DIRECT SURFACE SEEDING SYSTEMS FOR THE ESTABLISHMENT OF NATIVE WILDFLOWERS IN 2016 AND 2017

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Introduction

Seed of native plants is needed to restore rangelands of the Intermountain West. Reliable commercial seed production is needed to make seed readily available. Direct seeding of native range plants in the Intermountain West is often problematic. Fall planting is helpful in establishing stands for many of these native species to overcome physiological dormancy through cold stratification. Fall planting alone may be insufficient for adequate stands for seed production, and it may be necessary to combine fall planting with other techniques.

Previous trials to address poor stand examined seed pelleting, planting depth, and soil anticrustant with four fall-planted species (Shock et al. 2010). Planting at depth with soil anticrustant improved emergence compared to surface planting whereas seed pelleting did not improve emergence. Planting at ⅛-inch depth resulted in higher emergence than either surface planting or planting at ¼-inch depth for three of the four species. Emergence for one species was too poor for any conclusions to be made. Despite these results, emergence was extremely poor for all species tested. Soil crusting, loss of soil moisture, and bird damage could have contributed to the poor emergence.

In established native perennial fields at the Malheur Experiment Station, Ontario, Oregon, and in rangelands, we observed prolific emergence from seed naturally falling on the soil surface and subsequently covered by thin layers of normally occurring organic debris. Building on this observation, we developed and tested planting systems, focusing on surface-planted seed (Table 1, Shock et al. 2012-2014). Treatments included row cover, sawdust, sand, and seed treatments. Row cover can act as a protective barrier against soil desiccation and bird damage. Sawdust was intended to mimic the protective effect of organic debris. Sand could help hold the seed in place. Seed treatment could protect the emerging seed from fungal pathogens that might cause seed decomposition or seedling damping off. Trials did not test all possible combinations of treatments, but focused on combinations likely to result in adequate stand establishment based on previous observations.

Materials and Methods

In 2016 and 2017, 14 species for which stand establishment has been problematic were included and an additional species (*Penstemon speciosus*) was chosen as a check, because it has reliably

produced adequate stands at Ontario. Seed weights for all species were determined. In November each year, a portion of the seed was treated with a liquid mix of the fungicides Thiram and Captan (10 g Thiram, 10 g Captan in 0.5 L of water). Seed weights of the treated seeds were determined after treatment. The seed weights of untreated and treated seed were used to make seed packets containing approximately 300 seeds each. The seed packets were assigned to one of seven treatments (Table 1). The trials were planted manually on November 23, 2015 and on December 1, 2016. The experiments had randomized complete block designs with six replicates. Treatments were planted on beds 30 inches wide by 5 ft long. The seed was placed on the soil surface in two rows on each bed.

The four factors (row cover, sawdust, sand, and mulch) were applied in combined systems after planting. Sawdust was applied in a narrow band over the seeded row at 0.26 oz/ft of row (558 lb/acre). For the treatment systems receiving both sawdust and sand, sand was applied at 0.65 oz/ft of row (1404 lb/acre) as a narrow band over the sawdust. Following planting and sawdust and sand applications, some beds were covered with row cover. The row cover (N-sulate, DeWitt Co., Inc., Sikeston, MO) covered four rows (two beds) and was applied with a mechanical plastic mulch layer. Mouse bait packs were scattered under the row covers. For the hydroseeding mulch treatments, 10 lb of hydroseeding paper mulch (Premium Hydroseeding Mulch, Applegate Mulch, http://applegatemulch.com) was mixed in 50 gal of water in a jet agitated 50-gal hydroseeder (Turbo Turf Technologies, Beaver Falls, PA). The mulch was applied with the hydroseeder in a thin 3-cm band over the seed row. In early April each year, the row cover was removed and the trial was sprayed with Poast® at 24 oz/acre for control of grass weeds. The trial was hand weeded. Emergence counts were recorded in all plots on May 2, 2016 and May 4, 2017.

Tetrazolium tests were conducted to determine seed viability of each species (Table 2) and the seed viability results were used to correct the emergence data to emergence as a percentage of planted viable seed. Data were analyzed using analysis of variance (General Linear Models Procedure, NCSS, Kaysville, UT). Means separation was determined using a protected Fisher's least significant difference test at the 5% probability level, LSD (0.05).

