose, and veraison.

**TABLE 2. Effects of canopy management and fungicide applications on botrytis bunch rot and Chenin blanc grape yield, Monterey County, 1985**

| Fungicide treatment° | Hedged | Leaf removal | Shoot removal | Control | Mean |
|---|---|---|---|---|---|
| | *Incidence (percent diseased clusters)* | | | | |
| Sprayed | 44.1 | 16.9 | 47.0 | 46.8 | 38.7 NS |
| Nonsprayed | 47.4 | 23.9 | 42.9 | 55.0 | 42.3 |
| Mean | 45.7 | 20.4* | 44.9 | 50.9 | |
| | *Severity (percent rot per cluster)* | | | | |
| Sprayed | 8.05 | 1.69 | 11.30 | 9.30 | 7.58NS |
| Nonsprayed | 9.08 | 2.85 | 10.20 | 15.30 | 9.35 |
| Mean | 8.56* | 2.27** | 10.70 | 12.30 | |
| | *Yield (tons per acre)* | | | | |
| Sprayed | 6.54 | 7.59 | 4.84 | 8.19 | 6.76NS |
| Nonsprayed | 6.32 | 7.31 | 5.17 | 5.39 | 6.05 |
| Mean | 6.43 | 7.45 | 5.00* | 6.79 | |

NOTE: See table 1 NOTE. $*=P<0.05$. $**=P<0.01$.
° Sprayed with iprodione, 2 lb/acre, at bloom, preclose, and veraison.

**TABLE 3. Effects of canopy management and fungicide applications on botrytis bunch rot and Chenin blanc grape yield, Napa County, 1985**

| Leaf treatment | Control | Bloom | Preclose | Bloom + preclose | Mean |
|---|---|---|---|---|---|
| | Timing of fungicide application° | | | | |
| | *Incidence (percent diseased clusters)* | | | | |
| Removed | 6.17 | 7.08 | 4.00 | 5.07 | 5.58* |
| Intact | 30.52 | 29.19 | 29.18 | 20.70 | 27.40 |
| Mean | 18.35 | 18.14 | 16.61 | 12.89 | NS |
| | *Severity (percent rot per cluster)* | | | | |
| Removed | 0.30 | 0.43 | 0.14 | 0.27 | 0.31* |
| Intact | 3.36 | 5.14 | 3.65 | 3.06 | 3.80 |
| Mean | 1.87 | 2.78 | 1.89 | 1.66 | NS |
| | *Yield (tons per acre)* | | | | |
| Removed | 4.65 | 5.05 | 4.71 | 3.83 | 4.56NS |
| Intact | 5.80 | 5.20 | 5.40 | 5.36 | 5.44 |
| Mean | 5.23 | 5.13 | 5.06 | 4.60 | NS |

NOTE: Results are expressed as an average of four replicates. Mean differences were determined with orthogonal contrasts. Figures followed by an asterisk (*) denote a significant ($P<0.01$) effect from that treatment.
° Sprayed with benomyl 50W + captan 50W at 1.5 and 4.0 lb/acre, respectively.

Fungicide applications further reduced severity. The greatest reduction occurred in the shoot removal treatment, where severity was reduced from 1.58% to 0.22%.

Two treatments significantly reduced yields, shoot removal by 2.24 tons per acre and leaf removal by 1.4 tons.

**Monterey County, 1985.** Conditions in 1985 were more conducive to bunch rot development than in 1984. Leaf removal significantly reduced disease incidence, by 30.5% from the 50.9% reached in the nonmanaged control (table 2). Shoot removal and hedging treatments reduced bunch rot by only 6% and 5.2%.

Leaf removal and hedging also reduced rot severity significantly. Grapes on control vines had an average of 12.3% rot per cluster. Bunches on leaf-removal vines averaged only 2.27%. Shoot removal did not significantly reduce severity; hedging reduced rot severity from 12.3% to 8.56%.

Fungicide applications had no significant effect on bunch rot incidence in 1985. Only shoot removal affected yields in 1985, causing a reduction of 1.79 tons per acre.

**Napa County, 1985.** Leaf removal reduced incidence of bunch rot to 6.17%, compared with 30.52% in the control treatment, and reduced severity to 0.30% rot per cluster from 3.36% in the control treatment (table 3).

Single fungicide applications at bloom or preclose did not further significantly reduce disease incidence in the leaf removal vines, nor did applications at both bloom and preclose. Fungicides gave slightly better disease control on intact vines only when applied at both bloom and preclose. Yields were not significantly affected by any treatment.

## Discussion

Controlling botrytis bunch rot of grape in California by canopy management is a practical alternative to repeated fungicide applications. In field trials on Chenin blanc, leaf removal achieved excellent disease control even under conditions favoring severe rot. Other treatments did not appear as promising.

