

Do Management Regimes of Organically and Conventionally Managed Golf Course Soils Influence Microbial Communities and Relative Abundance of Important Turf Pathogens?

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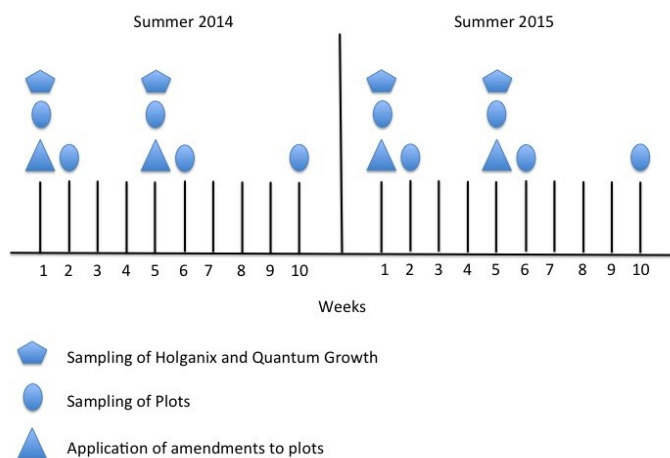
Objectives:

1. Refine RT-PCR assays for detecting DMI resistance in *S. homoeocarpa*, using fungal culturing, as well as detection from dollar spot infected leaf blades.
2. Employ HRM technology for detecting genetic mutations associated with TM-resistance in *S. homoeocarpa*, also from fungal cultures and infected leaf material.
3. Optimize these assays for use as a diagnostic service to golf courses so that they can be provided quickly and inexpensively.

All of the field collections for this project were completed in May and September of 2013 and 2014 successfully. From the Spring (May) 2013 and Fall (September) 2013 collections all samples have been processed for nematode identification and counts, soil nutrient and texture analysis, and DNA has been extracted. The Spring 2013 samples have been pyrosequenced using 16S and 18S ribosomal DNA to characterize the fungal and bacterial communities which have been completed by DR. Manter's laboratory at the USDA-ARS, Fort Collins, CO. These results have been analyzed for alpha and beta diversity and differences in abundances of known turf pathogens. Further analyses will include differences in abundances of beneficial microbes and PiCrust analysis to look at functional roles of the different bacteria and fungi.

The Fall 2013 samples have been processed for soil nutrient and texture analyses, nematode identification and counts, and DNA extractions. The Spring 2014 samples have also been processed for soil nutrient and texture analysis. Nematode analysis has been started for these samples.

The preliminary results for the nematodes counts among the different management areas and golf courses for the Spring 2013 collection were presented at the Crop Science Meeting in November 2013 in Tampa, FL. The pyrosequencing results from the Spring 2013 collection were presented at the national American Phytopathological Society meeting in August of 2014. The nematode results from the Spring and Fall 2013 collections will be presented at the end of October at the Northeastern Division of the American Phytopathological Society's annual meeting.



Timeline of Fieldwork for 2014 and 2015.

Our results suggest that management area significantly impacts fungivore nematodes and fungal community in soils, whereas bacterial community seems to be more influenced by management type (organic vs. conventional). Bacteriovore nematodes were higher on organic putting greens than conventional putting greens in Spring 2013, but this difference was not observed for the roughs and fairways or for all management areas in the Fall 2013. Few turf pathogens were detected and although some statistical differences were seen, they are most likely not biologically significant. This result suggests investigating the thatch for relative abundance of important foliar and root-infecting turf fungal and bacterial pathogens.

Summary Points:

Nematode Communities

- Fungivores were lowest on putting greens in both years (Figure 1).
- Carnivores were highest on the organic course in both years (Figure 2).
- Plant pathogens were lowest on the organic putting greens compared to the conventional and hybrid putting greens (Figure 3).
- Bacteriovores were higher on the organic putting green than the conventional and hybrid putting greens in Spring 2013 but not in Fall 2013 (Figure 4).

