

Inhibition of Forage Seed Germination by Leaf Litter Extracts of Overstory Hardwoods Used in Silvopastoral Systems

Dr. Jonathan Halvorson, USDA-ARS Research Soil Scientist, Dr. David P. Belesky, Research Assistant Professor, West Virginia University, and Mark West, USDA-ARS Statistician, Northern Plains Area

Silvopastures are an intentional combination of trees, forage plants and livestock designed to expand spatial and temporal boundaries of forage production, promote ecosystem integrity and generate multiple income opportunities. Silvopastoral management strategies include a combination of tree thinning and establishment of understory pastures that are mixtures of several functional classes of forage plants such as legumes, and both cool and warm-season grasses. Such mixtures can create a more dependable supply of herbage across heterogeneous landscapes that can supply an appropriate balance of energy (carbon) and protein (nitrogen) to animals. Successful establishment of silvopastures is affected by the biological, chemical, and physical interactions with overstory trees, including allelopathy. Allelopathy has been widely studied and occurs when plants produce secondary compounds that affect neighboring plants.



We examined the possible inhibitory effects of water extracts of leaf litter from three species of overstory hardwood trees, yellow poplar, red maple, and white oak, on germination of important forage species. Forages included legumes: red clover, white clover; and alfalfa; cool season grasses: orchardgrass, and tall fescue; and a warm season grass: crabgrass. We assessed effects on seed germination as a function of litter source, extract concentration, and forage species, and tested to see if effects on germination were permanent or could be alleviated by rinsing.

Litter extracts reduced germination in red and white clover in a concentration dependent manner with greatest effects observed for poplar > maple > oak extracts (Fig. 1). These reductions were linearly related to increasing osmolality and electrical conductivity of the leaf extracts (Fig. 2). Modified Gompertz growth curve models, fit to data, further indicated treatment with litter extracts, especially poplar, delayed and slowed germination. Similarly, cumulative germination of a variety of grasses was inhibited by filtered 6% (w/v) litter extracts with the effects of poplar > maple > oak. However, germination of all forages resumed after rinsing extract-treated seeds with water indicating inhibition could be due, in part, to osmotic effects of extracts or water-soluble allelopathic compounds. Final germination varied with forage species and extract type, but in most instances, did not reach the level of the control further suggesting specific ion toxicities as well (eg. Fig.3).

Management practices that account for the interactions between trees and forages are needed to ensure successful establishment and persistence of mixed species swards in silvopastoral systems. Our data suggest establishment of some forage species may be significantly delayed or inhibited under poplar trees, but less affected by an overstory of maple or oak trees. However, we caution that germination results should not be equated with effects on the vegetative growth of established swards.

