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Nontarget Effects of Turfgrass Fungicides on Microbial Communities in USGA Putting Greens

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Executive Summary

This research has been designed primarily to focus on the following objective:

To evaluate impacts of fungicide applications on levels of biological control in native and microbially-augmented USGA and soil-based putting greens.

This is the second year of funded research. The results from the 1996 field season can be summarized as follows; in addition, action plans for the 1997 season are given:

1. Trials were established on native (standard peat-sand) and microbially-augmented (constructed with the inclusion of composted brewery waste and with Bio-Trek 22G [containing *Trichoderma harzianum*] included). The following fungicides were applied at the maximum label concentration and minimum labeled time interval: chlorothalonil (Daconil Ultrex), iprodione (Chipco 26019 Flo), mefenoxam (Subdue Maxx), propiconazole (Banner Maxx), triadimefon (Bayleton), benzamide (Prostar 50WP), and cyproconazole (Sentinel). Plots were in a randomized pattern with 5 replications.

2. At various time intervals over the summer, cores (1 X 5 cm) were taken from each plot and microbial populations were assessed by dilution plating. Almost no detectable differences were obtained in total or specific fungal or bacterial numbers. Similarly, assays of BIOLOG plates to determine physiological groupings of microbial populations demonstrated no detectable effect of fungicide applications.

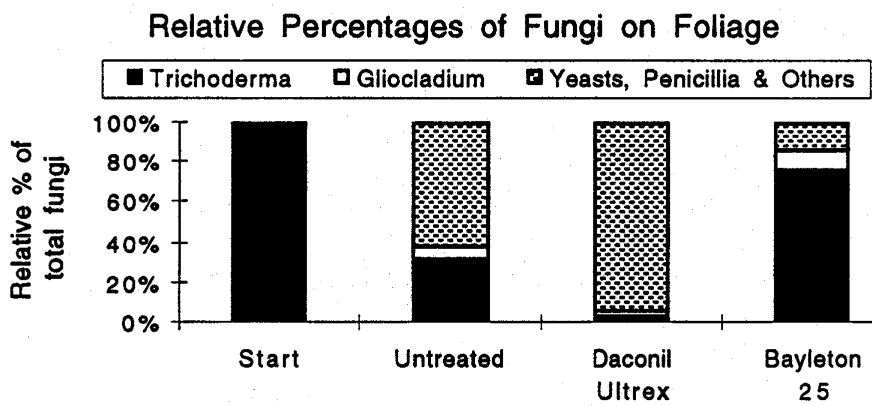
3. The only major effect of fungicide applications noted was in microbial respiration. Application of fungicides increased microbial activity.

Thus we saw few substantial effects in the 1996 trials. Therefore, we hypothesized that there were few effects on the root/soil microbes because of fungicide degradation or dilution. However, there should be effects on foliar microbes. Therefore, in 1997, we conducted similar trials on the augmented plots only, but cut each soil core into root and leaf portions by slicing the thatch layer near its upper surface with a razor blade. Data is compiled in the attached document, but results can be summarized as follows:

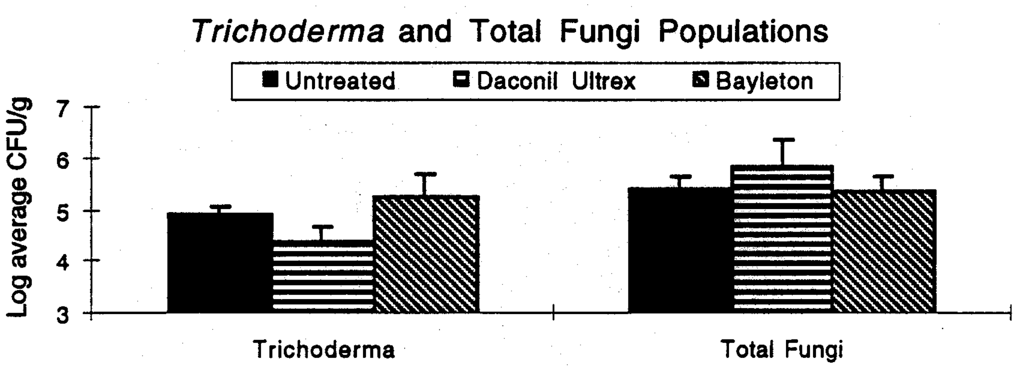
1. There was little long-term effect reduction of total fungi or bacteria on leaves or roots. The accompanying figure demonstrates representative results.

