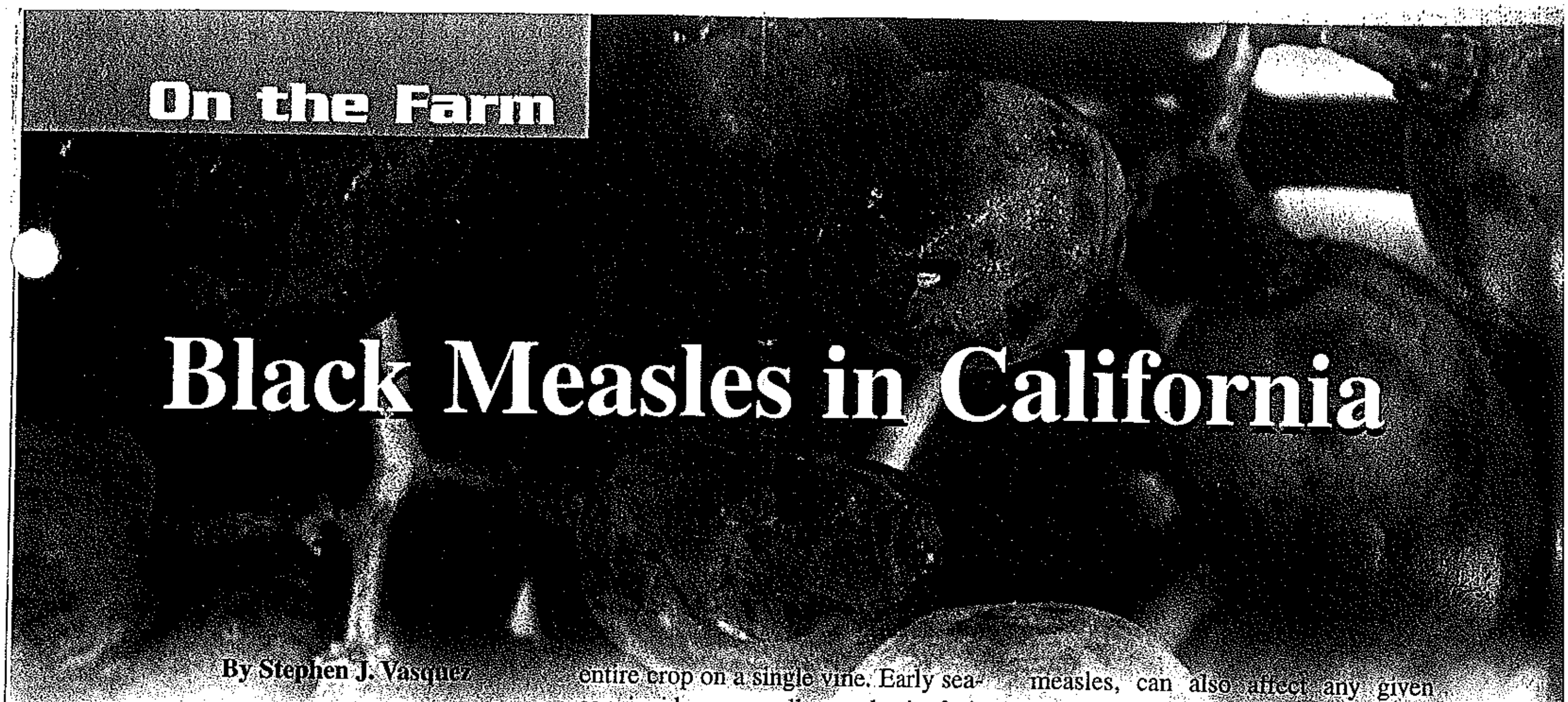


Black Measles in California

By Stephen J. Vasquez

Black measles has been around for many years; probably as long as grapes have been here in California. Measles, Spanish measles, black mildew, esca and apoplexy are some of the names that have been used over the years to describe the problem. In the early years, its cause was attributed to many things including fungi, bacteria and viruses. Its cause also was blamed on rising water tables, lack of soil moisture, alkali soils, over-cropping and nutrient deficiencies. Many of these problems brought about various remedies, most of which did not work, including the use of Bordeaux mixture which did not eradicate the disease or reduce its incidence.

Black measles continues to be a problem in all grape-growing regions of California and the world. Measles commonly affects grapevines that are 10 years old or older, destroying fruit and foliage. But vines as young as five years of age can also display symptoms. Grapevines display a myriad of symptoms throughout the growing season that continue to perplex growers.

