Corky Ringspot: A New Strain of Tomato Mosaic Virus in California

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ABSTRACT

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Unusual symptoms of virus infection have been found on several cultivars of fresh-market tomatoes grown throughout California during the past 2 yr. Raised, corky rings and line patterns develop on fruit, typically covering the entire surface and rendering the fruit unmarketable. The virus responsible appears to be a variant of tomato mosaic that is being referred to as the corky ringspot strain.

California is one of the nation's leading producers of tomatoes, both processing (84.2%) and fresh-market (28.1%) (2). Fresh-market tomatoes are grown along the coast continuously throughout the year and in the central valley during the summer months. As a result of continuous cropping and intensive manual labor, plant virus diseases are common and widespread in tomato fields (5). Among viruses known to occur, strains of tomato mosaic (ToMV) are the most common, and many fields are 100% infected. Under normal growing conditions, the cultivars of tomatoes grown in California show no fruit symptoms when infected with common strains of ToMV. In 1982 and 1983, however, tomatoes were found with unusual symptoms that consisted of raised, corky rings and line patterns that covered the entire fruit surface (Fig. 1). In some cultivars, fruit were small and unevenly ripened. Fruit symptoms were limited to the epidermis. Foliar symptoms ranged from mild to moderate mosaic. To date, the problem has been identified in five California counties: Fresno, Monterey, San Diego, San Joaquin, and Santa Clara (Fig. 2).

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MATERIALS AND METHODS

Diseased tomato plants collected from the field were screened by electron microscopy using leaf- or fruit-dip preparations. Freshly sliced tissue was dipped in drops of 2% phosphotungstic acid, pH 7.2, excess stain removed, and viewed in a Zeiss EM 9S-2 electron microscope. Because all diseased samples contained particles similar to those of a tobamovirus, the virus was partially purified using the procedure of Gooding and Hebert (3) for tobacco mosaic virus purification. Infected tomato plants (cultivar Valerie) collected from the field were used as a virus source. The virus was further purified by isopycnic density-gradient sedimentation in CsCl. The ultraviolet (UV) absorbing peak was removed, dialyzed against 0.01 M Na-K phosphate buffer, pH 7.2, and analyzed in the Beckman DU-8 spectrophotometer to determine the absorption spectrum and 260/280 absorption ratio. This same preparation was used to inoculate a range of indicator plants and several cultivars of tomatoes. The partially purified preparation was examined with the electron microscope and tested sero-

