

Determination of Drought Stress Thresholds in Nursery-Grown Evergreens Using the SAGE Gypsum Block Visual Monitoring Platform

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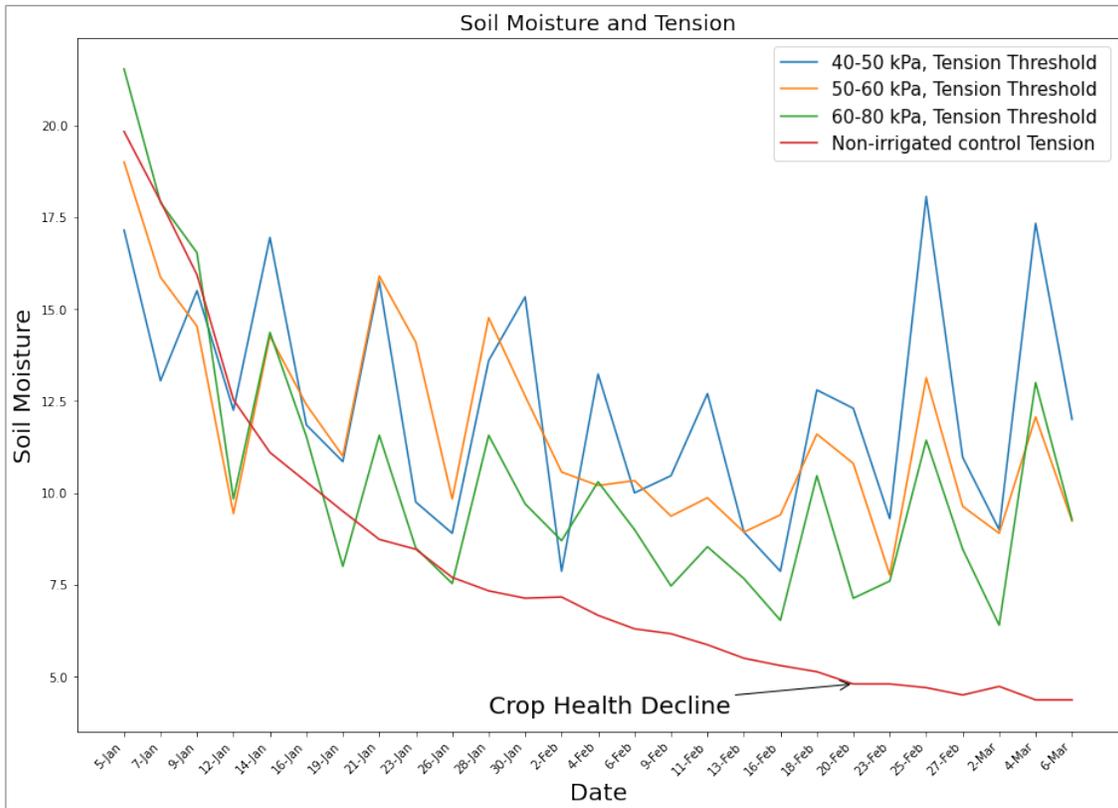
Abstract:

When conserving water, irrigation can be scheduled based on the specific needs of individual plant taxa need and determined using various tools like a time domain reflectometer (TDR)[BQ1.1], which quantifies volumetric water content (%), or tensiometers, which measure soil water tension (kPa). Identifying critical soil moisture levels is essential for maintaining pot-grown conifers such as mugo pine (*Pinus mugo*) under deficit irrigation conditions, as drought stress in these species is often not visually apparent until after the plant is already severely damaged or dead.

