on total sugars when tank-mixed with phenmedipham, ascorbic acid content of the fruit was reduced by 14% when compared to the weeded check. As separate treatments, chloroxuron and terbacil reduced soluble solids, while the combination had no effect.

Discussion

Terbacil was the most effective herbicide; however, weed control was significantly improved when tank-mixed with chloroxuron. The highest rates of terbacil severely injured the strawberry plants and resulted in a reduction in yield and fruit size. Phenmedipham would be more effective if applied 2 times during the season, since its persistance in soil is very short. Although sethoxydim controlled grass weeds for two months following application, it had no effect on broadleaf weeds and it reduced ascorbic acid and total sugar content of the fruit.

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Paradoxes Surrounding Our Understanding of Plum Leaf Scald

W. B. SHERMAN[1], C. E. YONCE[2], W. R. OKIE[2], AND T. G. BECKMAN[2]

Abstract

Xylella fastidiosa Wells et al., a xylem limited bacterium (XLB) and the causal agent of plum leaf scald, has also been shown to be the causal agent of Pierce's disease in grape, phony peach, and almond leaf scorch and has produced blight symptoms in citrus. Scientific and circumstantial evidence are presented for and against all 5 crop diseases being caused by the same XLB. This XLB has been transmitted among the 5 crops, but not in all combinations. The XLB has a wide host range, is transmitted by similar leafhoppers, is characterized by occlusions in the xylem with plant symptoms appearing most severely following stress (heavy crops), and results in decreased productivity and general

[1]Fruit Crops Dept., University of Florida, Gainesville, FL 32611.
[2]USDA SE Fruit and Nut Laboratory, Byron, GA 31008.
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plant decline. Germplasm resistant to plum leaf scald is recommended for breeding programs in the southeastern U.S.

Plum leaf scald (7), phony peach (12), almond leaf scorch (9), Pierce's disease of grape (10), and perhaps citrus blight (4), are incited by various strains of a xylem-limited, gramnegative bacterium (*Xylella fastidiosa* Wells et al.). Young vigorous trees typically take 2 to 3 years to show symptoms and display fewer symptoms than older plants stressed with heavy cropping (8). Infected scion trees of peach and almond on peach stocks respond positively for the root xylem test with acidified alcohol (6, 9, 15) whereas infected plum scions on peach roots tested positive, but infected plum scions on plum roots did not test positive (8). Pierce's disease, phony peach, plum leaf scald, and citrus blight strains of *X. fastidiosa* have wide host ranges (4). Plum, almond, and grape exhibit leaf margin scorch but not the dwarfness of peach. The bacterium has been isolated in stems and leaf petioles in all crops except with blight in citrus though it is difficult to find in large numbers in peach stems and petioles. Additionally in all instances except blight, the bacterium can be detected in the root systems though it is difficult to find in large numbers in citrus, plum and grape roots. Various strains of *X. fastidiosa* are known to occur and some bacterial transmissions have been made among the 5 fruit crops by common leafhoppers and by grafting, resulting in symptom expression typical of the disease in the inoculated crop. The following evidence ties all 5 diseases together, albeit not in all combinations (also see Fig. 1).

1. A strain of the bacterium was transmitted from blighted citrus trees to grapevine, resulting in Pierce's disease symptoms, using a common leafhopper vector (5). The bacterium was then cultured from the grapevine.
2. Pierce's disease strains of the bacterium from grape, also caused citrus blight symptoms when inoculated into rough lemon (4).
3. A strain of *X. fastidiosa* isolated from peach produced blight symptoms in rough lemon (4).
4. Almond leaf scorch is caused by a xylem limited bacterium similar to that causing phony peach and Pierce's disease (15). All 3 diseases are transmitted by the same leafhopper.
5. The bacterium causing almond leaf scorch has been transmitted to healthy grape, causing typical symptoms of Pierce's disease (9).
6. The bacterium causing plum leaf scald is considered the causal agent of phony peach (3, 8) and each has been transmitted, with symptom expression, to the other through grafting (3, 14).

