The Effect of Season of Seeding and Seeding Depth on Performance of Twenty-One Native Grasses: Implications for Reclamation

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Abstract

There is growing interest in the use of native species to revegetate degraded lands. The lack of knowledge regarding successful establishment methods for these species has, however, prevented many industries from pursuing their use. The objective of this study was to determine the optimum season of seeding, seeding depth and their interactions to maximize emergence and establishment. Plots were established near Nisku, Alberta. Twenty-one native grass species were selected based on their use in reclamation and seed availability. Two season of seeding treatments, spring (late June) and fall (early October) and three seeding depths, 0.5 cm, 1.5 cm and 2.5 cm were assessed. Seedling density, cover, height and presence of seed were measured. Season of seeding and seeding depth had a significant effect on plant performance. This effect, however, was dependent on the performance measure employed to evaluate revegetation success. In general, spring seeding at a mid range seeding depth such as 1.5 cm produced the greatest density and cover for the widest range of species.

Introduction

There is growing interest in the use of native species to revegetate degraded lands. In the past, non-native species were preferred as their seed was readily available, relatively inexpensive and species were proven to perform well in the field. Commonly used non-native species often have high germination and establishment rates thereby further reducing costs while enhancing erosion control and forage productivity. These species however often have aggressive growth strategies and can effectively outcompete remnant and establishing native plants.

Establishment of native rangeland contributes to preservation of the threatened prairie landscape and sustainable agriculture. Sustainability is essential to achieve reclamation success and to reduce maintenance costs. Native species facilitate effective nutrient and water cycling, reduce erosion, support wildlife, and promote a diverse sustainable cover. Native species are often considered to be better adapted to local conditions than non-native species. Even with these benefits, reservations with using native species arise from the lack of knowledge regarding successful establishment methods.

Research Objectives

The objectives of this study were:

1) To determine the optimum season of seeding, seeding depth and their interactions to maximize emergence and establishment.
2) To determine the relationship between Pure Live Seed and seedling emergence and establishment under greenhouse and field conditions.

This paper will only address the first objective.

Materials and Methods

Study Site

The study site was located in the Aspen Parkland ecoregion near Nisku, Alberta. Experimental plots were located on a 100 m by 25 m demonstration plot maintained by Prairie Seeds Ltd. The plots were bordered by fallow on three sides and adjacent to a rural road.

Experimental design

A complete randomized design was used. One of six treatment combinations was randomly assigned to each of 54 experimental units. Experimental units were 3.25 m by 5.30 m and consisted of 22 seeded rows, one for each selected species. Each species was randomly

assigned to a row within each experimental unit. Rows were spaced 23 cm (9 in.) apart. Each treatment was replicated 9 times per species.

Treatments

Two seasons of seeding treatments, spring and fall, and three seeding depth treatments, 0.5 cm, 1.5 cm and 2.5 cm were tested. Spring seeding occurred in late June 2001 and fall seeding in early October 2001. Seeding depth treatments were based on prior field experience and research, seed size and feasible seeding methods.

Twenty-one native grass species were selected for the study based on their use in reclamation and seed availability. They were *Bouteloua gracilis*, *Bromus ciliatus*, *B. carinatus*, *Elymus canadensis*, *E. innovatus*, *Festuca saximontana*, *F. campestris*, *Koeleria macrantha*, *Trisetum spicatum*, *Stipa viridula*, *S. comata*, *Poa alpina*, *P. palustris*, *Agrostis scabra*, *Deschampsia caespitosa*, *Oryzopsis hymenoides*, *Agropyron smithii*, *A. riparian*, *A. dasystachyum*, *A. trachycaulum* and *A. violaceum*. Italian ryegrass (*Lolium multiflorum*) was selected as a check as germination and establishment rates of this agronomic species are well documented.

Seedbed Preparation and Weed Control

The study site was fallow for the 2 years prior to experimental plot establishment. Prior to seeding, plots were packed and an application of Roundup conducted to control weeds. Immediately prior to seeding, sites were lightly raked to break clods and roughen surface.

A second herbicide application occurred in late July 2001. Hand weeding occurred in fall-seeded plots in September 2001, and in fall and spring seeded plots in July 2002.

Seed heads on all plants were cut before setting seed to prevent further establishment and competition.

Seeding Rates and Methods

In this study, a standard rate of 100 Pure Live Seed (PLS) per linear m was used. This PLS rate was based on current reclamation objectives of obtaining a final density of 55 to 65 plants m^{-2}. Seed viability tests were conducted on all seed lots by 20/20 Seed Labs.

