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Relative performance of native cultivar and wild collected seed for grassland restoration

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ABSTRACT

Availability of native plant materials for grassland restoration is limited. Even when available in sufficient quantities for ecological restoration projects, seed germination and establishment in relatively arid environments is often low. Poor revegetation results in soil erosion, invasion by non-native plant species and reduced aesthetics. Therefore, development and use of native plants bred for traits favourable for restoration should be considered. This study addressed whether native cultivar seed, commercially selected for advantageous growth characteristics, could improve native grass species reestablishment relative to wild collected seed. Cultivar and wild seed types of four cool season native grass species were investigated at three foothills fescue grassland reclamation sites: *Bromus carinatus* (mountain brome), *Elymus trachycaulus* (slender wheatgrass), *Festuca idahoensis* (Idaho fescue) and *Koeleria macrantha* (June grass). Seeding and transplanting were conducted and germination, emergence, density, height and health were determined from 2011 to 2013. No significant differences were detected between cultivar and wild seed types except laboratory germination, which was greater in the *Elymus trachycaulus* cultivar and in the wild collected *Koeleria macrantha*. *Bromus carinatus* performed poorly as a seedling from either seed type. Consistent trends in cultivar and wild seed performance, that reflected seed germination, were found for each species although results were not significant due to high variability. Results show that for these common grass species, seed type may not influence initial establishment. Differences among species were significant and varied with response measured, suggesting species characteristics are a key factor affecting native grass reestablishment. Species specific responses to seed type highlight the importance of making seed source decisions on a species basis.

1. Introduction

Wild collected seed is often considered the most appropriate seed source of native species for restoration as it is locally adapted to site conditions (Bucharova et al., 2016) and has high genetic integrity (Jones, 2003). However, native grassland restoration may be challenged by lack of establishment of native species from wild collected seed that comes from populations poorly adapted to increased resource availability and altered disturbance regimes on restoration sites relative to the intact native ecosystem (Daehler, 2003; Jones, 2003). Wild collected seed germination is often low, likely due to the need to overcome physical (seed coat) or biochemical dormancy (Hitchmough et al., 2000), although there is little research in this area. Since grasses are the dominant vegetation in grasslands and provide dense cover, lack of establishment results in high bare ground and/or establishment of non-native species. Collection of wild seed in quantities sufficient to sow at standard reclamation rates is labour intensive and often unreliable as seed maturity dates vary with species, site conditions and year (Broadhurst et al., 2015). Little is known of the ideal collection time for the variety of native grasses required to successfully reestablish native grasslands. Consequently, use of commercial seed mixes has been a common practice in reclamation (Desserud et al., 2010; Conrad and Tischew, 2011; Klopf and Baer, 2011).

Many native grass species are commercially grown as cultivars, cultivated varieties with potentially improved performance (Burton and Burton, 2002). Native cultivar grass seed bred with traits such as increased germination, growth, seed production and overall fitness and greater commercial availability than wild collected seed may lead to increased restoration success. Use of

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native grass cultivars in protected areas has been viewed cautiously since cultivated seed may have genetic differences that could alter genetic composition of native grass populations (Mutegi et al., 2014). Despite this, cultivars may be necessary in grassland restoration, particularly in areas threatened by non-native plant species. Research has demonstrated that native cultivars from commercially produced seed are vigorous, germinating and establishing in abundance in the first year or two following seeding and reducing bare ground and opportunities for non-native plants to establish (Helm, 1995; Jefferson et al., 2002).

Grass cultivars may have enhanced physiological activity (Lambert et al., 2011) and often have higher cover and biomass with grazing as many are selected for forage value (Chamberlain et al., 2012). Even if above ground growth differences are small, cultivars exhibit greater nutrient uptake and have larger root systems than plants from local seed (Klopf and Baer, 2011). Rapid establishment of native grass cover enhances nutrient cycling, through litter production and decomposition; shades the ground, increasing soil water content; reduces soil erosion; increases wildlife use; and generally makes soil more hospitable for other species to establish.

Given the potential benefits of choosing cultivar seed to improve native grass reestablishment, research comparing relative performances of wild collected and native cultivar seed is necessary to confirm if cultivar seed should be pursued in restoration practice. Some studies suggest cultivar performance varies with geographic source of the seed as some grow larger than the wild type and some smaller; cultivars may be more susceptible to disease and insect herbivory (Jacobson et al., 1984; Gustafson et al., 2001, 2004). More recent research concluded that cultivars are not more competitive than wild genotypes (Wilsey, 2010; Baer et al., 2014; Walker et al., 2015).

