Comparison of methods for seeding Nebraska sedge (*Carex nebrascensis*) and Baltic rush (*Juncus balticus*)

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ABSTRACT

Four methods of seeding Nebraska sedge (*Carex nebrascensis* Dewey [Cyperaceae]) and Baltic rush (*Juncus balticus* Willd. [Juncaceae]) were compared in a controlled greenhouse environment. Methods evaluated were: 1) tackifier; 2) Submerseed™ pellets; 3) surface pressed; and 4) drilled. Greenhouse trays were flooded following seeding, and seeds were allowed to germinate in saturated soil conditions. Treatments were then evaluated for percentage of seeds that germinated within the row in which they were sown, and for number of seedlings per section of row. Results show Submerseed pellets have a high capacity for holding seeds in place and provide good germination.

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KEY WORDS
wetland revegetation, seeding, germination, Cyperaceae, Juncaceae

NOMENCLATURE
USDA NRCS (2005)

Figure 1. Wetland ecosystem at Kirch Wildlife Management Area, Nye County, Nevada. Photo by Derek J Tilley

Restoration of wetlands is important but often difficult to accomplish (Figure 1). Revegetating with seedlings grown in containers in greenhouses is expensive because of nursery production costs and labor associated with outplanting in the field. A simpler, more cost-effective approach would be direct seeding by discing seedbeds on the project site, broadcasting seeds, and packing seeds into the soil. Unfortunately, direct seeding is usually not practiced because of unpredictable results.

Unpredictable results of direct seeding can often be traced to the 3 major requirements that seeds need to germinate: adequate heat, water, and light (Hoag 2000). Drilling or chaining seeds will cover them with soil, blocking sunlight necessary for germination (Jones 1999; Hoag and others 2001). Broadcast seeding has yet to be proven successful because seeds of most of the commonly used wetland species either float or can be easily displaced by water or wind (Hoag 2000). Often, these same species are perennial plants that spread primarily through vegetative reproduction and thus allocate less energy and effort into seed production. Although proliferation of rhizomes is desirable for soil stabilization, these plants typically produce few seeds, and are of low viability (Van der Valk and others 1999; Steed and DeWald 2003).

Photo by Derek J Tilley

Figure 2. Submerseed™ particles incorporated with alkali bulrush seeds.

Photo by Derek J Tilley

Figure 3. Submerseed™ particle with *Juncus* seedlings (6 d after planting).

New technologies have been developed that may be adapted to the problems faced in direct seeding of wetlands. Tackifiers commonly used for hydroseeding are available to glue seeds to soil. Another product, Submerseed™ from Aquablok Industries (Toledo, Ohio), involves binding seeds with clay or clay-sized material and organic polymers to a dense aggregate core (Figure 2). These aggregates absorb water and sink, preventing seeds from floating to the surface (Krauss 2004; Submerseed 2005).

In a preliminary test using these products, our results showed excellent germination rates without seed loss due to washout (Figure 3). We were encouraged because these products made planting seeds a relatively easy task. In this study, we tested the effectiveness of 4 seeding methods when followed by a single simulated flooding event to determine which (if any) method provides greater establishment success. The 4 seeding methods included: 1) tackifier to simulate a hydroseeding; 2) Submerseed™; 3) surface pressed to simulate broadcast seeding followed by a lawn roller or seed imprinter; and 4) drilled to simulate use of a seed drill with packer wheels.

MATERIALS AND METHODS

The experiment was conducted at the USDA Natural Resources Conservation Service Plant Materials Center in Aberdeen, Idaho. Seeds of Nebraska sedge (*Carex nebrascensis* Dewey [Cyperaceae]) and Baltic rush (*Juncus balticus* Willd. [Juncaceae] (Table 1) were planted on 20 April 2005 into 56 cm x 41 cm (22 in x 16 in) greenhouse trays filled with a 1:1:1 (v:v:v) mix of peat, perlite, and sand. Rows were created using an imprinting jig designed to make eight, 30-cm (12-in) rows, 6 mm (0.25 in) wide and 6 mm (0.25 in) deep. Treatments were placed in a randomized complete block design with 8 replicates. For both the surface pressed and drilled treatments, seeds were sprinkled by hand at a rate of 0.10 g seeds per row

TABLE 1

Seed origin and characteristics.