Microbe Communities

- Bacteria abundance (16S) was lowest on the organic course than the conventional and hybrid courses (Figure 5).
- Bacterial alpha diversity (observed species, species diversity, species richness, and species evenness) was lower on the organic course than the conventional and hybrid courses (Figure 6).
- Fungi abundance (18S) was highest on the organic course and highest on the roughs. The interaction of golf course and management area showed that fungi were lowest on the fairways for all three courses but greater on the organic putting greens and organic and conventional roughs (Figure 7).
- Fungal alpha diversity (observed species, species diversity, and species richness) was lowest on the putting greens with no significant differences in species evenness or between golf courses (Figure 8).
- Some turf pathogens were detected and had statistically significant differences in their abundances. However the low abundance of the pathogens in all samples may indicate that these results are not biologically significant (Figure 9).

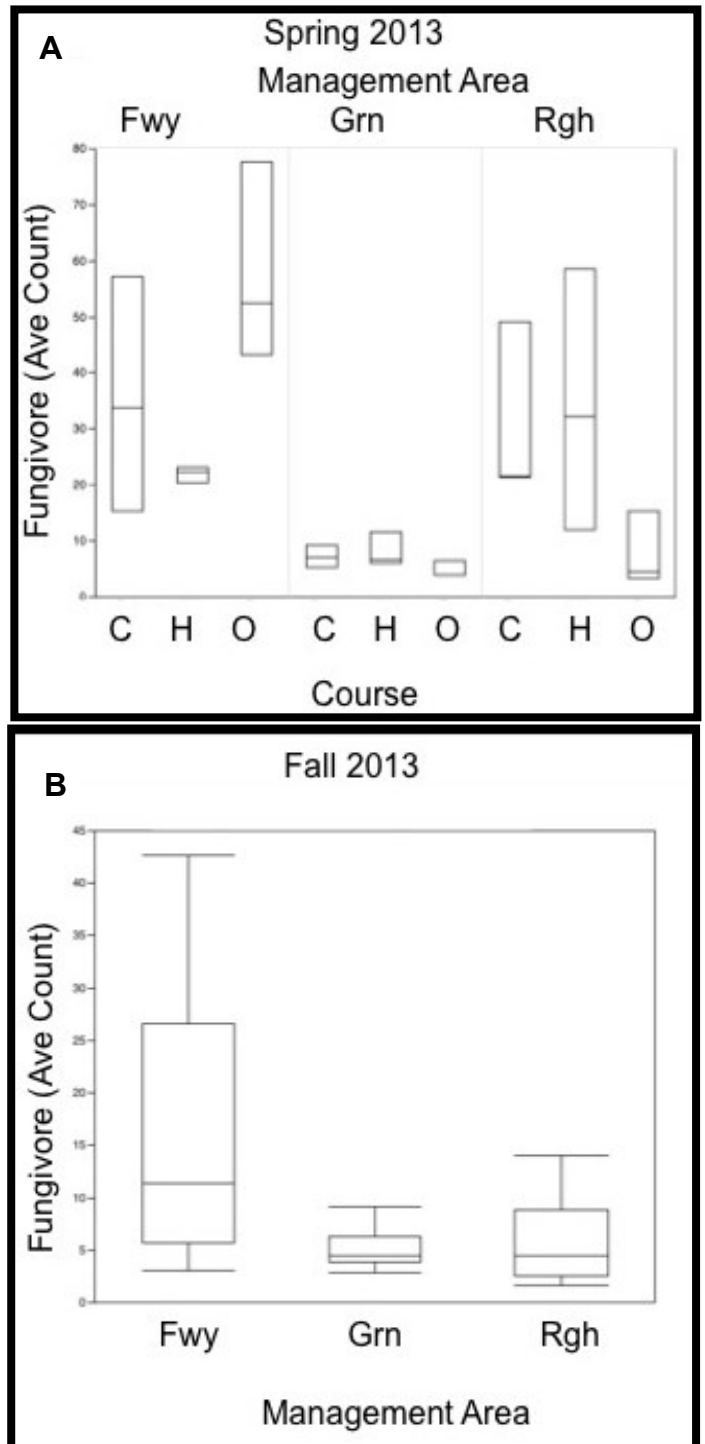


Figure 1. Fungivore nematode average counts A. among management areas ($p=0.0004$) and courses (NS) with a significant interaction between the effects ($p=0.0055$) in the Spring of 2013 and B. among management areas ($p=0.0313$) in Fall 2013 (courses and interaction effects were not significant). Fwy=fairway, Grn=putting green, Rgh=rough C=conventional, H=hybrid, and O=organic.

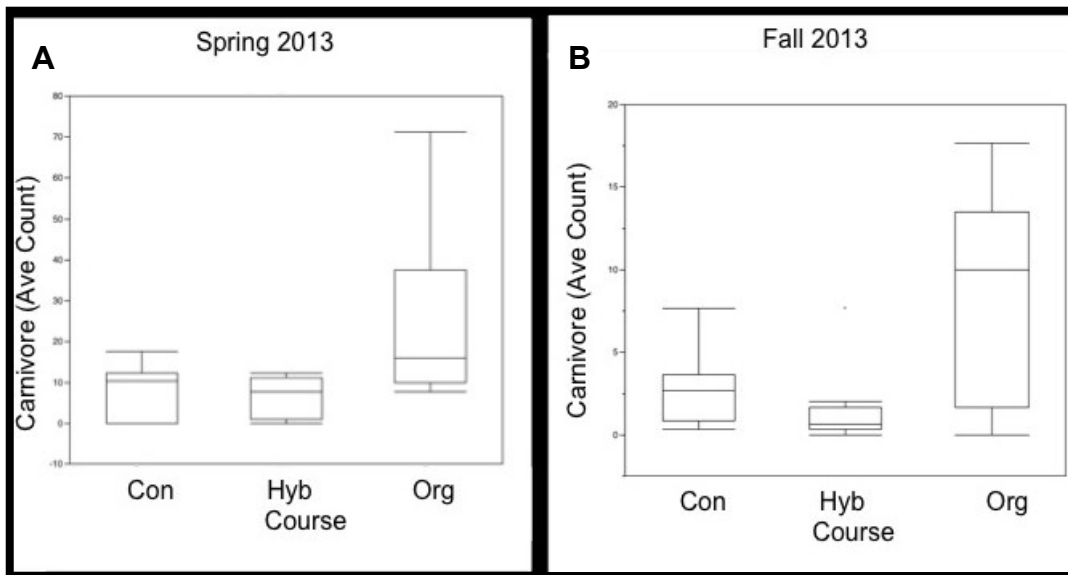


Figure 2. Carnivore nematode average counts among golf courses. A. Spring 2013 ($p=0.0040$) and B. Fall 2013 ($p=0.0016$). Con=conventional, Hyb=hybrid, and Org=organic.