However, application of some fungicides, especially Daconil Ultrex, may enhance development of some fungi such as yeasts on leaves and components of the fungi on leaves appear to vary as a percentage of the total.

2. Two related fungi, *Trichoderma harzianum* and *Trichoderma (Gliocladium) virens*, are the principal components of the endophytic fungi on leaves, and made up nearly all fungi tested at the start of the season. At the end of the trial, these two fungi comprised about 40% of the total fungi seen, but after treatment with some fungicides, especially Daconil, their numbers dropped to only about 6% of the total. On the other hand, the percentages of these two fungi increased to nearly 90% after treatment with Bayleton.



3. These results suggest that effects of fungicides on resident leaf fungi are not as dramatic as we expected. The apparent differences between percentages and total populations of fungi on the two graphs is a consequence of the difference between arithmetic and log plots. The main results of the chemical applications were to alter the fungal compositions but not their total numbers. Apparently, fungal populations only are slightly or transiently affected by chemical applications. However, the shifts in populations seen in this study could substantially affect disease incidence in the absence of actual toxicity of the chemical in question to the pathogen being controlled.



Gary E. Harman

Dr. Harman is a professor in the Departments of Horticultural Sciences and Plant Pathology at Cornell University's NYS Agricultural Experiment Station in Geneva, NY. He is also co-founder and acting-CEO of the biocontrol company BioWorks, Inc., also in Geneva. The research in his lab at Cornell University deals with, among other things, the biological control of plant diseases and with microbe/plant interactions. Over the last three decades, Gary has conducted extensive research on the beneficial fungus *Trichoderma harzianum.*

He earned a Bachelor's degree in botany from Colorado State University and a Ph.D. from Oregon State University.

He has served as chairman in the Department of Horticultural Sciences and as acting chairman and associate and assistant professor of the Department of Seed and Vegetable Sciences and the Department of Pomology and Viticulture. He was also a research associate at North Carolina State University.

Dr. Harman is a member of the American Phytopathological Society and International Society of Plant Pathology and is on the editorial board for the journals *Biological Control* and *Plant Varieties and Seeds.* Gary co-edited the book *Trichoderma and Gliocladium* and has nearly 100 refereed journal articles. He has received numerous awards and honors including being named a Fellow and the Award of Merit in Plant Pathology from the American Phytopathological Society. He also has been a visiting professor to the Agricultural University of Norway and Colorado State University and has been a contractee to the Office of Technology Assessment for the U.S. Congress to prepare a report on "Biologically-based Technologies for Pest Control: Pathogens that are Pests of Agriculture." He is also a member of Sigma Xi and Gamma Sigma Delta. Gary was recently elected a Fellow of the American Phytopathological Society.

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Eric B. Nelson

Dr. Nelson, an associate professor of plant pathology at Cornell University, conducts research in the ecology and control of soil-borne plant pathogens and is involved with extension in turfgrass pathology. His research activities have combined both fundamental and applied studies of various aspects of biological disease control, compost microbiology, and turfgrass pathology. His major research emphasis has been on the biological control of turfgrass diseases and the biology, ecology, and pathology of *Pythium* species.

He has published over 200 articles in scientific journals and extension and trade publications and has been an invited speaker at conferences and seminars all over the United States and Canada, as well as Europe, Australia, and Central America.

He is a member of the American Phytopathological Society, the American Society for Microbiology, the American Association for the Advancement of Science, Sigma Xi, and Gamma Sigma Delta. He earned a Bachelor's degree in botany from Indiana University and both his Master's and Ph.D. in plant pathology from Ohio State University.

