Technical Report
December 15, 2020

Assessing cost-effectiveness and establishment in prairie strips using surface and drill seeding methods

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Key Findings

- Surface seeding is a more cost-effective method than drill seeding when using a seed mix dominated by small-seeded species
- Small-seeded species were roughly twice as abundant in surface-seeded compared to drill-seeded treatments
- Both methods produced stands with similar native cover and species richness
- Seed should be sown in planting equipment that allows large-seeded species to be drilled into the ground while small seeds are placed on the surface

Introduction

Integrating reconstructed tallgrass prairie stands within and around crop fields holds great promise in reducing nutrient loss and increasing other ecological benefits. Past work shows that prairie strips reduce up to 90% of N and P surface runoff, reduce nitrates in shallow groundwater (Zhou et al. 2014), and fuel the denitrification process (Iqbal et al. 2014). Tallgrass prairie in and around farm fields can also enhance other ecological benefits like soil quality improvement, wildlife and pollinator habitat, and flood resilience (Schulte et al. 2017; Kordbacheh et al. 2020).

As the ecological benefits of tallgrass prairie become better understood, there are more initiatives to reconstruct prairie or prairie-like vegetation on agricultural landscapes. In addition to the broad adoption of USDA's Pollinator Habitat Initiative (CP-42) which established over 80,000 ha of native vegetation in Iowa from 2014-2018, the new Farm Bill establishes prairie strips as a Conservation Practice (CP-43) for the Conservation Reserve Program (CRP). This practice is flexible and easy to integrate into conventionally farmed fields (Farm Service Agency 2019). Given its relative adaptability and provision of multiple ecosystem benefits, the Prairie Strips practice has great potential to be widely adopted and highly impactful in agricultural landscapes.

Given the potential for many new adopters, it is important to ensure farmers succeed with their first experience planting tallgrass prairie. However, farmer success with this practice can be uneven due to a lack of training in planting and establishing prairie vegetation, and because current recommendations are often not based on limited applicable scientific research. The comparatively high initial cost of planting tallgrass prairie further increases the need for planting guidelines that help ensure predictably successful outcomes. In order to inform such guidelines, we need a better understanding of the methods that can achieve success in a cost-effective way.

In current practice, prairies are planted using an array of methods that focus on efficient seed sowing. Many practitioners prefer using seed drills, which ensure seed to soil contact and are familiar in conventional farm operations. Specialized native seed drill rentals are often available from county or regional wildlife organizations, making them relatively easy to access as a seeding method. Other practitioners prefer to use broadcast seeders which scatter seeds on the surface, and are often used in natural areas restoration using bulk harvested seed. Past research comparing these methods has shown broadcast seeding to produce better outcomes for some broad groups of species (forbs) and drill seeding to produce better outcomes for others (C4 grasses) (Larson et al. 2017). However, it is still unknown which method results in more cost-effective stands and why different species may establish better using different seeding methods.

Seed traits may help determine how species establish under varying planting conditions. Specifically, small seed size may increase a species' reliance on light for optimal germination and establishment. One study showed that small-seeded species germinated better with increasing levels of light (Jankowska-Blaszczuk & Daws 2007). Another found that small-seeded species only established well in the highest light conditions (bare soil compared to mowed or grazed areas) (Kahmen & Poschlod 2008). In the case of drill seeding (typically ~ 6 mm depth), small seeds may not receive the necessary light to germinate well. Light penetrates only 4 to 10 mm into the soil, and at the low end of that range when soils are dark and of small particle size (e.g., clay or silt loams) (Baskin & Baskin 2014). If seed size influences a species' ability to establish at different depths, practitioners may be able to increase cost effectiveness by calibrating or modifying planting equipment to seed small species separately and on the soil surface.

We assessed the effect of seeding depth used in planter equipment in a series of field trials conducted in recently retired farmland. Our objectives were to 1) evaluate plant establishment and cost-effectiveness for prairie plantings that were either surface- or drill-seeded, and 2) determine whether seed size provides a mechanism to explain differences in seeding method performance.

