

Occurrence in the United States of a Marigold Leaf Spot Incited by *Pseudomonas tagetis*

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ABSTRACT

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Several cultivars of marigold (*Tagetes erecta* L.) in a Milwaukee insect control trial garden were damaged by a disease of unknown etiology during September 1978. A gram-negative, fluorescent bacterium isolated from the leaf spots was identified as *Pseudomonas tagetis* Hellmers. This is believed to be the first report of this pathogen in the United States.

A disease of unknown etiology was observed to be damaging several cultivars of marigold (*Tagetes erecta* L.) in a Milwaukee insect control trial garden during September 1978. Foliage of severely damaged plants was collapsed and dark green. Examination revealed circular necrotic lesions (2–5 mm diameter) on the leaves and petioles. The lesions had dark purple margins without chlorotic halos and tan-colored centers. Large numbers of lesions on a leaf resulted in the leaflet tips becoming curled and dry (Fig. 1).

A gram-negative, fluorescent bacterium was consistently isolated from the leaf spots and was identified as *Pseudomonas tagetis* Hellmers (1). Identification was based on a comparison of nine isolates from the Milwaukee samples with a known isolate of *P. tagetis* (Department of Agriculture, Rydalmere, Australia, #26816). Tests used for identification of this species (7) included the LOPAT reactions; production of pyocyanin, H₂S, and indole; hydrolysis of gelatin and starch; methyl red and litmus milk reactions; denitrification; and the ability to utilize 32 compounds as sole carbon sources (2,3,5). All isolates behaved identically in all tests. The results also agreed with the previously reported data (7) except that, in our tests, all bacteria could not use ethanol, triacetin, or β -hydroxybutyrate as

carbon sources. Also, our isolates produced symptoms similar to those described by others (1,7). Inoculations were made by spraying 21-day-old marigold plants with a suspension (10⁸ cells/ml) made from 24-hr NDA slant. The plants were covered with plastic bags and maintained in the dark for 18 hr, then transferred to a greenhouse (24 C during the day, 18 C during the night).

We believe this is the first report of this pathogen in the United States. The disease was first reported by Hellmers in Denmark in 1955, although it had been present there at least since 1937 (1). Subsequently, it was observed in Australia (7), the Netherlands (7), Norway (6), Rhodesia, and the United Kingdom (New Zealand D.S.I.R. Plant Diseases Division Culture Collection, 1978, p. 46).

Along with the leaf spot symptom, Hellmers also noted chlorosis of the apical growing point of infected plants.

He did not include this symptom in his original description of the disease, however, because he was not certain that the yellowing was caused by the bacterium (7). Later, Bakker (7), working in the Netherlands, isolated two types of *P. tagetis*. One type produced only leaf spots, as we have observed in field examinations here, whereas the second type produced both leaf spots and apical chlorosis. Thus, Bakker demonstrated pathogen variability with respect to symptom expression. Unfortunately, her observations were recorded in annual reports and were not published. In Australia (7), both symptoms occurred but the apical chlorosis was more damaging.

Although chlorosis has not been observed in the United States, our isolates did cause apical yellowing of young seedlings that were spray-inoculated (Fig. 2). Though we do not yet understand the reason for this, the stage of growth when a plant becomes infected may be important, since chlorosis occurs only in rapidly growing tissues. The chlorosis is caused by a low molecular weight, extracellular toxin produced by some strains of the bacterium (4). We believe that both the leaf spot and the chlorosis phases should be considered in surveying for and diagnosing this disease in the future.

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Figs. 1 and 2. (1) Typical leaf spot symptoms on leaves of *Tagetes erecta* 'Crackerjack' naturally infected with *Pseudomonas tagetis*. (2) Apical chlorosis of *T. erecta* 'Sun Souffle' spray-inoculated with *P. tagetis* when plants were 21 days old.

Earlier reports indicated that differences exist in bacterial leaf spot susceptibility among *Tagetes* species. Indeed, all references before the report of Trimboli et al (7) described the disease only on the African marigold (*T. erecta*). Although we do not know whether earlier workers made field observations on the French marigold (*T. patula* Cav.), inoculations on *T. patula* did not result in leaf spot development (1,6). Sundheim (6) and Trimboli et al (7) failed to incite leaf spots on *T. tenuifolia* Cav. (*T. signata* Bartl.), although apical chlorosis could be induced after stem inoculations (7).

During September 1978, five African, six French, and three triploid hybrid cultivars in Wisconsin were observed for disease reaction. Leaf spots were observed on each group. African type cultivar reactions ranged from very susceptible ('First Lady' and 'Moonshot'), to moderately susceptible ('Orange Jubilee' and 'Crackerjack'), to moderately resistant ('Fantastic Orange'). Five French type cultivars were resistant; 'Petite Harmony,' 'Yellow Boy,' 'Petite Yellow,' 'Sparky,' and 'Aquarius' each had only a few lesions. 'Red Wheel,' however, was

susceptible, and many plants were dead. Two hybrid cultivars between *T. erecta* and *T. patula*, 'Triple Orange' and 'Triple Yellow,' were moderately susceptible, whereas 'Showboat' was very susceptible and died after infection.

It is possible that the bacterium was introduced through infected seed (1,7). The disease did not spread rapidly until after the plants were mature. Unusually heavy rains during July and August probably enabled the disease to develop from very low quantities of primary inoculum.

The bedding plant industry has been experiencing substantial growth in recent years, and marigolds are significant in this expansion. Of 25 annuals grown as a bedding plant crop, marigolds rank second only to petunia in popularity and are equal to tomato seedlings and geranium cuttings, with 10% of the total production (8). Marigolds have long been regarded as a relatively disease-free crop, which no doubt contributes to their popularity. Bacterial leaf spot of marigold should be considered a disease of potential importance to the bedding plant industry of the United States.

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