Late Season Water Deficits and Development of Cytospora Canker in French Prune

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ABSTRACT

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French prune trees subjected to postharvest moisture stresses developed significantly larger cankers following inoculation with mycelium of *Cytospora leucostoma* than did adequately irrigated trees. Tree water status was monitored in terms of (i) relative water tension with a pressure chamber and (ii) percent bark moisture. The pressure chamber gave a more sensitive evaluation of tree water status and provided data that correlated well with canker development.

Additional key words: Prunus domestica, pathogenesis, predisposition.

Cytospora canker is one of the most common diseases of prune, *Prunus domestica* L. 'French', in northern California. The causal organism, *Cytospora leucostoma* Sacc., is believed to be a weak pathogen of French prunes, only able to extensively parasitize nonvigorous trees (2). Insufficient soil moisture could result in a weakened tree. Fisher (9) believed that improper irrigation contributed to Cytospora canker of apples. Bier (3, 4, 5, 6) reported that reduced bark moisture, measured in terms of percent relative turgidity in cuttings of woody plants, could result in significant increases in diseases caused by several weak pathogens. Bloomberg (7) suggested a direct relationship existed between bark moisture content of poplar cuttings and resistance or susceptibility to damage by *Cytospora chrysosperma*. Using sections of peach stems, Wihrheim (12) presented data suggesting that development of Cytospora canker was related to a decrease in bark moisture as measured by Bier's method (3). In California, there is often a long delay before water is applied following prune harvest in August. In some cases, growers hope for early fall rains and do not give a postharvest irrigation. An experiment was set up in the field to determine the effect of late season moisture stresses on subsequent canker development resulting from artificial inoculation of otherwise healthy French prune trees with *C. leucostoma*.

MATERIALS AND METHODS

Differential irrigation plots were laid out in a 12-year-old commercial French prune orchard near Woodland, California, in August 1971. The trees selected for study were growing vigorously and were free of Cytospora cankers. The orchard had been uniformly irrigated through 4 August 1971. The differential irrigation consisted of three watering regimes: (i) dry–no irrigation after 4 August; (ii) intermediate–the normal four irrigations applied by the grower; and (iii) wet–twice the normal amount of water. The orchard is normally sprinkler-irrigated on a skip-row system so that during one irrigation sprinklers run in the odd numbered rows and in the next irrigation (about 10-14 days later) they run in the even numbered rows. In the wet treatments sprinklers ran in every row in each irrigation. Each irrigation regime was replicated once in each of three randomized complete blocks with three guard rows between each trial row of 10 trees. The three blocks were in a linear arrangement each separated by 35 nontest rows.

The water status of selected trees in each replication of each watering regime was monitored weekly with a pressure chamber (8). In the 2 weeks following inoculations (22 October 1971) all 10 trees in each replication of each regime were monitored with the pressure chamber. All pressure readings were taken in the field between 0500 and 0700. At this time of day, tree water potential would be at its maximum so that differences in the ability of the differential irrigations to supply the trees with water should be most apparent (10). Each pressure reading was taken on a single leaf and five leaves from each tree were sampled each time. The pressure end point was taken as that chamber pressure necessary to force internal leaf water to just wet the cut end of the petiole. The positive pressures observed with the pressure chamber are equivalent to water potential in absolute value but opposite in sign (1). The water status of one tree in each replication also was monitored weekly by a percent bark moisture method. The bark moisture value of each tree was calculated as the mean percent moisture

(fresh weight basis) of four 1.5 cm-diameter bark disks cut from the scaffold branches with a cork borer. The fresh and dry weights of the disks (dried at 105 C for 7 days) provided the data needed for this calculation. Bier's relative-turgidity method of measuring bark moisture (3) was not used in this work. It was believed that the quite thick bark disks cut from the trees used in this work might absorb water in excess of the amount present at full turgor owing to the large exposed surface of broken cells resulting from failure to remove many bark disks intact.

Ten trees in each replication were inoculated on 22 October 1971 with three isolates of *C. leucostoma* (F4, F24, and F40). Isolates F4 and F24 originally were isolated in 1958 from peach near Dinuba, California, and French prune near Live Oak, California, respectively. Isolate F40 was isolated in 1959 from President plum near Reedley, California. Inoculum was prepared by growing the three isolates on potato-dextrose agar (PDA) for 8 days at 27 C. The cultures were then cut into disks with a sterile 5 mm-diameter cork borer. Similar disks cut from sterile PDA plates served as the check inoculum.