Materials and Methods

Study site

The study site is located at the Prairie on Farms Research and Demonstration Site in Cedar Falls, IA (42° 51´ N, 92° 48´ W) in Black Hawk County (Fig. 1). The soil underlying the study site is primarily poorly drained Clyde clay loam (NRCS-Natural Resources Conservation Service 2016). Topographically, the study site is located on a low rolling hill, but slopes do not exceed 5% grade. Land use prior to this experiment was agricultural, with corn and soybeans consistently grown in rotation at the site.

We prepared the study site using tillage after crop production. In the summer of 2018, the farm operator grew corn throughout the site. The farm operator used a combine without a chopping header to harvest in the fall of 2018, leaving heavy residue throughout the site. To create a suitable seedbed before planting in the spring of 2019, we used four passes of disc cultivation, followed by one pass with a harrow in fall 2018. The prepared seedbed was firm, with clods less than 6.4 mm in diameter.

Study design

To assess cost-effectiveness and ecological performance of different seeding methods, weinstalled a pilot experiment with a completely randomized design consisting of four replicates in May 2019 (Fig. 2). We established a 35 × 90 m study area consisting of eight 8 × 30 m plots and a small informal demonstration area south of the plots. We randomly assigned a seeding method, surface seeding or drill seeding, to each plot (n = 8). We manipulated seeding methods at two levels: 1) surface-seeded and 2) drill-seeded.

We conducted establishment mowing over the first growing season to control weed growth. We mowed plots to 11.4 cm when vegetation height reached approximately 50 cm (4 total mowings: June 12, July 11, August 8, October 28), and left the resulting thatch on site.

Data collection and analysis

We measured plant density and canopy cover in September 2019 and August 2020, and used density estimates to calculate establishment and cost-effectiveness metrics. We sampled later in the year to allow seedlings to grow to a size that allowed for confidence in seedling identification. To sample plant density and canopy cover, we used eight 0.25 m^2 quadrats spaced every 3 m along a 27 m transectplaced randomly in each plot. To reduce edge effects, we did not lay quadrats within 1 m (north/south) or 3 m (east/west) of plot borders. In each quadrat, we counted and identified all individuals (ramets) of seeded species >10 cm tall. We recorded canopy cover values (Daubenmire classes) for each species and bare ground. To assess responses from functional groups and trait groups, we summed ramets and cover values among species belonging to each group. We also assessed responses of general vegetation types based

Figure 1: Location of study site within Iowa.

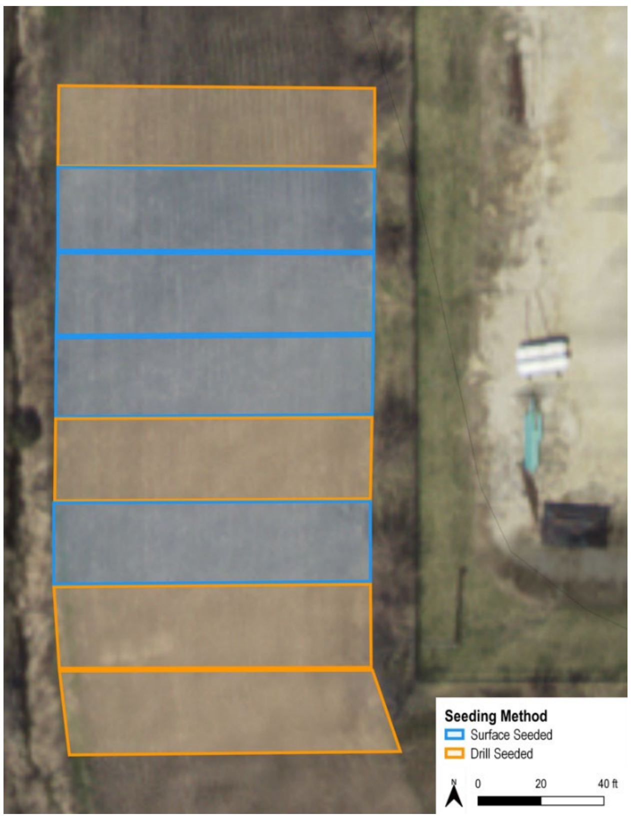

Figure 2: Experimental layout at the Prairie on Farms Research and Demonstration Area in Cedar Falls, Iowa.