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Kristen L. Ondik

Ms. Ondik is a Research Support Specialist in Gary Harman's lab in the Department of Horticultural Sciences at Cornell University's New York State Agricultural Experiment Station in Geneva, NY. While earning her Bachelor's degree in biology from Cornell University, Kristen was a member of Eric Nelson's lab where she worked on the biological control of turfgrass diseases. After accepting a position in Gary Harman's lab in 1995, her projects have included biological and integrated control of plant diseases (especially diseases of turfgrass), control of Phytophthora root rot of raspberries, and nontarget effects of fungicides on microbial communities in golf course greens. She is also a member of the American Phytopathological Society.

Kristen is the resident editor and proofreader and has been acknowledged in several publications including the 750-page book *Trichoderma and Gliocladium*, where she provided substantial editorial assistance and also co-authored a chapter.

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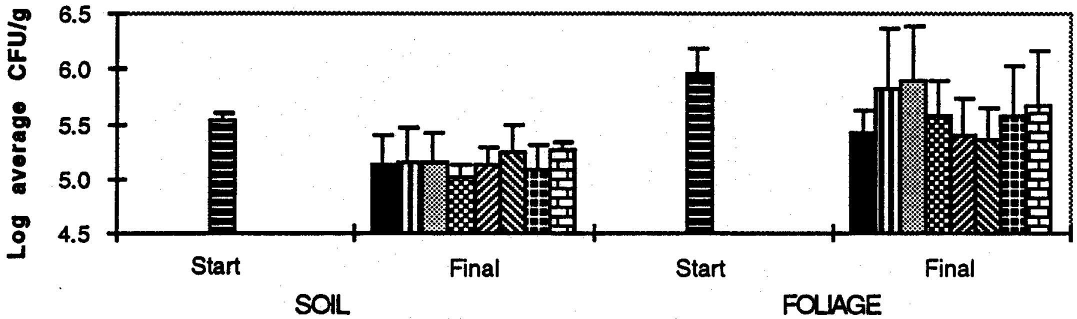
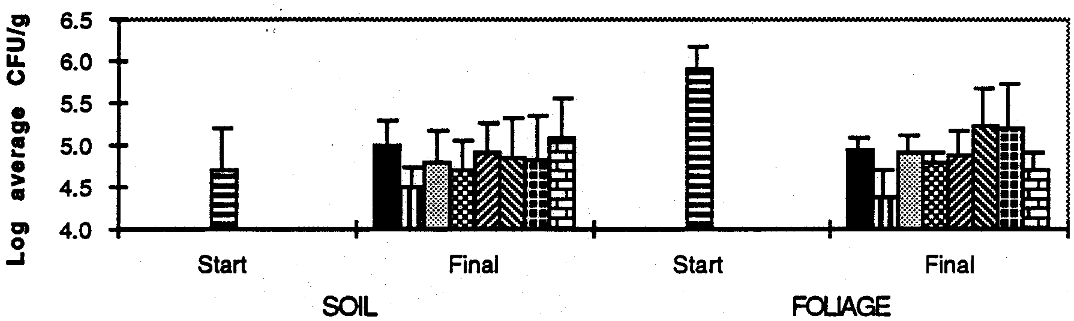
The following graphs represent the rest of this year's data:

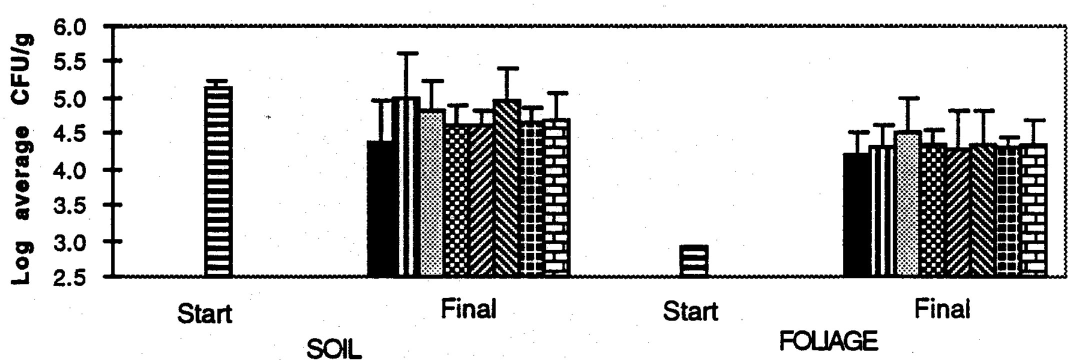
Total Fungi (1997 USGA)

