



RESEARCH SERVICES SECTION

TECHNICAL SUMMARY

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\$103,375



Purple prairie clover is a legume used in prairie restoration.

Improved Methodologies for the Inoculation of Prairie Legumes in Roadside/Revegetation Settings

What Was the Need?

Agricultural development over much of the 400 million acres of prairie grassland in the Great Plains has resulted in significant declines in tallgrass (99.9 percent decline), mixed grass (61 percent) and shortgrass (85.5 percent). Prairie restoration offers substantial environmental benefits, and planting low-maintenance prairie grassland is an important part of Mn/DOT's strategy to control roadside erosion. If the native prairie areas can become self-sustaining, Minnesota's roadsides can be both attractive and less expensive to maintain. However, prairie restoration can be a slow, multiyear process.

Researchers have identified that legumes are integral to prairie development; where legumes have not been successfully planted, prairie development is delayed. Legumes pull nitrogen gas—unusable by most living organisms—from the air and convert it to a biologically useful ammonia form of nitrogen. The roadside soils where the prairies are being re-established are often compacted and lack the bacteria needed by legumes to pull nitrogen out of the air. Inoculating legumes with appropriate bacteria can help compensate for deficient roadside soils and encourage more rapid prairie development.

Mn/DOT includes a number of indigenous legumes in its roadside vegetation and wetland restoration plant mixes. A [Mn/DOT-funded study completed in 2004](#) identified new inoculant cultures for the legumes being used by Mn/DOT. Improved methods of legume inoculation and better inoculant delivery systems are needed to ensure that the strains being used are effective under revegetation conditions.

What Was Our Goal?

The objectives of this study were to:

- Identify and test methods for the use of cereal crops like winter wheat and rye as a carrier for inoculating bacteria for prairie legumes.
- Evaluate different methods for effectively inoculating prairie legumes in a restoration setting.
- Determine the feasibility for the inoculation of legumes growing in heavily fertilized seed blankets.

What Did We Do?

Researchers first conducted a series of field and greenhouse trials to evaluate 33 cereal crops as inoculating carriers for the soil bacteria associated with prairie legumes. In the second part of the study, researchers established prairie areas at the University of Minnesota Sand Plain Research Farm over a three-year period to test several treatments at four areas each: granular clay-based inoculant, granular peat-based inoculant, seed-applied powdered peat inoculant, inoculated wheat seed applied as a cover crop, and uninoculated. Finally, they conducted a greenhouse experiment using pregerminated seed blankets with prairie mix seeds to test nitrogen rates and their effect on legume establishment following inoculation.

What Did We Learn?

With two exceptions, all fall-planted cereals and grasses tested regrew during the following season. Researchers noted that "Roughrider" wheat cultivar exhibited the best

“The results of this study show strong benefits with the methods identified in the research. We can apply these methods in field trials as a first step in modifying our seeding specifications.”

—Kenneth Graeve,
Botanist/Plant Ecologist,
Mn/DOT Office of
Environmental Services

“The ability to fix nitrogen in symbiosis is important for more than prairie restoration. If biofuel crops are to be efficient and sustainable, they also will need to be associated with nitrogen-fixing legumes and to satisfy their nitrogen needs through symbiosis.”

—Peter Graham,
Professor, University of
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Prairie plantings like this one in Minnesota are thought to help in the fight against global warming. Prairie restoration is critical for agricultural and wildlife maintenance.

results, and they recommended that it be studied further. They found that inoculating seed blankets was impractical because of the high levels of nitrogen fertilization used on seed blankets to achieve sufficient growth before the blankets are applied in the field.

Seed inoculation was found to be generally ineffective as well, but overall legume numbers in the prairie restorations were enhanced by both soil-applied granular and cover-crop applied inoculants, with the better inoculation practices also resulting in soil quality improvement over the course of the study. Inoculant rhizobia for *Dalea* accounted for 90 percent to 100 percent of the strains recovered from soil in the soil-applied granular peat and cover-crop-inoculated treatments, but only 4 percent in the seed-inoculated treatments, showing clear differences in the establishment of these organisms. Researchers preferred the granular peat-based inoculation treatment, citing uniformity of response and convenience of use. Increasing the number of bacteria applied was found to clearly benefit prairie establishment and function.

What's Next?

Recommendations from this study include:

- Using granular soil-applied peat inoculant for prairie seeding and restoration activities. Study results indicate the need to inoculate *Dalea purpurea* and *D. candida*; results with *Desmodium* were less clear.
- Fall seeding followed by spring inoculation so that the soil bacteria need not survive through the winter before legumes begin to germinate.
- A review by Mn/DOT to locate sources for peat, including an evaluation to ensure suitability for use in inoculant production. Implementing this study's recommendations will result in a substantial increase in the amount of peat needed for Mn/DOT's restoration activities.

Mn/DOT will evaluate these recommendations in upcoming field testing before making formal changes to its seeding specifications. This is only the second study that examines inoculation in connection with prairie establishment. Further research over a longer study period is needed to identify the best possible inoculants that will fix nitrogen, stay alive in the soil, compete effectively with stray bacteria and tolerate difficult environmental conditions over time.

This Technical Summary pertains to Report 2008-48, "Improved Methodologies for the Inoculation of Prairie Legumes in Roadside/Revegetation Settings," published October 2008. The full report can be accessed at <http://www.lrrb.org/PDF/200848.pdf>.