Results and Discussion

2016 Results

The row cover with sawdust plus seed treatment resulted in higher stands than no row cover (bare ground) with sawdust and seed treatment for *Chaenactis douglasii, Machaeranthera canescens, Phacelia hastata, P. crenulata, Heliomeris multiflora, Penstemon speciosus,* and *Achillea millefolium* (Table 3). Sawdust added to the row cover plus seed treatment only improved stand of *Penstemon speciosus* and reduced stand of *Nicotiana attenuata* and *Achillea millefolium.*

Adding seed treatment to sawdust plus row cover did not improve stand of any species and reduced stands of *Phacelia crenulata, Heliomeris multiflora,* and *Ipomopsis aggregata*. Adding sand to sawdust, seed treatment, plus row cover combination improved stand for *Machaeranthera canescens* and *Cleome lutea* and reduced stand for *Achillea millefolium.* Hydroseed mulch with seed treatment resulted in lower stand than row cover with seed treatment for *Machaeranthera canescens, Phacelia hastata, P. crenulata, Heliomeris multiflora, Nicotiana*

attenuata, Thelypodium milleflorum, Penstemon speciosus, and *Achillea millefolium.* For *Chaenactis douglasii, Phacelia linearis, Cleome lutea,* and *Ipomopsis aggregata,* there was no difference in stand between hydroseed mulch with seed treatment and row cover with seed treatment. However, for *Ipomopsis aggregata,* seed treatment was detrimental and all systems with seed treatment resulted in low stand, negating an evaluation of hydroseed mulch for this species.

2017 Results

The row cover with sawdust plus seed treatment resulted in higher stands than no row cover (bare ground) with sawdust and seed treatment only for *Machaeranthera canescens* (Table 4). Sawdust added to the row cover plus seed treatment did not improve stand of any species and reduced stand of *Nicotiana attenuata* and *Achillea millefolium.*

Adding seed treatment to sawdust plus row cover only improved stand of *Machaeranthera canescens* and *Chaenactis douglasii* and reduced stands of *Phacelia crenulata, Cleome serrulata,* and *Ipomopsis aggregata*. Adding sand to sawdust, seed treatment, plus row cover combination only improved stand of *Penstemon speciosus.* Hydroseed mulch with seed treatment resulted in lower stand than row cover with seed treatment for *Machaeranthera canescens, Nicotiana attenuata,* and *Achillea millefolium.* For the other species there was no difference in stand between hydroseed mulch with seed treatment and row cover with seed treatment. However, for *Ipomopsis aggregata,* seed treatment was detrimental and all systems with seed treatment resulted in low stand, negating an evaluation of hydroseed mulch for this species.

2-year Average Results

The row cover with sawdust plus seed treatment resulted in higher stands than no row cover (bare ground) with sawdust and seed treatment for *Machaeranthera canescens, Heliomeris multiflora, Penstemon speciosus,* and *Achillea millefolium* (Table 5). Sawdust added to the row cover plus seed treatment only improved stand of *Penstemon speciosus* and reduced stand of *Nicotiana attenuata* and *Achillea millefolium.*

Adding seed treatment to sawdust plus row cover only improved stand of *Machaeranthera canescens* and reduced stands of *Heliomeris multiflora, Ipomopsis aggregata, Phacelia crenulata,* and *Cleome serrulata*. Adding sand to sawdust, seed treatment, plus row cover combination improved stand of *Phacelia hastata* and *Cleome lutea* and reduced stand of *Achillea millefolium.* Hydroseed mulch with seed treatment resulted in lower stand than row cover with seed treatment for *Machaeranthera canescens, Phacelia hastata, Heliomeris multiflora, Nicotiana attenuata, Dalea ornata, Achillea millefolium,* and *Phacelia crenulata.* For the other species there was no difference in stand between hydroseed mulch with seed treatment and row cover with seed treatment. However, for *Ipomopsis aggregata,* seed treatment was detrimental and all systems with seed treatment resulted in low stand, negating an evaluation of hydroseed mulch for this species.

Averaged over species, the row cover with sawdust plus seed treatment resulted in higher stand than no row cover (bare ground) with sawdust and seed treatment in 2016, but not in 2017. Averaged over species, adding seed treatment to sawdust plus row cover reduced stands in 2016 and did not improve stands in 2017. Sawdust added to the row cover plus seed treatment did not

improve stands in 2016 and reduced stands in 2017. Adding sand to sawdust, seed treatment, plus row cover combination improved stands in 2016, but not in 2017.

Discussion

Snow cover over the winter of 2016-2017 was deeper and longer lasting than in 2015-2016. In the winter of 2015-2016 the ground was covered by snow continuously from December 18 to January 22 (36 days) with an average snow depth of 2.3 inches. In the winter of 2016-2017 the ground was covered by snow continuously from December 9 to March 5 (87 days) with an average snow depth of 13 inches. The longer snow cover in 2017 probably was a factor in row cover with sawdust plus seed treatment resulting in higher stand than no row cover (bare ground) with sawdust and seed treatment in 2016, but not in 2017.

