Ozone Stipple of Grape Leaf

lesions on the upper leaf surfaces and premature leaf fall occur on grapevines in areas polluted by air-borne ozone

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Grape leaf stipple occurs in the vicinity of Los Angeles and San Francisco.

Since the discovery of grape stipple in the San Bernardino Valley in 1954, the disease has been found in grape producing sections south to Corona and Santa Ana, north to Cajon, and west to Los Angeles and the San Fernando Valley. Stipple has been found on the wild grapes east of the San Bernardino Valley and near Elsinore. The disease was found on cultivated grapes near Walnut Creek and Concord in the San Francisco Bay area for the first time in 1957.

The primary symptoms consist of small, brown to black, discrete, dot-like lesions, which are easily distinguished from the lesions of other grape disorders because of the stippled appearance on the upper surface of the leaf.

The distribution, color, and size of the primary lesions are characteristic of the stipple disease. Most primary lesions finally become necrotic but retain their original size and stippled appearance and are exceptionally distinct against the background of the normal green tissues of the leaf.

The typical primary lesions vary in diameter from about 0.1 to 0.5 mm—millimeter—and are confined to groups of cells bounded by the smallest veins. Large lesions result from coalescence of small ones, and may measure up to 2.0 mm in diameter. Aggregates of these minute spot-like lesions produce the typical stipple appearance. The necrotic stipple lesions remain small in most grape varieties, such as Berger, Carignane, Mataro, Mission, Thompson Seedless, and Zinfandel; may become larger in a few varieties, such as Blue Elba and Grenache.

Perhaps the most unusual feature of the primary lesions is the degree to which they are restricted in their distribution to the chlorophyll-laden palisade layer of cells just below the upper epidermis of the leaf. There are very few, if any, stomata in the upper epidermis of the 16 varieties studied.

Field observations made in 1955, 1956, and 1957 demonstrated that stipple lesions occurred early in the growing season on relatively young but fully expanded leaves of the 16 varieties studied. Except in late season, the youngest, terminal, not fully expanded leaves were not affected. Lesions continued to be initiated throughout the season, and new stippling occurred on the maturing foliage. There is also a progressive accumulation of stipple on the older, matured leaves, suggesting that the inciting agent is present throughout the foliage season.

Stipple formerly was referred to as leaf bronzing, yellowing, premature senescence and leaf fall. Such abnormalities

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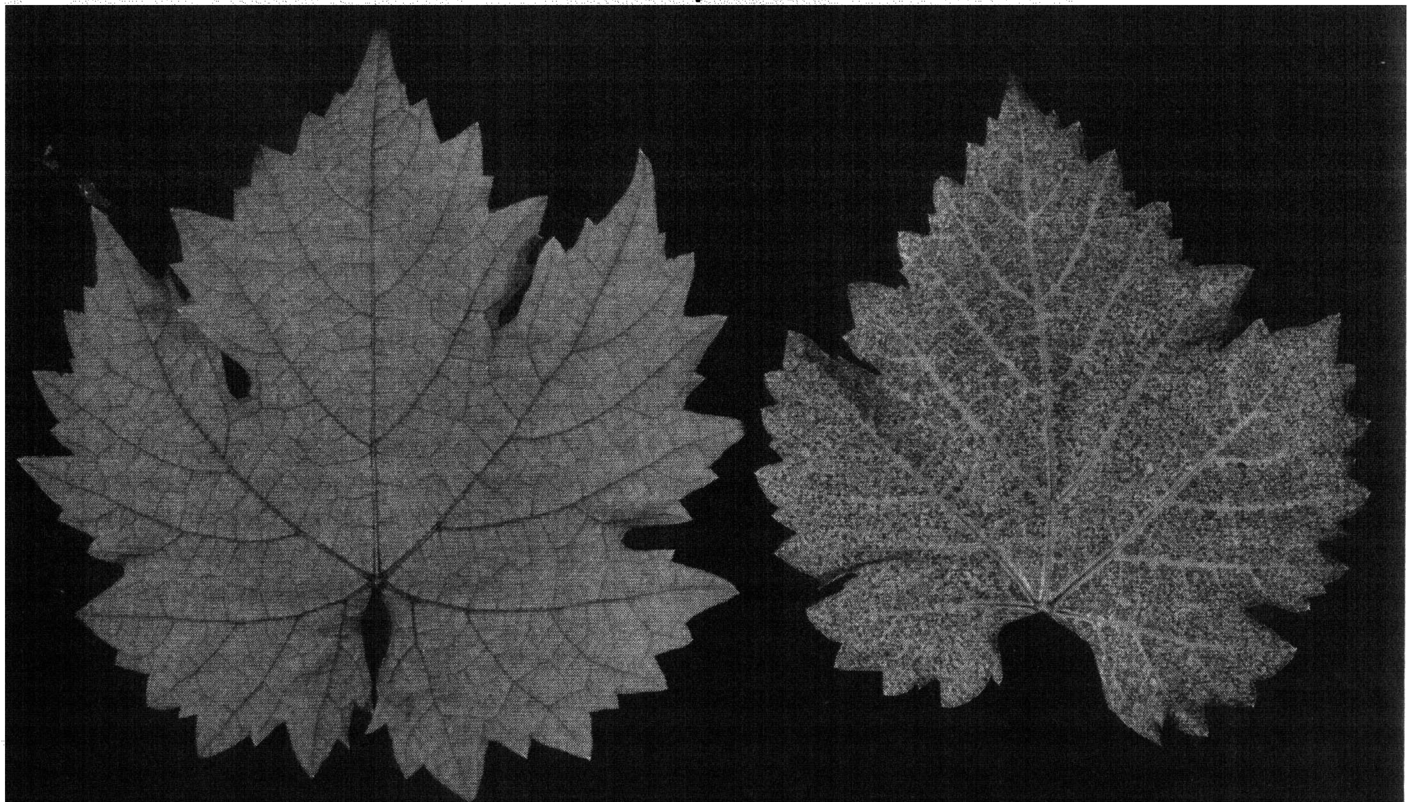
Stipple of glasshouse-grown Carignane grape leaves. *Left,* healthy upper leaf surface resulting from exposure to activated-carbon-filtered air. *Right,* upper leaf surface with small, brown to black, discrete punctate spots resulting from exposure to native polluted air.



