SOIL TILLAGE AND MANAGEMENT OF CONIFER ROOT ROT IN BARE-ROOT FOREST NURSERIES

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Root disease of conifer seedlings, particularly white pine, is a major disease problem in North Central bare-root forest nurseries regardless of whether soils are fumigated or not prior to crop establishment. Pathogenic soil-borne fungi and environmental conditions promoting white pine root rot have been investigated for several decades. Cultural practices, especially those involving soil management or treatment, are important in managing root diseases. Practices that influence the occurrence and level of root disease include tillage, soil water management, mulching, sowing of infested seed, fertilization, and fumigation. Tillage implements may produce compacted soil layers that impede internal drainage in a soil profile. Prolonged periods of wet soil conditions may then promote root rot development. Incorporation of cover crops or other organic amendments by tillage implements determines the depth and placement of such material and may lead to build-up of soil-borne pathogen populations. Surface mulch material may also affect populations near the soil surface by providing substrate for microorganism growth. Soil characteristics such as texture, penetration resistance, and pH are also important factors in managing root disease. A survey of pine fields at three North Central U.S. forest nurseries was conducted in 1994 and 1995 to characterize the fields according to selected soil properties, cultural practices, and *Fusarium* spp. and *Pythium* spp. populations. Correlation between these variables and historical and current root disease occurrence were then examined. Preliminary results are reported here.

One 2+0 red pine and one 2+0 white pine field at two nurseries (Minnesota and Wisconsin) and one 2+0 red pine field in a third nursery (Michigan) were studied. Tillage pans were found in the Minnesota and Wisconsin nursery fields based on cone penetrometer measurements; none were evident in the Michigan field (Figure 1). Pan occurrence and depth reflected different tillage implements used at the nurseries. Rotary tiller-induced pans at approximately 10 to 15 cm depth were formed after only one or two tillage events that occurred just prior to establishment of the conifer crop but after sub-soiling had been performed. Depending on the severity of the compaction, water infiltration may be hindered and the resultant condition may ultimately contribute to higher disease severity in areas of the fields where such compaction occurs. Current research is determining infiltration (or hydraulic conductivity, K_{sat}) for similar compacted areas in fields at two of the nurseries. Vertical distribution profiles of soil-borne *Fusarium* spp. at each nursery reflected the type of tillage implement used to incorporate cover crop material, which ultimately served as substrate for fungal population increase (Figure 2). For example, the steadily declining *Fusarium* population from 0 to 21 cm depth in the Michigan field (Figure 2E) is consistent with the decreasing concentration of incorporated cover crop material with depth when a disk is used for incorporation. Negligible levels of *Fusarium* spp. were found below the maximum depth of tillage implement disturbance in all locations, and correlated well with carbon distribution data.

In summary, compacted soil layers were formed by rotary tiller operation(s) conducted after sub-soiling had been completed in two nurseries. If such rotary tiller pans are found to significantly affect water infiltration, tillage conducted just prior to conifer crop establishment should be altered to eliminate or minimize pan formation within the seedling root zone. Secondly, the type of implement used to incoporate cover crops affected vertical distribution of crop residue which in turn affected populations of soil-borne microorganisms, such as plant pathogenic fungi. Shallower, more even residue distribution would be desirable in fields scheduled for chemical fumigation. Conversely, deeper burial of substrate may be advantageous in fields for which fumigation is not planned.