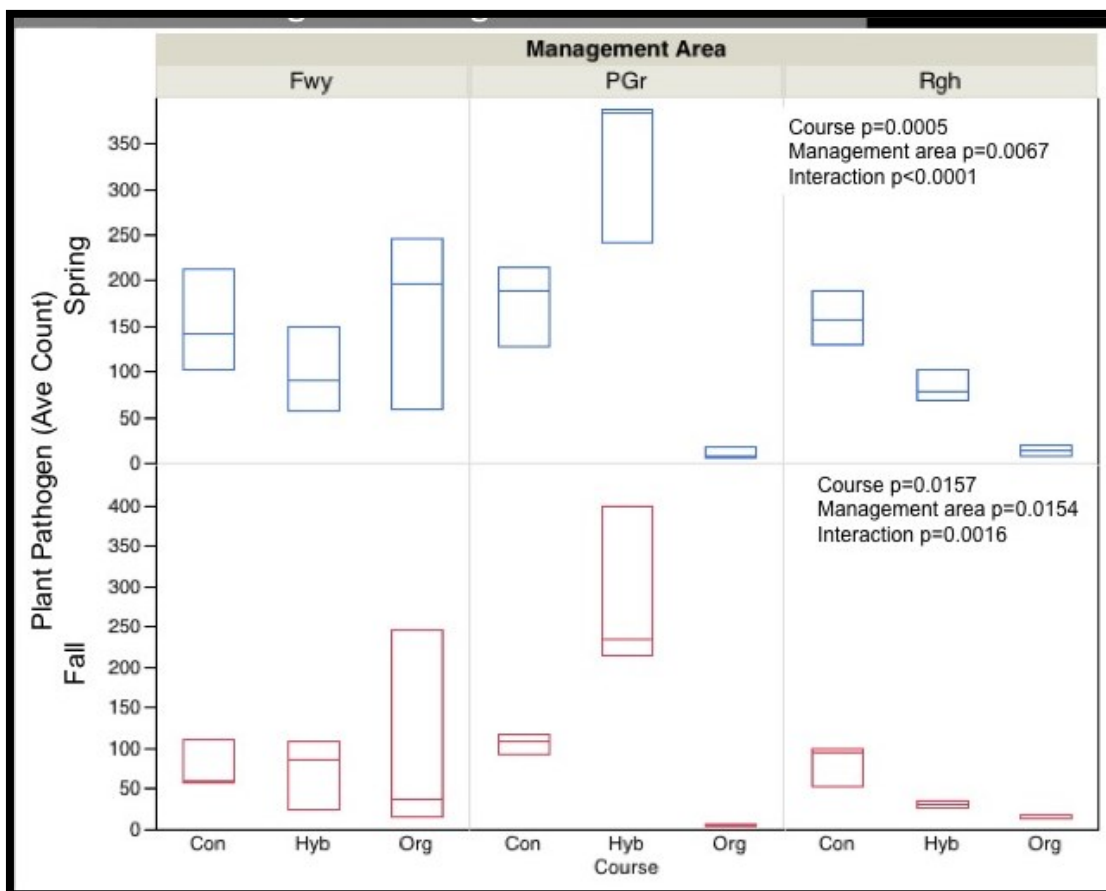


Figure 3. Plant pathogenic nematode average counts in the Spring and Fall of 2013. Fwy=fairway, PGr=putting green, Rgh=rough, Con=conventional, Hyb=hybrid, and Org=organic.

