Influence of DNA Herbicides and Glyphosate on Cold Hardiness During Field Overwintering

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Significance to Industry: Controlling weeds is one of the leading expenses in the nursery and landscape industry. The most commonly used method is chemical control; however, the interaction of chemicals on other cultural factors such as hardiness has not been investigated. Investigating the influence of DNA herbicides on cold hardiness during nursery field overwintering would be of immense help to nursery growers as DNA herbicides are the most commonly used in nurseries. In a study conducted at The Ohio State University, Columbus, Ohio with container-grown plants, prodiamine was found to increase regrowth rate after freezing temperatures were imposed significantly while oryzalin had no influence (Bigger and Mathers, 2005). The influence of different DNA herbicide applications on the cold hardiness of field-grown nursery plants prior to overwintering has never been studied. Much of the caliper tree production takes place in northern parts of US where plants experience severe temperature stress during winter. Knowledge of herbicides that affect cold hardiness is necessary to the economic survival of nursery and landscape industry. The objective of this study was to determine whole plant hardiness values and regrowth potentials for field grown plants receiving and not receiving herbicide treatments in spring and fall prior to overwintering.

Materials and Methods: Three species were used to evaluate the cold hardiness – Japanese tree lilac (*Syringa reticulata* 'Ivory Silk'), red maple (*Acer rubrum*), and crabapple (*Malus* 'Dolgo'). One year old plants were planted at the Waterman farm of The Ohio State University, Columbus, OH on April 26, 2006. Six field management treatments were imposed: trifluralin (2 lb ai/ac), prodiamine (2 lb ai/ac), oryzalin (2 lb ai/ac, trifluralin (2 lb ai/ac) with glyphosate (6% v/v), prodiamine (2 lb ai/ac) with glyphosate (6% v/v), and clean cultivation in the summer (July 9th) and fall (October 13th) 2006. Plants were fertilized with ammonium nitrate (42 g/tree) in June and irrigation was provided when needed. Cultivation was also performed as needed. The design of the experiment was a split plot (main plot was herbicide, subplot was species) with five replications. Plants were lifted from the field during November 2006 over a two week period. Roots were washed and placed in plastic bag and then kept in a cooler overnight at 5 °C to acclimate. The plants were then frozen to four temperatures (-5 ^{0}C, -10 ^{0}C, -15 ^{0}C and -20 ^{0}C) in an ultra low chest freezer (Forma Scientific, Inc., Marietta, OH). The ultra low chest freezer was set to lower at a rate of 5 ^{0}C/hr. Upon reaching the desired temperatures, plants were removed from the freezer and transferred into the 5 ^{0}C cooler overnight. The trees were then planted in 3.8 L pots and kept in a green house (24 °C day temperatures, 18 °C night temperatures) at OSU, Columbus, OH. Three viability methods, plant live height (regrowth), TTC analysis (Triphenyl Tetrazolium Chloride) and binomial data (dead/alive) were used to evaluate cold hardiness. TTC was performed by using the methods of Ruf and Brunner (2003).

Results and Discussion:

Most of the plants were dead at -20 ^{0}C, so only three temperatures (-5,-10,-15° C,) were taken into consideration for statistical analysis. The regrowth evaluations showed that the main effects of species (Figure1) and temperature (data not shown) and the interaction of species and temperature were significant (Figure 2) at ($p \leq 0.001$); however, no other effects were significant. *Acer* failed to regrow, possibly due to a lack of chilling units required to break dormancy (data not shown). *Syringa* showed the highest regrowth rate when compared to *Malus* in contrast to the absorbance (TTC) values. This may be attributed to the different growth habit of the species. The TTC analysis data revealed that the main effects of species (Figure 3) were significant at ($p \leq 0.001$) and the interaction of species and temperature was significant at ($p \leq 0.06$) (Figure 4). Absorbance values show that Malus is the species with greatest cold tolerance. This is also supported by binomial data based on the percentage of dead and alive plants. Dead or alive data (binomial) was taken at the end of the experiment (60 days after freezing) to run linear regression model and LD_{50} values were calculated based on the binomial data. LD_{50} values for *Syringa*, *Acer*, and *Malus* were -10.35 ^{0}C, -12.75 ^{0}C, and -15.45 ^{0}C (data not shown) respectively, across all treatments. No significant effects of herbicide treatment were found. This experiment will be re-evaluated in 2007 with different methodology for cold hardiness and regrowth evaluations.

References:

Ruf, M., and Brunner, I. 2003. Vitality of Tree Fine Roots: Reevaulation of the Tetrazolium Test. Tree Physiology. 23: Pp. 257-263.