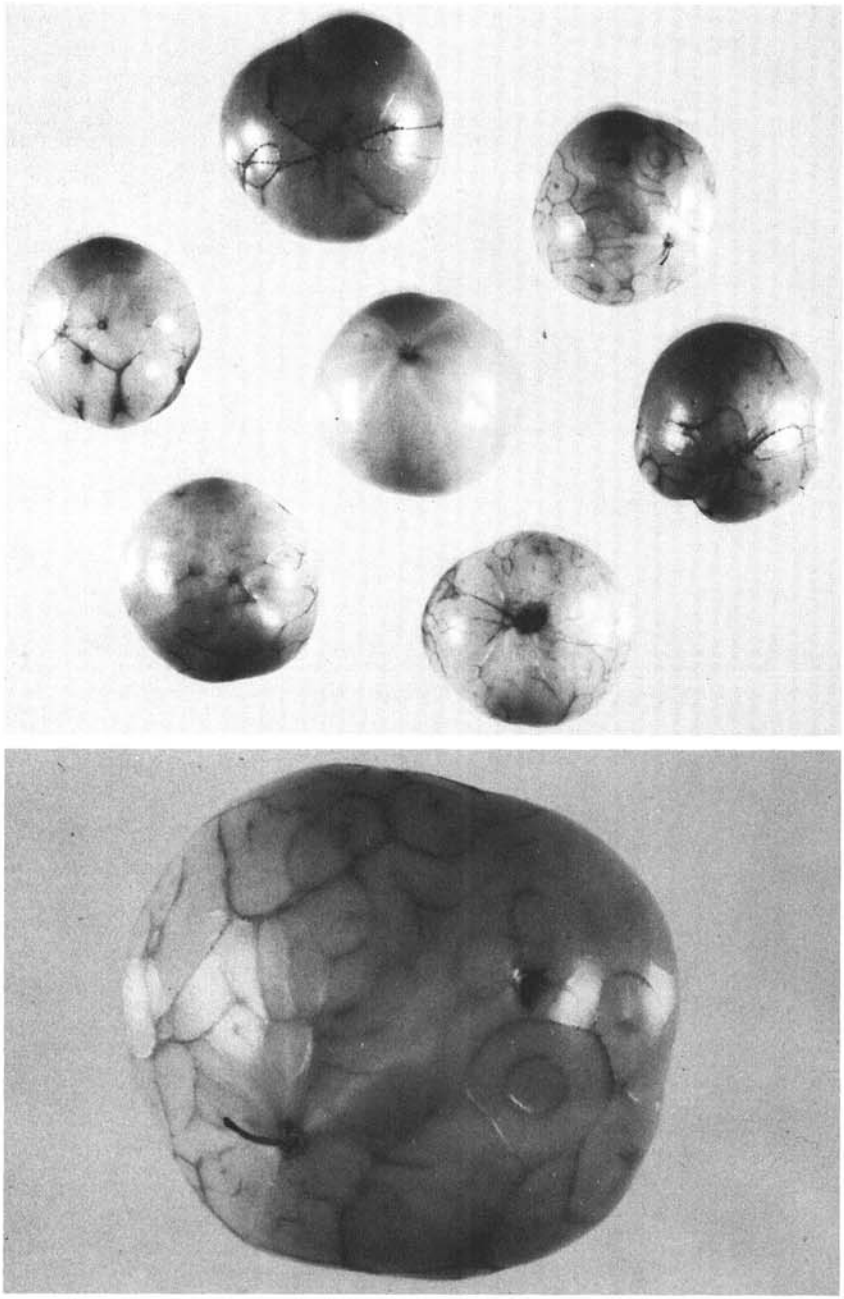

Fig. 1. (Top) Symptoms of corky ringspot strain of tomato mosaic virus on tomato fruit (*Lycopersicon esculentum* 'Valerie'); healthy fruit in center. **(Bottom)** Close-up of corky ringspot on tomato.

Fig. 2. Distribution of corky ringspot strain of tomato mosaic virus in California (shaded areas).

logically against an antiserum prepared against the type strain of tobacco mosaic virus (American Type Culture Collection PVAS 135a) using double diffusion in gel (1). Inoculated tomatoes showing disease symptoms were screened by electron microscopy.

RESULTS AND DISCUSSION

Tomato plants that showed fruit symptoms were all found to contain short, rigid, rod-shaped, viruslike particles about 18 × 300 nm. One UV absorbing peak was formed on density gradients. This peak, when analyzed spectrophotometrically, exhibited a typical nucleoprotein absorption spectrum and had a 260/280 absorbance ratio of 1.21. Electron microscopic examination of this peak showed the same short, rigid, rod-shaped particles as those seen in leaf and fruit dips. A strong precipitin band was formed when this virus was tested against tobacco mosaic virus antiserum.

In greenhouse inoculations, necrotic local lesions formed on inoculated leaves of *Nicotiana glutinosa, N. tabacum* 'Samsun NN' and 'Xanthi', *N. sylvestris, Datura stramonium,* and *Petunia hybrida.* Systemic mosaic developed in *N. tabacum* 'Turkish' and mosaic and "shoestringing" in *Lycopersicon esculentum* 'Ace Hybrid.' No symptoms developed on *Chenopodium amaranticolor, C. quinoa, Cucumis sativa* 'Boston Pickling,' *Cucurbita maxima, Gomphrena globosa, Phaseolus vulgaris* 'Great Northern,' *Vigna unguiculata,* or *Zinnia elegans.* Corky ringspot symptoms developed on fruit of the following tomato cultivars inoculated with partially purified virus: Castleby, Blazer, Firechief, Castlemart, and Valerie. Electron microscopic examination showed rod-shaped, viruslike particles similar to those present in the inoculum. Tomato cultivars Jackpot, Blazer, Valerie, and 6718 showed corky ringspot symptoms in the field.

On the basis of particle morphology, symptoms on indicator plants, biophysical characteristics, and serology, the virus described in this study is a strain of ToMV. It is identified as a new strain on the basis of symptoms produced on fruit of susceptible tomato cultivars. The symptoms of corky ringspot strain—thin, delicate, corky line patterns and concentric rings—are quite dissimilar to other strains that affect tomato fruit. The crusty fruit strain reported by Rast (7) produces asymmetrical, blistery, corky crusts, and the strain described by McGuire et al (6) produces necrotic blotches and streaks. Because of the apparent confusion over the identification of strains (4), no attempt was made to further characterize the corky ringspot strain.

The introduction and spread of the corky ringspot strain of ToMV poses a major economic threat to the California tomato industry.

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