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Changes in Fungicide Use Patterns

Historically, chemical control of plant diseases caused by fungi has been through preventive use of fungicides. Such materials as captan and maneb were used primarily as protective sprays that, for acceptable control, had to be in place before the pathogen arrived. These materials were applied often because new surfaces were produced by growth and because previously protected surfaces became vulnerable when the chemical broke down or washed off. The same materials were used successfully as seed treatments, by coating the seed and germinating seedling and by diffusing into the surrounding soil. Some locally systemic materials, such as carboxin, could penetrate the seed and destroy seedborne pathogens.

Meanwhile, growers have become accustomed to applying insecticides and herbicides with much greater flexibility and variety. For example, insecticides are frequently not used until the economic threshold for the pest is reached. Herbicides can be applied while the soil is being prepared for planting. Rescue treatments with insecticides or herbicides can be used if weed or insect problems become significant as the season progresses. Growers are now asking plant pathologists when such developments can be expected for plant disease control.

Research reported in *Fungicide and Nematicide Tests* indicates that changes in fungicide use patterns are already here! For example, epidemics of downy mildew can be controlled with one or two applications of the new fungicides. Downy mildew and rust, both foliar diseases, can be controlled with seed treatments. Impregnating fertilizers with fungicides before planting can lead to full-season control. Growers can wait to see if a disease will develop before deciding to apply fungicides.

The potential for new fungicide use patterns is primarily the result of the development of two major groups of fungicides, the sterol inhibitors and the acylalanines. Vast interest in these materials has been created because of their strong eradicative and systemic actions. During the late 1960s and 1970s, the benzimidazoles became available and promised to greatly change the way fungicides would be used because of their curative and systemic actions. Benzimidazole-resistant strains of pathogens soon appeared, however, necessitating either mixing or alternating the benzimidazoles with protectants. Thus, growers had to return to application schedules within the limits set by the protectant fungicides.

Eradication and rescue treatments. Rescue applications of fungicides are those made after an epidemic is under way. The treatment is designed to stop new disease development under heavy disease pressure and/or eradicate active infections. Turfgrass pathologists reported several successes with the sterol inhibitors in rescue roles. Ohio pathologists reported that Bayleton, Chipco 26019, BAS 43603F, CGA-64250, Rubigan, and Vorlan all brought dollar spot epidemics on bentgrass under control after two applications; about 50% of the plot area was affected at the time of the first application. New York and Maryland pathologists reported similar findings of curative action against dollar spot where epidemics of benzimidazole-resistant *Sclerotinia homoeocarpa* were present. Wisconsin scientists reported control of dollar spot with high rates of Daconil 2787, a noneradicative material. Curative control of red thread, caused by *Corticium fuciforme*, has been observed with most of these fungicides. Also, Bayleton controlled Fusarium blight of bluegrass when applied after early symptoms were observed. This approach is especially exciting because normal preventive treatments often are applied several weeks in advance of any symptoms and to sites where disease development is erratic.

Use of Ridomil for curative control of downy mildews and *Pythium* diseases is well established. Even though Ridomil is not labeled for rescue treatments, growers are using it regularly in a curative role on turf, tobacco, hops, and vegetable crops. Growers can easily see the striking results but, unfortunately, they cannot see the possible pitfalls. Tobacco researchers have shown that foliar applications of Ridomil can stop well-established epidemics of blue mold, caused by *Peronospora tabacina*. Both new infections and developing lesions were checked by a variety of Ridomil applications. Also, established lesions stopped sporulating, and the pathogen died. Farmers claim the lesions "dry up." In Kentucky, recent research showed that epidemics of black shank, caused by *Phytophthora parasitica* f. sp. *nicotianae*, could be greatly reduced by applications of Ridomil after plants showed symptoms. On highly susceptible burley cultivars, the disease incidence was reduced from 76% in the untreated control to 12% in plots treated after the disease was active. The yield difference was 3,000 lb and the cost benefit, over $5,400. Similar results were obtained with dark tobaccos. In a successful rescue approach to burley cutivars having moderate resistance, Ridomil applications were not started until black shank was detected.