Species	Common name	Collection location	Collection date	Purity (%)	Viability (%)	Estimated seeds/kg (lb)
Carex nebrascensis	Nebraska sedge	Aberdeen, Idaho, PMC wetland ponds	2000	99	88	1 852 000 (840 000)
Juncus balticus	Baltic rush	Sterling Wildlife Management Area, Bingham County, Idaho	2004	99	90	15 400 000 (7 000 000)

Photo by Derek J Tilley

Figure 4. Artificial wetland tank with greenhouse flats.

for *Carex* and 0.05 g seeds per row for *Juncus* providing approximately 185 *Carex* and 770 *Juncus* seeds per row. Seeds in the drilled and surface-pressed rows were then pressed into the soil using the imprinting jig to provide good seed-to-soil contact. Drilled rows were then covered with approximately 6 mm (0.25 in) of soil mix that was lightly pressed into the rows by hand. Tackifier treatments were applied as a tackifier–seed slurry using 0.05 g Turbo Tack High Performance Tackifier (Turbo Turf 2004) in 125 ml water with 0.80 g *Carex* seeds or 0.40 g *Juncus* seeds. The slurry was well agitated in a beaker and poured into the rows by hand. When poured over the 8 replicates this provided approximately the same seed rate as the drilled and surface-pressed treatments. Submerseed pellets were planted by hand at 20 pellets per row. With approximately 2 *Carex* seeds or 5 *Juncus* seeds per pellet, this provided about 40 *Carex* or 100 *Juncus* seeds per row.

The greenhouse trays were placed in a 1.2 m x 2.4 m x 0.3 m (4 ft x 8 ft x 1 ft) tank that was used to simulate a natural wetland in the PMC greenhouse (Figure 4). Water was added slowly to the tank allowing the trays to saturate from the bottom up to remove any air pockets in the medium. Water was then allowed to slowly spill over the edges of the greenhouse trays and into the rows. The tank was flooded until the water line was about 1.3 cm (0.5 in) above the medium surface. We then agitated the water in the tank by hand to create a current that would displace any floating seeds. After about 1 h the tank was drained until the water was just deep enough to keep the medium saturated. The tank was then covered with a clear sheet of plastic to maintain high temperatures and high humidity optimum for seed germination. Daily temperatures ranged between 24 and 38 °C (75 and 100 °F).

Rows were evaluated on 5 May 2005 (15 d after planting) for number of seeds germinated directly within the rows. Plants between rows were considered to be from displaced seeds and were not counted. *Carex* rows were evaluated for the number of

TABLE 2

Percentage of seed that remained in place and germinated following a simulated flood event.

Treatment	*Carex*	*Juncus*
Tackifier	22 b [z]	23 b
Submerseed™	57 a	66 a
Drill press	6 c	4 b
Surface press	14 bc	16 b

[z] Means followed by the same letter are not significantly different. $P \leq 0.05$

TABLE 3

Number of seedlings per segment of row.

Treatment	*Carex* Number/30 cm of row	*Juncus* Number/10 cm of row
Tackifier	40 a [z]	57 a
Submerseed™	23 b	22 bc
Drill press	11 b	10 c
Surface press	26 ab	41 ab

[z] Means followed by the same letter are not significantly different. $P \leq 0.05$

Photo by Derek J Tilley

Figure 5. Greenhouse flat with rows of *Carex* seedlings.

plants for the entire 31-cm (12-in) row, while *Juncus* rows were only evaluated in the middle 10 cm (4 in) because of the large number of seedlings in the *Juncus* rows. Germination percentage was determined by dividing the number of seedlings found by the estimated number of seeds placed in the rows (*Carex*) or row segment (*Juncus*). Data were then subjected to a single factor analysis of variance (ANOVA) and means separated using the Tukey test with a significance level of 0.05 (Zar 1999).

