EARLY BOTRYTIS ROT OF GRAPES AND ITS CONTROL

W. D. McCLELLAN, WM. B. HEWITT, P. LA VINE and J. KISSLER

The first, third and fourth authors are Farm Advisors, University of California Agricultural Extension Service, respectively for Tulare County, Visalia 93277; Stanislaus County, Modesto 95350; and San Joaquin County, Stockton 95205. The second author is Plant Pathologist, Department of Plant Pathology, University of California, Davis: 9240 South Riverbend Avenue, Parlier, California 93648.

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ABSTRACT

Early Botrytis rot of grapes is a new development in an old disease caused by *Botrytis cinerea* Pers. It is characterized by a brown rot of part of or most all grapes in a cluster from midseason to harvest in the absence of rain. Infection occurs through the stigmatic end of the flower at bloom time. There the fungus becomes latent until midseason or later, when it resumes growth and rots the grapes. Effective control was obtained with benomyl applied as a water spray (1 lb 50% active/acre) or as a dust (15 lb of 10% dust/acre).

Botrytis rot, a major fungus disease of grapes both in the vineyard and in storage, is caused by *Botrytis cinerea* Pers. Common Botrytis rot, also called grey mold or slipskin, occurs in all major grape-producing regions of the world. Ciccarone (1) recently reviewed the literature on *B. cinerea* in grapes with respect to the pathogen, factors involved in disease development, and control.

In California a survey revealed that *B. cinerea* is the dominant organism among molds of harvested wine grapes (7). Nelson (9,10) and Harvey (3) reported that the fungus is a primary cause of storage decay of table grapes and of rot that develops late in the harvest season, especially in years when rain occurs in vineyards for more than a day on mature grapes. In vineyards in Stanislaus County, Hewitt et al. (4) observed that bunch rots due to *B. cinerea* developed in midseason in the absence of rain. Infected berries of the clusters turned brown, lost moisture, shriveled, and exhibited a profusion of fungal sporulation from their surface. McClellan (8) established that the symptoms and disease were the result of bloom-time infections by the pathogen. The fungus infects the grape flower through the stylar end, and then becomes latent in the necrotic stigma and style tissues of the berry. Later in the development, as the grape matures, the fungus resumes growth and invades and rots the berry tissue. Midseason bunch rots caused by *B. cinerea,* which are due to bloom-time infections and occur in the absence of rain are called "Early Botrytis Rot". The disease has been found to cause up to 50% of the clusters to be rotted in some vineyards.

Control of *B. cinerea* rot in California vineyards has been based on the application of fungicides to prevent late season infections following rains (2,3, 11) and on the use of fumigation (10) to control decay in storage. Early Botrytis rot, recognized only recently, has not been taken into account in the control of rot in the vineyard or in storage.

This paper reports on the newly recognized disease of grapes, 'Early Botrytis Rot," describes its symptoms and development, and presents results of trials on control of the disease in vineyards.

MATERIALS AND METHODS

Test plots for fungicide trials were located in commercial vineyards in central and northern California. The designs used were completely randomized, randomized complete block, and split-block. Analysis of variance and Duncan's multiple-range test (P=0.05) were used for interpretation of all data (5,6).

The fungicides used were: Botran (2,6-dichloro-4-nitroaniline), spray, 50% wettable at 7.5 lb/acre; dust, 15% at 20 lb/acre. Captan [N-(trichloromethyl)-thio-4-cyclohexene-1,2-carboximide], spray, 50% wettable at 5 lb/acre; dust, 15% at 30 lb/acre. Benomyl [methyl-1-(butyl carbamoyl)-2-benzimidazole carbamate], spray, 50% wettable at 1 lb/acre; dust, 10% benomyl, 80% sulfur at 15-20 lb/acre. Thiabendazole [2-(4-thiazolyl)-benzimidazole], spray, 60% active at 4 lb/acre.

Sprays and dusts were applied at specific stages of flower and berry development. They were:

1) prebloom, more than 10 days before any bloom takes place; 2) early bloom, when 5-10% of the calyptras have been shed from clusters in the vineyard; 3) full bloom, when 50-100% of the calyptras have been shed; 4) postbloom, when 100% of the calpytras have been shed and many of the flowers in the clusters were losing their stamens; and 5) small pea size, when berries have lost their stamens and berry size was approximately 6-9 mm in diameter.