Bigger, M.M. and H.M.Mathers. 2005. Root hardiness and the influence of DNA herbicides on overwintered containers. SNA Research conference 50:22-25

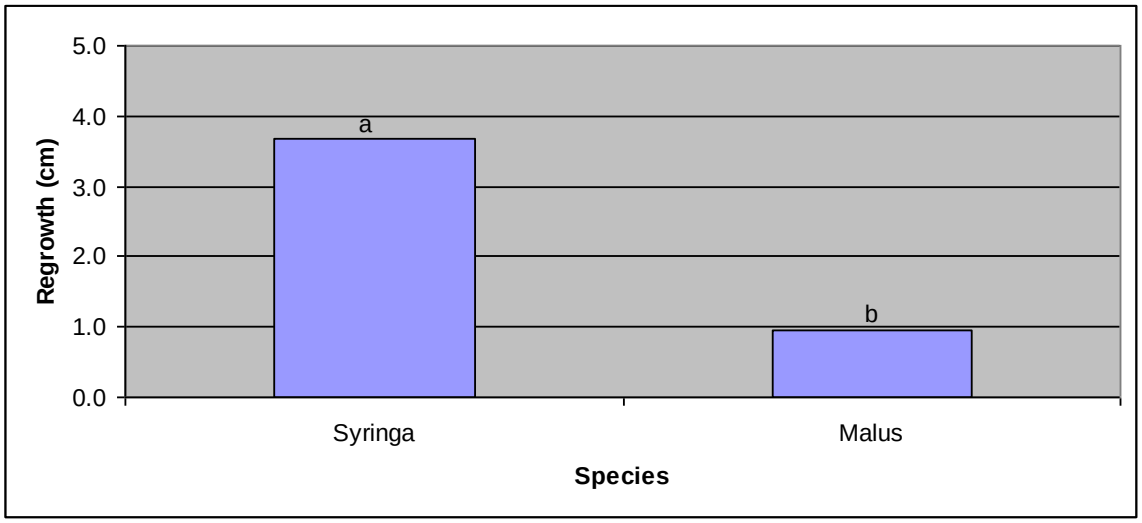

Figure1. Main effects of species on regrowth averaged over four temperatures and six treatments. Regrowth is based on mean of height before freezing to height after freezing. Different letters signify difference based on LSMeans ($\alpha = 0.05$).

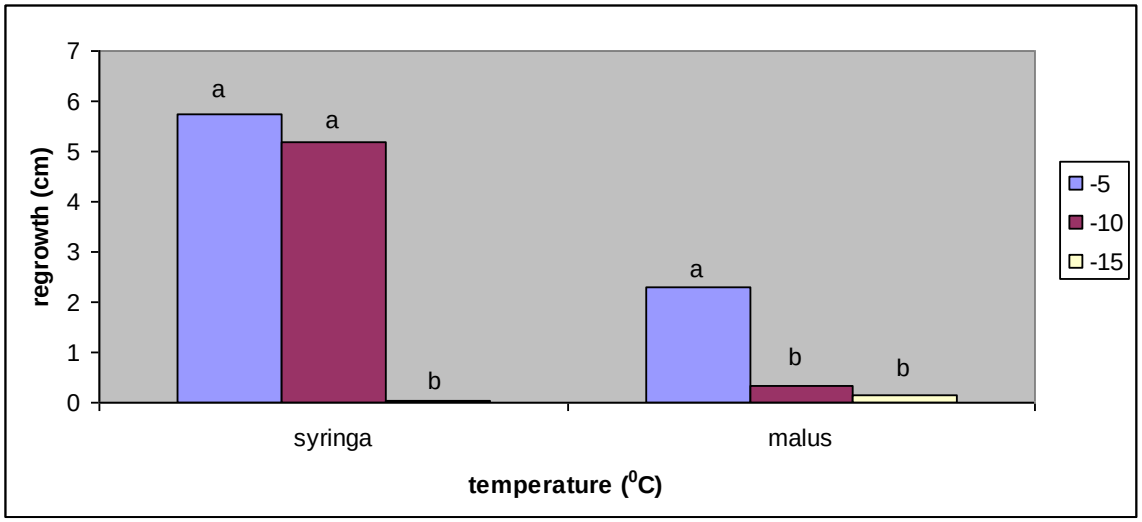

Figure 2. Species and temperature interaction across all treatments for Syringa and Malus on regrowth potential. Regrowth is based on mean of height before freezing to height after freezing. Different letters indicate significant differences within species based on LSMeans ($\alpha = 0.05$).

