Leafhoppers transmit citrus stubborn disease to weed host

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London rocket plants fed upon by healthy beet leafhoppers (left) and by beet leafhoppers from stubborn-affected plants (right).

Researchers report a new breakthrough in studies of citrus stubborn disease. Leafhoppers have been shown to transmit the disease organism to and from a weed plant—from diseased periwinkle to London rocket and from diseased London rocket to healthy periwinkle.

A European weed, London rocket (*Sisymbrium irio*), which is distributed from coastal and interior southern California to Modoc County in northern California, has been found to harbor *Spiroplasma citri*. We have succeeded in demonstrating transmission to London rocket by leafhoppers, *Scaphytopius nitridus* and *Circulifer tenellus*, and from these field plants to periwinkle (*Vinca rosea*) by *C. tenellus*.

The discovery that leafhoppers could transmit *S. citri* to and from periwinkle (*California Agriculture*, February 1975) and the subsequent finding of *S. citri*-infected periwinkle plants in the field intensified the search for naturally occurring plants that might harbor *S. citri* as a reservoir of the disease agent, which would be a source of infection for citrus trees. Moreover, a weed host with a wide geographical range would explain the occurrence of *S. citri* in areas outside the range of citrus culture (*California Agriculture*, June 1976).

In March 1975, a diseased London rocket plant with yellows symptoms, evidence of possible mycoplasma infection, was found near the U.C. stubborn disease plot at Moreno, California. Attempts to isolate *S. citri* from this plant were unsuccessful. Also, attempts to transmit *S. citri* from this plant before it wilted and died failed. However, in September 1975, seeds were collected from apparently healthy London rocket plants in the same area and saved for further tests in the laboratory.

In March 1976, stunted London rocket plants with yellows-type symptoms were again found at the Moreno plots. Specimens collected on March 23,

1976, were positive for *S. citri*. Meanwhile, the seeds collected in 1975 had been germinated in the greenhouse, and three London rocket seedlings were exposed to *S. citri*-infected *S. nitridus* and *C. tenellus*.

Leafhopper vector species and test plants were manipulated as follows:

(1) In the first test, 200 *S. nitridus* were caged on one healthy, greenhouse-grown London rocket plant. These leafhoppers had previously been caged for 18 days on a *S. citri*-infected periwinkle plant and were therefore considered infectious. The leafhoppers fed on the healthy weed for 24 days. Forty days later the test plant became chlorotic, wilted, and died. About 80 *S. nitridus* that still survived were transferred to a healthy periwinkle plant. In 35 days this plant became diseased with *S. citri* (that is, it showed stunt, chlorosis, and small-flower symptoms).

(2) The second test was made with the other two greenhouse-grown London rocket plants (in one pot). About 112 *C. tenellus* were caged on these plants after they had had an acquisition feeding period of 16 days on *S. citri*-affected periwinkle. The insects remained on the London rocket plant for 27 days. Then 60 living leafhoppers were transferred to a healthy periwinkle plant. The two London rocket plants and the periwinkle wilted and died. Also, *S. citri* was cultured from the London rocket and the periwinkle plants.

In other trials *S. citri*-free beet leafhoppers reared in the laboratory were caged on diseased London rocket plants growing at the Moreno stubborn plot. These insects fed for eight days, then were caged on a healthy periwinkle plant. After about four weeks, that plant became diseased, and *S. citri* was cultured from it.

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Several cultivars were tested in the field and the greenhouse for resistance to this wilt fungus.

Fusarium-resistant watermelon cultivars

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Fusarium wilt of watermelon, caused by *Fusarium oxysporum* f. *niveum*, can be a limiting factor in California watermelon production. Warm weather, which favors watermelon production, also favors the disease. The fungus lives in the soil for many years, and therefore rotation, although helpful, is not the answer to the problem. Studies were initiated in 1971 to test various watermelon cultivars for resistance to the *Fusarium* wilt fungus.

Field trials

All field trials were conducted at the Duke Layton watermelon breeding farm near Hemet. The soil was a sandy loam, which had been planted to watermelons for 18 consecutive seasons. *Fusarium* inoculum was at a high level in the trial plot area. Twenty-five seeds of each cultivar were planted in a 15-foot row. Plots were replicated four times.

Notes were taken during each trial on number of healthy and diseased plants. Isolations were made from wilting plants to confirm *Fusarium* as the cause of decline.

In the 1971 trial, seeds were planted on August 2, with excellent soil moisture for germination. The final count of healthy plants in each cultivar was made on October 13.

In 1972, watermelon seeds were planted on June 12, and the final count of healthy plants was made on July 23.

In 1973, seeds were planted on July 24, and the final count was made on September 6.

In all three field trials, Calhoun Gray had the highest level of resistance to *Fusarium* (see table). Conversely, Chilean Black Seed was very susceptible to the *Fusarium* wilt fungus. Although cultivar reaction varied somewhat from trial to trial, Charleston Gray, Sweet Princess, Picnic, and Layton 31—2 showed high tolerance to *Fusarium*. Seeds of the cultivars Charleston Gray and Peacock 124 were obtained from two companies, and the wilt reaction was essentially the same for both seed lots. Jubilee showed poor resistance in the 1971 field trial.

Greenhouse trials

Inoculum for the greenhouse trials at U.C., Riverside, was obtained by isolating *Fusarium oxysporum* f. *niveum* from a single wilting plant from the Layton watermelon nursery in the summer of 1971. The culture was single-spored, grown on PDA slants, and then shown to have high pathogenicity to several watermelon cultivars. Twenty watermelon seeds of each cultivar were planted in a 4-inch flat of sandy loam soil in a single row. Twenty-five cc of inoculum (500,000 spores per ml) were applied to each row before it was covered with soil. Flats were then placed on greenhouse benches where air temperature was 75° F, and healthy plants were counted after approximately one month. Isolations were made from wilting plants to confirm the presence of *Fusarium*. Plots were replicated two times.