Forest and Rangeland Ecosystem Science Center

Weed-Suppressive Bacteria

Weed-Suppressive Bacteria, or WSB, are bacteria strains of the soil bacterium *Pseudomonas flourescens* (D7, ACK55, and MB906) developed and marketed as a natural way to control exotic grasses, such as cheatgrass. In the late 1900s and early 2000s, scientists began experiments that looked for biological ways to selectively eliminate or inhibit growth of exotic annual grasses.

Does WSB work?

The answer has been "No" across a wide range of field and potted soil conditions and WSB application methods, to date. WSB trials in laboratory studies, specifically petri dishes, have also shown mixed results. WSB was developed to target invasive weeds with minimal impact to non-target plant species, such as native or agriculturally important plants. Testing and trials of WSB have been conducted independently by USGS and many other scientists and land managers across semiarid areas of the western U.S. WSB strains or products tested include D7, ACK55, and soil amendment MB906.

What problem is WSB trying to solve?

Invasive annual grasses, such as cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum caput-medusae*), are one of the most significant stressors to rangeland ecosystems in the western U.S. Cheatgrass and medusahead have origins in Europe or Eurasia and the Mediterranean region. Both species were introduced to North America in the mid- to late-1800's as a contaminant in seed and straw. They both germinate in fall or early spring, grow rapidly, and produce lots of seeds, making them highly competitive with western native rangeland species. Once established, they are very difficult to eliminate.

Why do these species matter?

Medusahead, and cheatgrass in later stages of growth, are unpalatable to grazing livestock and can cause injury as well. Both grass species create a thick thatch when they dry out and die in the summer. This thatch creates a continuous "carpet" that prevents native plant revegetation and is very flammable wildfire fuel.

What are the specific findings?

Special Journal Issue Focuses on Weed-Suppressive Bacteria

A special issue of Rangeland Ecology and Management focused on weed-suppressive bacteria and includes reports from five trails of WSB that collectively provide a spatially and temporally robust test of WSB in the western U.S. None of the five studies detected consistent effects of WSB. An introductory article summarizes the findings.

Germino, M.J., Lazarus, B.E., 2020, Synthesis of weed-suppressive bacteria studies in rangelands of the western USA- A special section of articles in Rangeland Ecology and Management provides a unified perspective: Rangeland Ecology and Management, p. online, https://doi.org/10.1016/j.rama.2020.02.007.

Weed-Suppressive Bacteria Fail to Control Bromus Tectorum

Researchers tested effects of ACK55 and D7, two weed-suppressive bacteria strains of *P. fluorescens*, on cheatgrass both in the laboratory and at field sites in Montana and Wyoming. The bacteria strains reduced cheatgrass germination and root and shoot lengths in Petri-plates but had no effect on plants during field experiments. Findings contribute to growing evidence that these strains do not reliably control cheatgrass in the Northern Great Plains, Central Rocky Mountains, and elsewhere.

Reinhart, K.O., Carlson, C.H., Feris, K.P., Germino, M.J., Jandreau, C.J., Lazarus, B.E., Mangold, J., Pellatz, D.W., Ramsey, P., Rinella, M.J., Valliant, M., 2019, Weed-suppressive bacteria fails to control Bromus tectorum under field conditions: Rangeland Ecology and Management, p. online, https://doi.org/10.1016/j.rama.2019.07.006.

Photos by Justin L. Welty, USGS

Weed-Suppressive Bacteria have no Effect on Exotic or Native Plants in Sagebrush Steppe

USGS researchers evaluated the effects of two strains of *P. fluorescens* - D7 and MB906 - on exotic annual grasses at three sagebrush steppe sites with contrasting soils and climate. Neither bacteria strain affected exotic annual grasses, perennial bunchgrasses, or total community cover, either applied alone or in combination with herbicides or discing. Results indicate a low likelihood of these strains to reduce annual grasses.

Germino, M.J., Lazarus, B.E., 2019, Weed-suppressive bacteria have no effect on exotic or native plants in sagebrush-steppe: Rangeland Ecology and Management, p. online, https://doi.org/10.1016/j.rama.2019.10.004.

Weed-Suppressive Bacteria Did Not Control *Bromus Tectorum*

USGS and USFWS researchers tested the ability of a bacterial bioherbicide known as D7 to control cheatgrass in south-central Washington. D7 applied as a spray or seed mixture did not significantly affect cover, biomass, or density of cheatgrass. This negative result can be useful to document D7's effectiveness at different rangeland sites.

Pyke, D.A., Shaff, S.E., Gregg, M.A., Conley, J.L., 2019, Weed-suppressive bacteria applied as a spray or seed mixture did not control Bromus tectorum: Rangeland Ecology and Management, p. online, https://doi.org/10.1016/j.rama.2019.11.001.

Bacterial Soil Amendment MB906 Shows Inconsistent Control of Invasive Annual Grasses

To accurately assess responses of both native and non-native grasses, land managers applied MB906 – a weed-suppressive bacteria – alone and in combination with the herbicide imazapic on sagebrush-steppe landscapes that burned several months prior. MB906 did not consistently reduce target invasive annual grass cover at the sites studied in the three years following treatment, although moderate effects on target annual grass cover suggest further investigation may be warranted.

Lazarus, B.E., Germino, M.J., Brabec, M.A., Peterson, L., Walker, R.N., Moser, A.M., 2020, Post-fire management-scale trials of bacterial soil amendment MB906 show inconsistent control of invasive annual grasses: Rangeland Ecology and Management, p. online, https://doi.org/10.1016/j.rama.2020.03.005.

Photo by Matthew Germino, USGS

Weed-Suppressive Bacteria Effects Differ in Culture Compared to in Soils

Researchers evaluated the effectiveness of WSB grown in soil vs. agar culture, and tested how soil sterilization and WSB concentration inhibited growth of invasive annual grasses. Sterilization had no effects on WSB effectiveness and were only partially selective for target weeds at low concentration. WSB applied at high concentration inhibited both invasive and native grass growth in agar cultures. Results suggest the desired effect is not reproducible for plants in soil, even when competing microbes are removed.

Lazarus, B.E., Feris, K.P., Germino, M.J., 2020, Weed-suppressive bacteria effects differ in culture compared to in soils and with or without microbial competition and separation of active ingredient: Biological Control, v. 152, p. 10442, https://doi.org/10.1016/j.biocontrol.2020.104422.

Where can I learn more?

Weed-Suppressive Bacteria – Testing a Control Measure for Invasive Grasses in the West

https://www.usgs.gov/centers/fresc/science/weed-suppressive-bacteria-testing-a-control-measure-invasive-grasses-west

Cheatgrass and Medusahead

https://www.usgs.gov/centers/fresc/science/cheatgrass-and-medusahead

Want a copy of a publication?

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