

# The Effect of Hemlock Woolly Adelgid Infestation on Water Relations of Carolina and Eastern Hemlock

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## Abstract

In North America, hemlock woolly adelgid (HWA; *Adelges tsugae*) is an exotic insect pest from Asia that is causing rapid decline of native eastern hemlock (*Tsuga canadensis* (L.) Carr.) and Carolina hemlock (*Tsuga caroliniana* Engelm.) populations. The exact physiological mechanisms that cause tree decline and mortality are not known, despite substantial research efforts on ecological impacts and potential control measures of HWA. Eastern and Carolina hemlock may be reacting to infestation in a manner similar to the response of Fraser fir (*Abies fraseri* (Pursh.) Poir.) to infestation by balsam woolly adelgid (BWA; *Adelges picea*). It is known that Fraser fir produces abnormal xylem in response to BWA feeding. This abnormal xylem obstructs water movement within the trees, causing Fraser fir to die of water stress.

In this study, water relations within 15 eastern and Carolina hemlock were evaluated to determine if infestation by HWA was causing water stress. Water potential, carbon-13 isotope ratio, stem conductivity, and stomatal conductance measurements were conducted on samples derived from those trees. In addition, branch samples were analyzed for possible wood anatomy alterations as a result of infestation. Pre-dawn branch water potential measurements were more negative in infested hemlock than in non-infested trees. Carbon isotope ratios of the branches were more positive for infested trees, while stomatal conductance was lower in infested trees. These results indicate that infested eastern and Carolina hemlock are experiencing drought-like symptoms. Wood anatomy of the branches provided evidence that infested hemlocks are experiencing abnormal wood production in the xylem, including lower earlywood to latewood ratios and increased frequency of false rings. The significant reduction in conducting sapwood area, terminal branch growth, and leaf area in infested trees were sufficient to influence sap flux and whole-tree water use.

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