Comparison of methods for seeding Nebraska sedge (*Carex nebrascensis* Dewey [Cyperaceae]) and Baltic rush (*Juncus balticus* Willd. [Juncaceae])

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INTRODUCTION

Restoration of wetlands is important but often difficult to accomplish. Vegetating wetlands with container grown greenhouse seedlings is expensive because of nursery production costs and the labor associated with outplanting in the field. A much simpler, more cost effective approach would be direct seeding by discing seedbeds on the project site, broadcasting seed, and packing or pressing seed into the soil. Unfortunately, direct seeding is usually not practiced because of unpredictable results and the lack of seed of the desired plant species.

Unpredictable results of direct seeding can often be traced to the three major requirements wetland species seed need to germinate: adequate heat, water, and light (Hoag 2000). Drilling or chaining, covers the seed with soil that blocks sunlight necessary for germination (Jones 1999; Hoag and others 2001). Further, broadcast seeding has yet to be proven successful because seed 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. While proliferation of rhizomes is desirable for soil stabilization, these plants typically produce very little seed and the seed produced typically has low viability (Van der Valk and others 1999; Steed and DeWald 2003).

New technologies have been developed that may be adapted to the problems faced in direct seeding wetlands. Tackifiers commonly used for hydro-seeding are available to glue seed to the soil. Another product, Submerseed™ from Aquablok Industries (Toledo, Ohio), involves binding seed with clay or clay-sized material and organic polymers to a dense aggregate core (Figure 1). These aggregates absorb water and sink, preventing seeds from floating to the surface (Krauss 2004; Submerseed 2005). In preliminary testing using these products, our results showed excellent germination rates without seed loss due to washout (Figure 2).

Figure 1. Submerseed™ particles incorporated with alkali bulrush seeds.

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 hydro-seeding; 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. Seed 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, 31 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, seed was broadcast by hand at a rate of 0.10 g seeds per row for *Carex* and 0.05 g seeds per row for *Juncus* providing approximately 185 *Carex* and 770 *Juncus* seeds/row. Seed 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* seed or 0.40 g *Juncus* seed. 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 seeding 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.

Figure 2. Submerseed™ particle with *Juncus* seedlings (six days after planting).

Table 1. Seed origin and characteristics.

Species	Common name	Collection location	Collection date	% Purity	% Viability	Estimated seeds/lb
Carex nebrascensis	Nebraska sedge	ID PMC wetland ponds	2000	99	88	840,000
Juncus balticus	Baltic rush	Sterling Wildlife Management Area, Bingham County, ID	2004	99	90	7,000,000

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 3). 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 which 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).

Figure 3. Artificial wetland tank with greenhouse flats.

Rows were evaluated on 5 May 2005 (15 days 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 plants for the entire 31 cm (12 in) of 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. Percentage germination 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. Percentage germination was lowest for both species in the drilled treatment. .

Table 2. Percent of seed that remained in place and germinated following a simulated flood event.

Treatment	*Carex*	*Juncus*
Tackifier	22b[1/]	23b
Submerseed	57a	66a
Drill Press	6c	4b
Surface Press	14bc	16b

[1/]Means followed by the same letter are not significantly different. $p \leq 0.05$

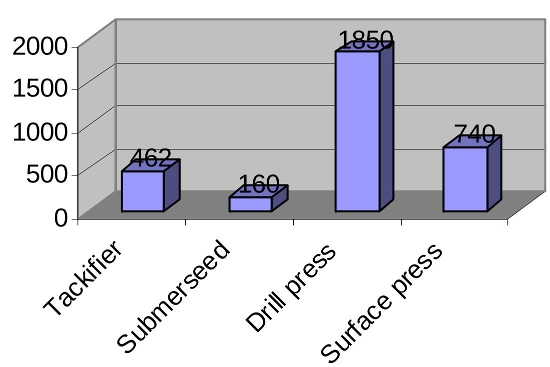
Because a much lower seeding rate was used in the Submerseed treatment (40 *Carex* and 100 *Juncus* seeds/row) than in the tackifier, drilled, and surface pressed treatments (185 *Carex* and 770 *Juncus* seeds/row), certain treatments, especially tackifier—seed slurry and surface pressed, yielded more 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 significantly different from Submerseed and drill treatments.

