DIRECT SURFACE SEEDING SYSTEMS FOR THE ESTABLISHMENT OF NATIVE PLANTS IN 2016

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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 has been problematic for many species evaluated at the Malheur Experiment Station. Fall planting is important for many species to overcome physiological dormancy through cold stratification, yet this technique still has resulted in poor stands some years at the Malheur Experiment Station. Inadequate soil moisture, crusting, and seed predation by birds are identified hindrances to adequate stand establishment for fall-planted seed. Previous trials to address these issues examined seed pelleting, planting depth, and soil anticrustant with four species planted in the fall (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 positive 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 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 include row cover, sawdust, sand, and seed treatments. Row cover acts as a protective barrier against soil desiccation and bird damage. Sawdust was intended to mimic the protective effect of organic debris. Sand can help hold the seed in place. Seed treatment can 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, 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 good stands at Ontario. Seed weights for all species were determined. In November, 2016, 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 trial was planted manually on November 23, 2015. The experimental design was a randomized complete block with six replicates. Plots were one 30-inch-wide by 5-ft-long bed. 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 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 treatments receiving both sawdust and sand, sand was applied at 0.65 oz/ft of row (1,404 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 cover. For the hydroseeding mulch treatments, 10 lb of hydro seeding 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. On April 6, 2016, the row cover was removed and the trial was sprayed with Poast® at 24 oz/acre for control of grass weeds. The trial was then hand weeded. Emergence counts were recorded in all plots on May 2.

Tetrazolium tests were conducted to determine seed viability of each species (Table 2) and the 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). To evaluate factors, 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; mulch, treatments 2 and 6.

Results and Discussion

2016 Results

Stand of *Phacelia linearis, Dalea ornata, D. searlsiae, and Cleome serrulata* across all treatments was 10% or less (Table 3). There was no significant difference in stand between planting systems for *Phacelia linearis, Dalea ornata, D. searlsiae,* and *Cleome serrulata*. There were statistically significant differences in stand between planting systems for 11 species.

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, Nicotiana attenuata,* and *Ipomopsis aggregata*. Adding sand to sawdust, seed treatment, plus row cover combination improved stand for *Machaeranthera canescens, Phacelia hastata, Heliomeris multiflora, and Cleome lutea,* but 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, Achillea millefolium,* and *Cleome lutea.* For *Ipomopsis aggregatta,* there was no difference in stand between Hydroseed mulch with seed treatment and row cover with seed treatment. However, for *Ipomopsis aggregatta,* 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, row cover with sawdust plus seed treatment resulted in higher stands than no row cover (bare ground) with sawdust and seed treatment. Averaged over species, adding sawdust to row cover and seed treatment did not improve stand. Averaged over species, when seed treatment was added to the row cover and sawdust combination, stands were reduced. Adding sand to sawdust, seed treatment, plus row cover combination increased stand. Applying hydroseed mulch over the seed row resulted in lower stand than row cover with seed treatment.

2013, 2015, 2016 Results

A subset of 8 of the 15 species in the 2016 trial were included in emergence trials in 2013 and 2015 (Shock et al. 2013, 2016) testing the same establishment systems. These results are presented in Table 4. The 3-year results show that planting systems that include row cover have most consistently improved stand establishment. Sawdust and sand are factors that for some species in some years have shown value in improving stand, but their performance has not been consistent. Averaged over the 3 years, sawdust had a negative effect on stand for *Phacelia hastata, Nicotiana attenuata,* and *Thelypodium milleflorum,* and a positive effect for *Machaeranthera canescens.* Averaged over the 3 years, sand had a positive effect on stand for *Chaenactis douglasii* and *Heliomeris multiflora.*

Seed treatments with the fungicides Thiram and Captan have generally had no effect or a negative effect on stand establishment. In the 3 years of testing, seed treatment improved stand only of *Penstemon speciosus* and *Machaeranthera canescens* in 2013. Seed treatment reduced stands of *Ipomopsis aggregata* in 2013 and 2016, *Heliomeris multiflora* in 2015 and 2016, *Nicotiana attenuata* in 2016, and *Phacelia hastata* in 2015.

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Table 1. Planting systems evaluated for emergence of 15 native plant species. Malheur Experiment Station, Oregon State University, Ontario, OR, 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 evaluated in the spring of 2016, Malheur Experiment Station, Oregon State University, Ontario, OR.