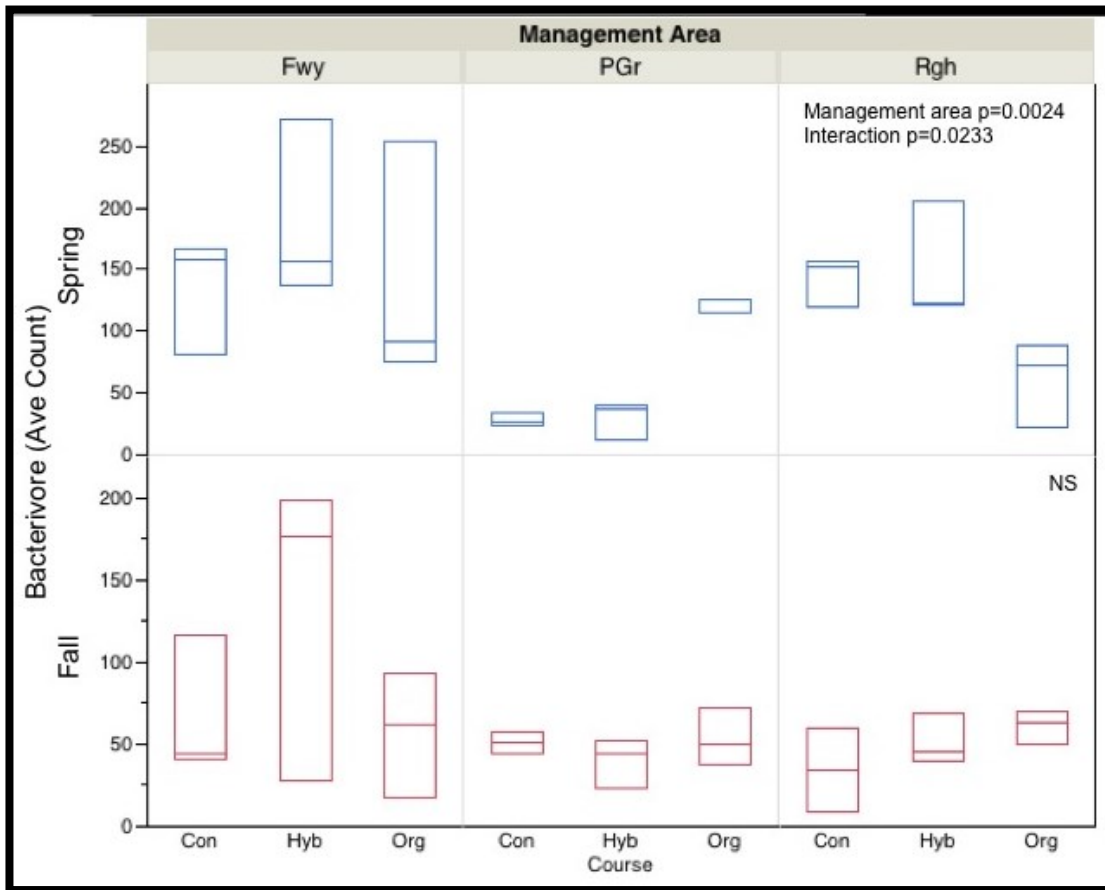


Figure 4. Bacteriophage nematode average counts in the Spring and Fall of 2013. Fwy=fairway, PGr=putting green, Rgh=rough, Con=conventional, Hyb=hybrid, and Org=organic.

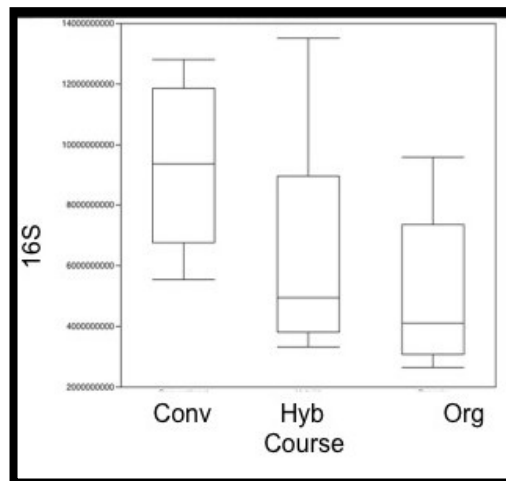


Figure 5. Bacterial abundance (16S) among courses (p=0.0019). There were no significant differences among management areas. Conv=conventional, Hyb=hybrid, and Org=organic.