Jonathan Halvorson 701.667.3094 jonathan.halvorson@ars.usda.gov

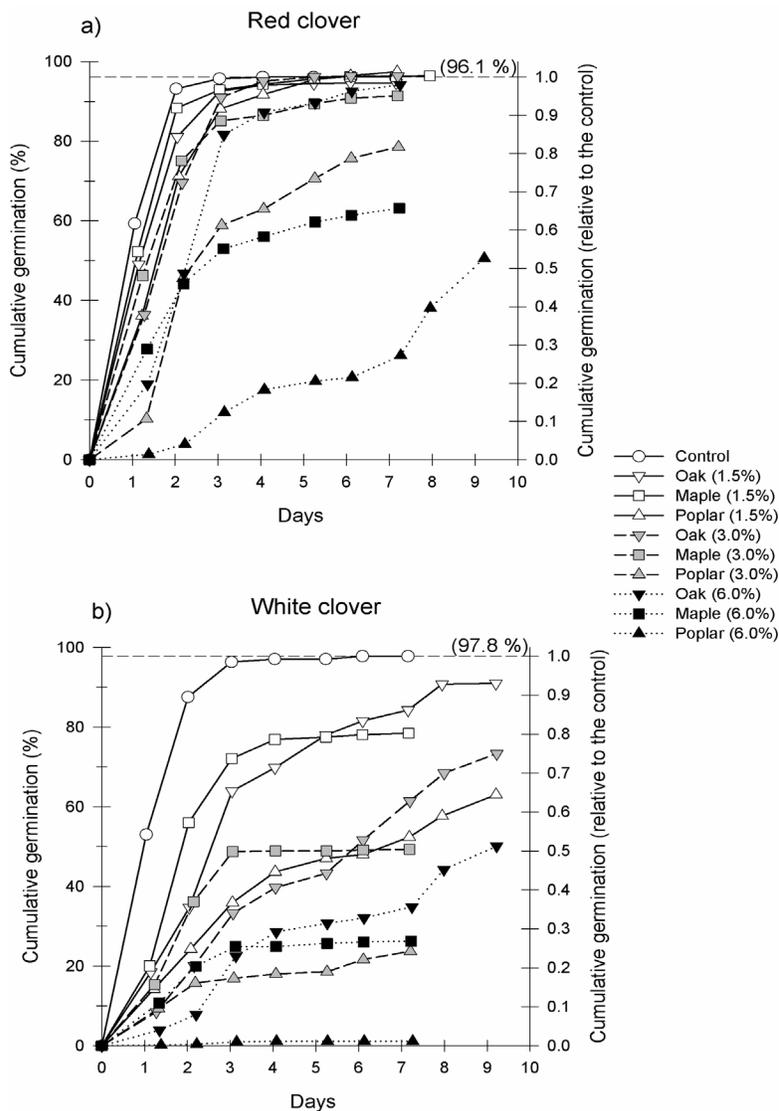


Figure 1. Average cumulative germination (N=5) of a) red clover and b) white clover seeds treated with three concentrations (1.5, 3.0, or 6.0%, w/v) of oak, maple, or poplar leaf litter extracts. Average % germination is indicated on the left ordinate while the right ordinate shows germination scaled relative to the Control (water).

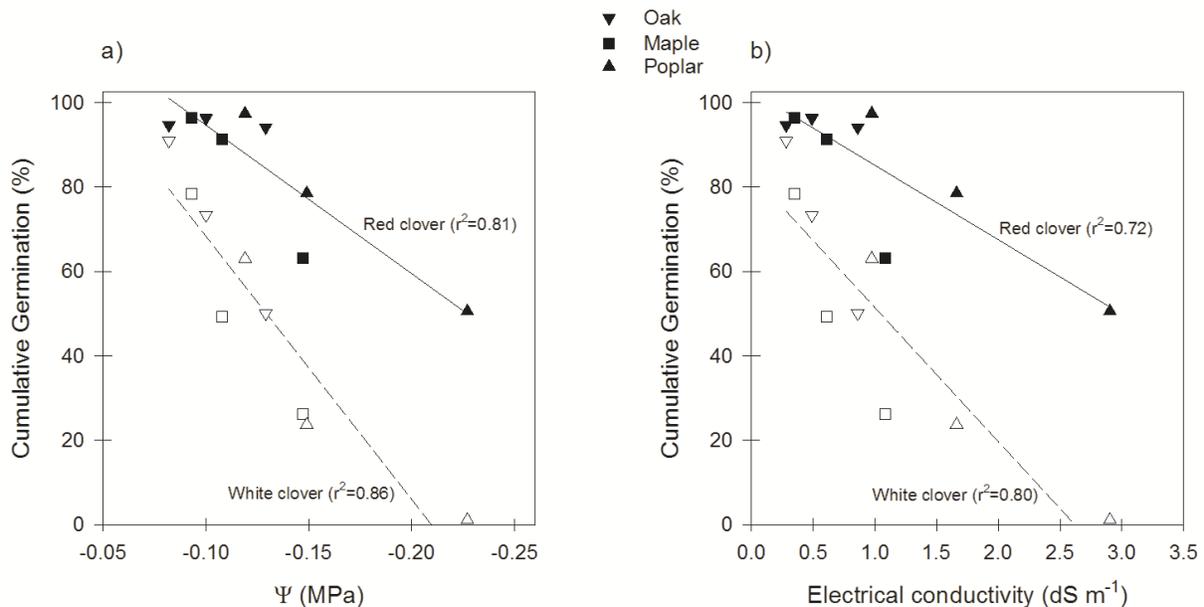


Figure 2. The relationship between a) osmolality and b) electrical conductivity and observed germination for 1.5, 3.0 and 6.0% extracts of oak, maple, and poplar leaf litter at the end of experiment 1.