RESULTS

During the flooding we observed numerous seeds floating and being displaced from their rows, especially from the tackifier and surface-pressed treatments. These were presumably displaced and redeposited in a random fashion throughout the tank.

Percentage of seed germination within rows was significantly greater for both species with the Submerseed treatment (Table 2). Submerseed pellets did not float and seemed to provide an excellent medium for seed germination. Statistically, the other 3 treatments were not significantly different, except for *Carex* where seed drilling yielded significantly lower germination than the tackifier–seed slurry and surface-pressed treatments. Germination percentage was lowest for both species in the drilled treatment.

Because a much lower seed rate was used in the Submerseed treatment (40 *Carex* and 100 *Juncus* seeds/row) than in the tackifier, drilled, and surface-pressed treatments (185 *Carex* and 770 *Juncus* seeds/row), certain treatments, especially tackifier–seed slurry and surface pressed, yielded more seedlings per row than Submerseed despite apparently high levels of seed washout (Table 3). In both species the tackifier–seed slurry and surface-pressed treatments were not significantly different from each other but were significantly different from Submerseed and drill treatments (Figure 5).

MANAGEMENT IMPLICATIONS

Our results indicate that restorationists have several options when direct seeding wetlands, but drilling seeds is not one of them, probably because the seeds, covered with soil, lack adequate light to germinate (Hoag and others 2001). If seeds are in limited supply and (or) it is important to maintain a uniform planting density, however, then Submerseed has the greatest ability to keep seeds in place and provide adequate germination. For Submerseed, a seeding rate of 200 pellets/m^2 (20 pellets/ft^2) amounts to approximately 2.25 kg pure live seeds (PLS) per ha (2.0 lb PLS/ac) of *Carex* and 0.7 kg PLS/ha (0.6 lb PLS/ac) for *Juncus*. Submerseed would require an initial cost for processing the seeds you provide, but pellets can probably be applied to the site at relatively low cost either by tossing pellets from a bucket by hand or by spreading them using a hand-pushed or ATV-pulled fertilizer spreader.

Conversely, if seeds are in good supply and movement of seeds and possible nonuniform spacing of subsequent plants is not a concern, then good stands can be achieved by using tackifier in a hydroseeding situation, or by surface pressing the seeds into the soil with a roller or imprinter. Using either the tackifier or surface-pressed treatments, however, would require at least twice as many seeds as a Submerseed application to obtain equivalent stands. Applying seeds in a slurry with tackifier requires specialized equipment and will probably require contracting with private hydroseeding operators. Surface-pressed methods can be achieved by first broadcasting the seeds by hand or with a mechanical broadcaster followed by a roller or imprinter.

Controlling water levels and flows is probably the most important factor in direct seeding of wetlands. Our trial only looked at a single flooding event followed by saturated soil conditions. This may not be representative of natural conditions encountered when seeding a wetland. Multiple flooding events and stronger flows certainly have the potential to wash away or bury more seeds than occurred in our study. Long periods of high water levels can also reduce seed-to-soil contact, dissolve tackifier, or degrade Submerseed clays and polymers, all of which would release more seeds into the water. A high sediment load in the flood waters also has the detrimental potential of covering surface-pressed seeds, tackifier seeds, and Submerseed as the water evaporates or recedes into the soil. More evaluations need to be conducted in the field to determine appropriate seeding rates for each of these methods. We have studies planned to test these direct seeding methods under field conditions in artificial and natural wetlands, and to compare them with the cost and effectiveness of greenhouse propagated plugs.

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