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Phosphorous acid salt: a promising chemical to control tomato bacterial wilt

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Tomato bacterial wilt

Bacterial wilt caused by *Ralstonia solanacearum* is a destructive and widespread soil-borne disease that limits tomato production in the tropics and subtropics. The pathogen has an extremely wide host range including many weed species and can be disseminated via contaminated water, infected propagation materials, and the movement of humans or machinery. Once the pathogen is introduced into a field it is difficult to eradicate. Except for chemical fumigants, no commercial pesticides are available for the control of this disease. Host plant resistance has been the major management strategy. Resistance sources have been identified and varieties with different levels of resistance have been developed. AVRDC has been the main institution developing and distributing resistant germplasm. However, resistance can be location-specific and strain-specific. Thus, integrating other practices with host resistance is necessary to manage the disease successfully. Components such as soil amendments and resistant rootstocks have been studied and applied by farmers (Lin et al. 2008). Recent studies have shown that phosphorous acid salts (PAS) could be promising chemicals for inclusion in integrated packages to manage tomato bacterial wilt.

Tomato plants display wilting symptoms caused by *R. solanacearum*. – C-H. Lin

Phosphorous acid salts

Phosphorous acid and its ammonium, sodium, and potassium salts and mono- and di-potassium salts are categorized as biopesticides by the US Environmental Protection Agency (http://www.epa.gov/pesticides/biopesticides/). They have low toxicity in the environment and are best known for their high efficacy in controlling diseases caused by oomycetes such as *Phytophthora*, *Plasmopara*, and *Pythium* (Ann 2001). The use of PAS to control bacterial diseases was reported only recently. Norman and others (2006) reported that drenching with PAS solution could protect geranium plants from infection by *R. solanacearum*. Drenching was also effective in controlling tomato bacterial spot in greenhouse and field experiments (Wen et al. 2009). The control mechanisms against oomycete diseases have been shown by direct actions, including the inhibition of mycelial growth, alteration or reduction of membrane metabolism, and phosphorylation reactions in the pathogen, and by indirect actions, including the stimulation of plant defensive responses (Grant et al. 1990; Guest and Bompeix 1990).

Moderately resistant tomato variety 'ASVEG No.10' showing significantly lower incidence of bacterial wilt when PAS was applied (left side of the tray) compared with the control (right side). – C-H. Lin

PAS shows good control efficacy

The simple do-it-yourself protocol (Ann 2001) could be adopted by smallholder farmers. Industrial grade phosphorous acid (95%) and potassium hydroxide (95 – 98%) are dissolved sequentially in water at a 1:1 ratio. The final solution (pH 6.0-6.2) should be used immediately to avoid oxidation of phosphite into phosphate.

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A series of greenhouse experiments were conducted to determine the suitable concentration, application method, and frequency. When tested on a susceptible tomato variety, L390, drenching with 30 ml / plant of 3000 ppm PAS at the 4 – 6 true-leaf stage one day before inoculation with the pathogen reduced disease incidence by 38%. Drenching was significantly more effective than foliar application. Effects were evaluated on the time of first application (days before inoculation) and additional application (once / week for 3 weeks). Drenching with 30 ml / plant of 3000 ppm PAS 3 days before inoculation with additional applications showed the best control effect. Testing this application package on four tomato varieties with moderate levels of resistance to bacterial wilt significantly reduced wilting incidence (17.5-30.4% reduction).

A field experiment was conducted: application was made by drenching with 10 ml / plant of 3000 ppm PAS in cells 3 cm in diameter 3 days before transplanting, and three more applications (50 ml / plant) were made once a week after transplanting. The results showed significant control effect of PAS treatment over five tomato varieties.

Field application of PAS on tomato (3000 ppm and 50 ml / plant) using a hand pump (left) with a plastic beaker attached at the end of the applicator (right). – C-H. Lin

No biocidal effect was found when *R. solanacearum* was cultured overnight in tested PAS concentrations at 30°C. The control mechanism could be related to activating plants' defensive systems. Guest and Bompeix (1990) reported the additive effect of PAS and host resistance in tobacco-*Phytophthora* pathosystem. Similar observations were made in the case of tomato bacterial wilt. Thus, PAS is an ideal component for integrated package for the management of tomato bacterial wilt.

Outlook

Successful management strategies integrate host resistance with technologies to reduce pathogen inoculum and prevent the pathogen from coming in contact with the plant. Applying PAS to enhance tolerance to *R. solanacearum* is an ideal practice for an integrated management package. Trials should be conducted on-site to determine the efficacy and potential damage to local tomato varieties. PAS may be effective in controlling other tomato diseases, and this would increase its adoption. For further dissemination, note the following: 1) Material cost of PAS is estimated to be US$130 / ha (30,000 plants) following the above method; although the cost seems low, cost-effectiveness should still be evaluated. 2) Phosphorous acid and potassium hydroxide are strong chemical compounds and should be handled with care. 3) PAS can hydrolyze easily at room temperature; it should be stored in an air-tight container or a desiccator.

Further reading

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