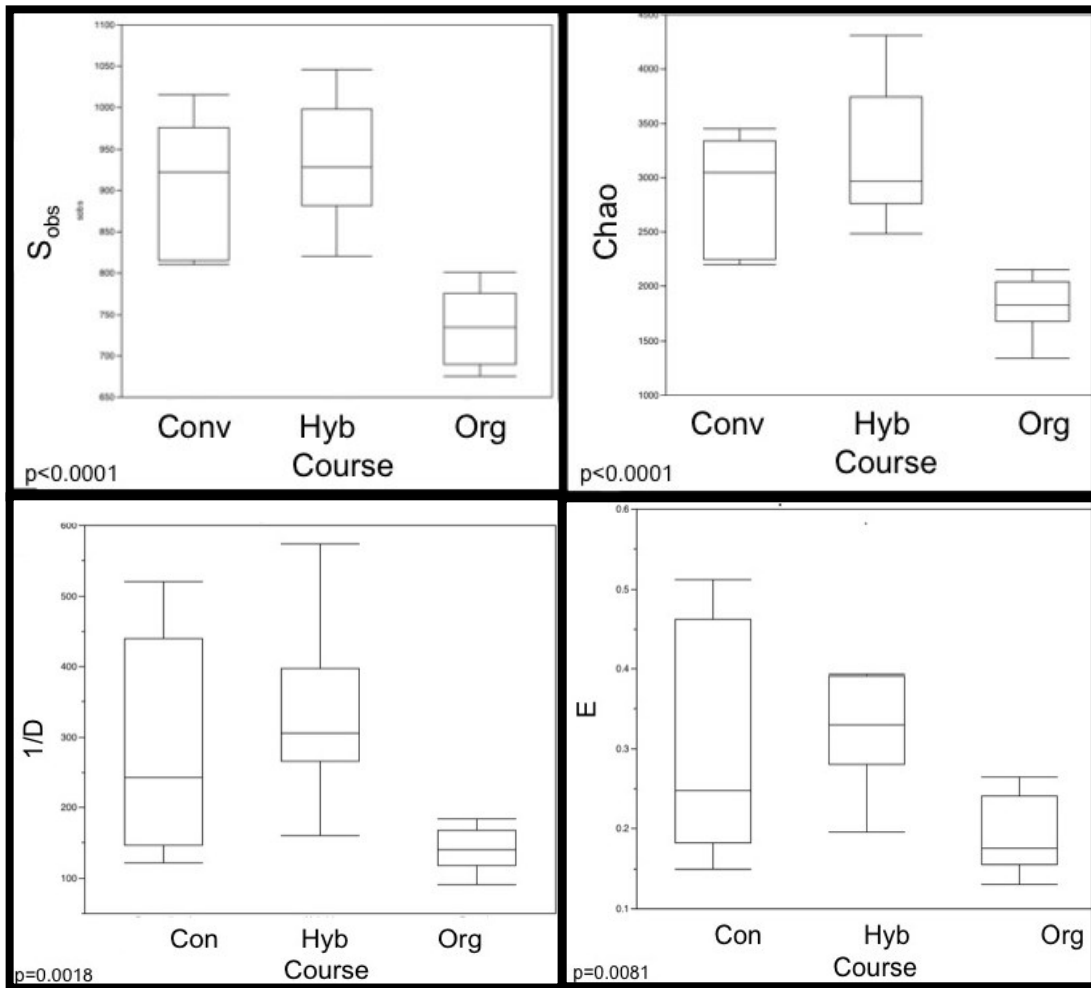


Figure 6. Bacteria alpha diversity among golf courses (there were no significant differences among management areas). A. Number of observed species, B. Chao estimated of species richness, C. Simpson's Inverse Diversity Estimate, and D. Simpson's Species Evenness Estimate. Con=conventional, Hyb=hybrid, Org=organic.