on typical land management objectives of prairie strips (i.e. prioritizing native perennial plants of high conservation value). We defined the following classifications within this group: 1) sown species (sown forbs and graminoids), 2) bare ground, 3) ruderal weeds (annual or biennial species of any origin with a coefficient of conservatism (CoC) ≤ 1), 4) ruderal native perennials (unsown perennial native species with CoC ≤ 1), 5) perennial weeds (introduced perennial species), 6) woody plants (tree and shrub species of any origin), and 7) other native species (unsown native species with CoC ≥ 2).

To assess cost-effectiveness, we divided the cumulative number of observed ramets of each sown species in each plot by the cost of seed per plot for each species (stems/$1). To analyze the effects of seeding method on cost-effectiveness and native plant establishment, we used Welch's t-tests with 2020 data (excepting cumulative measures). We used t- tests to compare differences in vegetation and cost-effectiveness measures (both overall and within functional groups) with a significance threshold of $p < 0.05$ among seed mix treatments. For all analyses, we used R (R Core Team 2020).

Results

With some exceptions, we found that seeding method influenced metrics of overall plant establishment. On average, surface- seeded plantings produced nearly twice as many stems overall (240 stems/m^2 (SE, 24 stems/m^2)) than drill-seeded ones (138 stems/m^2 (SE, 23 stems/m^2)) ($t = 3.0$, $df = 6.0$, $p < 0.05$) (Fig. 3). Species richness was very similar among seeding treatments, and surface-seeded plantings contained 17 species (SE, 2 species) and drill-seeded plantings 16 species (SE, 2 species). This difference was not statistically significant. We found that overall seedling emergence was low in both treatments, but we observed seedling emergence to be higher in surface seeded (17% (SE, 2%)) compared to drill seeded plantings (16% (SE, 2%)) ($t = 2.6$, $df = 5.3$, $p < 0.05$). Even though the overall plot level emergence rates were low, we found that many species established at uncharacteristically high rates, with estimates of seedling emergence nearing 50% for *Sporobolus compositus* and *Heliopsis helianthoides*.) Emergence rates derived from observed species densities are reported in (Table 1)

Table 1. Species emergence of seed mix dominated by small seeded species. Values reflect plants observed during the first growing season divided by seeds sown for each species among all plots where it was planted (n=8).

Common Name	*Scientific Name*	*Emergence (%)*	*± SE*
smooth oxeye	*Heliopsis helianthoides*	55.16	21.02
composite dropseed	*Sporobolus compositus*	49.50	10.85
wild quinine	*Parthenium integrifolium*	43.55	15.48
wholeleaf rosinweed	*Silphium integrifolium*	40.64	13.71
showy ticktrefoil	*Desmodium canadense*	37.74	16.96
roundhead lespedeza	*Lespedeza capitata*	34.84	13.88
Canada wildrye	*Elymus canadensis*	32.52	6.51
Indiangrass	*Sorghastrum nutans*	26.13	5.04
sideoats grama	*Bouteloua curtipendula*	24.39	5.74
big bluestem	*Andropogon gerardii*	23.81	4.25
common milkweed	*Asclepias syriaca*	23.23	8.78
arctic brome	*Bromus kalmii*	20.90	3.40
Mexican muhly	*Muhlenbergia mexicana*	15.39	3.01
blackeyed Susan	*Rudbeckia hirta*	11.90	2.30
partridge pea	*Chamaecrista fasciculata*	8.71	4.25
biennial beeblossom	*Oenothera gaura*	8.71	6.11
largeleaf wild indigo	*Baptisia lactea*	5.81	5.81
stiff sunflower	*Helianthus pauciflorus ssp. pauciflorus*	5.81	3.80
white sagebrush	*Artemisia ludoviciana*	2.71	0.64
Virginia mountainmint	*Pycnanthemum virginianum*	1.94	0.64
flat-top goldentop	*Euthamia graminifolia*	0.97	0.77
great blue lobelia	*Lobelia siphilitica*	0.93	0.56
prairie wedgescale	*Sphenopholis obtusata*	0.87	0.36
bluejoint	*Calamagrostis canadensis*	0.58	0.24
tall cinquefoil	*Drymocallis arguta*	0.58	0.41
fowl mannagrass	*Glyceria striata*	0.58	0.31

