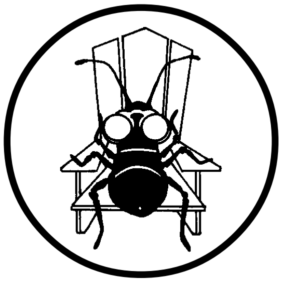
C U T T

Do Bio-Controls and Pesticides Mix?



Pest Watch

Our studies were designed to first determine the in vitro toxicity of various herbicides, insecticides, and fungicides to selected turfgrass pathogens so that laboratory and field results could be properly interpreted.

Experiments were conducted in 1998 to examine the impact of pesticide applica tions on the efficacy of commercial microbial inoculants used to suppress turfgrass diseases. Our goal in this research was to document any positive or potentially negative combinations of biological disease control products with commonly-used fungicides, insecticides, and herbicides. Our studies were designed to first determine the in vitro toxicity of various herbicides, insecticides, and fungicides to selected turfgrass pathogens so that laboratory and field results could be properly interpreted. Next,. we examined in laboratory studies, the impacts of high label rates of selected chemical pesticides on the efficacy of inoculants for control of *Pythium graminicola, Sclerotinia homoeocarpa,* and *Rhizoctonia solani* on creeping bentgrass.

Procedures and Results

Objective 1: Determine the direct toxicity of selected herbicides, insecticides and fungicides to various turfgrass pathogens so that laboratory and field results may be properly interpreted.

The following pesticides were studied:

Fungicides
chlorothalonil (Daconil)
triadimefon (Bayleton)
etridiazole (Koban)
propamocarb (Banol)
iprodione (Chipco 26019)
mefanoxam (Subdue Maxx)

Insecticides
imidacloprid (Merit)
chlorpyriphos (Dursban)
trichlorfon (Proxol)

Herbicides
prodiamine (Barricade)
mecoprop (Weedstroy)
dicamba (Banvel)
fenoxaprop (Acclaim)

Pesticides were incorporated into corn meal agar or potato dextrose agar for *Pythium graminicola* isolate PRR-11 or *Sclerotinia homoeocarpa* isolate shgu and *Rhizoctonia solani* isolate R6, respectively. Data were subjected to probit analysis to calculate LD_{50} values for each of the selected pesticides against each of the three pathogen isolates. The smaller the LD_{50} value, the more toxic the pesticide.

Each of the three pathogens differed greatly in their sensitivities to the various pesticides. In general, the herbicides and insecticides were the least toxic to *P. graminicola.* The insecticide Merit was the least toxic whereas the fungicides Banol and Daconil were the most toxic to the organisms. Interestingly, Daconil is not typically believed to have significant toxicity to *Pythium* species. *Sclerotinia homoeocarpa*, on the other hand, was considerably more sensitive to nearly all of the pesticides tested and was highly insensitive only to the herbicide Banvel. For example, *S. homoeocarpa* was extremely sensitive the fungicides Daconil and Banner

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Pest Watch

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Maxx. This was expected given the labeled control achieved with these fungicides in the field. However, *S. homoeocarpa* was also extremely sensitive to the herbicides Trimec, Dacthal, Barricade, and MCPP as well as the insecticides Merit, Dursban, and Proxol, and the fungicides Subdue Maxx and Chipco 26019. Subdue sensitivity is rather unusual since this fungicide has specific activity against oomycetes such as *Pythium. Rhizoctonia solani* was also highly sensitive to Subdue. This unusual behavior in culture suggests that the formulation contained materials toxic to a broader range of fungi than the target oomycetes for which Subdue is registered. *R. solani* was also highly sensitive to the fungicide Prostar and the insecticide Merit. *R. solani* was highly tolerant of the herbicides Trimec and Banvel.

Such compatibility was essential in order to establish the direct toxicity of various chemical pesticides to these turfgrass pathogens and allow bioassays with these pathogens and pesticides to be interpreted properly. Any bioassays in subsequent parts of this study could be interpreted erroneously without knowing the direct impacts on pesticides on the activity of the pathogen.

Objective 2: Evaluate the efficacy of microbial inoculants in the field with and without pesticide applications.

Plots were established on a creeping bentgrass/*Poa annua* putting green at the Robert Trent Jones Golf Course at Cornell University. Treatments were arranged in a split plot randomized complete block design. Subplots consisted of no superimposed treatments or conventional golf course management treatments. Inoculant treatments were randomized within three replicate blocks within each major subplot. Control plots consisted of untreated turf (no inoculant treatment) within each pesticide block. Inoculants were applied to 2 ft X 2 ft plots at 14-day intervals at rates of shown in. Unless stated otherwise, inoculants were applied in 2 gal water/1000 ft^2. Treatments were first applied on 6/30/98. Plots were rated between 7/16/98 and 8/11/98 on a scale of 0-10 where 0=no symptoms and 10=100% of the plot area symptomatic. Only fungicides were applied to the plots under conventional golf course management through the course of the study.