Since variable and complex results on relative growth and establishment of wild collected and native cultivar grasses are evident in the literature, further research is necessary to assess growth and establishment differences between the two seed types during grassland restoration. Differences in seed type performance for different planting methods should be considered. For example, wild collected seed may be equal or better for transplants and poor for direct seeding.

This research addressed relative performance of cultivar and wild collected seed for four foothills fescue prairie cool season grasses, *Bromus carinatus* Hook. & Arn. (mountain brome), *Elymus trachycaulus* (Link) Gould *ex* Shinners (slender wheatgrass), *Festuca idahoensis* Elmer (Idaho fescue) and *Koeleria macrantha* (Ledeb.) J. A. Schultes (June grass) in the first two years of revegetation. Each seed type was directly seeded and transplanted to contribute data on the relative effectiveness of the two revegetation methods.

2. Methods

2.1. Research sites

Research sites were located in Waterton Lakes National Park in the Rocky Mountains of southern Alberta, Canada. Sites were a former landfill and two former borrow pits within a 2 km radius of each other, with similar topography and soils (Stover, 2013), surrounded by foothills fescue grassland. The growing season is characterized by cool, wet springs from May to June and hot, dry summers from July to September. Mean annual precipitation is 807.6 mm and mean annual temperature is 5.5 °C (Environment Canada, 2012). Soils had low organic matter and high coarse grained sediment content typical of disturbed grasslands altered by past land use.

2.2. Experimental design and treatments

A split plot design was established at each of the three research sites. Seed type (cultivar, wild collected) was the main effect and grass species (4 species) the subplot effect. At each site two 2 × 2 m plots were located on even terrain with similar soils and vegetation. Seed type was randomly assigned to half of each plot and species randomly assigned to four subplots within each seed type. This resulted in a total of 6 replicates per seed type × species combination. In spring 2011, prior to research, vegetation was removed within plots by application of the herbicide glyphosate and soil lightly tilled by hand to prepare the seed bed.

Four cool season C3 grass species were selected based on their suitability for restoration of foothills fescue grasslands, common use in grassland restoration in general and commercial availability: *Bromus carinatus*, *Koeleria macrantha*, *Festuca idahoensis* and *Elymus trachycaulus*. Sources for wild and cultivar seed are provided in Table 1. Grasses were sown June 13–16 2011. At one end of each subplot, two 3–5 cm deep and 10 cm diameter holes were dug, 20 healthy seeds deposited in each and seeds lightly covered with soil. Grass plugs were grown from the same wild collected and cultivar seed at the University of Alberta plant growth facility from January to May 2012. Plants were grown in large shallow trays until they were approximately 4 cm in height, then transferred to 11.4 cm deep and 2.5 cm wide root trainers. *Bromus carinatus* seed had poor emergence and establishment so was not used in the transplant experiment. Sixteen grass plugs were planted May 29–June 5 2012 in each subplot, adjacent to the seeded area.

2.3. Vegetation assessments

Seedlings in subplots were assessed in mid July and August 2011; early June and late July 2012 and; late July 2013. Each seedling was counted and height measured. In 2013, percent canopy cover was visually determined.

Transplants were assessed in late June and July 2012 and in late July 2013. Transplant health was scored using a 0–5 scale: 0 for plants that could not be located, 1 for dead plants (0% live material), 2 for necrotic plants (< 25% live material), 3 for severely chlorotic or wilting plants (25–50% live material), 4 for chlorotic or wilting plants (51–75% live material) and 5 for healthy plants (greater than 75% live material). Height was measured and presence of seed heads and evidence of grazing by wildlife were recorded. Grazing can be detrimental to seedling and transplant establishment.

Germination tests were conducted in the laboratory. For each seed type and species combination, 12 seeds were deposited on damp paper towel in each of 5 replicate petri dishes. Seeds were selected based on visual indicators that they were healthy. Germination was monitored over 14 days. Distilled water was added every 1–2 days to keep the paper towel damp but not wet. Germinated seeds were counted daily and removed.

2.4. Data analyses

Mean percent laboratory germination was calculated for each species. For the portion of each subplot seeded (n = 6), field emergence and mean seedling height were calculated. Field emergence was calculated as percent of total seeds sown that produced a seedling. For the portion of each subplot transplanted (n = 6), mean transplant health score and height were determined. Percent of transplants in each subplot (16 total) producing seed, showing evidence of grazing and mortality (health score of 0) was calculated.

Data were tested for normality and homogeneity of variance prior to analyses. The effect of seed type, species and their interaction on seed germination, seedling density, emergence and height and transplant health and height were analyzed using two-way