Symptoms

Fruit symptoms are the most devastating to grape production. The name measles refers to the purple to black speckles found on the grapes. Grape berries can display the dark spots anytime after berry set, which can affect a few berries on a single cluster or the entire crop on a single vine. Early season incidence usually results in fruit that cracks, dries and falls off the vine. Late-season fruit symptom incidence can also cause cracking, but more often remain on the vine and become raisined. Measles-infected clusters can become infection courts for other fungi such as Botrytis (which causes bunch rot) or *Penicillium*, *Aspergillus* and *Cladosporium* (the sour rot fungi), potentially causing problems nearby in healthy clusters.

Foliar symptoms also show variation during the season, ranging from leaves displaying mild chlorotic spots confined to a few leaves on a single cane to apical tip dieback with complete defoliation of one to several canes. Leaves normally become chlorotic at the margins, followed by necrosis, leaving only green tissue near the large veins. Young leaves near the apical tip of a shoot that has not dried often become distorted and chlorotic. Additional symptoms include non-uniform wood maturity throughout canes displaying fruit or foliar symptoms and vascular discoloration. Red varieties show reddening instead of chlorosis, followed by necrosis.

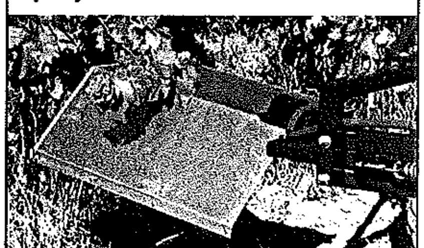
Symptoms of measles are sporadic. Foliar and fruit symptoms can appear simultaneously on any given vine, but foliar symptoms also can show without fruit symptoms and vice versa. In following years, grapevines having displayed measles one year may not show any symptoms the next year.

In addition to the chronic symptoms described, apoplexy, the acute form of measles, can also affect any given vine. Apoplexy describes the complete defoliation of a vine and drying of the clusters. Apoplexy is common mid-season to late-season and, as with the chronic symptoms of measles, it may not appear in consecutive years. Vines that display apoplexy symptoms in a single growing season sometimes produce new growth from lateral buds in the same season.

Cause of Black Measles

Numerous isolations from grapevines displaying measles symptoms resulted in many different fungi. *Phaeoacremonium inflatipes* and *P. chlamydosporum* were found to be the most prevalent. These fungi have been used to inoculate Thompson Seedless and Red Globe cuttings, resulting in foliar symptom expression, non-uniform wood maturity and internal wood discoloration. Reproducing fruit symptoms have proved more difficult for researchers. It is thought that toxins produced by *Phaeoacremonium* species are responsible for fruit symptoms.

P. chlamydosporum produces pycnidia, which produce millions of spores. *P. inflatipes* and *P. chlamydosporum* both make web-like structures called mycelium, producing thousands of spores. Spores are the infectious structures that have the potential to be moved by wind, rain or insects. The general biology of these fungi is not fully understood and continues to be worked on by researchers at UC Davis. In order to develop good



control measures, a better understanding of their biology is needed, including sources of inoculum.

Incidence and Severity in California Vineyards

Four Thompson Seedless vineyards were surveyed during the 1997-1998 growing season for measles symptoms. Vineyards were located in Madera, Tulare and Kern counties. The vineyards were similar in characteristics: ranging in age from 24 years to 30 years; grown on a standard T-trellis; cane pruned; on fine sandy loam; and furrow irrigated.