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

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 factors, 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 crenulata	15.5	13.9	30.5	17.1	2.3	1.9	0.8	11.7
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
Average	15.6	16.3	18.0	18.7	6.1	4.2	4.0	
LSD (0.05)								
Treatment	1.6							
Species	2.8							
Treatment X species	7.3							

Table 4. Plant stands of nine native plant species in response to seven planting systems used in 2013, 2015, and 2016. Stand for each species was corrected to the percent of viable seed based on the tetrazolium test. To evaluate factors, 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. Continued on next page

Year	Species	Row cover, seed treatment, sawdust	Row cover, seed treatment	Row cover, sawdust	Seed treatment, sawdust	Row cover, seed treatment, sawdust, sand	Mulch, seed treatment	Untreated check	Average
		% Stand							
2013	*Chaenactis douglasii*	18.8	26.5	17.5	4.2	39.1	12.2	5.4	17.7
	Machaeranthera canescens	67.3	47.4	48.8	18.7	57.7	19.1	22.1	40.2
	Phacelia hastata	10.6	23.6	19.9	1	14.2	0.7	2	10.3
	Phacelia linearis	2.6	0.1	0.1	0	2.7	0	0.1	0.8
	Heliomeris multiflora	8	14.3	11.2	0.3	17.4	0.1	0.3	7.4
	Nicotiana attenuata	4.4	11.8	1.8	0	4.2	12.2	0	4.9
	Thelypodium milleflorum	23.2	37	28.5	1.7	19.7	2.4	2	16.4
	Ipomopsis aggregata	0.3	1.1	14.3	0	1	0	0.7	2.5
	Penstemon speciosus	27	27	7.6	0	33.1	0.7	0.1	13.6
	Average	18	21	16.6	2.9	21	5.3	3.6	12.6
2015	*Chaenactis douglasii*	3.9	2.9	14.8	2.6	4.3	1.1	7.3	5.3
	Machaeranthera canescens	35.4	30.7	30.5	17.7	27.4	8.3	17.4	23.9
	Phacelia hastata	0.9	2.5	1.8	2.2	2.4	2.3	1.3	1.9
	Phacelia linearis	9	4	3.1	5	11.6	4.4	1.8	5.6
	Heliomeris multiflora	27.5	27.1	44.4	9.1	31.6	6	9.9	22.2
	Nicotiana attenuata	1.2	0.8	1.8	0.2	1.3	0	0.3	0.8
	Thelypodium milleflorum	1.4	2.1	2.1	1.2	2.2	1.6	1.6	1.7
	Ipomopsis aggregata	0.3	1.7	2.5	0.7	2.2	0.6	0.3	1.2
	Penstemon speciosus	4.7	1.6	2.1	1.3	10.2	0.6	1.6	3.2
	Average	9.4	8.2	11.5	4.4	10.4	2.8	4.6	7.3

Table 4. Continued. Plant stands of nine native plant species in response to seven planting systems used in 2013, 2015, and 2016. Stand for each species was corrected to the percent of viable seed based on the tetrazolium test. To evaluate factors, 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.

Year	Species	Row cover, seed treatment, sawdust	Row cover, seed treatment	Row cover, sawdust	Seed treatment, sawdust	Row cover, seed treatment, sawdust, sand	Mulch, seed treatment	Untreated check	Average
		% Stand							
2016	*Chaenactis douglasii*	22.3	16.3	24.2	10.7	23.2	14.2	5.3	16.6
	Machaeranthera canescens	28.9	26	25.2	14.8	38.7	16.2	16	23.7
	Phacelia hastata	23.2	28.3	21.8	11.1	31.7	3.6	8.5	18.3
	Phacelia linearis	6.2	1.8	2.3	4.5	11.7	2.7	1.8	4.4
	Heliomeris multiflora	33.1	31	44.9	6.7	41.2	1.2	2.3	22.9
	Nicotiana attenuata	6.5	21.7	15.2	0.1	10.1	0.1	0.4	7.7
	Thelypodium milleflorum	10.9	15.3	9.8	9.3	14.4	6.1	5.2	10.1
	Ipomopsis aggregata	2.6	1.8	22.9	0.6	4.1	0.2	2.7	5.0
	Penstemon speciosus	23.4	11.4	15.9	3.7	26.3	0.5	0.5	11.7
	Average	17.5	17.1	20.2	6.8	22.4	5	4.8	13.4
Average	*Chaenactis douglasii*	15.7	15.2	18.6	5.8	22.2	9.2	6	13.2
	Machaeranthera canescens	44.3	34.7	34.8	17.1	41.3	14.5	18.5	29.3
	Phacelia hastata	11.6	18.2	14.5	4.9	16.1	2.2	3.8	10.2
	Phacelia linearis	5.9	1.9	1.8	3.2	8.7	2.4	1.3	3.6
	Heliomeris multiflora	22.9	24.1	33.5	5.4	30	2.4	4.2	17.5
	Nicotiana attenuata	4.1	11.4	6.3	0.1	5.2	4.1	0.2	4.5
	Thelypodium milleflorum	11.8	18.1	13.5	4.1	12.1	3.4	2.9	9.4
	Ipomopsis aggregata	1.1	1.5	13.2	0.4	2.4	0.3	1.3	2.9
	Penstemon speciosus	19.2	14	8.5	1.7	23.2	0.6	0.7	9.7
	Average	15.2	15.5	16.1	4.7	17.9	4.3	4.3	11.1
	LSD (0.05)								
	Treatment	1.6							
	Species	2.3							
	Year	1.1							
	Treatment X species	6.2							
	Treatment X species X year	8.9							