All trees were inoculated three times, once with each isolate, by pressing a 5 mm-diameter mycelial-PDA disk into a 1.7 cm-diameter wound. The wounds were made by placing a 1.7 cm-diameter steel bolt against the limb and striking it with a hammer until the bark was broken. The broken bark was lifted slightly, inoculated, replaced, and bound with tape. Check inoculations with sterile PDA disks were handled in the same manner. Cankers were evaluated monthly for longitudinal extension beginning January 1972.

Results were analyzed statistically by using a *t*-test and analysis of variance.

RESULTS AND DISCUSSION

The tree water status, as influenced by differential irrigation, was determined by means of bark moisture and pressure chamber measurements (Fig. 1). Although the differences between treatments measured with the pressure chamber were much larger than those measured in terms of percent bark moisture, tree water status as

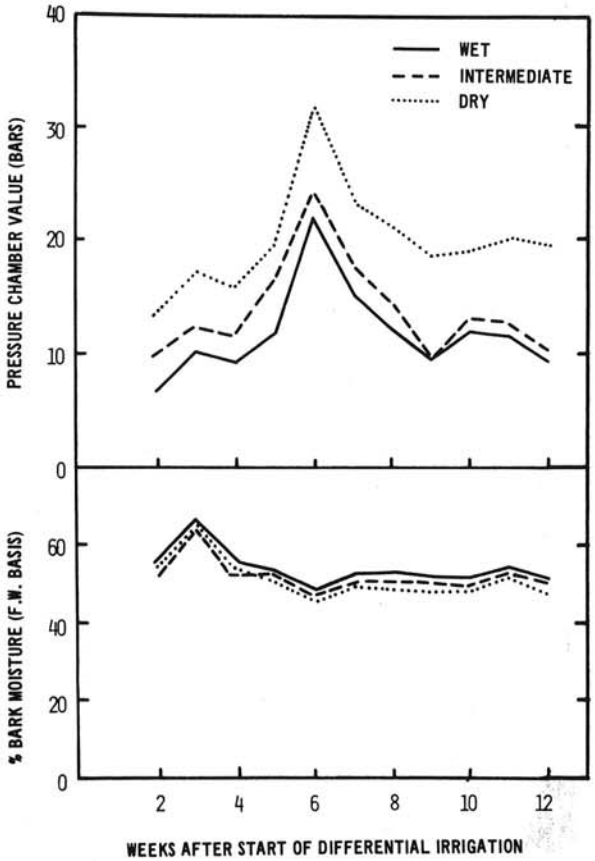

Fig. 1. Effect of three differential irrigation treatments on the weekly water status of French prune trees as measured with a pressure chamber and by percent bark moisture. Inoculations with *Cytospora leucostoma* were made on 22 October, approximately 11 weeks after the start of differential irrigation.