Treatments were seeded by hand. Furrows were made with a hoe to the required depth and checked at a few points along the row. Based on rates, an appropriate amount of seed was weighed out for each row length, evenly spread in the furrow and soil placed over top. Soil was firmly pressed over the seed by foot.

Greenhouse Experiment

Five-inch diameter pots were filled with sterilized soil from the study site. Pots were randomly assigned a species and seeding depth treatment, for a total of 5 replicates per species/depth combination. Each replicate consisted of 20 PLS. Greenhouse conditions were kept constant at 23 ^{o}C with a 16-hour photoperiod, soil was kept moist. Seed was sown at assigned depths in mid June.

Vegetation Measurements

Field plots were monitored every week from the date of seeding for spring-seeded treatments and every two weeks beginning in the middle of May 2002 for fall seeded treatments. At each monitoring period, the number of seedlings in the centre metre of the row was counted. At the end of each season data on cover, height and presence of seed were also collected.

Greenhouse trials were monitored every 4 days for 8 weeks. Emergence, seedling density and vigour were assessed.

Statistical Analyses

Treatment analyses were conducted within species. Analysis of variance (ANOVA) was carried out to determine if significant treatment effects were present. T-tests were conducted between greenhouse and field emergence for each species. A significance level of 0.05 was used.

Results and Discussion

Season of Seeding and Seeding Depth

There was a significant interaction between season of seeding and seeding depth for most species, however, it is difficult to determine how

much of this effect may be due to drought and subsequent poor plant establishment in 2002. Our check species *L. multiflorum* did not establish in 2002.

The majority of species had higher density, cover, height and frequency of seed when spring seeded compared to fall. The exceptions were *S. viridula* and *S. comata* which had greater cover and height and *B. carinatus* and *O. hymenoides* which had higher density and height in fall seeded treatments. Season of seeding and seeding depth had no effect on *A. dasystachyum*, *A. smithii* and *E. canadensis*, while spring seeding only increased the density of *A. trachycaulum*; other measures were not affected by season.

For most species there was not one seeding depth that was the most effective, rather species tended to do well in the shallower or the greater depths. Large seeded species ($\leq$200,000 kg^{-1}) such as *Agropyron* and *Stipa* never performed well in the shallowest seeding depth (0.5 cm). It was hypothesized that small seeded species ($\geq$1,000,000 kg^{-1}) would perform better at the 0.5 cm depth than the greater depths. While 5 of the 8 small seeded species had high densities at the 0.5 cm depth, none was exclusive to this depth and other small seeded species such as *D. caespitosa* and *B. gracilis* preferred greater seeding depths. Of those species with high densities at the 0.5 cm depth only *P. alpina* also had greater cover at this depth.

Effective seeding depths were dependent upon the performance measure used. Cover and height were less affected by seeding depth than density. The cover of small seeded species was not affected by seeding depth as a large increase in stem density was required to result in a change in cover. While most mid to large seeded species had higher densities at greater depths, some of these species had greater cover and/or height at shallow seeding depths.

Greenhouse and field results were not similar. Significantly more seed germinated and seedlings established in the greenhouse than in the field. Species also performed better at shallow depths compared to in the field. No species performed best at the greatest seeding depth of 2.5 cm. Four species performed best at the 0.5 cm depth, 3 species at 1.5 cm and a third at either the 0.5 cm or 1.5 cm depth. Another third of the species were not affected by seeding depth.

Implications for Reclamation

Season of seeding and seeding depth had a significant effect on plant performance. This may, however, be dependent on the performance measure that is employed to evaluate revegetation success. Soil moisture also had an effect on appropriate seeding depth.

In the field, spring seeding at depths of 1.5 to 2.5 cm was most effective to enhance plant performance. While some smaller seeded species did well at the shallowest seeding depth, none was exclusive to this depth. In years with increased moisture, shallower seeding depths may be more appropriate. In general, a mid range seeding depth such as 1.5 cm produced the greatest density and cover for the widest range of species.

Agropyron dasystachyum, *A. smithii*, *A. trachycaulum*, and *E. canadensis* performed well under a variety of seeding conditions and can produce high cover, densities and seed within one season.

Acknowledgements

The authors would like to thank Prairie Seeds Ltd. and 20/20 Seed Labs Ltd. for their in-kind and technical support during this study.