STIPPLE

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are, however, secondary symptoms that result from the cumulative effect of the primary injury initiated on the upper leaf surface. Secondary symptoms are common in a number of varieties—particularly Carignane, Grenache, Palomino, and Pedro Ximenes—but are less pronounced and less common in the varieties Berger, Thompson Seedless, and Zinfandel. The early yellowing and leaf drop on affected vines expose the grapes prematurely to the sun and sometimes cause scalding and withering of the fruit.

Because stipple on grape leaves resembles markings produced by fumigation with ozone on some other plants, tests were made with rooted grape cuttings. The studied varieties were grown in a glasshouse provided with activated-carbon-filtered air, free from oxidants. The plants produced were completely free from stipple and other leaf disorders. Twelve cuttings each of 10 varieties were selected for uniform leaf and plant size. Six replicates of the varieties were retained in the filtered-air glasshouse, while the other six replicates were placed in a glasshouse receiving unfiltered air. One week later the vines in the unfiltered air showed typical stipple, while those in the filtered air did not. The range of values observed is represented by the following varieties, in which the amount of injury is expressed as a percentage of the entire leaf surface affected: Carignane, 89; Palomino, 62; Blue Elba, 43; Thompson Seedless, 9; all controls, 0.

The same plants were maintained as two separate groups for an additional eight weeks, when it was observed that stipple continued to develop on recently expanded leaves and that injury increased on the older, lower leaves. The terminal, undeveloped leaves did not show stipple symptoms. Leaf drop occurred in all varieties grown in native air, but not in the same varieties grown in filtered air.

The absence of lower leaf surface damage on grape plants and its common occurrence on Pinto bean indicator plants suggested that grape was not susceptible to oxidant. Bean, on the other hand, typically did not show ozone stipple and chlorosis, whereas grape did, suggesting that grape may be particularly susceptible to ozone.

Fumigation with 0.5 part per million of ozone for three hours consistently produced stipple symptoms on 16 grape varieties. Repeated fumigations allowed for the accumulation of injuries with severe stipple, leaf yellowing, and leaf fall. The stipple symptoms produced on Mission grape leaves by fumigation with ozone are indistinguishable from those occurring naturally. Lesions produced by ozone on all 16 varieties in these fumigations were compared with the type of lesions found on the same varieties grown in the field. The lesions produced by ozone on glasshouse-grown plants were so similar to those on corresponding varieties collected on the same date from the vineyards in the area that identical cause can be assumed.

Ozone stipple can be distinguished from oxidant injury—caused by oxidized organic compounds—in that in grape the upper leaf surface is stippled and there is no pronounced silvering or glazing of the lower leaf surface, as found on herbaceous crops and weeds in and near affected vineyards.

Toxic ozone levels occur in the polluted air mass above the Los Angeles and San Francisco areas, where stipple is found. Stipple has not yet been seen in the grape producing areas in the Coachella, Napa, Sacramento, and San Joaquin valleys.

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