Perennation of Powdery Mildew in Buds of Grapevines

MARY ANN SALL, Assistant Professor, and JEANETTE WRYSINSKI, Staff Research Associate, Department of Plant Pathology, University of California, Davis 95616

ABSTRACT

Sall, M. A., and Wrysinski, J. 1982. Perennation of powdery mildew in buds of grapevines. Plant Disease 66:678-679.

The presence of perennating bud infections caused by *Uncinula necator* was confirmed on grapevines (*Vitis vinifera*) in California. These perennating infections tend to occur on the same vines in successive years. They are formed more frequently on buds arising from spurs than from the vine arm. Infected buds open slightly later than uninfected ones. Judging from the masses of conidia found on their surface, the mildew flag shoots begin to liberate inoculum shortly after the onset of growth.

Additional key word: epidemiology

Perennation, or survival from one growing season to the next, of the grape powdery mildew fungus, *Uncinula necator* (Schw.) Burr., has been thought to be accomplished by ascospores in cleistothecia (5,9) and/or by mycelia infecting shoot primordia under bud scales (1,7). The role of ascospores is in doubt because convincing evidence that they can cause infection has not been published. Also, cleistothecia of *U. necator* are unknown in Australia, where grape powdery mildew is common (6), and were not found in Europe until 50 yr after the fungus was introduced there from America (2). When cleistothecia are not present, the fungus undoubtedly perennates under bud scales.

In California, cleistothecia are formed abundantly on all cultivars of commercial grapevines (*Vitis vinifera* L.). Their importance in the epidemiology of grape powdery mildew has not been established here. Moreover, shortly after budbreak, heavily infected shoots can be found that possess the characteristic signs associated with perennating bud infections, particularly on cultivars Carignane and Thompson Seedless. Typically, vineyards with these early infections sustain severe powdery mildew damage on the fruit. In some if not all areas, perennating bud infections appear to provide an important source of initial inoculum.

We report here observations and experiments we have done to confirm the presence of *U. necator* in buds of grapevines and to document the pattern of its occurrence on vines in California.

Supported by Hatch Project 3247.

Accepted for publication 19 October 1981.

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

0191-2917/82/08067802/$03.00/0

MATERIALS AND METHODS

A small block of vinifera vines, cultivar Carignane, grown near Fresno, CA, was observed from 1977 to 1980. Each year when shoots were about 10 cm, 40 vines (20 in 1978) were examined for the heavily infected shoots that Boubals (1) refers to as flags and that are associated with perennating bud infections (Fig. 1). The origin of each shoot, on spurs or vine arms, was noted. Mildew flags were marked with paint to facilitate locating them for further observations.

During dormancy, the vines were pruned to two- or three-bud spurs. Canes that developed from the marked shoots were collected and stored in a 1.5 C cold room. From time to time, two-bud cuttings were made from the collected canes, surface-sterilized with 0.5% sodium hypochlorite, inspected for the presence of cleistothecia, and placed in sand on a heated rooting bench in a greenhouse. After shoots were produced on the cuttings, they were examined for evidence of perennating powdery mildew infections. We judged these infections to be present when the fungus colonization on the young shoot extended from its basal node and when the two primary leaves were heavily colonized and deformed. We know from experience that even very early secondary infections do not produce these characteristic signs and leaf symptoms. Although sources of secondary inoculum were present in the greenhouse, we believe that the judgment criteria were specific enough to allow us to differentiate between primary and secondary infections. Cleistothecia, though abundantly formed on leaves, were rarely found on canes.

Some buds were allowed to swell and were then removed from the cuttings for dissection. These buds were teased apart, and the primodia were dipped in alcohol

Fig. 1. Powdery mildew flag shoot (left) and healthy shoots on grape cultivar Carignane.

and stained for 10 sec in phloxine B. They were examined microscopically for the presence of septate mycelia on the shoot and leaf primordia.

In 1980, two groups of 12 vines were identified from the 40 vines in the observed vineyard. Each group consisted of vines with similar numbers of mildew flags in the previous year, and the mean number of flag shoots per vine for each group was 2.3 (SD_1 = 1.8, SD_2 = 1.7). While the vines were fully dormant (29 February), they were pruned. The vines in the first group were selectively pruned to discriminate against those spurs that had produced mildew flags in the previous year. These spurs were completely removed to the vine arm. If the arm arising from the cordon showed multiple infections and a renewal spur was available, the arm was completely removed to the main cordon. The second set were pruned normally by an experienced pruner. After the onset of shoot growth (17 April), the vines were examined for mildew flags. The number of infected shoots per vine was compared in an unpaired *t*-test.

RESULTS

In our observation vineyard, more than 65% of the vines had evidence of one or more perennating bud infections (Table 1). The number of these infections varied slightly from year to year, reaching a maximum in 1978 (mean of 3.2 infections per vine) and a minimum in 1979 (1.7 per vine).

Most of the mildew flag shoots originated from buds borne on spurs; that is, on short branches of one year's growth retained after pruning. Of the 5,578 shoots on spurs examined over the four seasons, 5.3% were mildew flags. Fewer perennating infections are associated with shoots arising on an arm of the vine; of 2,086 examined, 0.8% were infected.

In general, we found that vines with perennating bud infections in one year tend to have them the following year. Over the four seasons, 84% of the vines had mildew flag shoots for two successive seasons. However, only 38% had such infections for all four observed years.

