

Breeding Hemlocks for Resistance to Hemlock Woolly Adelgid

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Abstract

The eastern North American native hemlock species, *Tsuga canadensis* and *T. caroliniana*, 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* Carriere 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* and *T. heterophylla*, since the early 1900s.

In Japan and China, HWA appears to be a relatively minor pest of *T. diversifolia*, *T. sieboldii*, and *T. chinensis*, whose impact is limited by natural enemies, host resistance, and scattered distribution (McClure 1992, 1995, 1996; Montgomery 1999). In a comparison of HWA performance on and damage to the four North American species and one Asian species, *T. diversifolia*, McClure (1992) reported dramatically greater HWA survival, egg laying, and hemlock bud kill on the two eastern species. Hemlock bud kill was greater than 80% on *T. canadensis* and *T. caroliniana*; it was 1% or less on the western and Asian species.

No adelgids have been observed on the few *T. chinensis* and *T. diversifolia* at the U.S. National Arboretum (USNA) in the past 10 years although HWA-infested trees are located in close proximity. At the Morris Arboretum in Philadelphia, Pennsylvania, adelgid has been observed on *T. diversifolia* but not on *T. chinensis*. Infestations and damage on *T. sieboldii* at USNA, Glenn Dale, Maryland, and Morris Arboretum have ranged from none to severe. Similar occurrences were found at arboreta on the East Coast of the United States in the early 1990s (R.J. Lewandowski, personal communication).

The USNA has initiated a breeding program 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*. From controlled pollinations between the five species, more than 5,000 seedlings were germinated. A selected number of putative hybrids from each cross were tested for authenticity by DNA fingerprinting. 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. Crosses between the Asiatic species also were successful. A single hybrid between *T. caroliniana* and *T. canadensis* was identified. Selfing was

demonstrated in all species. Documented hybrids and parent species will be planted in field trials and evaluated for adelgid resistance and the degree to which resistance may be transferred from the Asian species into hybrid offspring, especially hybrids with the eastern North American species. Plants will be evaluated for form, hardiness, and also for suitability for landscape use. Future plans may include greenhouse studies of hybrids for HWA resistance and evaluation of *T. chinensis* germplasm collected in China.

Keywords:

Breeding program, resistance, susceptible species, *Tsugae*.

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