Use of *Pseudomonas fluorescens* as a bioherbicide for cheatgrass and other invasive winter annual grass control

Daniel R. Tekiela, University of Wyoming Assistant Professor and Extension Specialist of Invasive Plant Ecology

Cheatgrass (*Bromus tectorum*) and other invasive annual grasses cover an estimated 100 million acres of the western United States and cover hundreds of thousands of acres in Wyoming.

These grasses are capable of reducing forage quality, biodiversity, and wildlife habitat. There is great interest in effective, long-term control of these grasses. There has been an increased interest in using bioherbicides to manage and control invasive annual grasses.

Work over the past 15 years has identified unique strains of the ubiquitous soil bacteria *Pseudomonas flourescens* to control invasive annual grasses. These strains were originally identified from wheat fields in Washington with annual grass injury. From those, specific strains were identified that are reported to only affect certain invasive annual grasses. These strains colonize intercellular space in the roots of the target invasive annual grass and reduce plant growth by inhibiting root cell membrane production. This results in stunting of the target plant. There are currently two strains potentially being utilized as bioherbicides, D7 and ACK55.

D7

Pseudomonas flourescens D7 is registered as a bioherbicide as of 2014 and is being produced by Verdesian Life Sciences, LLC, Cary, NC. It is labeled for control of "Downy Brome (cheatgrass), Medusahead, Japanese Brome, and Jointed Goatgrass on Wheat, Barley, Triticale, Oats, and Rangeland" (D7 Label); however, some report it has no effect on Japanese brome. D7 is delivered in a freeze-dried form and can be dissolved into a liquid solution and broadcast sprayed or alternatively used as a seed treatment. Because *Pseudomonas flourescens* is a cool, moisture-loving bacteria, application should occur when temperatures are below 50F in the fall to ensure ideal growing conditions. Lab studies have shown D7 reduced root growth of annual grasses in petri dishes and when tested in growth chambers (Kennedy, Johnson, & Stubbs, 2001). Additionally, three study sites across Washington showed natural populations of cheatgrass had reduced seed production (16-64 percent), shoot mass (0-54 percent), and plant density (0-35 percent) less than a year after application (Kennedy, 1991); however, there has been limited success in duplicating these results. Recent reports suggest results in the field may not be seen for up to three to five years. No published studies examine the long-term effects of D7 beyond this initial year. There is no published evidence of D7's effectiveness or lack thereof in field conditions in the Rocky Mountain region. Because this is a living organism, environmental conditions are likely far more important for efficacy than for synthetic herbicides, and regionality may be critically important.

ACK55

Pseudomonas flourescens ACK55 is undergoing the EPA registration process and is not commercially available. ACK55 is reported to be more selective and to only control downy brome (cheatgrass), medusahead, and jointed goatgrass, but is said to more greatly reduce target plant growth. No peer-reviewed information exists on the effects of ACK55, so its effects are largely unknown, especially in the Rocky Mountain region.

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MB906

Although also *Pseudomonas fluorescens*, MB906 is not labeled as a bioherbicide but is labeled and marketed as a soil inoculant to "enhance biodiversity in soil" (MB906 label). This product cannot be used to control annual grasses. Additionally, there is no published information on the effects of this soil inoculant.

STRAIN	REGISTERED AS A BIOHERBICIDE?	SUMMARY OF PUBLISHED EFFICACY DATA
D7	**Yes.** Labeled for control of downy brome (cheatgrass), medusahead, Japanese brome, and jointed goatgrass. Registered crops include wheat, barley, triticale, oats, and rangeland.	D7 suppressed downy brome in field studies in 1988 (Kennedy et al. 1991), but attempts to duplicate those results in subsequent field studies were largely unsuccessful (Tranel et al. 1993). Lab studies have shown D7 reduces root growth of downy brome and other annual grasses in petri dishes and in growth chambers (Kennedy et al. 2001); however, in those same laboratory studies D7 also caused root growth suppression in some desirable grasses, including wheat, barley, smooth brome, and tall wheatgrass (Kennedy et al. 2001).
ACK55	**No**. EPA registration as a bioherbicide is pending.	None available.
MB906	**No**. This product is not registered for use as a bioherbicide for weed control; it is labeled as a soil inoculant to enhance biodiversity in soil.	None available.

RESOURCES

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