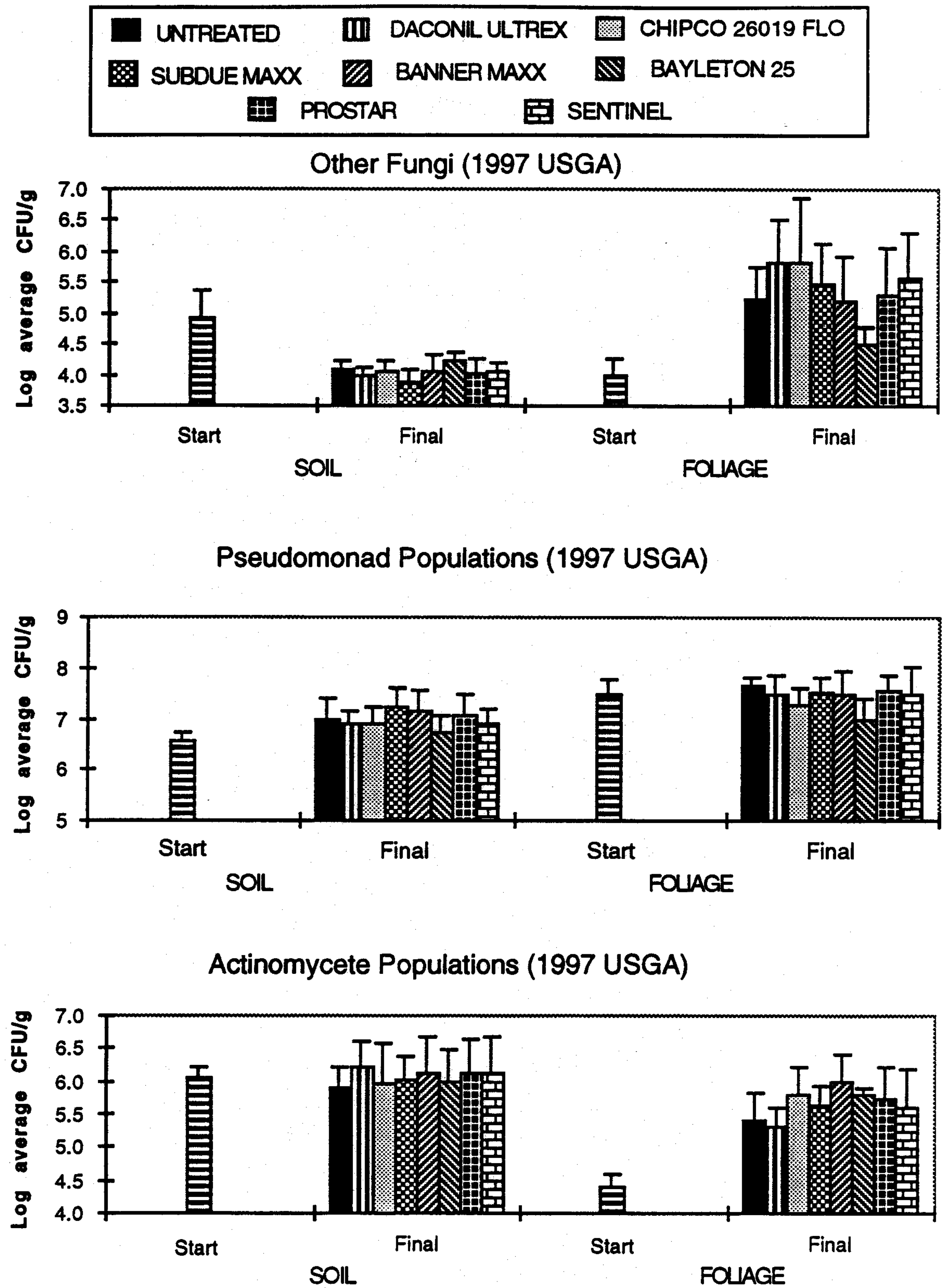


Trichoderma Populations (1997 USGA)