Seed treatment, sawdust, and sand were factors that had inconsistent results for most species over the 2 years. Some species showed consistent results over the 2 years for seed treatment and sawdust. Seed treatment resulted in lower stands for *Ipomopsis aggregata* and *Phacelia crenulata* both years. Sawdust reduced stands of *Nicotiana attenuata* and *Achillea millefolium* both years.

References

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Table 1. Planting systems evaluated for emergence of 15 native plant species. Malheur Experiment Station, Oregon State University, Ontario, OR, fall 2015 and 2016.

#	Row cover	Seed treatment[a]	Sawdust	Sand	Mulch
1	yes	yes	yes	no	no
2	yes	yes	no	no	no
3	yes	no	yes	no	no
4	yes	yes	yes	yes	no
5	no	yes	yes	no	no
6	no	yes	no	no	yes
7	no	no	no	no	no

[a]Mixture of Captan and Thiram fungicides for prevention of seed decomposition and seedling damping off.

Table 2. Seed weights and tetrazolium test (seed viability) results for seed used for the planting system treatments in the fall of 2015 and 2016, Malheur Experiment Station, Oregon State University, Ontario, OR.

			Tetrazolium test	
Species	Common name	Preplant untreated seed weight	2016	2017
		seeds/g	%	
Chaenactis douglasii	Douglas' dustymaiden	682	72	29
Machaeranthera canescens	hoary tansyaster	1,590	70	83
Phacelia hastata	silverleaf phacelia	1,098	98	95
Phacelia crenulata	cleftleaf wildheliotrope	918	87	89
Phacelia linearis	threadleaf phacelia	4,091	98	98
Heliomeris multiflora	showy goldeneye	1,800	76	76
Nicotiana attenuata	coyote tobacco	8,333	90	93
Thelypodium milleflorum	manyflower thelypody	3,629	97	96
Ipomopsis aggregata	scarlet gilia	616	81	79
Penstemon speciosus	showy penstemon	662	85	86
Dalea ornata	Western prairie clover	341	84	83
Dalea searlsiae	Searls' prairie clover	274	81	51
Achillea millefolium	common yarrow	12,162	37	45
Cleome lutea	yellow beeplant	214	87	85
Cleome serrulata	Rocky Mountain beeplant	134	90	97

Table 3. Plant stands of 15 native plant species on May 2, 2016 in response to 7 planting systems used in November 2015. Stand for each species was corrected to the percent of viable seed based on the tetrazolium test. To evaluate systems, the following treatment comparisons were used: Row cover, treatments 1 and 5; Seed treatment, treatments 1 and 3; Sawdust, treatments 1 and 2; Sand, treatments 1 and 4. Oregon State University, Malheur Experiment Station, Ontario, OR.

Species	Row cover, seed treatment, sawdust	Row cover, seed treatment	Row cover, sawdust	Row cover, seed treatment, sawdust, sand	Seed treatment, sawdust	Mulch, seed treatment	Untreated check	Average
	---------- % stand ----------							
Chaenactis douglasii	22.3	16.3	24.2	23.2	10.7	14.2	5.3	16.6
Machaeranthera canescens	28.9	26.0	25.2	38.7	14.8	16.2	16.0	23.7
Phacelia hastata	23.2	28.3	21.8	31.7	11.1	3.6	8.5	18.3
Phacelia linearis	6.2	1.8	2.3	11.7	4.5	2.7	1.8	4.4
Heliomeris multiflora	33.1	31.0	44.9	41.2	6.7	1.2	2.3	22.9
Nicotiana attenuata	6.5	21.7	15.2	10.1	0.1	0.1	0.4	7.7
Thelypodium milleflorum	10.9	15.3	9.8	14.4	9.3	6.1	5.2	10.1
Ipomopsis aggregata	2.6	1.8	22.9	4.1	0.6	0.2	2.7	5.0
Penstemon speciosus	23.4	11.4	15.9	26.3	3.7	0.5	0.5	11.7
Dalea ornata	4.0	6.4	4.8	4.0	0.4	0.1	0.0	2.8
Dalea searlsiae	2.8	2.3	1.0	3.0	0.3	0.1	0.1	1.4
Achillea millefolium	27.9	51.1	25.7	18.2	10.5	8.0	9.3	21.5
Cleome lutea	19.0	14.4	18.2	28.9	11.9	6.3	6.1	15.0
Cleome serrulata	7.2	2.6	7.0	7.7	4.6	1.4	1.5	4.6
Phacelia crenulata	15.5	13.9	30.5	17.1	2.3	1.9	0.8	11.7
2016 Average	15.6	16.3	18.0	18.7	6.1	4.2	4.0	11.8

Table 4. Plant stands of 15 native plant species on May 4, 2017 in response to 7 planting systems used in November 2016. Stand for each species was corrected to the percent of viable seed based on the tetrazolium test. To evaluate systems, the following treatment comparisons were used: Row cover, treatments 1 and 5; Seed treatment, treatments 1 and 3; Sawdust, treatments 1 and 2; Sand, treatments 1 and 4. Oregon State University, Malheur Experiment Station, Ontario, OR.

