

TSUGA CHINENSIS AS A SOURCE OF HOST RESISTANCE TO THE HEMLOCK WOOLLY ADELGID

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ABSTRACT

The eastern North American native hemlock species, *T. canadensis* [L.] Carrière and *T. caroliniana* Engelm., are highly susceptible to injury from the hemlock woolly adelgid (HWA), while the Asian species, *T. chinensis* (Franch.) E. Pritz., *T. diversifolia* (Maxim.) Mast., and *T. sieboldii* Carrière, are reported to show more tolerance (McClure 1992, 1995). In western North America, the adelgid is not considered a pest problem, although it has been documented on the two native species, *T. mertensiana* (Bong.) Carrière and *T. heterophylla* (Raf.) Sarg. since the early 1900s. In Japan and China, HWA appears to be a relatively minor pest of *T. chinensis*, *T. diversifolia*, and *T. sieboldii* whose impact is limited by natural enemies, host resistance, and scattered distribution (McClure 1996, 1995, 1992, Montgomery 1999).

In the eastern U.S., resistance or tolerance by Asian species, most especially *T. chinensis*, has been supported by observation. No adelgids have been observed on the few *T. chinensis* and *T. diversifolia* at the U.S. National Arboretum for more than 10 years, although HWA infested trees are located in close proximity. At the Morris Arboretum in Philadelphia, adelgid has been observed on *T. diversifolia* but not on *T. chinensis* and recent plantings of *T. chinensis* at the Morris Arboretum are also thriving (M. Montgomery, personal communication). Similar occurrences were found at arboreta on the east coast of the United States in the early 1990s (R.J. Lewandowski, unpublished survey, personal communication). Recent research at the Arnold Arboretum examined tolerance to HWA and

growth of *T. chinensis*. *T. chinensis* seedlings planted in a heavily HWA infested stand of *T. canadensis* were found to be completely free of HWA egg sacs and producing abundant new shoot growth in number and length after 4 years of exposure to HWA (Del Tredici and Kitajima 2004). For its resistance, plus shade tolerance and hardiness in USDA Zone 6, the authors found *T. chinensis* a suitable landscape alternative to *T. canadensis*.

The U.S. National Arboretum initiated a breeding program in the early 1990s to assess the potential for controlled hybridization among different hemlock species utilizing both susceptible eastern species and the Asian species *T. chinensis*, *T. diversifolia* and *T. sieboldii*. Attempts to hybridize *T. canadensis* with three Asiatic species were unsuccessful. However, more than 50 authentic hybrids from crosses between *T. caroliniana* and *T. chinensis* were identified by DNA fingerprinting. Hybrids were also identified from crosses between the *T. caroliniana* and *T. chinensis* and between the Asiatic species, *T. chinensis*, *T. diversifolia* and *T. sieboldii*. In 2002, the parents, their hybrids, and self-pollinated progeny were planted in a randomized block design at the USDA's South Farm, Beltsville, MD. Beginning in 2004, data collection began on important horticultural attributes of each tree including survival, growth rate, form, phenology, injury from cold, heat or pests, and evidence of natural adelgid infestation. Plants will be evaluated for adelgid resistance by artificial inoculation and data will be collected for such factors as plant growth,

adelgid survival, number of ovisacs produced, number of eggs/ovisac, number of crawlers, and feeding injury. The research will be in cooperation with Michael E. Montgomery, USDA Forest Service, Center for Forest Health Research, Hamden, CT. The degree to which resistance, if observed, may be transferred from the Asian species into hybrid offspring, especially hybrids with the eastern North American species, will be of particular interest.

Because the Beltsville, MD location is outside the natural range of hemlock, propagation of hybrids to facilitate possible greenhouse studies of hybrids for HWA resistance and field testing in other geographic locations has also begun. Additionally, a field planting of 20 accessions of wild-collected *T. chinensis* and relatives were planted in 2004-2005 at the USDA's South Farm site. This germplasm includes accessions from two explorations to the People's Republic of China sponsored by the North American China Plant Exploration Committee (NACPEC) in 1996 and 1999. Accessions also represent regional and elevation variations which may affect the hardiness and/or suitability of *T. chinensis*. Trees in both hybrid and *T. chinensis* species plantings will be evaluated for form, hardiness, reproductive behavior and suitability for use in the forest or landscape.

Acknowledgments

This research was funded in part by USDA Forest Service Forest Health Technology Enterprise Team Agreement 11-2442-97-05 and RFP 2005 Interagency Agreement 05-IA-11242326-005.

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