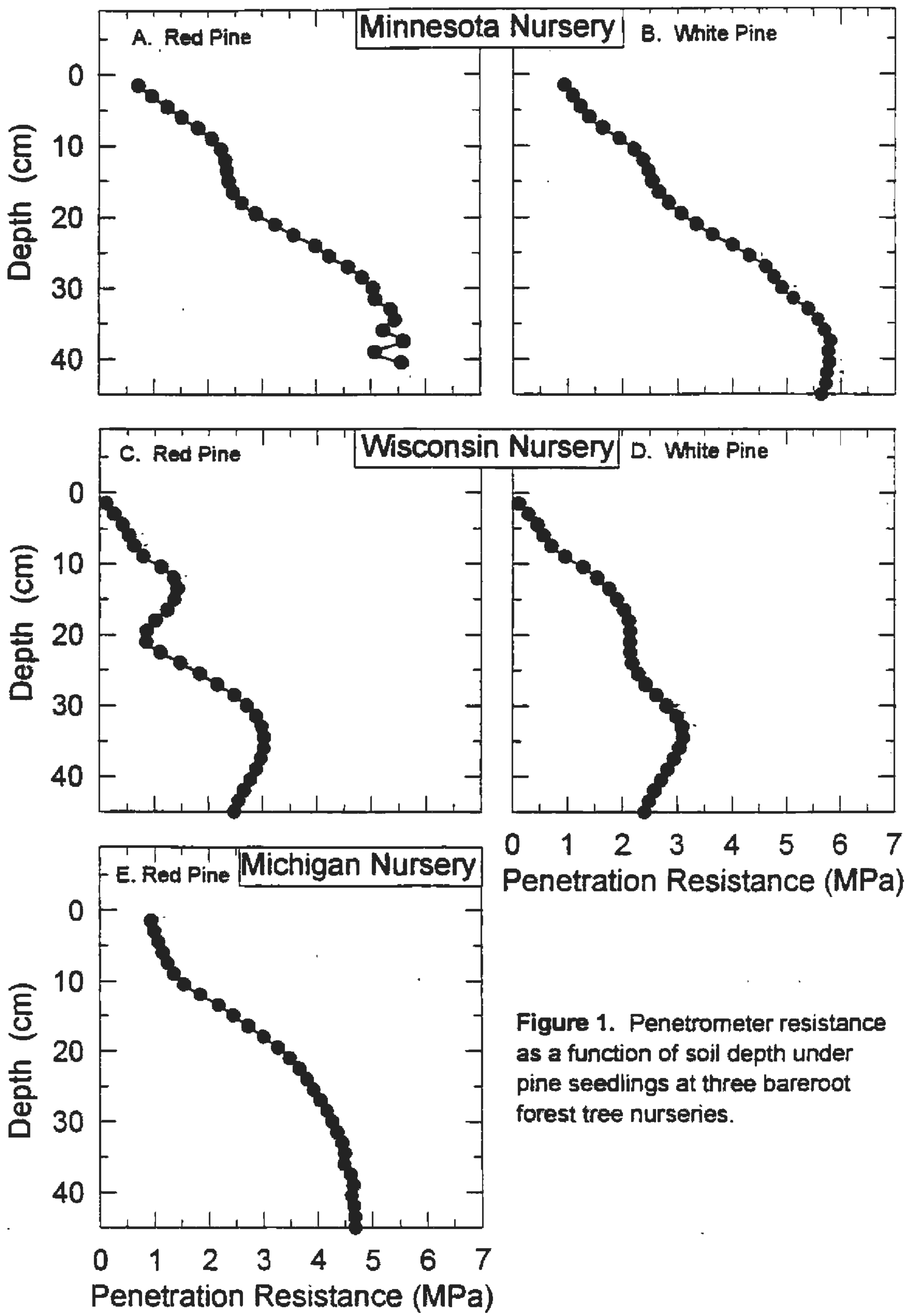

Figure 1. Penetrometer resistance as a function of soil depth under pine seedlings at three bareroot forest tree nurseries.

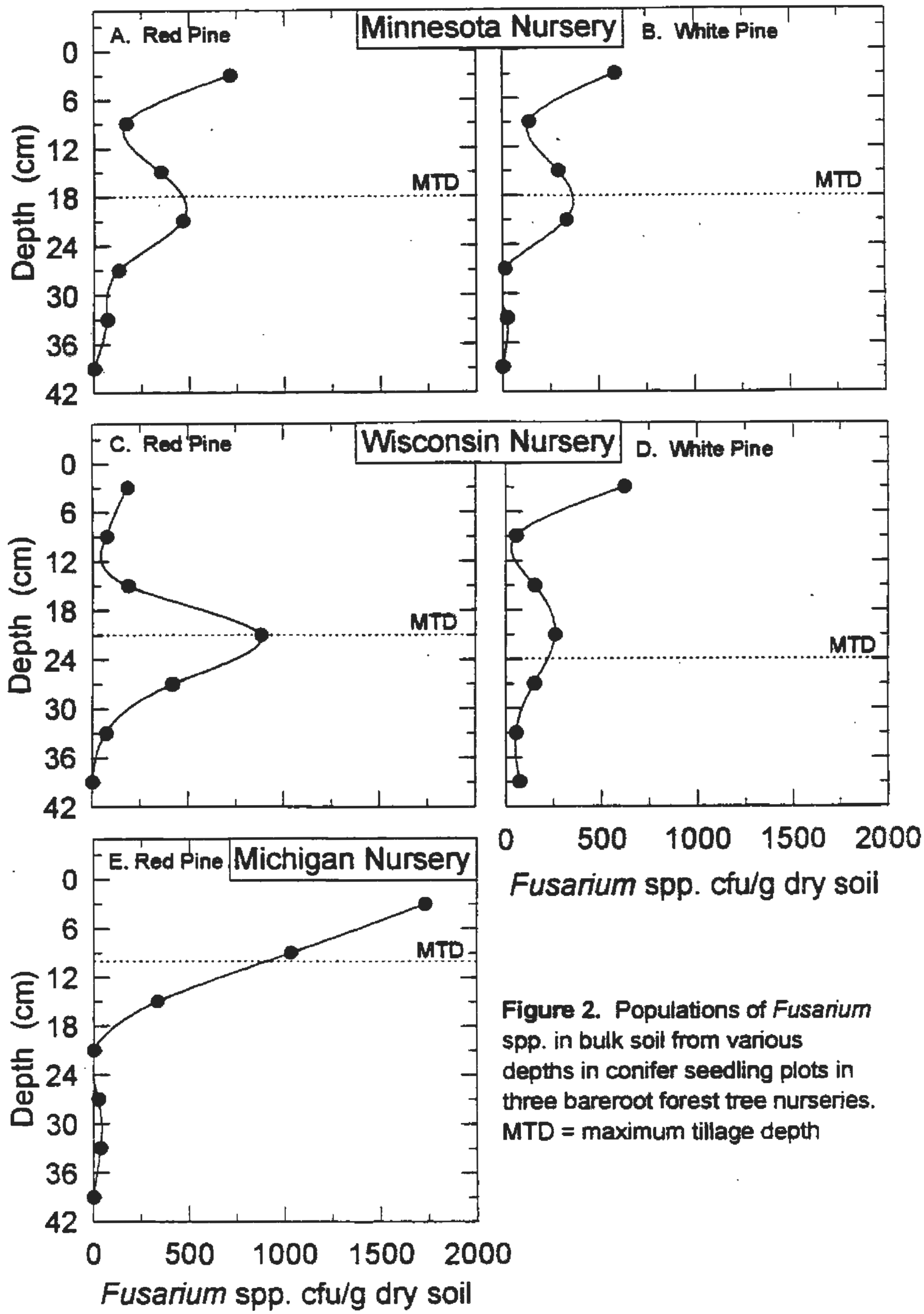

Figure 2. Populations of *Fusarium* spp. in bulk soil from various depths in conifer seedling plots in three bareroot forest tree nurseries. MTD = maximum tillage depth