HYPERSPECTRAL IMAGING FOR THE PREDICTION OF FREEZE DAMAGE AND MINIMUM WINTER TEMPERATURE AT SEED SOURCE ORIGIN OF LOBLOLLY PINE SEEDLINGS

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Freeze tolerance is the most important adaptability trait for deployment of loblolly pine in the southeastern US. Minimum winter temperature (MWT) at the seed source origin is the standard indicator of cold adaptability. In this study, we investigated a novel approach for the assessment of freeze-induced damage and prediction of MWT at seed source origin using hyperspectral imaging of seedlings. A population comprising 98 seedlots from Virginia to Florida was subjected to an artificial freeze. A custom-assembled hyperspectral imaging system was used for scanning the seedlings prior to the freeze and on four subsequent occasions after the freeze. On day 44 post the freeze event, seedlings freeze damage was visually scored and the logit link function was used to model the probability of freeze damage. The hyperspectral image data comprised spectra of each seedling that were then averaged for each family, and used to develop family-level predictive models for each scanning date. A significant positive relationship (R^2 = 0.28; $p < .001$) between the family MWT and logit scores for freeze damage was observed. Prediction accuracies of freeze damage and MWT based on hyperspectral data varied among scanning dates. The highest prediction accuracy of freeze damage (R^2 = 0.79) was achieved using hyperspectral data obtained 41 days after the freeze event. The highest prediction accuracy of MWT (R^2 = 0.78) was achieved using hyperspectral data obtained prior to the freeze event. In our study, the best hyperspectral model gave predictions of MWT with a root mean squared error of 2.45 °F, which suggests sufficient precision to rate families for seed source transfer well within a 10 °F plant hardiness zone. Therefore, this research demonstrates that hyperspectral imaging has the potential to serve as a rapid, nondestructive and objective tool for the prediction of MWT of origin of loblolly pine seedlings.