History

Plum leaf scald is a relatively new disease and is not mentioned in the literature prior to the 1960s and its causal agent was described in 1975 (7) For example, scald was either not evident in the 1940s in Texas or else mild symptoms were attributed to potassium deficiency or lack of soil

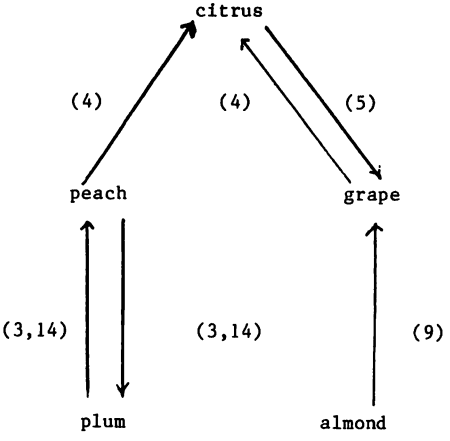


Figure 1. Direction of transmission of *Xylella fastidiosa* strains.

moisture during summer, but it was not recognized as a major plum disease (A. H. Krezdorn - per. comm.). Leaf scald resistance was not one of the initial goals for the USDA plum breeding program at Byron, GA in the early 1960s (Victor Prince - per. comm.). Scald was certainly not severe enough to be a major problem in the southeastern U.S. peach belt when phony peach was rampant during the 1950s. Scald was not a major disease in the plum cultivar test plots at Mississippi State University in the early 1960s, nor was it mentioned by J. P. Overcash in his observations. Evidently, plum scald was not an important criterion at the beginning of the Auburn plum breeding program in the early 1960s and most early releases proved to be highly susceptible in recent cultivar tests. However, neither large commercial plantings nor old test plantings of plum cultivars were established throughout the phony peach area of the southern U.S. so that potential for detection of plum scald could have been low.

Discussion

If plum leaf scald is incited by the same strain of *X. fastidiosa* that causes phony peach (3) and is closely tied to almond leaf scorch, Pierce's disease, and citrus blight, then some questions arise. Why is plum leaf scald a serious disease of Japanese plums in southern Brazil to Argentina (2) where phony peach is unknown in relatively large peach industries? Plums showing scald certainly transmit severe phony symptoms to peach in the southeastern U.S. when grafted onto healthy peach trees (3, 14). Perhaps there are several strains of the bacteria that cause scald in plums but only some (one) of the strains that result in phony symptoms. California has almond leaf scorch and Pierce's disease in grape but no plum leaf scald or phony peach. Eleven percent of an 18-month-old field population of plum seedlings at the University of Florida, Gainesville, showed symptoms of scald (Sherman - unpublished data). Usually it takes 2 to 3 years from inoculation for phony symptoms to appear in healthy trees of peach in the orchard (6), but only 9 months occurred for symptoms to occur in plum and peach after reciprocal inoculations (14). Plum trees, exhibiting suspect scald symptoms in a 6-month-old cultivar test block at Byron, Georgia, tested positive for scald (Okie - unpublished data). The bacterium is also found in high concentrations in plum leaf petioles (8). Thus, the bacterium may be in the xylem trace leading to the bud and could be occasionally transmitted through June budding, without wood in the shield, to the propagated trees. Perhaps the bacterium spreads more quickly in small plum plants or exhibits symptoms more quickly in plums than in peach.

Why is it that transmission of the disease has not been found between all combinations of the 5 fruit crops? Perhaps certain strains are more host specific and are partially or not effective in other hosts. This leads to the possibility of several strains causing symptoms of various degrees in each host. The possibility also exists for cross protection by inoculating with mild strains specific to each host crop. Does the pathogen change? Why the apparent rise in plum leaf scald in the last 20 years in the southeastern U.S.? For example, the scald resistant plums 'Byrongold,' 'Segundo,' and 'Robusto' from the USDA breeding in Byron, Georgia became severely infected in the summer of 1988 when they had previously exhibited high resistance for more than 10 years in the presence of high infection pressure (Okie - unpublished data). Perhaps the dry summer of 1988 induced extra stress and enhanced symptoms. Eight of 11 advanced plum selections from the University of Florida, Gainesville program also exhibited scald symptoms for the