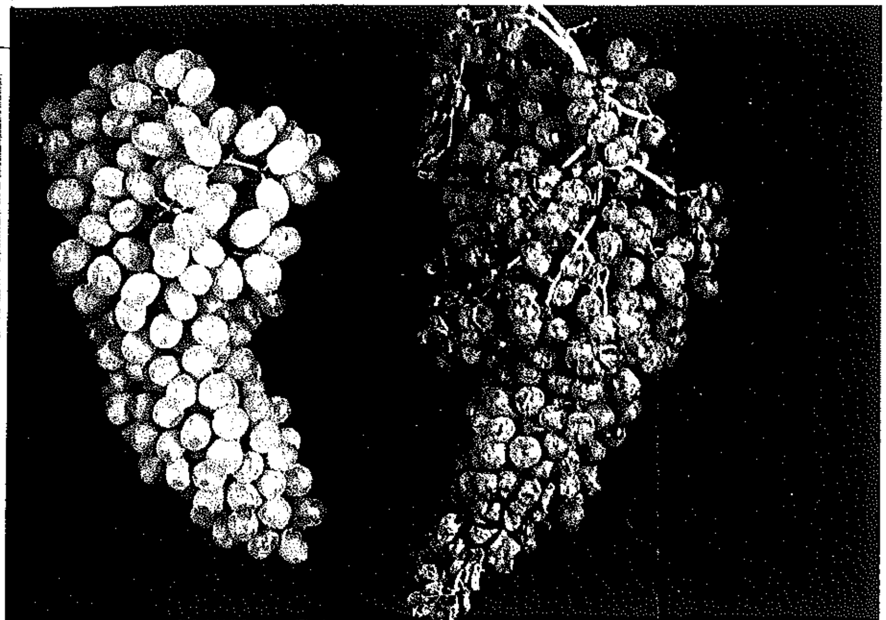
Disease incidence, as evaluated by visual foliar and fruit symptoms, consistently increased for each vineyard over time for both 1997-1998, with most vines expressing foliar symptoms in either May or June, respectively. The incidence of foliar measles ranged from a low of 16 percent in Kern County and a high of 68 percent at Tulare-1 for 1997. In 1998, foliar incidence decreased at the end of the season in all but one vineyard; Kern County increased from 16 percent in 1997 to 17 percent in 1998. Percent incidence of fruit symptoms ranged from a low of 15 percent for Kern County to a high of 59 percent for Tulare-1 in 1997. In 1998, the low again was in Kern County at 13 percent and the high was 36 percent for Tulare-1. Table 1 summarizes the data for foliar incidence and severity for 1997-1998, and Table 2 shows data for fruit incidence and severity for 1997-1998. Percent of foliar and fruit severity followed similar trends, but decreases can be found. The decreases are a result of averages taken over the entire vineyard.

Foliar and fruit severity was determined by rating each vine on a scale from 0 (no measles symptoms) to 5 (foliar or fruit symptoms over the entire vine). The ratings were then converted to percentages and averaged for the total vines displaying symptoms.

Maps were made of each vineyard for both years to exhibit the disease incidence and severity for each survey date. The maps use a color-coding system that correspond to the fruit symptoms, and patterns represent foliar symptoms on individual grapevines for each research site. These maps allow researchers to follow the disease for each grapevine and can then be used for fungicide field trials.

In order to determine yield loss due to measles, cluster weights from healthy vines were weighed from each vineyard. Two healthy and two mildly infected vines were chosen to compare weights and obtain averages. On average, healthy clusters from Thompson Seedless vineyards were half a pound more than measles-infected clusters.

Here is internal chlorosis which will be followed by necrosis. Typical foliar symptoms can range from leaves displaying mild chlorotic spots confined to a few leaves on a single cane to apical tip dieback with complete defoliation of one to several canes.



A healthy cluster (left) compared to an infected cluster. On average, healthy clusters from Thompson Seedless vineyards weighed 1/2 pound more than measles-infected clusters.

The most significant yield loss in 1997 was found in Tulare-1 with 29 percent of fruit infected, amounting to 4,127 pounds of fruit. In 1998, Tulare-1 again had the highest yield loss with 21 percent infected fruit totaling 1,958 pounds (Table 3).

Management of Black Measles

Previous methods included dormant applications of sodium arsenate applied to the trunks and arms of older vines. The use of sodium arsenate was as sporadic as the disease itself, reducing the incidence but not completely eradicating measles. Work done by university researchers found that sodium arsenate could cause bud necrosis. When sprayed on young canes, it entered through leaf scars and fresh pruning wounds, moving through the xylem vessels (water conducting tissue) and into the buds, killing them. The activity that sodium arsenate had on measles control was never understood.

Currently, we have no chemical or cultural controls for black measles. Fungicides continue to be screened for the control of *Phaeoacremonium inflatipes* and *P. chlamydosporum*. Fungicides are screened using poison agar plates with potato dextrose agar as the base medium. Benlate has consistently inhibited the growth of both *P. inflatipes* and *P. chlamydosporum*; other fungicides also show some promise, but the challenge lies in introducing them into the grapevine.

Fungicide trials were established in 1998 using the survey data from 1997. Three methods were used for introducing fungicides into the trunks of the vines:

1) Three 60 cc syringes with 50 ml of fungicide solution were inserted into pre-drilled holes around the base of grapevines displaying measles.

2) An injection gun, which forced the fungicide solution into the xylem vessels of measles-infected vines.

3) Fungicide applications were placed in fresh girdling wounds of infected Thompson Seedless vines.

Although the results vary for the three types of applications, the latter may be the best approach. Research continues at UC Davis to determine what the best approach for controlling measles might be. W.B. Hewitt, a UC plant pathologist in the 1950s sums up the disease best: "The function of sodium arsenate in the control of black measles is not understood. An answer to this question probably awaits an understanding of the cause or causes of the disease."

Despite having a better understanding of what the primary cause of black measles is, we still do not have a complete picture – and it may be some time until we do. ❑

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