Section IV
Cereal Crop Pests

neotyphodium fungi

ENDOPHYTE DIVERSITY IN TALL FESCUE AND RESISTANCE TO BIRD CHERRY – OAT APHID

L. R. Elberson and S.L. Clement
USDA-ARS, Plant Germplasm Introduction and Testing Research Unit, Washington State University, Pullman, Washington 99164-6402
509/335-3609
elberson@mail.wsu.edu

Many grasses of the subfamily Pooidae are inhabited by asymptomatic endophytic fungi (Clay 1988, Leuchtmann 1992). Asexual systemic endophytes infest tall fescue, *Festuca arundinacea* Schreber, by intercellular growth of hyphae in stem and leaf sheath tissue (Bacon and Seigel 1988). The tall fescue endophyte was originally thought to be the asexual anamorph of *Epichloe typhana* (Pers.) Tul., but was determined to be another genus and is now called *Neotyphodium coenophialum* Glenn, Bacon, and Hanlin (formerly *Acremonium*) (Morgan-Jones and Gams 1982, Glenn et al. 1996). Maternal transmission of the fungus is vertical by growth of hyphae into developing ovules and seeds. The presence of endophytic fungi was linked with mammalian toxicity in the 1960s (Ball et al. 1993) and insect resistance in the 1980s (Clement et al. 1994). This toxicity and resistance to insects is the result of the fungus or the grass-fungus interaction producing alkaloids (Clay 1988). Presently, over 40 insect species are known to be adversely affected by the presence of *Neotyphodium* in fescue and ryegrass species (Clement et al. 1994, Saikkonen et al. 1998). However, presence of the endophyte does not confer resistance in all cases.

In a survey of tall fescue grass accessions from Morocco, Tunisia, and Italy, Clement et al. (2001) revealed the presence of diverse *Neotyphodium* fungi through isolation, conidial measurement and differential survival of *Rhopalosiphum padi* (bird cherry-oat aphid). Results of Morocco and Sardinia tall fescue and *R. padi* bioassays found resistance in all endophyte infected accessions. However, endophyte infected tall fescue from Tunisia exhibited both resistance and susceptibility to *R. padi*. We examined this phenomenon further by expanding the bioassays to 17 infected tall fescue accessions from Tunisia. Our results indicate wide variability in these accessions for resistance and susceptibility to *R. padi* (Fig. 1).