Table 3. Number of seedlings per segment of row.		
	Carex	*Juncus*
Treatment	#/12" of row	#/4" of row
Tackifier	40a[1/]	57a
Submerseed	23b	22bc
Drill Press	11b	10c
Surface Press	26ab	41ab
[1/]Means followed by the same letter are not significantly different. $p \leq 0.05$		

MANAGEMENT IMPLICATIONS

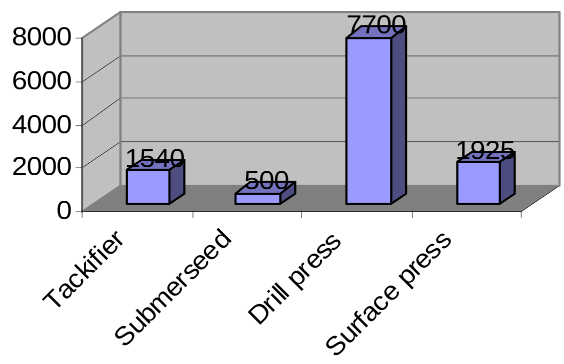
Our results indicate that several options are available for direct seeding wetlands, but drilling seeds is not one of them. If seed is in limited supply and (or) it is important to maintain a uniform planting density, Submerseed has the greatest ability to keep seed in place and provide adequate germination. Tables 4 and 5 show the approximate number of seeds required to establish 100 seedlings for each method. In all cases, Submerseed is most efficient followed by tackifier, surface pressing and finally drilling. For Submerseed, a seeding rate of 200 pellets/m2 (20 pellets/ft^2) amounts to approximately 2.25 kg PLS/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 costs either by tossing pellets from a bucket by hand or by spreading them using a hand-pushed or ATV-pulled fertilizer spreader.

Table 4. Seeds needed to establish 100 *Carex* seedlings



Conversely, if seed is in good supply and movement of seed and possible non-uniform spacing of subsequent plants is not a concern, then good stands can be achieved by using tackifier in a hydro-seeding 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 two to three times as much seed as a Submerseed application to obtain equivalent stands. Applying seed in a slurry with tackifer requires specialized equipment and will probably require contracting with private hydro-seeding 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.

Table 5. Seeds needed to establish 100 *Juncus* seedlings



Controlling water levels and flows is probably the most important factor in direct seeding 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 seed 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 seed into the water. A high sediment load in the flood waters also has potential of covering surface pressed seeds, tackifier seeds, and Submerseed as the water evaporates or recedes into the soil.

We recommend that additional studies 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 these studies with the cost and effectiveness of greenhouse propagated plugs.

REFERENCES

Hoag JC. 2000. Harvesting, propagating, and planting wetland plants. Aberdeen (ID): USDA Natural Resources Conservation Service Plant Materials Center. Riparian/Wetland Project Information Series 14. 9 p.

Hoag JC, Dumroese RK, Sellers, ME. 2001. Perigynium removal and cold, moist stratification improve germination of *Carex nebrascensis* (Nebraska sedge). Native Plants Journal 2:63-66.

Jones KL. 1999. Germination ecology of *Carex rostrata* (Stokes ex. With.) and *Carex nebrascensis* (Dewey) [MSc thesis]. Provo (UT): Brigham Young University. 106 p.

Krauss E. 2004. Personal communication. Toledo (OH):Aqualblok Ltd.

Steed JE, DeWald LE. 2003. Transplanting sedges (*Carex* spp.) in southwestern riparian meadows. Restoration Ecology 11(2):247—256.

Submerseed. 2005. Submerseed Composite Seeding Technology. URL: http://www.aquablokinfo.com/SubmerSeed/SSoverview.htm (accessed 4 Apr 2005).

Turbo Turf. 2004. URL: www.turboturf.com (accessed 5 Apr 2004).

[USDA NRCS] USDA Natural Resources Conservation Serivce. 2005. The PLANTS database, version 3.5. URL: http://plants.usda.gov. (accessed 3 Oct 2005). Baton Rouge (LA): National Plant Data Center.

Van der Valk AG, Bremholm TL, Gordon E. 1999. The restoration of sedge meadows: seed viability, seed germination requirements, and seedling growth of *Carex* species. Wetlands 19: 756—764.

Zar JH. 1999. Biostatistical analysis. Fourth edition. Delhi (India): Pearson Education, Inc. 663 p.