Late-season hedging is used in some areas to remove the lower canopy curtain and allow for better airflow under and through the canopy. The discrepancy between 1984 and 1985 data obtained from both shoot removal and hedging can be explained partially by the stage of plant growth when these treatments were made. In 1984, shoots were removed near cluster set and resulted in less lateral shoot growth than in 1985, when shoots were removed prebloom. Hedging in 1984 was at late bloom, resulting in greater lateral shoot development than in 1985, when hedging was at preclose.

Based on 1984 results, shoot removal also has potential for bunch rot control. Although disease control was minimal when fungicides were not used, excellent control was achieved when fungicides were applied to vines in which shoots were removed at cluster set.

Previous studies have reported that midseason hedging was responsible for slightly lower disease levels. Our results also showed that hedging offers only minimal disease control when done in midseason and gives no control when done early in the season. If hedging promotes lateral shoot growth, the canopy density may increase and create a microclimate more conducive to *Botrytis* infection. This study further confirmed previous reports that hedging can delay maturity, thus making this type of canopy management questionable from a viticultural standpoint.

Yield loss from botrytis bunch rot in California varies from year to year, influenced primarily by late-summer and fall weather conditions. Wineries generally will accept up to 2% rot. More than that may result in significant cullage, increased harvesting costs, and lower quality or yield. In these studies, even under conditions conducive to high rot incidence, rot severity was reduced to less than 3%, permitting growers to harvest all fruit produced.

Fungicides are widely used in California to control *B. cinerea* on grapes, but they generally become less effective as the grapevine matures because of heavy canopy growth and bunch closing. Usually, by the third fungicide application at or near veraison, it becomes virtually impossible to penetrate the canopy well enough to protect the cluster targets adequately. Preliminary spray tests have shown that leaf removal does improve spray coverage within the canopy.

Fungicide timing trials also lead us to question the need for a fungicide application at bloom. Our tests show no significant difference in disease control between single fungicide applications made at bloom or at preclose.

Fungicides alone do not provide adequate protection against *B. cinerea* during severe disease pressure. By integrating leaf removal with chemical control, growers might eliminate at least two fungicide applications. One fungicide application at either bloom or preclose appears to afford adequate protection when used in conjunction with leaf removal.

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# Attitudes of California milk producers toward bovine somatotropin

Lydia Zepeda

***A survey in late 1987 revealed that, despite widespread publicity, many California dairy farmers had not yet heard of bovine somatotropin (BST), a milk production stimulator. Of those who had, most said they would either wait to see how well BST worked on other dairies before they tried it, or they wouldn't use it on their herds at all.***

Bovine somatotropin is a naturally occurring hormone produced in the pituitary gland of cattle. Biotechnology has made possible commercial production of the material, which, when injected into dairy cows, stimulates feed intake, increases milk production, and improves the efficiency of feed conversion per unit of milk. Although the Food and Drug Administration has not approved BST for commercial use, and is not likely to before 1990, its possible effects on the dairy industry have aroused controversy.

To evaluate the potential impact of bovine somatotropin in California, a survey queried dairy farmers on their attitudes and concerns about BST. A sample of 7% of all Grade A dairy farmers in the state was drawn at random. The 153 farmers selected were telephoned between August 10 and October 23, 1987, and asked a total of 43 questions. The first part of the survey focused on attitudes toward BST, and how much milk producers knew about it. The second part concerned characteristics of respondents and their dairies. These characteristics were correlated with potential BST use.

## Characteristics

A total of 131 milk producers representing 146 dairies responded to the survey. Of the original 153 dairy farmers in the sample, seven had sold out or participated in the dairy termination program, ten declined to participate, and five could not be reached or did not respond. The final response rate was 86%.

The survey covered three regions: 78 dairies in northern California, 36 in the southern San Joaquin Valley, and 32 in southern California. These numbers are representative of the distribution of Grade A dairies in the state.

The average respondent was 46 years old, had a high school education, and had managed a dairy for 21 years. Most (90%) were involved in daily operation and decisions on their dairies.

The average milking herd size was 508 cows, including dry cows (table 1). Herds had an average of 6.5% registered cows.

The 1987 rolling herd average, in pounds of milk per year per cow, for survey respondents was 17,885 pounds. For 1986 and 1985, the averages were 17,084 and 16,735 pounds, respectively.

Over half (56%) of the respondents said they planned to increase milk production in

**TABLE 1. Average herd size, total number of cows, and average milk production per herd of survey respondents, 1987**

| Region | Herd size | Total cows in survey | Avg. herd prod. |
|---|---|---|---|
| | *No. cows* | | *lb/yr/cow* |
| Northern Calif. | 381 | 29,722 | 17,454 |
| South Valley | 590 | 21,246 | 17,880 |
| Southern Calif. | 725 | 23,200 | 18,935 |
| California | 508 | 74,168 | 17,885 |