Metabolites from Neotyphodium, perennial forms are the most toxic to insects

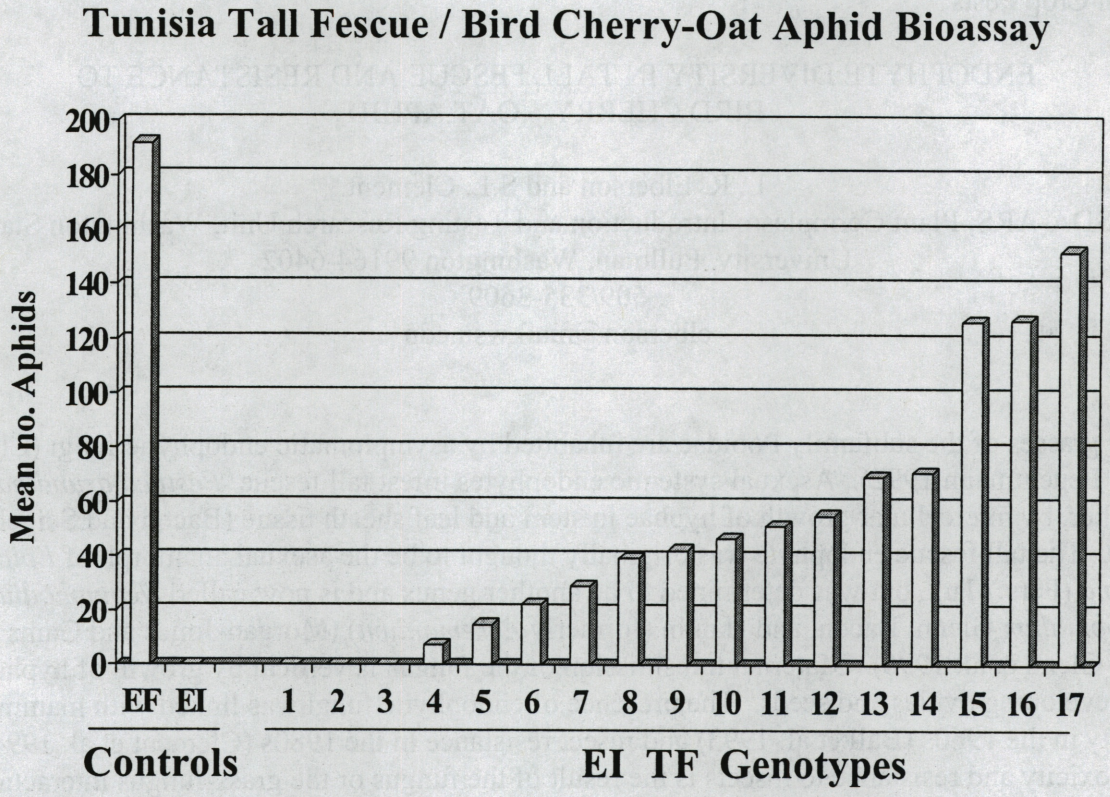

Figure 1. Mean number of bird cherry-oat aphids colonizing endophyte infected (EI) Tunisia tall fescue (TF) accessions 10 days post-infestation. Endophyte infection in experimental plants (clones of plants from original seed) was confirmed by isolation on agar.

The diversity revealed in this study of *Neotyphodium*/tall fescue/*R. padi* interaction is not unique. Alkaloids produced by grass endophytes in culture and within plants vary in the type and amount. Production of alkaloids is influenced by a complex of factors, i.e. infection rate, endophyte biotype, host biotype, insect pest-host interaction, environmental conditions, and nutrient availability (Bacon 1995, Leuchtmann et al. 2000).

Researchers and commercial seed companies are beginning to take advantage of the vast diversity of *Neotyphodium* species and strains that differ in their ability to produce particular alkaloids. Turf grasses infected with *Neotyphodium* have been developed and marketed for better stand persistence and insect resistance. Forage grasses are being developed for resistance

to insect pests without toxicity to mammals. The future for biotechnological manipulation of new grass-endophyte associations creates a vast potential of commercial production for specific purposes.

References:

Bacon, C.W. 1995. Toxic endophyte-infected tall fescue and range grasses: historic perspectives. Journal of Animal Science 73:861-870.

Bacon, C.W. and M.R. Siegel. 1988. Endophyte parasitism of tall fescue. Journal of Production Agriculture 1:45-55.

Ball, D.M., J.F. Pedersen, and G.D. Lacefield. 1993. The tall-fescue endophyte. American Scientist 81:370-379.

Clay, K. 1988. Fungal endophytes of grasses: a defensive mutualism between plants and fungi. Ecology 69:10-16.

Clement, S.L., L.R. Elberson, N.N. Youssef, C.M. Davitt, and R.P. Doss. 2001. Incidence and diversity of *Neotyphodium* fungal endophytes in tall fescue from Morocco, Tunisia, and Sardinia. Crop Science 41:570-576.

Clement, S.L., W.J. Kaiser, and H. Eichenseer. 1994. *Acremonium* endophytes in germplasms of major grasses and their utilization in insect resistance. P. 185-199. *In* C.W.Bacon and J.F. White, Jr. (ed.) Biotechnology of Endophytic Fungi of Grasses. CRC Press, Boca Raton, FL.

Glenn, A.E., C.W. Bacon, R. Price, and R.T. Hanlin. 1996. Molecular phylogeny of *Acremonium* and its taxonomic implications. Mycologia 88:369-383.

Leuchtmann, A., D. Schmidt, and L.P. Bush. 2000. Different levels of protective alkaloids in grasses with stroma-forming and seed-transmitted *Epichloe/Neotyphodium* endophytes. Journal of Chemical Ecology 26:1025-1036.

Leuchtmann, A. 1992. Systematics, distribution, and host specificity of grass endophytes. Natural Toxins 1:150-162.

Morgan-Jones, G., and W. Gams. 1982. Notes on Hyphomycetes. XLI. An endophyte of *Festuca arundinacea* and the anamorph of *Epichloe typhina*, new taxa in one of two new sections of *Acremonium*. Mycotaxon 15:311-318.

Saikkonen, K., S.H. Faeth, M. Helander, and T.J. Sullivan. 1998. Fungal endophytes: a continuum of interactions with host plants. Annual Review of Ecology and Systematics 29:319-343.