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 are currently conducting a similar greenhouse experiment with native species from knapweed-invaded grasslands in Wisconsin, where spotted knapweed has recently invaded. Based upon the results of our 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. 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 are currently examining the root exudates of numerous native plant species for the presence of oxalic acid. We want to determine if this is a widespread mechanism that conveys tolerance to native plant species that have not coevolved with knapweeds and therefore have not developed more specific defenses. In another series of experiments we are developing new methods for studying interactions between the roots of invasive knapweeds and native resistant species. These experiments will allow us to develop a more complete understanding of the belowground biochemical interactions that occur between invasive and native plants. We hope that this knowledge will lead to innovative new methods for managing weed infestations.

Literature Cited

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

Figure 1: Photos of rootboxes containing spotted knapweed (left) and blanketflower (right). These rootboxes have been developed to study the biochemical interactions between invasive knapweeds and native species that seem to resist the toxic effects of knapweed root exudates. The rootboxes contain clear plexiglass doors that allow the root systems to be photographed and allow for collection of root exudates. Rootboxes containing mixtures of knapweeds and native species are currently being established to study the biochemistry of root interactions.