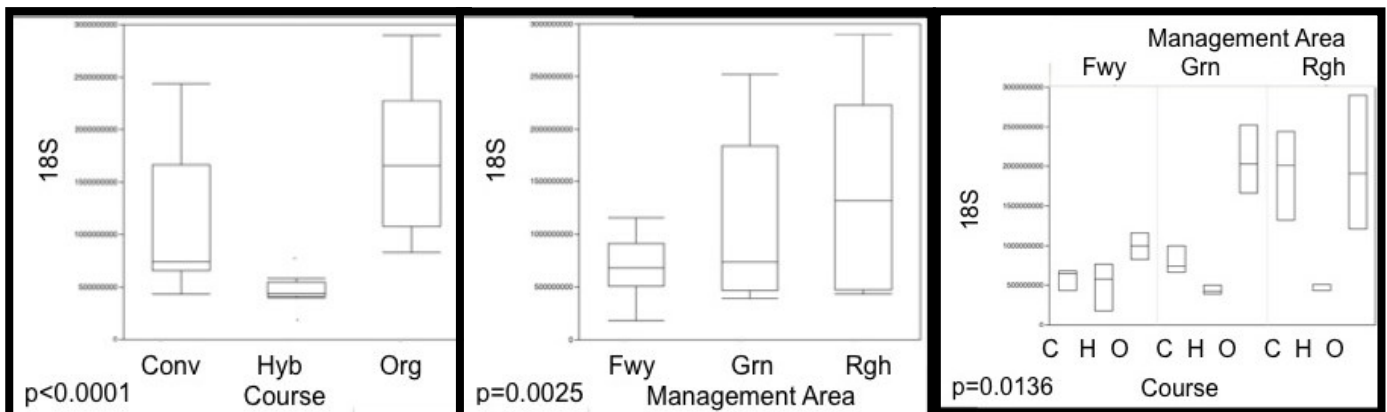


Figure 7. Plant pathogenic nematode average counts in the Spring and Fall of 2013. Fwy=fairway, PGr=putting green, Rgh=rough, Con=conventional, Hyb=hybrid, and Org=organic.