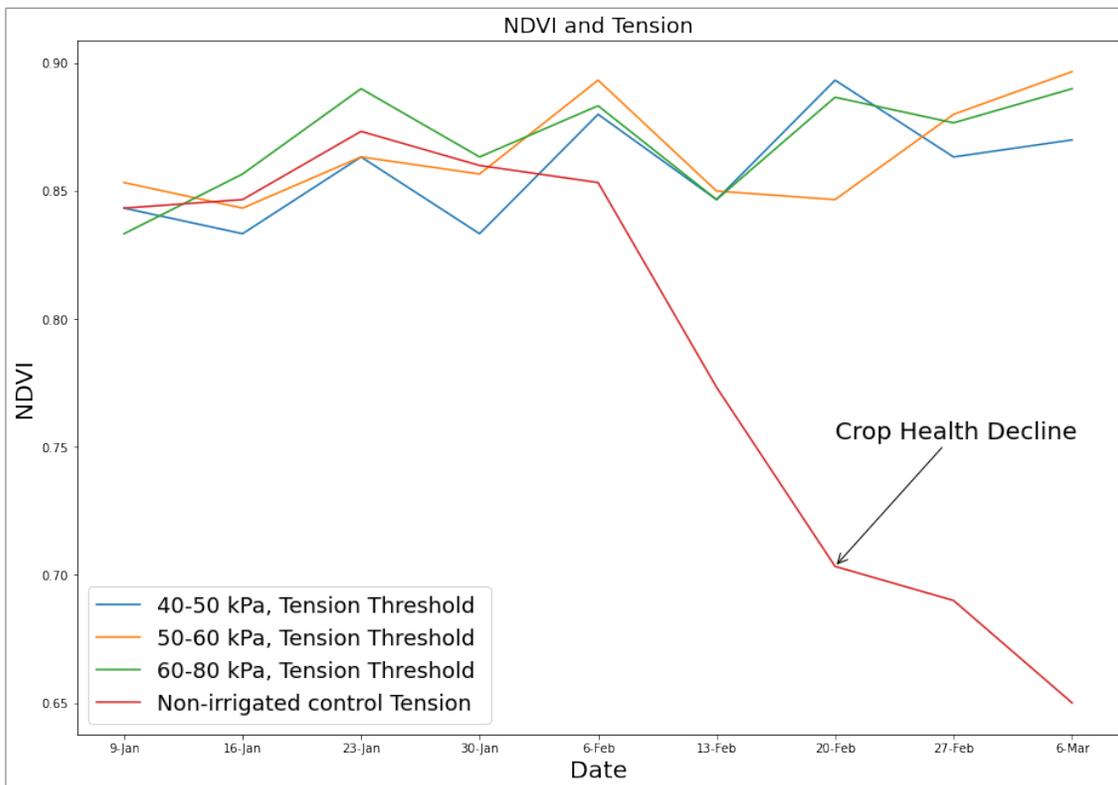
The objective of this research was to establish critical moisture thresholds for potted mugo pine using measurements of soil water tension (kPa) and volumetric water content (%). This study was conducted in a greenhouse in Corvallis, OR set to 21 °C during the day and 16 °C at night. Mugo pine plants grown in native silt loam soil were transplanted into 3-gallon pots. The experimental design was a randomized complete block with three replications.

Treatments consisted of irrigation events triggered when tensiometer readings reached the following threshold levels: 40-50, 50-60, and 60-80 kPa, along with a non-irrigated control treatment. Irrigation application rates were 3 L per pot (equivalent to approximately 5 cm water depth). Soil water tension readings were obtained using gypsum blocks connected to a SAGE visual tension system (Stevens Water Monitoring Systems Inc, Portland, OR), installed at a 8 cm depth in each pot. Beginning January 5, 2026, tension readings were recorded every Monday, Wednesday, and Friday.

Response variables included soil volumetric water content at 8 cm depth, number of irrigation events applied per pot, plant visual quality (rated on a 1- 9 scale), and normalized difference vegetation index (NDVI). As of February 27, 2026, all non-irrigated plants had died, while all other treatments remained alive. Treatments receiving irrigation, regardless of the kPa threshold level, produced very high NDVI values of 0.9 or greater (with 1.0 being the maximum possible value) and high visual quality ratings . These results suggest that irrigation triggered at 60-80 kPa or a volumetric water content of approximately 6.4 -7.5% was sufficient to sustain healthy growth of potted mugo pine.



Soil Moisture versus time measured with the HydraProbe Soil Sensor showing the three irrigation tension thresholds. The non-irrigated control reached a soil moisture of 6% on February 13th coinciding with NVDI-detected drought stress.



NDVI of the four treatments versus time. The non-irrigated control replicates first showed signs of stress on February 13th and became severely impaired on February 20th.