Seeding method influenced sown species differently based on seed size. Specifically, small- seeded species respond positively to surface sowing (Fig. 4). We found 154 stems/m² (SE, 26 stems/m²) of small-seeded species in surface-seeded treatments, which was about twice as many stems as in drill-seeded plantings (77 stems/m² (SE, 16 stems/m²)) ($t = 2.5$, $df = 5.0$, $p > 0.05$). We did not detect a significant difference between surface (86 stems/m² (SE, 6 stems/m²)) and drill seeding (61 stems/m² (SE, 12 stems/m²)) with large-seeded species. Several species responded strongly to different seeding methods when considered individually. We found three small-seeded species with much higher stem densities in surface compared to drill seeded plantings. White sagebrush (*Artemisia ludoviciana*) was nearly twelve times more abundant, composite dropseed (*Sporobolus compositus*) approximately twice as abundant, and great blue lobelia (*Lobelia siphilitica*) over 80% more abundant in surface- compared to drill-seeded treatments. We did not observe any small-seeded species to perform substantially better in drill-seeded compared to surface-seeded plantings. Several large-seeded species were more abundant in drill-seeded compared to surface-seeded plots, including wholeleaf rosinweed (*Silphium integrifolium*) which was four times more abundant. Biennial beeblossom (*Oenothera gaura*) and stiff sunflower (*Helianthus pauciflorus* ssp. *pauciflorus*) were large-seeded species recorded only in drill-seeded plantings. We found two large-seeded species to be more abundant in broadcast compared to drill seeding treatments— sideoats grama (*Bouteloua curtipendula)* was

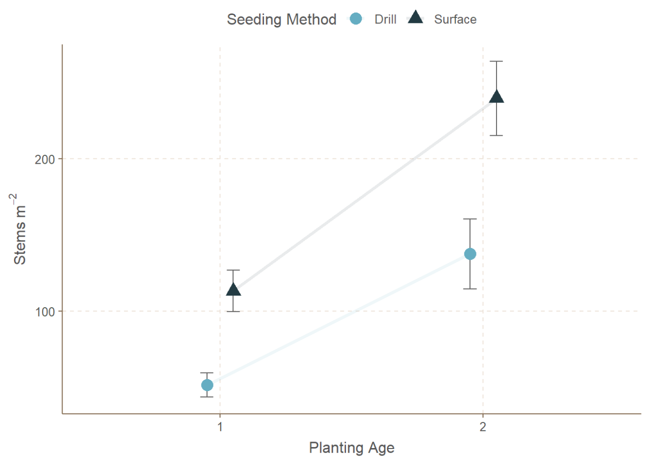

Figure 3: Ramet density of all sown native species among seed mixes sown on the surface or drilled into the soil.

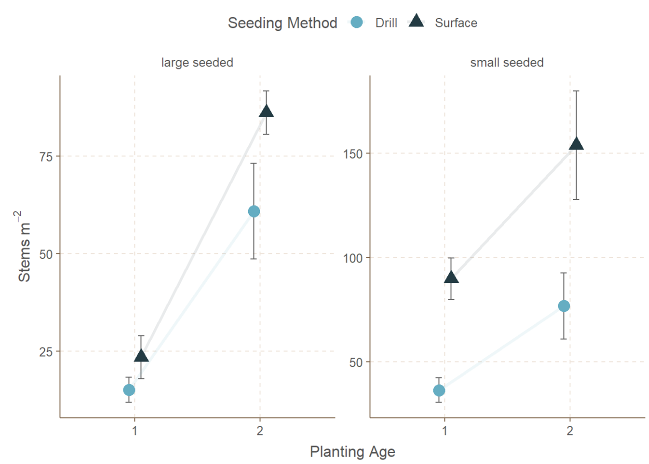

Figure 4: Ramet density of large and small seeded native species among seed mixes sown on the surface or drilled into the soil.

over three times more abundant and smooth oxeye (*Heliopsis helianthoides*) was over seven times more abundant in surface compared to drill seeded plantings.