The most obvious treatment effect from the field study was a significant block effect. In other words, disease severity was significantly greater in plots receiving no additional management than in those receiving conventional golf course management practices. However, in no case were there significant treatment effects in plots under traditional golf course management practices. Also, there were significant replicate effects at all rating dates (ANOVA not shown). Consistently, the replicate closest to

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the outside of the putting green differed significantly in disease intensity. This replicate was dropped from subsequent analyses.

A number of different diseases appeared on plots throughout the 1998 season. In mid July, following the first application of treatments, small reddish-brown patches appeared on plots. These symptoms were subsequently diagnosed as *Pythium* root rot. Following one application, none of the treatments was effective in reducing symptom expression below that of untreated plots, despite the fact that disease ratings ranged from 1-6. This indicates the considerable level of variability throughout the experiment.

Toward the end of July, *Pythium* root rot symptoms had disappeared and brown patch symptoms were apparent. A number of significant treatment effects were observed at both the 7/30 and 8/6 rating dates. Most importantly, the experimental inoculant RD-107 showed a significant suppressive effect toward brown patch on the 7/30 date. Additionally, Bac Pac, Daconil Ultrex, EcoSoil B-1b, Roots 1 and 3, and Super Bio showed significant reductions in symptoms over the untreated control. By 8/6, brown patch symptoms were beginning to disappear (as indicated by ratings of untreated plots). At this date, only the Super Bio treatment was significantly less diseased than the untreated control plots.

Anthracnose became prevalent on experimental plots toward mid August. However, none of the treatments significantly reduced disease severity over that in untreated plots. Despite this, plots treated with Bio-F, Daconil Ultrex, Roots 3, and Super Bio all showed numerically reduced levels of disease compared with treatments such as Actinovate and Root Shield.

General Summary

Results from this study reveal a number of important findings. First, and somewhat surprising, is the fact that a number of pesticides commonly used in golf turf management have significant toxicities to nontarget pathogens. This is best exemplified by the activity of Daconil against *P. graminicola*, Trimec and Merit against *S. homoeocarpa*, and Subdue Maxx against *R. solani*. These finding complicate the interpretation not only of bioassay results, but of field results when such pesticides are used in combination with biological agents. Second, our results clearly show that a number of pesticides used in combination with inoculants can dramatically affect their suppressive qualities toward various diseases. This is best illustrated by the impact of Bayleton and Proxol on the suppression of *P. graminicola* by *E. cloacae*. Finally, our results have shown that some suppression of brown patch can be detected in a number of commercially-available microbial inoculants.

Future Directions

It is clear that commonly-used pesticides will have impacts on biological control organisms. Even though the inoculant may tolerate the pesticide, changes in biological control activity are going to occur. However, it is unlikely that any potentially negative responses will be observed when biological inoculants are used in combination with chemical pesticides. It is also apparent that, in a golf course setting, there will be little control over the types of materials that are applied. Thus, emphasis should be redirected to other aspects of product development that may have a more direct influence on the suppressive activities of introduced inoculants.

Since it is apparent that some of the inoculants have potential suppressive activity, future work should focus on ways of maximizing their activities in golf turf settings. One of the more obvious areas for improvement is in application frequency and timing as well as application volumes. It was clear from work with many of these inoculants that 2 gallons of water per 1000 ft^2 is insufficient for maintaining maximum activity. Inoculants that failed in this current trial performed well in other trials where the gallonage of water was substantially increased. Furthermore, in other trials with some of the same inoculants, increasing the application frequency and timing significantly improved their performance. Therefore, future work should emphasize these aspects of product development.

Also essential to this work are the capabilities to accurately follow populations of introduced organisms. Without this capability, many subsequent experiments will also be difficult to interpret. If treatments fail, we need to know whether it was a problem with the persistence and development of the introduced organism(s). Equally important will be studies directed toward defining cell density effects on suppression of various diseases and the relationships of cell densities of the introduced inoculant to that of the target pathogen. It is most likely that many of these inoculants will have maximum activity (at a given cell density) when disease pressure is low and will tend to fail under conditions of high disease pressure. We expect to follow this line of investigation in the coming years.

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