Species	Row cover, seed treatment, sawdust	Row cover, seed treatment	Row cover, sawdust	Row cover, seed treatment, sawdust, sand	Seed treatment, sawdust	Mulch, seed treatment	Untreated check	Average
	---------- % stand ----------							
Chaenactis douglasii	26.2	21.5	13.5	25.3	26.2	24.4	12.9	21.4
Machaeranthera canescens	77.7	77.4	13.7	73.4	67.7	59.4	18.6	55.4
Phacelia hastata	9.5	13.7	12.3	15.2	11.8	11.8	12.7	12.4
Phacelia linearis	13.7	10.7	13.3	12.1	10.7	11.5	11.2	11.9
Heliomeris multiflora	7.7	8.7	16.2	10.2	8.2	11.3	12.4	10.7
Nicotiana attenuata	12.5	35.8	10.2	21.1	9.9	6.3	8.4	14.9
Thelypodium milleflorum	6.3	6.1	10.2	5.3	9.3	8.7	11.2	8.2
Ipomopsis aggregata	0.6	4.9	18.6	0.3	0.2	3.5	12.5	5.8
Penstemon speciosus	10.8	7.6	13.0	20.2	12.7	10.3	11.2	12.3
Dalea ornata	11.0	9.6	10.3	11.6	6.0	2.1	3.6	7.8
Dalea searlsiae	3.2	2.1	2.6	3.8	1.1	1.1	1.2	2.1
Achillea millefolium	30.6	49.0	36.4	27.4	31.1	38.6	46.0	37.0
Cleome lutea	18.1	19.0	26.1	24.6	22.5	21.2	32.5	23.4
Cleome serrulata	8.4	8.6	24.4	8.2	10.5	9.6	36.9	15.2
Phacelia crenulata	5.2	11.5	15.0	8.7	5.7	3.9	13.3	9.0
2017 Average	16.1	19.1	15.7	17.8	15.6	14.9	16.3	16.5

Table 5. Plant stands of 15 native plant species averaged over 2 years in response to 7 planting systems used in the previous fall. Stand for each species was corrected to the percent of viable seed based on the tetrazolium test. To evaluate systems, the following treatment comparisons were used: Row cover, treatments 1 and 5; Seed treatment, treatments 1 and 3; Sawdust, treatments 1 and 2; Sand, treatments 1 and 4. Oregon State University, Malheur Experiment Station, Ontario, OR, 2016-2017.

Species	Row cover, seed treatment, sawdust	Row cover, seed treatment	Row cover, sawdust	Row cover, seed treatment, sawdust, sand	Seed treatment, sawdust	Mulch, seed treatment	Untreated check	Average
				% stand				
Chaenactis douglasii	24.3	19.1	18.4	24.3	18.4	18.8	8.8	18.9
Machaeranthera canescens	53.3	51.7	19.4	56.1	41.2	37.8	17.3	39.6
Phacelia hastata	16.4	21.0	17.1	23.4	11.4	7.7	10.6	15.4
Phacelia linearis	9.9	6.2	7.8	11.9	7.6	7.1	6.5	8.2
Heliomeris multiflora	20.4	19.8	30.6	25.7	7.5	6.2	7.3	16.8
Nicotiana attenuata	9.5	28.7	12.7	15.6	5.0	3.2	4.4	11.3
Thelypodium milleflorum	8.6	10.7	10.0	9.8	9.3	7.4	8.2	9.2
Ipomopsis aggregata	1.6	3.4	20.8	2.2	0.4	1.9	7.6	5.4
Penstemon speciosus	17.1	9.5	14.5	23.2	8.2	5.4	5.9	12.0
Dalea ornata	7.5	8.0	7.5	7.8	3.2	1.1	1.8	5.3
Dalea searlsiae	3.0	2.2	1.8	3.4	0.7	0.6	0.6	1.8
Achillea millefolium	29.3	50.0	31.0	22.8	19.9	23.3	29.1	29.3
Cleome lutea	18.5	16.7	21.8	26.6	17.2	13.7	19.3	19.1
Cleome serrulata	7.8	5.6	15.7	8.0	7.6	5.5	19.2	9.9
Phacelia crenulata	10.3	12.7	22.8	12.9	4.0	2.9	7.0	10.4
2016-2017 Average	15.8	17.7	16.8	18.2	10.8	9.5	10.2	14.2
LSD (0.05)								
Treatment	1.4							
Species	2.4							
Year	0.9							
Species X year	3.5							
Treatment X species	6.4							
Treatment X year	2.4							
Treatment X species X year	9.2							