Canopy cover of general vegetation types in the second growing season was typically not different between treatments, though we found evidence for differences in weed cover between seeding methods. The general makeup of both treatments was somewhat atypical for a two-year-old prairie planting in post long-term conventional agricultural fields— both were similarly dominated by unsown ruderal native perennials (Fig. 5). Ruderal native perennial cover averaged 34% to 38%. All other unsown native species were found at unimportant levels (< 1% canopy cover). Bare ground cover was also similar among

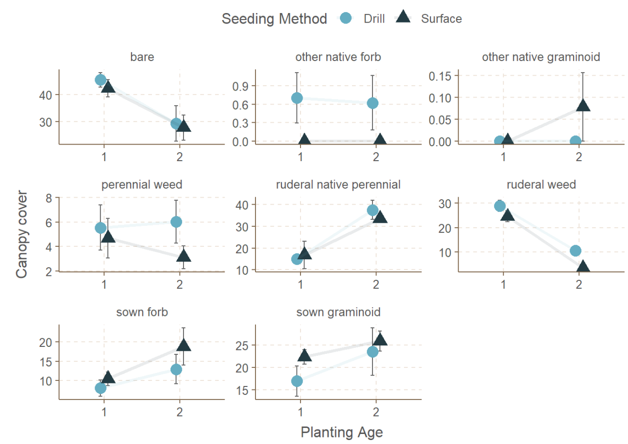

Figure 5: Canopy cover of general vegetation types observed among seed mixes sown on the surface or drilled into the soil.

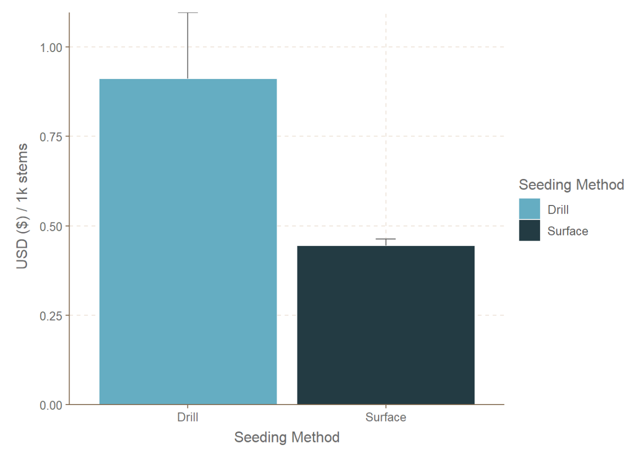

Figure 6: Cost (US dollars) to produce one thousand stems among seed mixes sown on the surface or drilled into the soil. Costs reflect the price of seed mix..

treatments, ranging from 28% to 29%. While ruderal weed cover was low overall among seeding treatments, surface-seeded plantings produced about three times less ruderal weed cover (3% canopy cover (SE, 0% canopy cover)) compared to drill-seeded plantings (11% canopy cover (SE, 2% canopy cover)) ($t = 3.8$, $df = 3.2$, $p < 0.05$). We also found canopy cover of perennial weeds (3% canopy cover (SE, 1% canopy cover)) to be about two times less in surface-seeded plantings compared to drill-seeded plantings (6% canopy cover (SE, 2% canopy cover)) (difference not significant). We observed that surface-seeded treatments produced more forb cover (19% canopy cover (SE, 5% canopy cover)) and grass cover (26% canopy cover (SE, 2% canopy cover)) compared to

Table 2. Number of plants produced from $1 of seed. Values reflect 2020 plants per dollar for each species among all plots where it was planted (n=8).