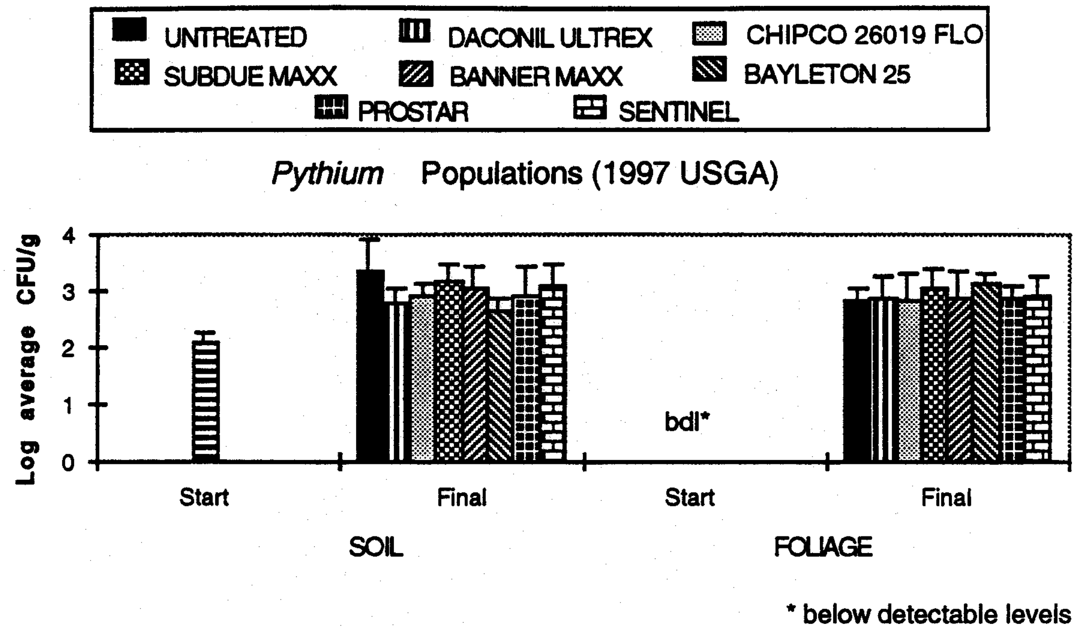


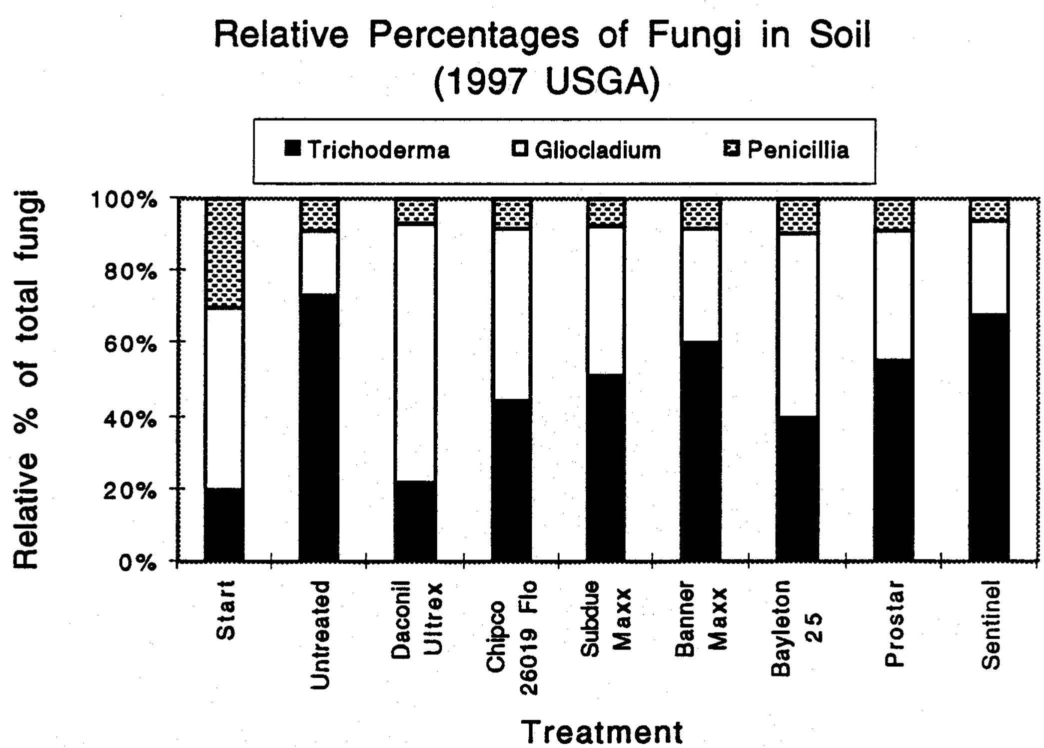
Gliocladium Populations (1997 USGA)

