

Storage Rot of California-Grown Kiwifruit

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ABSTRACT

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Storage rot of kiwifruit grown in California was reported from several packinghouses. *Botrytis cinerea*, *Alternaria* sp., and *Penicillium* sp. were routinely isolated from softened internal portions of the fruit. When healthy kiwifruits were inoculated, the suspected pathogens were reisolated after 8 wk, but only *B. cinerea* and *Penicillium* sp. produced a soft rot at low temperatures. Only *B. cinerea*, however, was able to incite the characteristic disease symptoms.

Kiwifruit grown in California is attacked by few diseases and pests (2). When stored at 2–3 C and 85–90% RH, the firmness and quality of fruit is maintained for as long as 4 mo. *Diaporthe actinidiae* has been reported on New Zealand-grown kiwifruit imported to the United States (1,5). Secondary invaders of damaged kiwifruit grown in New Zealand are reported to be soft rot bacteria, *Cladosporium herbarum*, *Glomerella cingulata*, *Penicillium* sp., and *Alternaria* sp. (3). *Botrytis cinerea* is reported to cause blossom blight and fruit rot in the field when conditions are humid (3). This disease may account for considerable fruit drop and badly blemished unusable fruit in the New Zealand crop. In the United States, *A. alternata* and *B. cinerea* have been mentioned as causing storage problems of kiwifruit (4), but evidence confirming their pathogenicity has not been reported.

In December 1981, 2 mo after initiation of storage, diseased kiwifruit samples of the cultivar Chico-Hayward began appearing at our laboratory. In most cases, one to several fruits in a flat were

covered with a gray to white mycelium and a watery exudate. Black sclerotia 1–3 mm in diameter were found on the undersides of the fruits toward the stem ends, and the fruits were softened only in the areas where sclerotia appeared. Softened areas were often shriveled, depressed, flattened, or sunken. When affected fruits were cut in half through the diseased area, the flesh appeared to be a light caramel color in affected areas near the stem end.

This study was made to determine the organisms responsible for this kiwifruit deterioration and postulate why it may be occurring.

MATERIALS AND METHODS

Isolations were made from the surfaces of diseased fruit, from areas immediately below the skin in the caramel colored tissues, and from discolored deep green portions of the fruit. In each case, a small piece of the flesh or fruit skin (2–3 mm³) was removed with a flame-sterilized spear and placed on potato-dextrose agar (PDA). Of 278 isolations, 139 were *B. cinerea*, 103 were *Cladosporium* sp., and 37 were miscellaneous fungi including *Penicillium* sp., *Alternaria* sp., *Epicoccum* sp., a fluorescent *Pseudomonas* sp., and *Erwinia* sp. The only organism consistently isolated from internal kiwifruit tissues that were discolored and rotted was *B. cinerea*.

Sixteen uniformly firm Chico-Hayward kiwifruit taken from cold storage were surface-sterilized for 15 min by immersion

in 0.5% NaOCl. Eight sites were marked equidistant from each other on the surfaces of kiwifruits after they had been allowed to air-dry. Each fruit was inoculated with eight treatments by using a randomized complete block design. Treatments consisted of spore and cell suspensions of the following organisms originally isolated from kiwifruit: *Alternaria* sp., *B. cinerea*, *Cladosporium* sp., *Epicoccum* sp., *Erwinia* sp., *Penicillium* sp., *Pseudomonas* sp., and a sterile water control. One drop of each spore or cell suspension was placed beneath the skin of the fruit at the designated site by using a tuberculin syringe. The 16 inoculated fruits were divided into two identical replicates and incubated at 20 and 5 C.

RESULTS

After 1 wk at 20 C, three sites inoculated with *B. cinerea* and three sites inoculated with *Penicillium* sp. each had large depressions of 15.0 × 7.0 mm or greater. Sites inoculated with *Alternaria* sp. had small depressions of 3.0 × 1.5 mm and the tissues remained firm. Sites inoculated with *B. cinerea* or *Penicillium* sp. were soft with discoloration around the point of inoculation. Reisolation of *B. cinerea*, *Penicillium* sp., and *Alternaria* sp. from diseased inoculated fruit was successful in all attempts.

The inoculated fruit stored at 5 C performed identically to those at 20 C, except the symptoms were not as pronounced. After 2 wk, the *B. cinerea* inoculations showed eight sites of large soft depressions of 15.0 × 7.0 mm, whereas the *Penicillium* inoculations had six sites with smaller but soft depressed areas of 7.0 × 5.0 mm. None of the other inoculated organisms showed any response. Both *B. cinerea* and *Penicillium* sp. were successfully reisolated from diseased tissues on all inoculated fruit that had symptoms of soft rot. When inoculated fruits were observed over

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extended periods of time, only those inoculated with *B. cinerea* were covered with a gray mycelium. After 6–8 wk, the characteristic watery exudate and small black sclerotia were also visible.

DISCUSSION

Of the organisms isolated from diseased kiwifruit, *B. cinerea* and *Penicillium* sp. were the only ones capable of causing fruit rot at low storage temperatures. Unlike the *Alternaria* sp. that produced a localized infection at high temperature, both *B. cinerea* and *Penicillium* sp. were able to soften and macerate kiwifruit tissue at high and low

temperatures. Pure cultures of *B. cinerea* were consistently isolated from diseased fruit, and inoculations produced symptoms characteristic of the disease. Apparently, *B. cinerea* can cause a storage decay of California-grown kiwifruit.

Flats with diseased fruit often had firm fruit with a considerable amount of *B. cinerea* sporulating on attached sepals. Packers who had seen this condition on fruit at harvest had not considered it to be more than an aesthetic or minor defect. It is possible, however, that dead sepal tissue provides an initial colonization site for the fungus, whereas the broken

stem provides a later site for initiation of infection and fruit rot after several weeks in cold storage.

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