Common Name	*Scientific Name*	*Plants/$1*	*± SE*
composite dropseed	*Sporobolus compositus*	8152.17	1185.67
blackeyed Susan	*Rudbeckia hirta*	7462.37	1836.73
big bluestem	*Andropogon gerardii*	4646.97	881.06
Canada wildrye	*Elymus canadensis*	3398.36	657.10
Indiangrass	*Sorghastrum nutans*	2938.03	608.51
sideoats grama	*Bouteloua curtipendula*	2169.73	542.49
partridge pea	*Chamaecrista fasciculata*	1021.92	386.25
Mexican muhly	*Muhlenbergia mexicana*	848.07	115.24
arctic brome	*Bromus kalmii*	742.60	139.76
smooth oxeye	*Heliopsis helianthoides*	693.63	196.56
showy ticktrefoil	*Desmodium canadense*	216.77	54.62
roundhead lespedeza	*Lespedeza capitata*	162.58	84.25
wild quinine	*Parthenium integrifolium*	151.55	83.22
fowl mannagrass	*Glyceria striata*	140.76	65.16
flat-top goldentop	*Euthamia graminifolia*	132.86	65.86
great blue lobelia	*Lobelia siphilitica*	98.80	41.28
white sagebrush	*Artemisia ludoviciana*	87.10	30.82
common milkweed	*Asclepias syriaca*	58.06	24.44
prairie wedgescale	*Sphenopholis obtusata*	45.99	22.44
tall cinquefoil	*Drymocallis arguta*	43.90	21.42
largeleaf wild indigo	*Baptisia lactea*	43.87	26.32
Virginia mountainmint	*Pycnanthemum virginianum*	38.92	20.17
wholeleaf rosinweed	*Silphium integrifolium*	37.16	15.53
biennial beeblossom	*Oenothera gaura*	33.00	13.79
bluejoint	*Calamagrostis canadensis*	31.91	15.57
stiff sunflower	*Helianthus pauciflorus ssp. pauciflorus*	19.84	13.92
pale purple coneflower	*Echinacea pallida*	14.52	14.52

drill-seeded ones (13% canopy cover (SE, 4% canopy cover) for sown forbs; 24% canopy cover (SE, 5% canopy cover) for sown graminoids), though these differences were not statistically significant (Fig. 5).

Seeding method influenced cost effectiveness measures. We found that surface seeding ($0.44/1000 stems (SE, $0.02/1000 stems)) was approximately two times more cost effective than drill seeding ($0.91/1000 stems (SE, $0.18/1000 stems)), though this finding was only marginally statistically significant ($t = 2.5$, $df = 3.1$, $p > 0.05$) (Fig. 6). Of species we observed to establish using both seeding methods, composite dropseed (*Sporobolus compositus*), blackeyed Susan (*Rudbeckia hirta*) and big bluestem (*Andropogon gerardii*) were the top three most cost-effective species with plants/$1 values ranging from 8152 plants/$1 (SE, 1837 plants/$1) to 4647 plants/$1 (SE, 881 plants/$1) (Table 2). Species with low (but not zero) cost-effectiveness included bluejoint (*Calamagrostis canadensis*), stiff sunflower (*Helianthus pauciflorus* ssp. *pauciflorus*), and pale purple coneflower (*Echinacea pallida)* with plants/$1 values ranging from 32 plants/$1 (SE, 16 plants/$1) to 15 plants/$1 (SE, 14 plants/$1).

Discussion

Both drill- and surface-seeding methods produce successful stands, but surface-seeding improves overall establishment of sown species. In our study, initial density of sown species was very high, and well over the threshold some authors set for long-term expectations of stand success (11 stems/m² (Smith et al. 2010)). Surface seeding approximately doubled sown species density compared to drill seeding. By the second year, density further increased, suggesting these plantings are likely to remain on track to produce satisfactory long-term ecological outcomes. Interestingly, among other establishment metrics like sown species canopy cover and species richness, we found little difference among seeding methods. Yurkonis and others (2010) found a similar result using a C4 grass-dominated tallgrass prairie seed mix and showed insignificant differences in relative abundance and species richness in prairies seeded using broadcast or drill methods. In contrast, a similar study using the same seed mix as Yurkonis and others found a consistent improvement in establishment metrics of species richness and sown species cover when drill seeding compared to broadcast seeding (Larson et al. 2011). The discrepancy in our results may be the result of contrasting seed mixes: our study seed mix was dominated by small species which would be expected to perform best when surface sown, while their mix was dominated by C4 grasses which have been shown to perform well when drill seeded (Redmann & Qi 1992).