Our observations indicate that buds with perennating infections may open slightly later than uninfected buds. On 8 April 1980, 22.5% of all buds were closed. However, later observations indicated that 67.9% of infected buds had been closed at that time. Nine days later, virtually all shoots had begun to grow. Also, preliminary observations seem to indicate that severely affected shoots may die shortly after the onset of growth.

The presence of the mildew flag shoots is associated with very early secondary infections. Secondary infections were recorded on 3.4% of the shoots on 29 April 1977. The shoots at that time (about 3 wk after the beginning of shoot growth) averaged 7.5 cm long.

Table 1. Observations on the occurrence of perennating bud infections on 40 vines (cultivar Carignane) grown near Fresno, CA

Year	Vines with perennating infections (%)	Number of infections per vine: Mean	SD[a]	Origin of infected shoots[b]: Spurs (%)	Arms (%)	Infected vines that had infections the previous year (%)
1977	70.0	2.4	±2.9	5.8	0.0	...
1978[c]	81.0	3.2	±3.1	6.0	1.6	93.0
1979	67.5	1.7	±1.9	3.7	0.4	65.0
1980	75.0	2.1	±2.0	6.4	1.0	93.0

[a] Standard deviation.
[b] Percentages are based on the total number of shoots arising from spurs and arms, respectively.
[c] Based on observations of 20 vines.

In 1978 and 1979, 410 cuttings were made and rooted in the greenhouse. Although they were taken from the heavily infected observation vines, no mildew flag shoots were produced. In 1980, 57 cuttings were made, and 12.2% were found to possess the characteristic signs indicating perennating bud infections. These cuttings were taken from spurs with such infections the previous year. Of the buds retained on the vine after pruning, 30.3% from spurs with previous infections were found to be infected in the spring of 1980.

Thirty buds were dissected, and three were found to have septate mycelia on leaf and shoot primordia. Spores of *Alternaria* spp. were also observed, but no indications of infection by this fungus were found on these buds or on any shoots that were allowed to develop in the greenhouse.

Although in 1980 one group of vines was carefully pruned to remove spurs with previous bud infections, an unpaired *t*-test failed to find a significant reduction in the number of mildew flags compared with vines that had been pruned normally. The mean number of infected shoots per vine in the selectively pruned group was 2.0 and in the normally pruned group was 2.9.

DISCUSSION

The consistent appearance of mildew flags from year to year, their production in the greenhouse in the absence of cleistothecia, and the presence of septate mycelia on shoot and leaf primordia of unopened buds confirm the presence of perennating bud infections on grapevines in California.

Boubals (1) did not observe mildew flags arising from the basal two buds. However, in our study, infections were consistently found on the two- or three-bud spurs remaining after pruning. We intended to investigate the distribution of infected buds in the greenhouse; unfortunately, the cold temperatures during storage probably eliminated many of the infections, as it has been thought to do in peaches and gooseberries (4,8). Thus, we were unable to find any position effect.

Judging from their powdery appearance and from microscopic observations of masses of conidia, the mildew flag shoots begin to liberate inoculum shortly after the onset of growth. Grape powdery mildew control recommendations advise applying elemental sulfur to prevent infections, beginning when shoots average 15 cm (3). From our observations, this may be too late to protect young shoots from the initial inoculum where perennating infections are present.

ACKNOWLEDGMENTS

We are grateful to L. Odone for microscope work, F. J. Schick for data analysis, J. K. Clark for photography, and D. H. Ford and the staff of Elanco Field Research Station at Fresno, CA, for allowing us access to the observation block.

LITERATURE CITED

1. Boubals, D. 1961. Etude des causes de la résistance des vitacees à l'Oidium de la vigne, *Uncinula necator* (Schw.) Burr, et de leur mode de transmission héréditaire. Ann. Amelior. Plant. 11:401-500.
2. Bulit, J., and Lafon, R. 1978. Powdery mildew of the vine. Pages 525-548 in: The Powdery Mildews. D. M. Spencer, ed. Academic Press, New York. 565 pp.
3. Hewitt, W. B., and Jensen, F. L. 1973. Powdery mildew disease of grapevines. Calif. Agric. Exp. Stn. Ext. Serv. Leafl. 212.
4. Preece, T. F. 1965. Early stages of American gooseberry mildew. Plant Pathol. 14:83-86.
5. Rasulev, U. U. 1965. Significance of the ascus state of the causal agent of powdery mildew of the vines. Ex Sporovye Rast. Sred Azii i Kazakhstana: 107-111. (Rev. Appl. Mycol. 46:104. 1967)
6. Taylor, R. H. 1957. Oidium (powdery mildew) of the grape. J. Agric. (Victoria, Aust.) 55:465-472.
7. van der Spuy, J. E., and Matthee, F. N. 1977. Overwintering of the oidium stage of *Uncinula necator* in the buds of the grapevine. Plant Dis. Rep. 61:612-615.
8. Weinhold, A. R. 1961. The orchard development of peach powdery mildew. Phytopathology 51:478-481.
9. Weltzien, H. C., and Weltzien, M. 1962. Cleistothecien von *Uncinula necator* in Wurttemberg 1961. Z. Pflanzenkr. (Pflanzenpathol.) Pflanzenschutz 69:664-667.