Integrated Control of Spotted Knapweed:
Utilizing Spotted Knapweed-Resistant Native Plants to Facilitate Revegetation
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Invasive plants are recognized as having severe ecological and economic impacts. Affordable long-term management methods are lacking for many of the most destructive exotic invasive plants, including spotted knapweed. Research on weed invasions has primarily focused on aboveground processes. However, we now know that plant roots are unparalleled factories of diverse chemicals, and the secretion of toxins by the roots of knapweed is a possible mechanism for their success in replacing our native species. Understanding this belowground chemical warfare can suggest completely new approaches to managing and restoring invaded landscapes.

We are studying the biochemical interactions between invasive knapweeds and native rangeland plants. In a laboratory study, we discovered that many native plants from the western US seem to resist the toxin produced by spotted knapweed roots, while others are more susceptible to it (Perry et al., 2005). In a follow-up greenhouse study we found that these tolerant native species were quite good at growing with knapweed while the less tolerant native plants were not. We then conducted similar greenhouse experiments with native species from knapweed-invaded grasslands in Wisconsin and Washington (Alford et al, *in press*). Based upon the results of these greenhouse studies, we have initiated two field experiments in knapweed infested areas of Montana to study the effects of different seed mixes on resistance to knapweed reinvasion. This study is ongoing, and due to a record heat wave in 2006 we have seen little native recruitment in 2006 or 2007. Therefore, a similar study is being established on two additional sites in Montana during the fall of 2007. Additional field studies were established in Wisconsin and Washington during 2006. These field studies have been sampled during the summer of 2007 and data analysis is pending. Results from these field studies should result in recommended seed mixtures for reclaiming knapweed infested rangelands in the western US.

In addition to these applied studies we are also working on figuring out the underlying mechanisms responsible for our previous observations. In laboratory studies we discovered that oxalic acid was a contributing factor in the resistance of some native species to knapweed toxins (Weir et al., 2006). We found that oxalic acid is secreted by these native plant species and alleviates the effects of damage to their root tissues caused by knapweeds. We conducted a greenhouse experiment from August 2006 to April 2007 (Figure 1) to evaluate whether these resistant plants might be used to ameliorate knapweed soils and facilitate the subsequent establishment of native species that are more susceptible to (±)-catechin. Results from this study are being analyzed and will be prepared for publication as part of the MS thesis of Matt Schultz.

Literature Cited

Alford, É.R., J.M. Vivanco and M.W. Paschke. The effects of flavonoid allelochemicals from knapweeds on legume - rhizobia candidates for restoration. Restoration Ecology (*In press*).

Perry, L.G., Johnson, C., Alford, E.R., Vivanco, J.M., and Paschke, M.W. (2005) Screening of grassland plants for restoration after spotted knapweed invasion. Restoration Ecology 13:725-735

Weir, T.L., Bais, H.P., Stull, V.J., Callaway, R.M., Thelen, G.C., Ridenour, W.M., Bhamidi, S., Stermitz, F.R., and Vivanco, J.M. (2006) Oxalate contributes to the resistance of Gaillardia grandiflora and Lupinus sericeus to a phytotoxin produced by Centaurea maculosa. Planta 223:785-795.

a.  b. 

 c.

Figures 1a, b and c: (a) Photo of rootboxes before planting. Rootboxes were used to study biochemical interactions between spotted knapweed and resistant plant species at the Colorado State University greenhouse. (b) Photo of the rootboxes during the experiment at the Colorado State University greenhouse. (c) Rootboxes receiving UV exposure to stimulate root exudates outside the Colorado State University greenhouses.