P. M. PHIPPS, Tidewater Research and Continuing Education Center, Suffolk, VA

Requirements and Developments in Small Grain Seed Treatments

Seed treatment fungicides are used routinely in crop production for prevention of disease caused by seedborne and soilborne microorganisms. Although several fungicides are registered for use as seed treatments, the need to continuously research and refine strategies for improved protection against disease is sustained by changes in production technology, dynamic shifts in pest populations, and discoveries in research on the biology of pathogenic agents.

In addition to protection against seed decay and seedling disease, control of seedborne smut diseases is a prerequisite for small grain seed treatment fungicides. This requirement has resulted in the need for chemicals with systemic activity. In the search for such chemicals, new compounds have been discovered that afford control of seed and seedling diseases and also suppress important diseases that occur long after the seedling stage of plants. These discoveries have opened a new frontier for chemical control of small grain diseases.

The need for improved seed treatment fungicides for small grain in the United States can be expected to increase with the adoption of intensive management practices for high yields. The core of these programs includes increased nitrogen fertilization coupled with increased plant populations, both contributing to elevated pressure by several important diseases. Mid- to late-season applications of foliar fungicides can be effective in control of such diseases, but the added expense in production has limited their acceptance. The development and registration of improved seed treatment fungicides with use patterns that achieve suppression of these diseases may enable more economical use of foliar fungicides later in the season.

Several new systemic fungicides have been introduced for evaluation in recent years, and some have shown remarkable activity. These fungicides control many of the chronic seedborne and soilborne smut diseases, and some are persistent enough to suppress certain foliar diseases. Over the past 5 years, results of 138 field tests of seed treatments for small grain (90 wheat, 13 oats, 35 barley) have been reported in *Fungicide and Nematicide Tests*. In addition to chemicals with full registration as seed treatments, numerous experimental fungicides have been tested for efficacy against a wide variety of small grain diseases. The diseases include seed decay and seedling blight (*Fusarium, Pythium, Helminthosporium*, and *Rhizoctonia* spp.), covered smut (*Ustilago hordei*), covered smut or common bunt (*Tilletia* spp.), loose smut (*Ustilago* spp.), flag smut (*Urocystis agropyri*), dwarf bunt (*Tilletia controversa*), leaf rust (*Puccinia recondita*), stripe rust (*P. striiformis*), net blotch (*Pyrenophora teres*), barley stripe (*Pyrenophora graminea*), leaf blotch (*Septoria tritici*), glume blotch (*S. nodorum*), spot blotch (*Cochliobolus sativus*), take-all (*Gaeumannomyces graminis*), powdery mildew (*Erysiphe graminis*), downy mildew (*Sclerophthora macrospora*), and scab (*Fusarium* spp.). The following summary focuses on chemicals that have been repeatedly shown to control one or more of these diseases.

Labeled products. Captan, maneb, and thiram (various trade names) are not systemic but have provided control of seed rots and seedling blights. Maneb and thiram are also registered for use to control covered smut of wheat and barley but generally provide only partial suppression. These fungicides, alone or combined with carboxin, are routinely used as reference standards in evaluations of experimental materials.

Carboxin (Vitavax), a systemic fungicide, is registered for control of several soilborne and seedborne diseases of field crops. Carboxin alone or combined with captan or thiram has been evaluated extensively as a seed treatment for small grain. Carboxin has shown fair to good efficacy in control of covered and loose smut of barley, oats, and wheat. Control of wheat flag smut and suppression of barley stripe have also been reported.

Hexachlorobenzene (various trade names) has been used either alone or combined with captan and/or maneb for surface disinfestation of seed. Good to excellent control of covered smut and suppression of flag smut of wheat have been reported. Hexachlorobenzene is not a systemic fungicide and has been ineffective for control of loose smut of wheat.

Imazalil (Fecundal) was registered recently for use as a seed treatment to control barley leaf stripe and common root rot (*Helminthosporium sativum*) of wheat and barley. Imazalil has been reported to provide fair to good control of covered smut and net blotch of barley and to suppress common root rot and leaf stripe of barley. Evaluations have indicated that imazalil does not control covered and loose smut of wheat, leaf blotch of wheat, and Helminthosporium blight of oats. In some instances where imazalil was used as seed treatment, reduced stands in barley have been reported.

Metalaxyl (Apron) is a systemic fungicide having activity specifically useful for controlling diseases caused by species of *Pythium* and *Phytophthora*. Metalaxyl has been effective for controlling Pythium damping-off of wheat, barley, rye, oats, rice, and corn. Suppression of downy mildew of oats has also been reported. Combinations of metalaxyl with etaconazole, quintozene, carboxin, and triadimenol have been shown to broaden the spectrum of disease control to include smuts and some stem and foliar diseases.

Quintozene (Terra-Coat), not a systemic fungicide, has been evaluated alone and combined with numerous fungicides. Quintozene has shown fair to good efficacy for control of covered smut of wheat and barley and flag smut of wheat.

Thiabendazole (Mertect) is a systemic fungicide and has been shown to be one of the more effective compounds for controlling dwarf bunt of wheat.

Experimental chemicals. Triadimenol (Baytan) is a broad-spectrum systemic compound belonging to the triazole group of fungicides. Triadimenol has been evaluated extensively as a seed treatment and has provided good to excellent control of covered and loose smuts of small grains. It has also suppressed certain other diseases, including take-all, flag smut, leaf rust, powdery mildew, leaf blotch, and stripe rust of wheat and net blotch, leaf stripe, and powdery mildew of barley. The observed activity of triadimenol in suppressing diseases beyond the seedling stage makes this fungicide attractive for application in intensive management systems of wheat production. Triadimenol has not given consistent results in control of dwarf bunt and has not suppressed scab or spot blotch of wheat or leaf rust or spot blotch of barley. The existence of triadimenol-insensitive strains of *Pyrenophora teres* in New Zealand was reported in 1985 to result in little or no control of net blotch of barley. Triadimenol + imazalil, however, resulted in near complete control of net blotch. Triadimenol has been reported to slow the rate of seedling emergence and, at high rates, to reduce stands. Triadimenol is

currently pending registration as a seed treatment for small grains and corn in the United States.

Etaconazole (Vangard, Pace) is also a systemic fungicide belonging to the triazole group. Etaconazole has been tested extensively and shown to be effective in controlling covered smut in small grains and loose smut in wheat and barley. Suppression of dwarf bunt, flag smut, and Septoria leaf blotch of wheat has also been reported. Phytotoxicity and reduced stands have been reported with etaconazole treatments in several tests. Efforts to develop this fungicide were discontinued recently by Ciba-Geigy.

Fenfuram (Panoram) has given good to excellent control of covered and loose smut of barley in Australia.

Furmecyclox (Campogran, Epic) has given good to excellent control of loose smut of oats and wheat, flag smut of wheat, and covered smut of oats and barley. Several instances of reduced stands in barley have been reported after use of furmecyclox.

Nuarimol (EL-228) has given good control of flag smut of wheat and fair to good control of covered smut of wheat, oats, and barley. Suppression of net blotch, leaf stripe, and spot blotch of barley and of spot blotch and leaf blotch of wheat has also been reported. High rates of nuarimol have been reported to reduce stands of barley and wheat.

Chevron XE-779 has given good to excellent control of covered and loose smut of barley, loose smut of oats, and covered smut and flag smut of wheat. Suppression of leaf stripe of barley has also been reported.

Dr. Phipps is editor of the seed treatments section 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.*