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Tomato Hybrids with Nonspecific Immunity to Viral and Mycoplasma Pathogens of Potato and Tomato

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Origin

Two F_5 breeding lines from a tomato hybrid (*Lycopersicon peruvianum* L. x *L. esculentum* L. cv. Bonnie Best), designated as Pr18-4 (Fig. 1A) and Pr8-5 (Fig. 1B), each derived from a separate interspecific pollination, were released by the Agricultural Research Service, U.S. Dept. of Agriculture, and the Agricultural Experiment Station of Washington State Univ. in 1992. These lines are unique because they contain a resistance mechanism that nonspecifically confers immunity or extreme resistance to phloem-inhabiting pathogens of potato and tomato. These pathogens include potato leafroll virus (PLRV) (Hassan and Thomas, 1988; Thomas et al., 1988); tomato yellow top virus (TYTV); beet curly top virus (BCTV) (Thomas and Boll, 1978; Thomas and Martin, 1974); and the beet leafhopper-transmitted virescence agent (BLTVA), a mycoplasma that causes tomato big bud disease (Thomas and Hassan, 1992). The mycoplasma was transmitted to tomato by graft inoculation from purple top diseased potatoes (Thomas and Hassan, 1992). Highly effective resistance against any of these pathogens in either potato or tomato has been reported only for PLRV in primitive germplasm (Brown and Thomas, 1993; Thomas and Hassan, 1992).

The male parent, *L. peruvianum* P.I. 128655, was originally collected at Charanilla Tampaca, Peru, in 1938, by L.H. Blood (from his original record), and increased by open pollination at Logan, Utah. Bulk seed was collected from 11 plants of this line that failed to develop BCTV disease following massive field exposure at Prosser, Wash., in 1972 (Accession No. 143). A plant selected from Accession No. 143 for graft immunity to BCTV served as the male parent for interspecific crosses with 'Bonnie Best' tomato. Embryo rescue methods were employed to achieve hybridization (Smith, 1944). Seed of the F_2 and F_3 generations was produced by open pollination in the field under exposure to BCTV. Plants with graft immunity to BCTV were selected among the F_3 progeny of both hybrids. Plants with graft immunity to TYTV were selected among F_4 progeny of the BCTV-immune, open-pollinated parents, and F_5 seed was produced by open pollination among the TYTV-immune F_4 parents.

Description

About 65% of the F_5 progeny are immune to all four of the pathogens (PLRV, TYTV, BCTV, and BLTVA) (Hassan and Thomas, 1988; Thomas and Hassan, 1992). The viral pathogens will not move through stem sections of these immune plants following the grafting of susceptible scions on infected stocks (Hassan and Thomas, 1988). Movement through stem sections was not tested for the BLTVA.

The remaining 35% of the plants also ap-

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Fig. 1. Tomato lines Pr18-4 (**A**) and Pr8-5 (**B**). The ruler on the left is 30.48 cm in length.

pear to be immune to PLRV, TYTV, and BCTV by standard criteria (Hassan and Thomas, 1988; Thomas and Hassan, 1992). They remain symptomless following insect inoculation in the greenhouse or field, and virus cannot be recovered from stems or foliage of these inoculated plants by graft or insect transmission. However, closer inspection shows that these plants are not actually immune. Virus moves to their roots following inoculation and there remains latent for at least a year (longer periods were not tested) (Hassan and Thomas, 1988). Virus that is confined to the roots can be induced to move systemically by transferring the plants from a glasshouse to a plastic greenhouse (Thomas et al., 1988). This novel effect was recorded repeatedly over subsequent years. Plants susceptible to root infection (35%) also become systemically infected by all four pathogens following graft inoculation in the greenhouse (Hassan and Thomas, 1988; Thomas and Hassan, 1992). However, the graft union must remain intact for 3 to 6 months for systemic infection to occur. Even then, infected plants do not express symptoms. Furthermore, they contain low concentrations of virus compared with infected tomato or potato plants, and the virus present is often distributed irregularly in the plant (Hassan and Thomas, 1988).

The two hybrid lines, Pr18-4 and Pr8-5, are essentially identical with regard to resistance to the four pathogens examined. Although both have many characteristics in common with their wild *L. peruvianum* ancestor, Pr18-4 has slightly larger fruit than Pr8-5. These lines provide unique sources of resistance for the improvement of potato and tomato and the development of multiple-disease-resistant cultivars. They also may be used to investigate the nature and inheritance of pathogen resistance.

Fertility

Neither of the hybrid lines crosses readily with tomato, but both are cross-compatible within the hybrid populations. The original F_1 plants did not produce fruit or seed when crossed in the greenhouse. Under open pollination in the field, only two to six fruits were obtained per plant, each containing only one to 16 seeds. Fertility has increased in each succeeding generation, but seed production still does not match that of the parents. Under open pollination in the field, the current generation produced ≈50% to 60% as much seed as the wild *L. peruvianum* parent.

Chromosomes were counted in root tips produced from stem cuttings. Root tips were pretreated with 0.002 M 8-hydroxyquinolin for 2 h, fixed in 95% ethanol-glacial acetic acid (3:1) for 2 h at room temperature, preserved at 4 °C in 70% ethanol until used, hydrolyzed in 1 N HCl for 8 min at 60 °C, squashed in 2% acetocarmine, incubated for 30 min in an acetic acid–saturated atmosphere, and examined microscopically. Both Pr8-5 and Pr18-4 were found to be diploid (2n = 24).

Pollen stainability was determined on pollen from freshly opened flowers. Anthers were massaged on glass slides in 2% acetocarmine. The slides were held in a chamber saturated with 45% acetic acid for 30 min, and examined under a microscope. Based on pollen stainability of two samples of 2000 pollen grains for each line, 61.84% of Pr8-5 pollen is potentially viable while 44.5% of Pr18-4 may be viable. Pollen stainability of the male parent was 91.65%.

Availability

Small amounts of seed of these lines are available from Dr. Peter E. Thomas, Vegetable and Forage Crop Production Research Unit, USDA–ARS, Rt. 2 Box 2953A, Prosser, WA 99350-9687.

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