Several sterol inhibitors are highly effective in postinfection applications against apple scab, cedar-apple rust, and cherry brown rot. A New York scientist reported that Vangard, Rubigan, Baycor, Sisthane, Funginex, and Prochloraz checked scab development when applied after inoculation but before symptoms appeared. Others reported these materials markedly reduced secondary scab development when applied in situations where numerous primary lesions were sporulating, although the lesions and sporulation were not checked. Much more research is needed to determine timing, rates, and economic threshold, but growers should soon have a rescue tool for controlling many fruit diseases. Vangard, Baycor, Funginex, and Rubigan provided excellent control of cherry leaf spot and brown rot in postinfection applications in Michigan, but there was no saving in the number of sprays required compared with a preventive program.

Preplant applications. Tobacco growers are now using Ridomil 2E, a systemic fungicide, to control three major diseases with a single preplant application. Significant, full-season protection from Pythium soft rot, black shank, and blue mold is being obtained in most tobacco production areas. Rates vary according to soil type, climate, disease pressure, and tobacco type, but a single broadcast spray is applied preplant and incorporated by disking. Herbicides and insecticide-nematicides are often applied in the same operation, even in the same spray tank, making this method very attractive to growers. Supplemental applications at the last cultivation are used under severe disease pressure.

In Kentucky, the local fertilizer dealer impregnates dry fertilizer with the fungicide (Ridomil 2E), herbicide, and insecticide, and thus much of the pest control program is applied when the fertilizer is spread and incorporated. This program is very attractive to small producers without broadcast spray equipment and to many others because grower contact with pesticides is greatly reduced. The only problems, which have not surfaced with tank-mixing the herbicide, fungicide, and insecticide, have involved poor distribution in the corners and outer rows. Farmers are reluctant to fertilize the weeds!

Fungigation. Protective and systemic

fungicides are being applied through a variety of irrigation systems (fungigation) with surprisingly favorable results. In Michigan, Bravo 500 + Citcop 4E and Dithane M-45 F + Tribasic Copper Sulfate were applied on tomatoes through center-pivot irrigation vs. conventional fixed-wing aircraft application. Significant differences in the control of foliar diseases and fruit rots were observed only between the fungicides and the untreated control, not between the methods of application. Fungigation has been used successfully to apply several flowable and EC formulations of fungicides on vegetables, turf, peanuts, tobacco, and ornamentals for control of a wide variety of foliar and soilborne diseases.

Plant injections. Plant pathologists are often asked, "Isn't there an injection I can give my plant?" Injection of elm trees with such benzimidazole fungicides as Arbotect to control Dutch elm disease is becoming increasingly common. Research from several institutions indicates that annual preventive injections for Dutch elm disease are promising. Curative treatments, however, have generally been promising only when the injections are made before the pathogen colonizes 5% of the upper portions of the tree. Some successes in suppressing other vascular wilts and cankers have been reported. Illinois researchers reported significant reduction in the incidence of anthracnose cankers, caused by *Gnomonia platani*, in sycamore by injections of a 1:20 dilution of Arbotect 20-S.

Seed treatments. Kansas scientists reported that a Baytan seed treatment significantly reduced leaf rust, caused by *Puccinia recondita* f. sp. *tritici*, and speckled leaf blotch, caused by *Septoria tritici*, of wheat. Brazilian researchers reported the control of net blotch, caused by *Pyrenophora teres*, of barley with seed dressings containing triadimenol and nuarimol. The foliar disease net blotch was significantly controlled 50 days after planting. Seed treatments containing metalaxyl resulted in downy mildew control in oats, sorghum, and alfalfa that persisted well into the growing season.

The results of recent fungicide evaluations suggest a future for fungicide use that is more compatible with modern farming systems. However, much more research, both basic and applied, is needed. The stage set for the immediate future includes much flexibility based on the availability of new compounds and aggressive testing programs. Meanwhile, growers should apply all fungicides according to current labeling, avoiding the temptation of unproven, ie, unlabeled, approaches.

Dr. Nesmith is immediate past editor of Fungicide and Nematicide Tests, *David F. Ritchie, Editor, published annually by the New Fungicide and Nematicide Data Committee of The American Phytopathological Society. Copies of current and past volumes may be obtained from Richard E. Stuckey, Business Manager F & N Tests, Plant Pathology Department, University of Kentucky, Lexington 40546.*