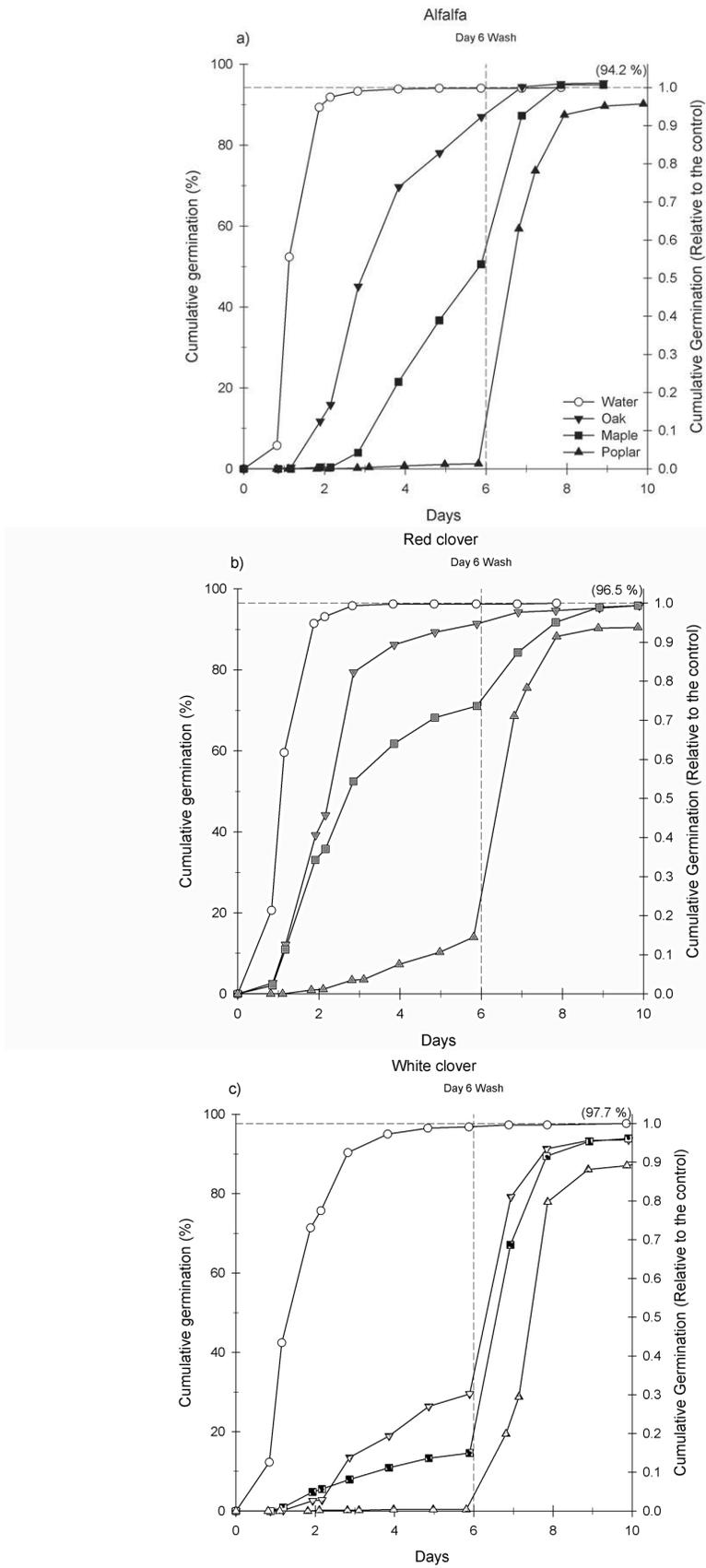


Figure 3. Cumulative germination of seeds treated with 6% leaf litter extracts followed by subsequent a rinse with deionized water (3 X 100 mL) for a) alfalfa; b) red clover; c) white clover. Average % germination (N=5) is indicated on the left ordinate while the right ordinate shows germination scaled relative to the Control (water)