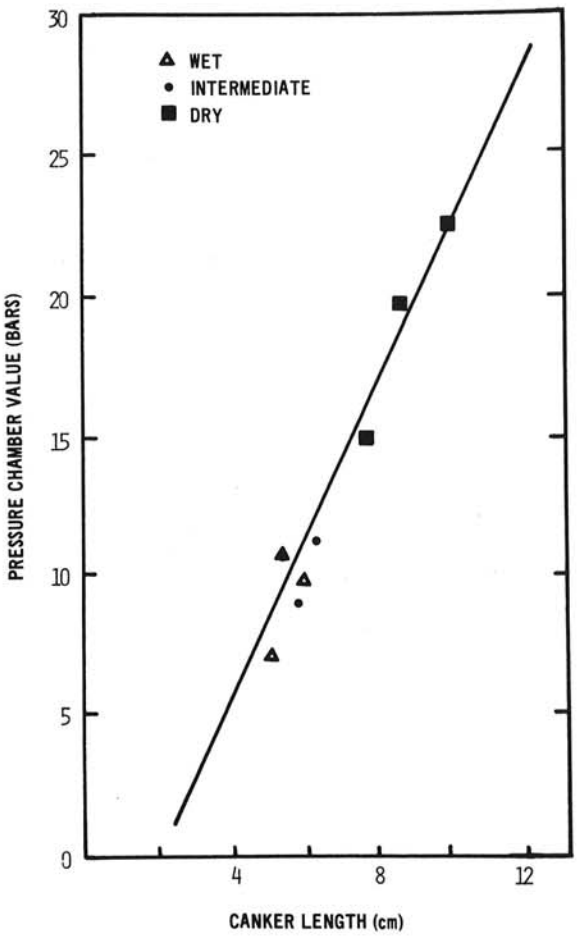

Fig. 2. Effect of fall irrigation as monitored with a pressure chamber on subsequent development of artifically induced cankers caused by *Cytospora leucostoma* in French prune trees during a 216-day incubation period (22 October 1971 to 26 May 1972). Each point represents the mean of two postinoculation pressure-chamber readings of five leaves per tree (25 October and 3 November 1971) and three canker measurements per tree in 10 trees. Note the coincidence of one of the wet and intermediate points.

measured by both methods tended to follow similar trends. For example, trees in the wet plots had the highest bark moisture and lowest pressure chamber values as expected, and trees in the dry plots had the highest leaf water tension values and for the last 8 weeks the lowest bark moisture values. It is evident from Fig. 1 that the bark did not clearly begin to respond to the differential irrigations until the 5th week after their initiation. The leaves, however, showed a very clear response 2 weeks after beginning the differential irrigation treatments that were applied. The large differences between treatments shown by the pressure chamber values were not apparent from the bark moisture values. Evidently, the pressure chamber values, which are inversely related to leaf water potential (1), provided a more sensitive measure of plant water status than did measurement of bark moisture. The difference in pressure chamber readings between the wet and dry treatments varied from 6.5 bars, two weeks after the beginning of differential irrigation, to 10.3 bars 10 weeks later. For these same two dates the difference in bark moisture values between the wet and dry treatments varied from 0.7 percent to 3.2 percent. The differences between the wet and dry treatments, as measured with the pressure chamber, were significant ($P = 0.05$) every week, whereas the differences based on bark moisture were not always significant. There was, however, a significant difference ($P = 0.05$) in bark moisture percentage between the wet and dry plots at the time the inoculations were made (11 weeks after the start of differential irrigation). Pressure chamber values were much more easily and rapidly obtained than bark moisture values and are considered to be a more sensitive measure of tree water status.

The three isolates differed somewhat in virulence. Isolate F40 was significantly ($P = 0.05$) more virulent than either F4 or F24. Isolates F4 and F24 were not significantly different in virulence. Isolates of *Cytospora leucostoma* having different degrees of virulence have been reported previously (13). Since the differences in virulence among the isolates were consistent in all treatments, the canker values for each tree were taken as the mean canker length produced by the three isolates. There was no infection in any of the check inoculations.

There was a good correlation ($R^2 = 0.96$) between fall water status of the host as measured with a pressure chamber and subsequent canker development (Fig. 2). The wet and intermediate irrigation regimes did not differ significantly in effect on canker development. Canker development in the dry treatments was significantly greater ($P = 0.01$) than in the other treatments. In the driest of the dry plots (indicated by the highest mean pressure chamber value) canker development was significantly greater ($P = 0.05$) than in the other two dry plots which were not significantly different in terms of canker development.

In late May of 1972, beginning with the first irrigation, one replicate of the wet and one of the dry treatments were reversed to test whether extra or less water at this time would have an effect on extension of cankers initiated the previous fall. Host water status was monitored weekly with a pressure chamber and canker extension was evaluated monthly. Adding water to a previously dry treatment or discontinuing irrigation of a formerly wet treatment had no significant effect ($P = 0.10$) on canker development between the end of May and the end of July 1972, when the experiment was terminated. Canker activity during this period was decreasing in all treatments, probably due to the resumption of growth of the host which corresponded with a rapid healing around the canker margins (2). The balance of host factors that regulates healing is not known, but appears to be related to overall vigor of the host.

These results suggest that fall moisture stress for only one season in otherwise healthy French prune trees resulted in significantly increased Cytospora canker activity during the succeeding 7 months. If the trees had not been initially vigorous or the stresses had been allowed to continue over several seasons, the effects might have been much greater. Droughts brought on by lack of rainfall or mismanagement of irrigation are believed to be associated with the natural occurrence of Cytospora canker in larch (11) and apple (9).

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