OUTLOOK FOR MANAGING PHYTOPHTHORA DISEASES ON CALIFORNIA STRAWBERRIES WITHOUT METHYL BROMIDE

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Phytophthora cactorum and *P. fragariae* var. *fragariae* (*Pff*) both cause economic loss in the California strawberry production system, but the former is more prevalent. Both pathogens are managed primarily by pre-plant fumigation with methyl bromide-chloropicrin mixtures. *P. cactorum* is regularly detected on susceptible cultivars in most phases of nursery and fruit production. However, confirmed recent losses due to *Pff* have been limited to fruiting fields near Watsonville and in the Central Valley. Here we report on research concerning genetic, cultural, and integrated chemical approaches for managing Phytophthora diseases on strawberries without methyl bromide (MBr).

Genetic resistance to *P. cactorum*. At Monterey Bay Academy (MBA, near Watsonville), cultivar resistance to *P. cactorum* was tested in plots that were artificially infested with the pathogen. The inoculum was produced on a V8 juice-oat-vermiculite substrate. Control plots were amended with sterile substrate. There were four replicate 10-plant plots per inoculum-cultivar combination. The resistance to *P. cactorum* was assessed according to plant health (monthly vigor-survival scores) and marketable fruit yields through the season. Pajaro and Parker were included as susceptible and resistant standards, respectively. In two successive years (1999 and 2000 fruiting seasons), Diamante, Gaviota, and Pajaro were highly susceptible to *P. cactorum*; in the infested plots they produced 30 to 43% of their yields in non-infested plots. Aromas, Pacific, and Parker were relatively resistant and in infested plots produced 77 to 94% of their yields in noninfested plots. Camarosa had an intermediate response in infested plots (58% of control yields). Supplemental tests indicated that greenhouse screening for resistance *P. cactorum* is less reliable than field screening. Apparently, good genetic resistance to *P. cactorum* is available in useful strawberry cultivars and can be used to augment present and future *Phytophthora* management strategies.

Genetic resistance to *P. fragariae* var. *fragariae*. Growth chamber and greenhouse screens were used to assess resistance to *Pff* in the seven California cultivars tested with *P. cactorum*. Six additional cultivars from sets used to distinguish races of *Pff* were included as standards. The plants were inoculated by dipping the roots in a mycelial slurry of four *Pff* isolates. Control's roots were dipped in sterile slurry. The plants were planted in UC mix immediately after dipping, subjected to soil flooding for 48 hr, and held at 10 to 15°C. One month

after inoculation, susceptibility was assessed according to microscopic determination of percentage of infected root tissue (PIRT, van de Weg 1996). There were four replicate plants per inoculum-cultivar combination in each of three experiments. In all three tests, all seven tested California cultivars and only one differential (Del Norte) were susceptible (mean PIRT values 30 to 81). The other differentials (Aberdeen, MD 683, Sparkle, Stelemaster and Yaquina A) and all noninoculated controls had no disease. If sanitation practices are compromised due to ineffective fumigation options, many California strawberry cultivars will be at risk due to inherent *Pff* susceptibility, when grown at *Pff*-infested sites.

Irrigation drip line spacing and *P. cactorum*. In 1999/00 at MBA, plots of Aromas and Diamante were planted in non-infested soil or soil artificially infested with *P. cactorum.* The plots were irrigated with two drip lines that were spaced 0, 4, 8, or 12 inches apart on double-row 52-inch beds. There were three replicate plots per treatment combination. *P. cactorum* caused greater yield loss from Diamante than from Aromas, but drip line spacing had a relatively small effect.

Systemic fungicides. Ridomil Gold EC® and Aliette WDG® fungicides were tested on plots of Aromas and Diamante planted in either noninfested soil or soil artificially infested with *P. cactorum.* Without fungicide in *P. cactorum*-infested plots, Aromas (resistant) produced an average of 71 to 86% of its marketable fruit yield, compared to its marketable yield in nontreated, noninfested plots. In the same non-treated, infested plots Diamante (susceptible) produced only 33 to 43% of the control yields in non-infested plots. In the infested plots, three soil drenches of Ridomil over the season boosted marketable fruit yields of Aromas and Diamante to 108 and 90% of the control yields in nontreated noninfested plots, respectively. Aliette as a preplant dip and four foliar sprays increased marketable yields of Aromas and Diamante in infested plots to 82 and 72% of the control yields, respectively. Our results indicate that Ridomil and Aliette fungicides can play an important role in augmenting *Phytophthora* management strategies.

Alternative fumigants. Several MBr alternatives are being team tested for efficacy in controlling soilborne inoculum of *P. cactorum* at commercial nursery and fruiting sites. The work is part of a larger team effort involving several other soilborne pathogens and pests. The team includes many commercial cooperators, the California Strawberry Commission, and labs of J.M. Duniway, S.A. Fennimore, F.N. Martin, H. Ajwa, B. Westerdahl, and R. Goodhue. The tested alternatives (iodomethane + chloropicrin, drip or shank applied; chloropicrin, drip or shank; Inline, drip; Telone C35, shank; and propargyl bromide, drip) all offered promise for *Phytophthora* management in the first year of formal team testing (2000), but the results also indicated that acceptable efficacy of some of the fumigants is sensitive to rates, mulching system, or emulsifiers used (for drip formulations).