In evaluating the results, counts were made on both the number of clusters per vine and the number of clusters with rot. A diseased cluster was defined as one which had symptoms of *B. cinerea* rot; a cluster with a single diseased berry was counted the same as a cluster that was entirely rotted. Random samples of diseased clusters were collected for verification in the laboratory of the presence of *B. cinerea*. In small plots of less than 10 vines per replication, all vines in the plots were evaluated, whereas in the large plots of more than 20 vines/replication, disease counts were made on every second or third vine. When trials were repeated in the same plot for more than a year, the same vines were counted each season.

RESULTS AND DISCUSSIONS

Early Botrytis rot: The time of infection and symptom development without rain distinguishes Early Botrytis rot from Common Botrytis rot. Early Botrytis rot results from infection during bloom time, with the rot developing near midseason or later without rain. Common Botrytis rot results from direct infection through the skin of the grape during late-season rain, with the rot developing some few days after the infection.

In California, Early Botrytis rot develops in clusters of many varieties of grapes in the vineyards, usually near the period of veraison. In some varieties such as 'Emperor' and 'Tokay' the symptoms did not develop until near or after harvest. The infected clusters have groups of dry shriveled berries (Figure 1). The fungus mycelium and spores often cover the berries, giving them a velvety gray appearance. Dried-up grapes or their mummies on clusters left on the vine become a source of inoculum within the vineyard (Figure 2).

Figure 1. Clusters of 'Grey Riesling' grapes showing stages in development of Early Botrytis rot.

Figure 2. The fruiting (spore production) of *Botrytis cinerea* on old grape mummies and cluster stems that had overwintered on the vine.

TABLE 1

Effect of Dormant and Full Bloom Applications of Two Fungicides in the Control of Early Botrytis Rot in Grenache Vineyards, Stanislaus County, California. Figures are Percent of Clusters with Early Botrytis Rot.

Treatment (full bloom)	Dormant treatment[1]	
1967	**Bordeaux**	**No Bordeaux**
Captan spray (5 lb/acre)	17.8a[2]	14.2
Botran spray (7.5 lb/acre)	14.0b	17.2
Control	24.0c	18.4
1968	**Botran**	**No Botran**
Captan spray (5 lb/acre)	8.0a	10.6
Captan spray (5 lb/acre) + Captan dust (July—15%; 30 lb/acre)	6.7a	10.7
Captan dust (15%; 30 lb/acre)	10.4b	9.7
Botran spray (7.5 lb/acre)	19.6c	15.3
Botran spray (7.5 lb/acre) + Botran dust (July—15%; 30 lb/acre)	18.7c	15.5
Botran dust (15%; 30 lb/acre)	11.1b	14.3
Control	11.8b	16.0

[1] Dormant treatments were as follows:
Bordeaux mixture (5-5-50) applied during late dormant period (pregrowth) to vines and soil under the vines.
Botran spray (50%; 5 lb/acre) applied to vines and soil under the vines.

[2] Values within each year's treatments followed by the same letter are not significantly different at the 5% level.

Control trials: In the 1967 and 1968 seasons, field plots were used to evaluate the effectiveness of bloom-time applications of Botran and Captan for the control of Early Botrytis rot. Split-block designs were used with Bordeaux (1967) and Botran (1968) as dormant treatments in attempts to reduce any inoculum in the vineyard, such as mummies (Figure 2), sclerotia, or mycelium in decayed plant tissue (1). Table 1 presents the results of two seasons' trials with these fungicides on the variety 'Grenache'. The dormant treatments in both years showed no significant effect on the outcome of the full-bloom treatment. Captan was generally more effective than Botran when used as a full-bloom treatment. The incidence of Early Botrytis rot varied with the season. It was higher in 1967 than 1968. An added dust treatment in July, 1968, did not affect the results significantly.

Preliminary trials in 1967 with the fungicides benomyl and thiabendazole applied at full bloom indicated that both were effective for controlling early Botrytis rot. The incidence of disease in the variety 'Grenache' was reduced from 37% in unsprayed vines to 5% in vines with a full-bloom spray. In the variety 'Grey Riesling' the disease incidence was 25% in control vines but only 2% in vines treated at full bloom with benomyl and 4% in vines treated at full bloom with thiabendazole.

Table 2 shows the response of seven varieties to application of benomyl and thiabendazole. Both fungicides showed excellent promise. A single spray applied at full bloom significantly reduced disease incidence. Sprays in addition to the spray at full bloom generally reduced the incidence of disease still further, though not always.

In 1969 test plots were established on the variety 'Grenache' to test benomyl, the more effective of the two chemicals.

