Pierce's disease (PD) is the principal factor limiting the production of bunch grapes (Vitis vinifera L. and V. labrusca L.) throughout Florida and in the coastal plain areas of South Carolina, Georgia, Alabama, Mississippi, Louisiana, and Texas (1, 5, 10, 13). Resistance to PD has been found in Vitis species native to these states (2, 6, 9). The grape industry in the southeastern United States is based on derivatives of these resistant Vitis species.

Muscadine grapes (V. rotundifolia Michx.) comprise a major part of the grape industry in the Southeast. The popularity of muscadine grapes in this area depends primarily on their high level of tolerance to PD, which is exemplified by their excellent vigor and longevity (5). The presence, however, of the xylem-limited bacterium that causes PD has been reported in several muscadine cultivars (4, 7).

In highly susceptible V. labrusca 'Schuyler', the highest concentration of bacterial occlusions occurred in June and July, the time of symptom development (3). Bacterial infestations in leaf veins correlated better with leaf marginal necrosis than did infestations in petioles and stems. In muscadine grapes in Florida, the first PD symptoms occur about 2 months later than in bunch grapes. Symptoms are less pronounced in muscadines, and PD rarely kills the entire vine. The primary purposes of this study were: (a) to compare the accumulation of the PD bacterium in a susceptible bunch grape, 'Schuyler', to that in 2 more tolerant muscadine grapes, 'Carlos' and 'Welder', and (b) to determine the relationship between the bacterial infestation and the time and severity of symptom development in the 2 types of grapes.

V. labrusca 'Schuyler' and V. rotundifolia 'Carlos' and 'Welder' which were naturally infected with PD were sampled on 11 May, 14 June, 12 July, 7 Sept., and 24 Oct. 1981. The same 3 vines of each cultivar were sampled on each date. The 'Schuyler' and 'Carlos' vines had shown marginal leaf necrosis the previous year while the 'Welder' vines were symptomless. Three stem, petiole, and leaf vein samples were collected from each vine on each date. Leaves with marginal necrosis were sampled when available. Samples were cut into 5-mm pieces, fixed in FAA (formalin-alcohol-acetic acid) for 48 hr, dehydrated in tertiary butyl alcohol, and embedded in purified paraffin and plastic polymer media. Sections 15-µm thick were cut with a rotary microtome, mounted on slides with adhesive, stained with Harris' hematoxylin, and counterstained with Orange G (12).

Values given for bacterial infestation represent the mean of 9 random cross sections of each of 9 samples from 3 vines (81 cross sections). The numbers of xylem vessels infested with bacteria within 5-mm pieces of tissue were determined and were expressed as percentages of the total vessel counts as previously described (3).

The period of most rapid increase in PD bacteria in the highly susceptible 'Schuyler' bunch grape occurred between mid-May and mid-July (Fig. 1). Leaf marginal necrosis symptoms were first observed the end of June. Bacterial infestation of xylem vessels was highest and earliest in the leaf veins. By mid-July, the bacterial infestation of vessels in the stems was also quite high. In July and Aug., these stem sections came from shoots that were dying-back. Infestations of petioles were not as great as the leaf veins or stems. The time of rapid increase in bacterial infestations of 'Carlos' xylem vessels was about 2 months later than that of 'Schuyler' (Fig. 2). Leaf marginal necrosis symptoms first appeared the last 2 weeks of August. The percentage infested leaf vein vessels of 'Carlos' was similar to that of 'Schuyler' at the time of symptom production. Contrary to 'Schuyler', bacterial infestations in the petioles were similar to those in the leaf veins. Bacterial populations increased more slowly in the stems. The bacterial populations in 'Welder' built up at the same time as in 'Carlos' (Fig. 3). 'Welder' differed from 'Carlos' in that bacterial populations increased at the same rate in the stems as in the petioles and leaf veins. The seasonal infestation of 'Schuyler'
‘Carlos’, and ‘Welder’ grape tissue with PD bacteria occurred at the time of symptom development. Infested and plugged veins were approaching their maximum in leaves at the time of marginal necrosis development. The bacteria do not accumulate in the muscadine plants until the fall, when cool weather may slow the bacterial growth or cold weather may produce dormancy in the grapevines and kill the bacteria (11). On the other hand, the bacteria accumulate in ‘Schuyler’ bunch grape in early summer and affect the plants for several months, often killing them. Thus, the time of symptom development could be a factor in the greater tolerance of the muscadines to PD.

The relationship between time of fruit maturation and time of maximum bacterial populations in the plants may be significant. In Leesburg, Fla., where this study was conducted, the approximate fruit-ripening dates for the cultivars are: ‘Schuyler’, 7 July; ‘Welder’, 22 Aug.; and ‘Carlos’, 26 Aug. (8). These ripening dates are nearly identical to the dates of PD-symptom occurrence. The bacteria were observed in ‘Carlos’ and ‘Welder’ in May but did not increase until much later. Some physiological change apparently occurred in the grapevine which triggered the increase in the PD-bacterial populations. From this and earlier observations in both the field and greenhouse that the PD bacterium does not develop in actively growing juvenile tissue, we believe that stress resulting from fruit maturation and hormone balance in the grapevine may play roles in PD symptom development. The effect of various growth regulators on the multiplication of the PD bacterium and the development of PD symptoms is being investigated currently.

The relative populations of PD bacteria in the stem, petiole, and leaf veins of the 3 cultivars can be related to the type of field symptoms observed in these cultivars. ‘Carlos’ is the muscadine cultivar that, in Leesburg, has leaf marginal necrosis every year, but usually grows normally in the spring and continues to produce an adequate crop. In addition to leaf symptoms, ‘Schuyler’ and ‘Welder’ have severe stunting and dieback. It appears this difference in symptoms results from the rapid build up of PD bacterial populations in both leaves and stems of ‘Schuyler’ and ‘Welder’. Bacterial populations increase much more slowly in stems of ‘Carlos’. Because the bacteria build up within the plant is related to the maturity of the fruit, however, the cultivars ‘Welder’ and ‘Carlos’ are more tolerant to PD than ‘Schuyler’.

**Literature Cited**