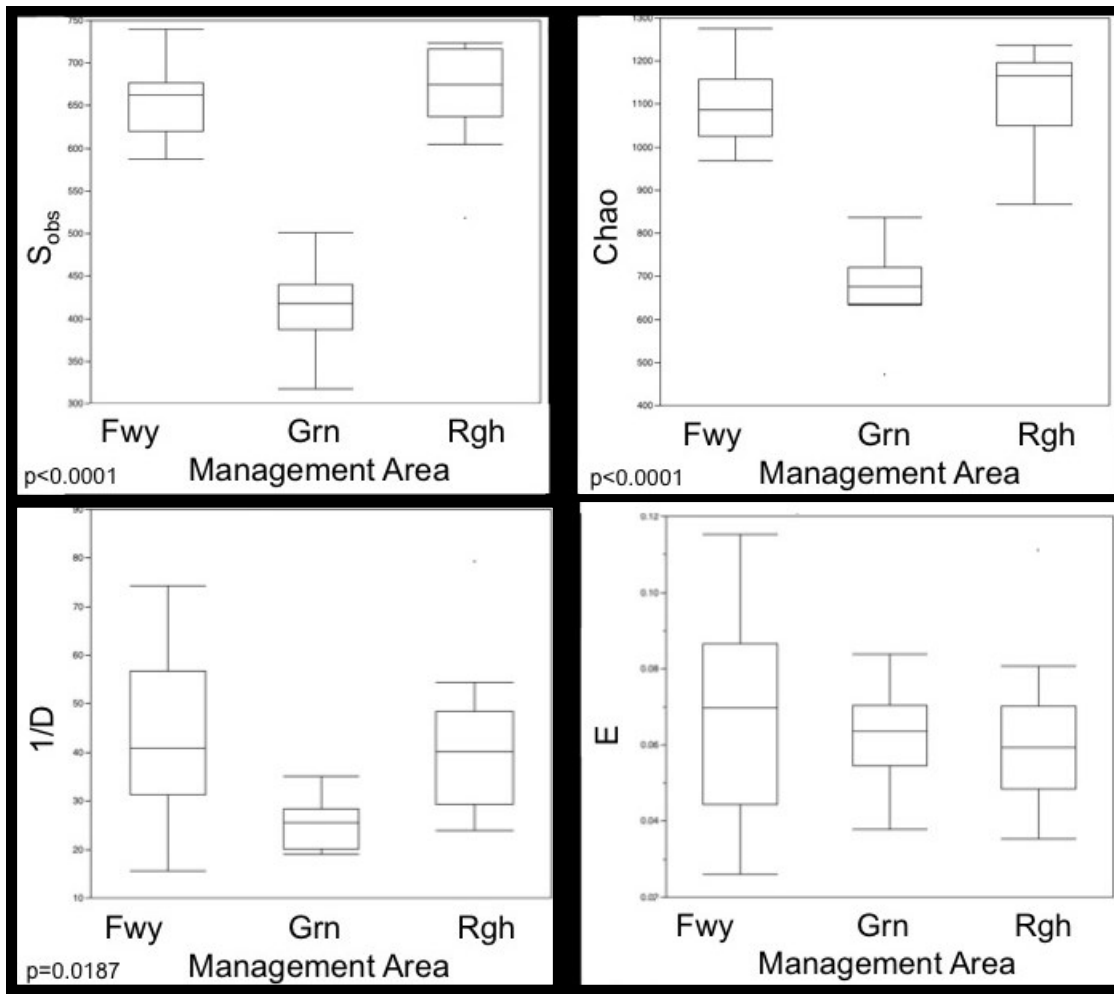


Figure 8. Fungi alpha diversity among management areas (there were no significant differences among golf courses). A. Number of observed species, B. Chao estimated of species richness, C. Simpson’s Inverse Diversity Estimate, and D. Simpson’s Species Evenness Estimate. Fwy=fairway, Grn=putting green, and Rgh=rough.

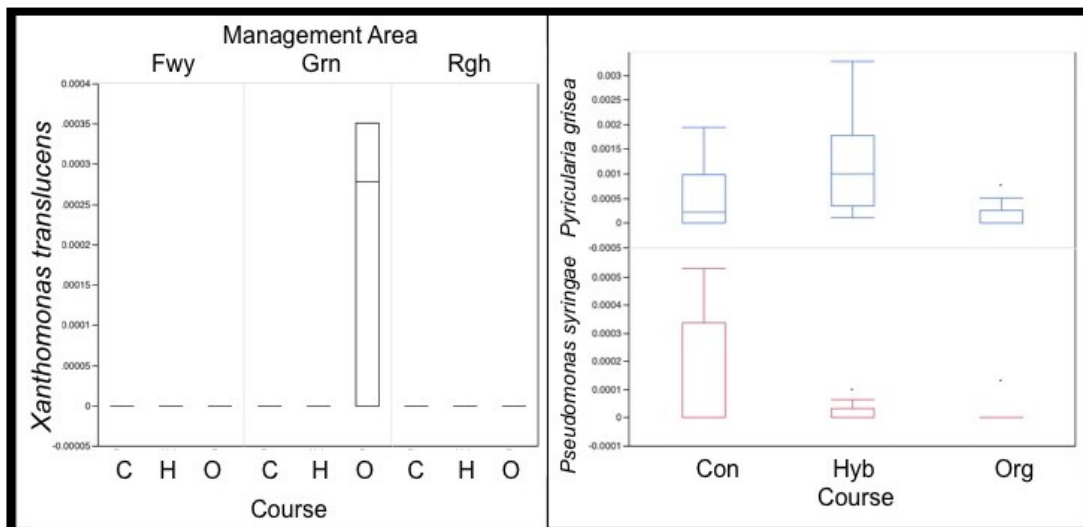


Figure 9. Significantly different relative abundances of turf pathogens (label A, B, C on the figures) A. *Xanthomonas translucens* (course at $p=0.0407$, management area at $p=0.0407$) and B. *Pyricularia grisea* (course at $p=0.0235$) and C. *Pseudomonas syringae* (course at $p=0.0166$). Con or C=conventional, Hyb or H=hybrid, Org or O=organic, Fwy=fairway, Grn=putting green, and Rgh=rough.