first time in 1987 and 1988. The old line Pierce's disease resistant grape cultivars from the Leesburg, Florida breeding program also show increasing susceptibility (John Mortensen - per. comm.). In fact, almond leaf scorch, first detected in 1958 in California, was reported to be spreading in 1974 and a severe disease of almonds in 1979 (9, 15). Citrus blight was first reported in the 19th century, but has become a major problem since 1970. Phony peach disease showed a substantial increase since the mid-1970s, long after the major infected tree removal programs of the 1950s and early 1960s were drastically reduced. Although strains may be becoming more virulent, recent data from phony inspection records and dormancy chilling hours in Georgia, compiled over a period of 60 years, revealed that a significant correlation exists between mild winters and phony disease incidence (Yonce - unpublished data). Whenever excessively lower than normal chilling was recorded for 1 or more years in succession, phony disease incidence began to increase 2 years later. The longer mild winters persisted, the more phony disease increased. When chilling unit accumulations were higher than normal for 1 or more successive years, phony incidence began to show a decline 2 years later. This was observed 3 different times during the 60 year period at intervals of approximately 20 years apart. This is an indication that phony disease (16) and leaf scald (1) bacteria are highly sensitive to cold as is Pierce's disease of grapevines (13).

The primary phony peach leafhopper vector, *Homalodisca coagulata* (Say), is extremely abundant near the Georgia-Florida state line. It does not occur above the "fall-line" in Georgia, South Carolina, and Alabama, and is almost non-existent as far south as Fort Lauderdale, Florida (16, J. H. Tsai, per. comm.). Fluctuations in population levels are observed some years, but there is not sufficient data to relate these levels to severe cold temperature. Nonetheless, evidence suggests that the primary leafhopper vector is indeed cold sensitive as is the bacteria itself (16).

Breeding for Resistance

Scion cultivar resistance to plum leaf scald (8, 14) and Pierce's disease in grapes (11) is documented as well as rootstock resistance to citrus blight. No scion or stock cultivar differences have been reported for phony in peach or for leaf scorch in almonds. In fact, phony peach was rampant in the large peach and nectarine cultivar test plot in Byron, Georgia in the mid-1970s and no differences were noted (Sherman - unpublished data and Victor Prince per. comm.). Almond leaf scorch has been observed in more than 11 almond cultivars comprising 86% of the California acreage (9, 15) suggesting no difference in cultivar susceptibility. In screening potential plum germplasm for resistance to scald, symptoms have been found in *Prunus salicina* alone or hybridized with *P. americana, P. cerasifera, P. simonii, P. munsoniana, P. triflora, and P. angustifolia* (8, 14). While levels of resistance to plum leaf scald do exist in most if not all of these species, enough long term resistance must be found and incorporated into acceptable commercial cultivars. This is in view of the fact that not only does plum scald resistance appear to be breaking down, but also there appears to be recent rises in incidence of phony peach, Pierce's disease in resistant grapes, almond leaf scorch, and citrus blight.

The University of Florida began a low-chill plum breeding program in 1970 with goals for fruit quality similar to existing programs in Byron, Georgia and Auburn, Alabama. In view of the recent developments in plum leaf scald and related diseases of *X. fastidiosa,* plum breeding programs in the south-

eastern U.S. must locate and incorporate sources of resistance which appears to occur in strong dosage in native species and feral genotypes.

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Performance of Strawberry Cultivars in the North Central Region of the United States[1]

ERIC J. HANSON[2]

Abstract

Strawberry cultivar trials conducted in the North Central region of the United States between 1980 and 1988 were used to compare the productivity of 15 cultivars. 'Kent' and 'Honeoye' were the most productive cultivars tested extensively. 'Delite,' 'Allstar' and 'Scott' also performed well. A comparison of the yield stability of six selected cultivars indicated that 'Honeoye' and 'Earliglow' were among the most stable producers, whereas 'Guardian' and 'Redchief' were the least.

Introduction

The most important strawberry cultivars in the north central region of the United States (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin), are 'Earliglow,' 'Guardian,' 'Honeoye,' 'Midway,' 'Raritan' and 'Redchief' (4). Other promising cultivars are 'Allstar,' 'Jewel,' 'Kent,' 'Lester' and 'Scott.' Strawberry cultivar trials

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[2]Assistant Professor, Department of Horticulture, Michigan State University, East Lansing, MI 48824.