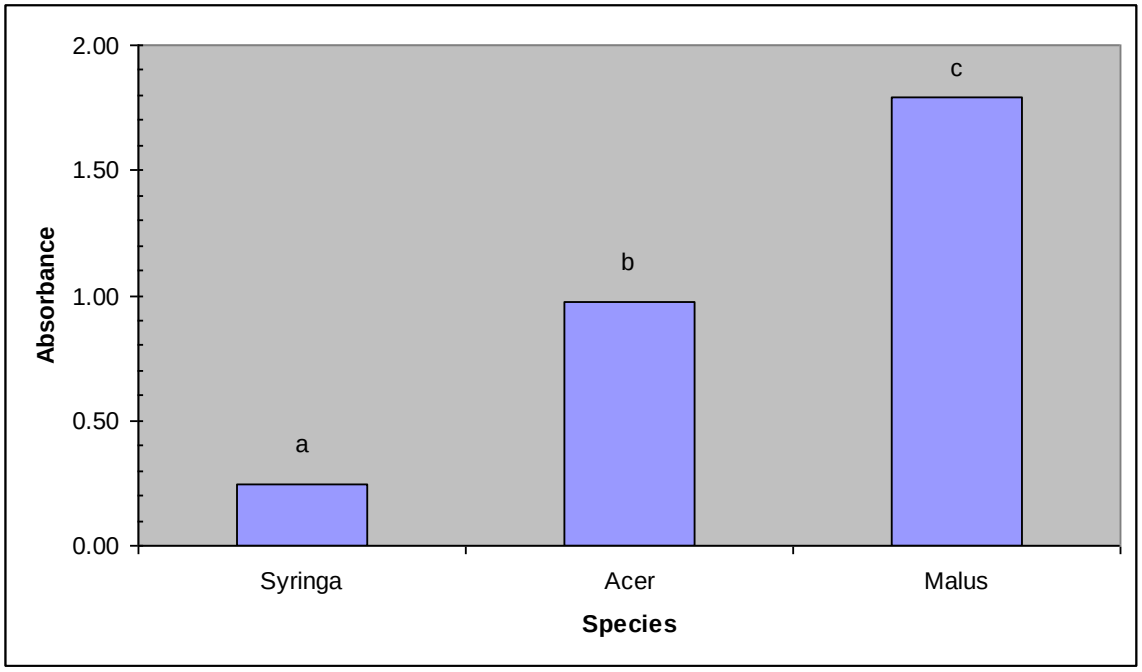

Figure 3. Main effects of species on triphenyltetrazolium chloride absorbance readings averaged over six treatments and three temperatures (-5, -10, -15 °C). Different letters indicate significant differences within species based on LSMeans ($\alpha = 0.05$).

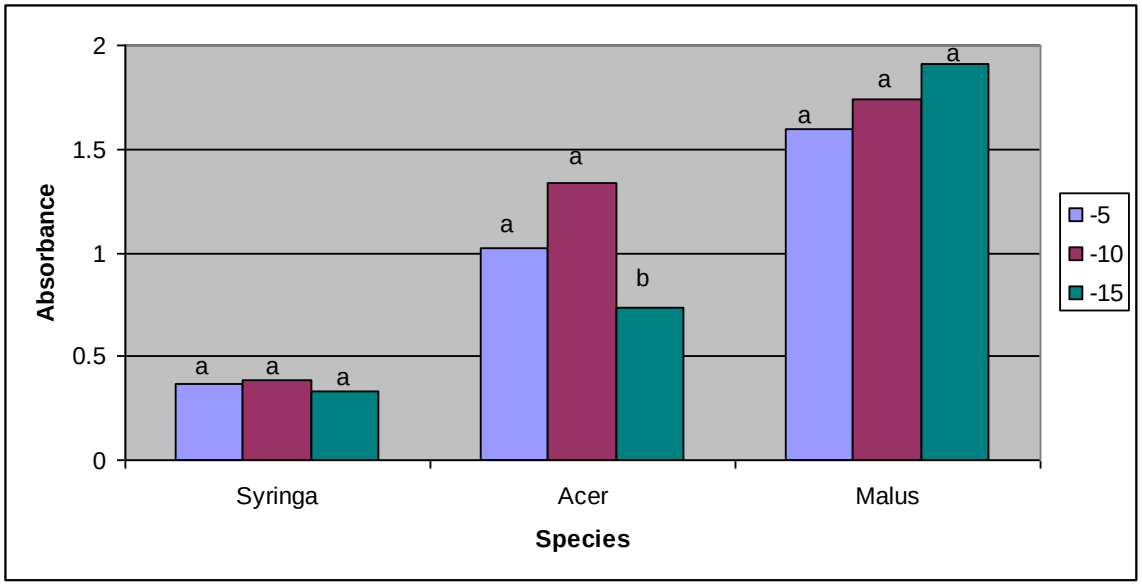

Figure 4. Species and temperature interaction for triphenyltetrazolium chloride absorbance values averaged over six treatments at three temperatures (-5, -10, -15 °C). Different letters indicate significant differences within species based on LSMeans (α = 0.05).