OSMRE National Technology Transfer Team (NTTT), **Applied Science Final Report***
U.S. Department of the Interior, OFFICE OF SURFACE MINING RECLAMATION AND ENFORCEMENT

Tradeoffs and Challenges in Development of Prototype Seed Enhancement Technologies for Sagebrush

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Project Background and Objectives:

In disturbed areas, it may take decades for sagebrush to establish naturally by re-seeding itself inward from the edges. To speed up the recovery process sagebrush is typically seeded via aerial or surface broadcasting, but these methods often result in poor establishment. Most of the sagebrush seedlings that do emerge in the spring after seeding succumb to dry conditions during the summer. Seed Enhancement Technologies (SETs) provide one potential pathway to boosting sagebrush establishment. The goal of the prototype seed technologies tested here was to enhance outcomes like seed survival and seedling vigor by stimulating root growth, which could provide a greater likelihood of surviving hot, dry summer days.

The objective of our study was to test whether combining fertilizer with Wyoming big sagebrush seeds (*Artemisia tridentata* var. *wyomingensis*) in a SET could improve seedling emergence, survival and growth in the lab and at freshly reclaimed mine sites in Wyoming.

Applicability to Mining and Reclamation:

The results of this study will inform whether and what type of SET could improve sagebrush establishment on revegetation sites, like mine reclamations. This knowledge could aid practitioners in meeting bond release requirements around shrub density.

Methodology:

We tested multiple prototype SETs and bare seed in lab trials where we monitored seedling emergence, survival and above and belowground biomass. We tested these same SETs and bare seed at McIntosh Mine, a freshly reclaimed uranium mine site in Wyoming, in two times since reclamation (zero and one year after reclamation) and in run-on swales versus run-off slopes. We monitored all sagebrush seedlings throughout the growing season to track emergence, survival and seedling height. Prototype SETs included a variety of film coatings of substances with potential to enhance seedling growth and two externally applied fertilizers.

Figure 1: Freshly reclaimed portion of McIntosh mine where the 2021-2022 field experiment was set up.

Highlights:

The most significant results from this study are:

1. There is a tradeoff between delivering a sufficient quantity of fertilizer to enhance growth and inhibiting seedling germination and emergence, particularly for small seeded species like sagebrush.

2. Film coating had little effect on sagebrush seedlings. Higher rate externally-applied fertilizers enhanced growth but reduced emergence.

3. Establishment was higher in swales. Neighboring vegetation reduces seedling growth via competition, but some cover can enhance early emergence.

Figure 2: Sagebrush seedling at the McIntosh Mine site.

Conclusions:

These studies show that SETs may not be an effective approach for sagebrush, given the challenges of small seed size and emergence inhibition. However, some general principles for reseeding sagebrush did emerge. If resources are limited, we suggest focusing seeding on swales or other microsites that capture and retain moisture. Sowing from seed into bare, freshly reclaimed soil is likely to have highly variable outcomes. If emergence is poor in the first year of sowing, we recommend re-sowing the next fall, since establishment is generally good during this phase when there is some facilitative cover but low competition from established perennial vegetation.

Figure 3: Swales at the McIntosh Mine retaining moisture into late spring while the slopes have dried out. Targeting sagebrush seeding in these wetter areas can be advantageous.

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