SOIL WATER MANAGEMENT AND FUSARIUM ROOT ROT IN EASTERN WHITE PINE SEEDLINGS

J. Juzwik[1], D. J. Rugg[1], P. J. Menes[2], and K.R. Cease[1].
[1]USDA Forest Service, North Central Forest Experiment Station, St. Paul, MN, USA,
[2]Ontario Forest Research Institute, Ministry of Natural Resources, Sault Ste. Marie, Ontario, Canada.

Root rot has been observed in various ages of eastern white pine seedlings (*Pinus strobus*) and transplants in bare-root forest nurseries in the north central states of the USA and Ontario, Canada, for many years. Levels of mortality have varied annually, but significant losses have occurred periodically through the years in non-fumigated fields and fields fumigated with methyl bromide-chloropicrin, dazomet, or metam sodium. At least three different genera of fungi (*Fusarium*, *Cylindrocladium*, *Cylindrocarpon*) have been associated with the disease in Michigan, Ontario, and Wisconsin nurseries. Field and controlled environment studies were conducted between 1989-94 to determine the effect of soil moisture extremes on severity of root rot in white pine, with particular emphasis on *Fusarium*-caused rot.

Field Studies. Mortality and root disease severity were monitored during the second growing season in two fields with loamy sand soils at a southern Wisconsin state nursery and a southeastern Ontario provincial nursery. Soil moisture and plant moisture stress levels were also monitored in the same fields. Spatial trends in mortality and disease severity were observed in both fields. Systematically placed plots in the outer two beds in the Wisconsin methyl bromide - chloropicrin fumigated field had higher mortality than the other beds, and had higher disease severity in July and October ($P<0.05$). Mean daily soil matric potentials (smp) were determined throughout the growing season. Differences in mean monthly readings among the plots were observed for June, July, and August. Plot soils in the outer two beds were saturated (smp > -0.25 bars) for a significantly greater number of days than those in the inner two beds. Conversely, soils in the inner beds were drier (smp < -0.65) for a significantly greater number of days than those in the outer beds. Preliminary regression analysis showed that higher disease incidence is positively correlated with less negative smp (wetter soils) and lower incidence with more negative smp (drier soils) over the range of soil moisture conditions encountered in the field. Plot locations in the non-fumigated Ontario field were stratified according to topographic features (low, mid-slope, and high). Cumulative mortality in the field did not differ among location type; however, higher disease severity was observed in the low areas in July and October compared to mid-slope and high areas. Analyses with soil water content data from the same plots are being conducted; regression analyses between soil moisture and disease severity are also planned.

Controlled Environment Studies. Effects of soil moisture and soil fungal treatment on disease development and severity were evaluated in one growth room and two growth chamber trials using seedlings grown in leach tube containers. In the growth room, soil moisture treatments were applied to 7 week old seedlings for 33 days: saturated = watered when soil moisture content (smc) reached 17%; field capacity = watered when smc was approximately 11%; and dry = watered when smc reached 5%. Soil fungal treatments were: 1) non-pasteurized field soil with naturally occurring *Fusarium* spp. populations, 2) pasteurized field soil to which dry inoculum of *Fusarium oxysporum* f.sp. *pini* was added, and 3) pasteurized field soil. Higher disease severity levels were found in saturated and dry treatments compared to field capacity in all soil treatments ($P=0.009$). There was also a significant effect of soil fungal treatment on disease severity ($P=0.049$).

The growth chamber trials included three soil moisture treatments and five soil fungal treatments. Seedlings were grown with pasteurized soil that was infested with propagules of pathogenic isolates of *Fusarium oxysporum* f.sp. *pini*, *F. oxysporum* var. *redolens*, *F. solani*, or *F. proliferatum*, or amended with sterile inoculum substrate (control). The soil moisture treatments were initiated when seedlings were 10 weeks old and continued for 39 days. Watering within each treatment was based on soil moisture endpoints as described for the previous trial (saturated: 6-7%, field capacity: 3-4%, dry: 2%). Higher disease severity levels were again observed in saturated and dry treatments compared to field capacity in both experiments. In both experiments, disease severity for seedlings subjected to the saturated and the dry treatments was similar ($P>0.45$); however, field capacity treatment resulted in lower disease severity than the dry and saturated treatments ($P<0.02$). A significant effect of *Fusarium* spp. soil treatment on disease severity was found for the second trial. *F. oxysporum* var. *redolens* and *F. solani* treatments yielded similar disease severity ($P=0.37$), but greater severity than the other *Fusarium* spp. and the control ($P<0.0001$).

Conclusions. Preliminary results of the Wisconsin field study suggest that soils that are saturated over a number of days during the second growing season promote greater root disease development in white pine seedlings than soils that apparently dry out fairly soon after irrigation or rainfall. Dry soil conditions experienced during the growing season did not appear to be severe or long enough to affect root rot severity. The controlled environment results showed that both saturated and dry soil conditions favored root rot development compared to field capacity conditions for a loamy sand soil. These results suggest that considerable control of white pine root rot may be achieved through soil water management practices that focus on maintaining field capacity conditions. This control may be possible even in the absence of pre-plant soil fumigation or pasteurization.