A concentrate spray of 1 lb 50% wettable/50 gal/acre as a full-bloom spray reduced rot from 10% in the control to 1% in the treated areas. Vines treated with regular concentrations of benomyl (1 lb 50% wettable/200 gal/acre) applied at full bloom also resulted in only 1% of clusters diseased.

The early tests with benomyl suggested that time of application might be an important factor for control. In 1970 a test was made on time of application of benomyl both as a spray and as a dust. Table 3 shows the results. Sprays applied prebloom reduced Early Botrytis rot, but sprays at early bloom were more effective. An additional spray applied at the small-pea stage further reduced the rot incidence. Two postbloom sprays were not as effective as the single spray at early bloom. Dusts of benomyl were approximately as effective as sprays.

In the 1970 tests, control of both Early Botrytis rot and Common Botrytis rot was evaluated. In all treatments except the prebloom spray with benomyl there was a 2-5-fold increase in the amount of Botrytis rot between August 26, just after the appearance of Early Botrytis rot symptoms, and September 30, just prior to harvest, when Common Botrytis rot was apparent. The increase in disease in this plot ap-

TABLE 2

Effect of Two Systemic Fungicides on Control of Early Botrytis Rot in Seven Grape Varieties. Figures Are the Percent of Clusters with Symptoms of Early Botrytis Rot (1968).

		Treatment[a]					
		Benomyl (1 lb 50%/acre)			Thiabendazole (3.3 lb 60%/acre)		
Variety	Control	(1)	(2)	(3)	(1)	(2)	(3)
'Grey Riesling'	3.9	2.9	0.8	1.2	3.8	0.6	3.6
'Zinfandel'	17.9	8.0	5.9	8.1	9.0	8.1	4.8
'Pinot St. George'	21.1	12.8	8.6	2.6	11.8	9.0	10.3
'Grenache'	21.8	1.7	2.8	2.7	9.2	4.9	2.8
'Tokay'	26.2	10.3	11.5	12.1	13.6	14.6	8.4
'Chenin blanc'	36.6	23.4	8.5	9.2	15.2	16.3	14.6
'Sauvignon vert'	60.5	28.4	26.9	10.7	48.3	23.0	33.5
MEAN	22.3	11.1	9.7	6.1	13.5	9.1	8.1

[a] (1) early bloom; (2) early bloom and July 8-13;; and (3) Early bloom, July 8-13, and August 5-10.

TABLE 3

Effect of Time of Application of Benomyl Fungicide on the Control of Early Botrytis Rot on the Grape Variety 'Grey Riesling'

	% clusters with rot	
Treatment[1]	**8/26/70**	**9/30/70**
Control	16.2c[2]	37.0
Benomyl spray (1 lb 50% active/acre)		
10 days before bloom	10.7b	22.2
Early bloom	2.1a	8.1
Early bloom, small pea	1.6a	7.9
Post bloom, small pea	7.8b	31.0
Early bloom, preharvest	1.4a	8.0
Benomyl dust (15 lb/acre; 10% dust)		
Early bloom	1.1a	3.5
Early bloom, small pea	4.3a	11.2
Early bloom, preharvest	2.5a	14.7

[1]Each treatment was a plot of 8 vines, replicated 4 times.

[2]Values followed by a common letter are not significantly different at the 5% level.

peared to be from inoculum provided by bloom-time infection by *B. cinerea,* for there was neither rain nor the prolonged periods of high relative humidity associated with Common Botrytis rot. Although preharvest benomyl sprays for the control of Common Botrytis rot have been reported (1) to reduce its incidence effectively in Europe, our results showed no significant effect of such applications on the apparent late-season spread of Early Botrytis rot (Table 3).

SUMMARY

Early Botrytis rot, a new development in this old disease, is characterized by a brown rot of part or all of the cluster which starts in midseason and may continue to develop until harvest in the absence of rains. The disease is caused by *Botrytis cinerea.* Infection occurs in the stigmatic portion of the flower at bloom time. The fungus remains latent in the necrotic stigmatic tissue until midseason or later, when it renews growth and rots the grape. In the cluster the fungus usually spreads and may rot most of the grapes. Rotten grapes usually dry and mummify. Losses due to Early Botrytis rot in California have been as high as 61% of the clusters, as seen in the very susceptible variety 'Sauvignon vert' (Table 2).

The results of this study show that: 1) dormant fungicide treatments were not effective; 2) bloom-time applications of Captan reduced disease in the vineyard; 3) early-bloom application of benomyl was very effective in control, more so than either prebloom or postbloom applications.

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