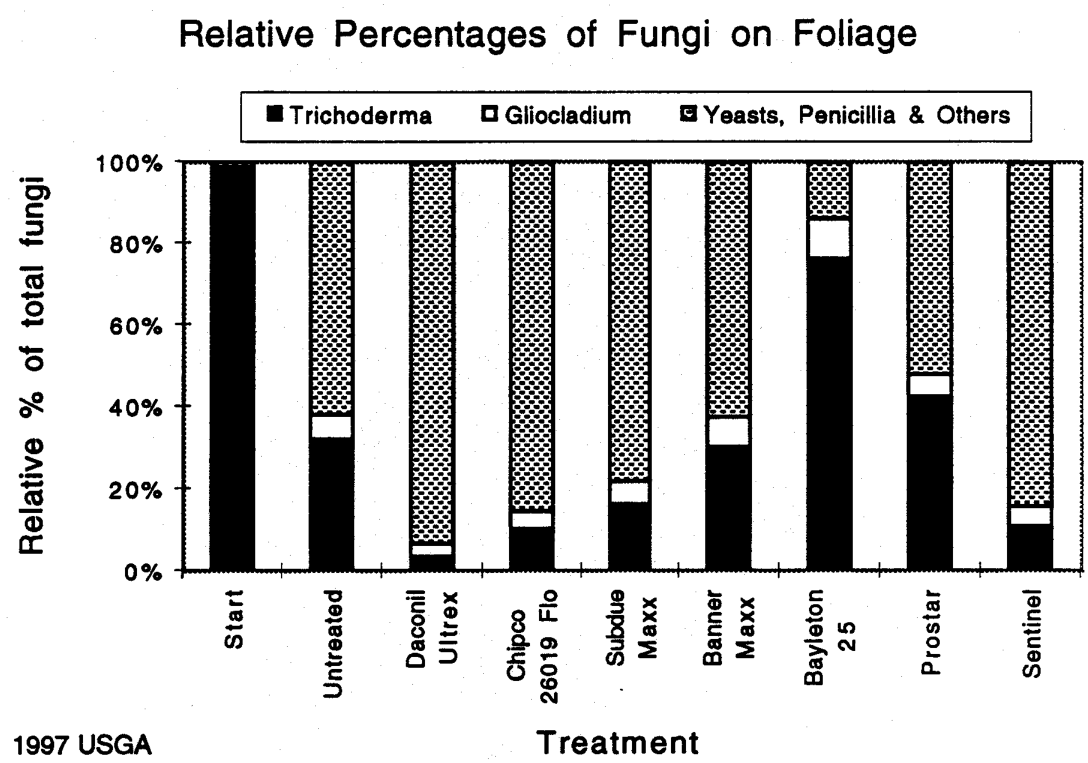




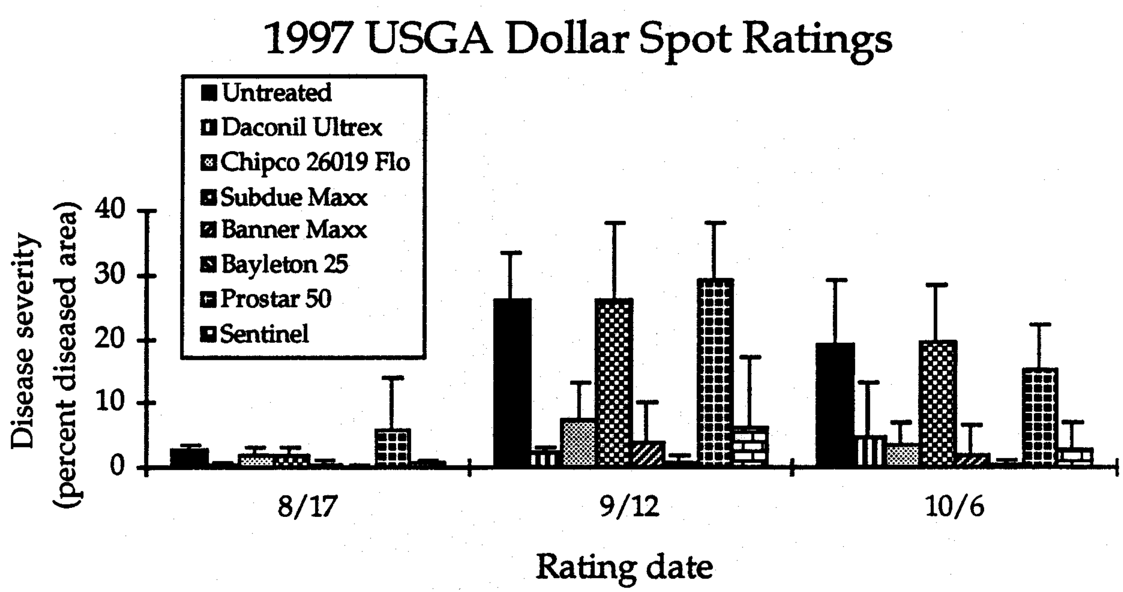
UNTREATED
DACONIL ULTREX
CHIPCO 26019 FLO
SUBDUE MAXX
BANNER MAXX
BAYLETON 25
PROSTAR
SENTINEL
Other Fungi (1997 USGA)
Log average CFU/g
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
Start
Final
Start
Final
SOIL
FOLIAGE
Pseudomonad Populations (1997 USGA)
Log average CFU/g
9
8
7
6
5
Start
Final
Start
Final
SOIL
FOLIAGE
Actinomycete Populations (1997 USGA)
Log average CFU/g
7.0
6.5
6.0
5.5
5.0
4.5
4.0
Start
Final
Start
Final
SOIL
FOLIAGE


UNTREATED
DACONIL ULTREX
CHIPCO 26019 FLO
SUBDUE MAXX
BANNER MAXX
BAYLETON 25
PROSTAR
SENTINEL
Pythium Populations (1997 USGA)
Log average CFU/g
0
1
2
3
4
bdl*
Start
Final
Start
Final
SOIL
FOLIAGE
* below detectable levels


Relative Percentages of Fungi in Soil (1997 USGA)
Trichoderma
Gliocladium
Penicillia
Relative % of total fungi
0%
20%
40%
60%
80%
100%
Start
Untreated
Daconil Ultrex
Chipco 26019 Flo
Subdue Maxx
Banner Maxx
Bayleton 25
Prostar
Sentinel
Treatment



Relative Percentages of Fungi on Foliage
Trichoderma
Gliocladium
Yeasts, Penicillia & Others
100%
80%
60%
40%
20%
0%
Relative % of total fungi
Start
Untreated
Daconil Ultrex
Chipco 26019 Flo
Subdue Maxx
Banner Maxx
Bayleton 25
Prostar
Sentinel
1997 USGA
Treatment



1997 USGA Dollar Spot Ratings
Untreated
Daconil Ultrex
Chipco 26019 Flo
Subdue Maxx
Banner Maxx
Bayleton 25
Prostar 50
Sentinel
40
30
20
10
0
Disease severity (percent diseased area)
8/17
9/12
10/6
Rating date