Poster Session: Fungicide Resistance

232-P

Detection and molecular characterization of fenhexamid resistance in *Botrytis cinerea* isolates from strawberries.

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Gray mold is one of the most important diseases of strawberry. In the southeastern United States, the disease is primarily caused by *Botrytis cinerea* and to a much lesser degree by *B. caroliniana*. The control of gray mold is mainly based on the application of fungicides during bloom and fruit maturation. Several fungicides from different modes of action are registered for gray mold control, including the hydroxyanilide fenhexamid. This fungicide specifically inhibits the 3-ketoreductase of the ergosterol biosynthesis pathway and is therefore prone to resistance development. In order to determine levels of fenhexamid sensitivity in North and South Carolinian strawberry fields, 217 single-spore isolates were collected and subjected to a spore germination assay that distinguishes sensitive from resistant isolates. Fenhexamid resistance was found in three of four locations from North Carolina and in four of seven locations from South Carolina. Approximately 20% of all isolates were resistant to fenhexamid. Detached fruit studies demonstrated that field rates of Elevate controlled sensitive but not resistant isolates. Resistance was associated with three mutations in the *erg27* gene, encoding 3-ketoreductase, at position 412 leading to amino acid changes F412S, F412C, and F412I. A rapid polymerase chain reaction method was developed to distinguish sensitive from resistant genotypes.

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Using boosted regression trees to evaluate the association of drought indices and local weather conditions with stripe rust epidemics in Kansas
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Stripe rust (*Puccinia striiformis*) is an economically important wheat disease in Kansas. Major epidemic years include 2001, 2003, 2005, and 2010 with 7.3, 10.6, 8, and 10.3 percent statewide losses reported respectively. In 2010, 42.5 million bushels of wheat were lost from stripe rust costing Kansas's farmers approximately 221 million U.S. dollars. The objectives of this research are to identify environmental conditions that are conducive for stripe rust epidemics in the central Great Plains region of the U.S., and to develop predictive models for stripe rust epidemics in Kansas. Boosted regression trees were developed to determine the relative influence of weather-based predictor variables on stripe rust epidemics and to estimate the accuracy of preliminary prediction models. The preliminary models indicate that epidemics are strongly influenced by moisture conditions in the southern Great Plains. Models can be further refined with combinations of winter and spring temperatures from Kansas. These results suggest that it should be possible to predict wheat stripe rust epidemics in Kansas prior to producer fungicide decisions.

Integration of soil-applied neonicotinoid insecticides and acibenzolar-S-methyl for systemic acquired resistance (SAR) control of citrus canker on young citrus trees
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Soil application of systemic neonicotinoid insecticides for control of psyllid vectors of Huanglongbing disease on young citrus trees also produce season-long SAR control of citrus canker caused by *Xanthomonas citri* subsp. *citri*. Neonicotinoids, imidacloprid (IMID; Admire, Bayer) and thiamethoxam (THIA; Platinum, Syngenta), were compared with soil or microsprinkler applications of the commercial SAR inducer acibenzolar-S-methyl (ASM; Actigard, Syngenta) and foliar sprays of copper hydroxide (CH; Kocide 3000, Dupont) or streptomycin (STREP; FireWall, Agrosource) to evaluate their effects on the percentage of canker-infected leaves on 2 yr-old Vernia orange and 3 yr-old 'Ray Ruby' grapefruit trees in Ft. Pierce, FL. All treatments significantly reduced incidence of foliar canker compared to the untreated check. Soil drenches of ASM and season long rotations with IMID and THIA were highly effective for suppressing foliar canker on young grapefruit and orange trees under weather conditions absent of high intensity rains or tropical storms. Microsprinkler application of ASM was less effective than soil drench. The level of control for SAR treatments was comparable to eleven 21-da interval sprays of CH or STREP. SAR induced by soil-applied insecticides

isolates from a worldwide collection
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Sporangial length and width, pedicle length, oospore diameter, sporangia and chlamydospore production, and growth at 32, 35, and 38°C was determined for 124 *Phytophthora capsici* isolates from 12 countries. Sporangial length (38 to 60 µm), sporangial width (23 to 35 µm), length:breadth ratio (1.34 to 2.07), pedicle length (20 to 260 µm), and oospore diameter (22 to 37 µm) varied widely among isolates. Differences in sporangia production were observed among isolates, and isolates from non-vegetable hosts produced fewer sporangia than isolates from vegetable hosts. When cultures were incubated in liquid medium, 35 *P. capsici* isolates formed chlamydospores; all of the isolates that produced chlamydospores were originally isolated from vegetable hosts. Most (122 of 124) of the isolates were able to grow at 35°C, but all of the isolates grew poorly at 38°C. The results of this study indicate substantial variation in morphological and physiological characteristics among *P. capsici* isolates.

***Pospiviroid* detection in greenhouse and field crops: A sensitive RT-PCR assay for genus- and species-level identification**
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Pospiviroids have been a focus of disease prevention strategies in potato and other solanaceous vegetable crops since their discovery. In recent years, this genus of plant pathogens has garnered increasing attention in greenhouse-grown ornamental plants and in plants subject to phytosanitary certifications. There are at least six species of pospiviroids found in greenhouse and field crops, including *Chrysanthemum stunt viroid* (CSVd), *Citrus exocortis viroid* (CEVd), *Potato spindle tuber viroid* (PSTVd), *Tomato apical stunt viroid* (TASVd), *Tomato chlorotic dwarf viroid* (TCDVd) and *Tomato planta macho viroid/Mexican papita viroid* (TPMVd/MPVd). Non-degenerate primers were designed from the conserved sequences of the members of this genus, allowing for detection of these six pospiviroids at the genus-level, and at the species-level through sequence analysis. The test was screened against a collection of previously characterized viroid species, including other members of *Pospiviroidae* and *Avsunviroidae*, to confirm genus-level specificity. The sensitivity of this two-step RT-PCR assay was demonstrated using composites of a single infected tomato leaflet among a pool of healthy leaflets, and by screening samples of quantified RNA. This reliable and sensitive approach to detect pospiviroids in foliar tissues can be used to prevent the spread of the pathogen and aid in its eradication. Validation of this assay to effectively screen tomato seed lots for seed-borne and seed-transmitted pospiviroids is underway.

Effects of multiple sources of seasonality on the risk of pathogen spread to vineyards: Vector pressure, natural infectivity, and host recovery
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For vector-borne pathogens, seasonality may manifest in the variability in vector abundance, vector infectivity, and host-infection dynamics over the year. The relative importance of multiple sources of seasonality affecting the possible spread of a plant pathogen, *Xylella fastidiosa*, into vineyards was explored. Observed seasonal population densities of the primary leafhopper vector, *Graphocephala atropunctata*, from 8 years of surveys in Northern California were incorporated into a model of primary spread to estimate the risk of pathogen infection under different scenarios regarding seasonality in vector natural infectivity (i.e. constant or increasing over the season) and grapevine recovery from infection (i.e. none or seasonal recovery). Seasonal natural infectivity, seasonal recovery, and especially the combination, reduced (up to 8-fold on average) within-season and cumulative yearly estimates of pathogen spread. Estimated risk of infection also differed greatly among years due to large differences in vector abundance, with wet and moderate winter and spring conditions favoring higher *G. atropunctata* abundance. Seasonal variation of the pathogen - vector interaction may play an important role in the dynamics of disease in vineyards, reducing the potential prevalence when these agents are less abundant. Moreover, climate, by affecting sharpshooter abundance or activity, may influence Pierce's disease dynamics.