Surface seeding improves establishment of small-seeded species, and seed size provides a mechanism for understanding the improved performance of surface seeding as a whole. We found that small-seeded species, but not large-seeded ones, were more abundant when surface seeded compared to drill seeded. While some key large-seeded species performed better with surface seeding (e.g. *Heliopsis helianthoides*, *Bouteloua curtipendula*), the majority of species with improved establishment with surface seeding were small. Our results accord with other studies in seed ecology. In a review of seed germination ecology literature, Baskin and Baskin (2014) show that many species require light to germinate, and that as little as 2 mm of soil can inhibit germination for many species. Further, they showed that small seeds establish best in bare, unshaded environments, which would accord with our finding that small-seeded species established better when seeded on the surface rather than buried in ~ 6 mm of dark, clay loam soil. We also found some of the species that Baskin and Baskin (2014) identified to require light for germination (e.g. *Lobelia* spp.) at higher abundance in surface seeded plantings.

Under the conditions of our study, drill seeding provides limited benefits compared to surface seeding. We found that no group of species performed better when drilled, though a few species appeared to be reliant on soil burial to establish at all, such as *Oenothera gaura* and *Helianthus pauciflorus*. It is possible that these species were particularly palatable to granivores (Riebkes et al. 2018), and thus burial may have provided a means to escape predation. Unlike other studies of tallgrass prairie seeding methods, we did not find a benefit to C4 grasses (which are almost uniformly large seeded) when drilled. Working in tallgrass prairie restorations, both Yurkonis and others (2010) and Larson and others (2011) found that C4 grass abundance was greater when drill seeded compared to broadcast seeded. However, compared to our study, they seeded primarily grasses (70% by number seeds sown), whereas these made up a relatively small number of seeds in our mix (17%). Because these species were the dominant seeds sown in their studies, the observed benefit from drilling could have been one of predation avoidance of these light insensitive seeds. In our study, we may not have seeded the C4 grasses at a high enough rate to be able to observe a beneficial effect from drilling. While drill seeding was generally similar to surface seeding on most plant community metrics other than small seeded species abundance (including sown native species cover), we surprisingly found higher canopy cover of ruderal weeds in drill seeded treatments. This finding runs counter to other studies, which found that drill seeding produces more native cover and less weed cover compared to broadcasting seed (Larson et al. 2011). In our study, the increased sown species plant density in the surface sown treatments may have created a more competitive environment than the less dense environment of the drill seeded plantings and resulted in fewer ruderal weeds. Still, it is curious that canopy cover of native species was no different among treatments, which may suggest underground competition may be driving the abundance of ruderal weeds.

Our preliminary results show that to increase cost-effectiveness in prairie restoration, small seeded species should be surface sown. Assuming native seed drills are the most commonly used planting equipment currently in service, providers and conservation practitioners should ensure that seed is purchased pre-sorted into large and small seed batches, and sown in planting equipment that allows large seeded species to be drilled into the ground while small seeds are placed on the surface. Most seed drills in conservation use have the capacity to sow at least two types of seed. Some drills are engineered to set differential seeding depths by seeding box, though with others the practitioner must modify the drill by disconnecting tubes leading from the seed cups. Importantly, using this method does not increase costs, assuming a native seed drill is available for use. Broadcast seeding followed by dragging or cultipacking is similar to the method we tested and may also be expected to produce cost-effective results.

We urge caution in interpreting our results given the small-seeded seed mix design we used in this study. While our small-seeded demonstration mix was reasonably priced and established quite successfully, it does not represent many other seed mixes available. Many other mixes include more species with intermediate seed size which we do not anticipate to be affected as much by seeding method. We would expect a more modest benefit from surface seeding in these mixes, with the benefits of increased establishment and cost effectiveness accruing from the small seeded species they contain. This impact would likely be most important in seed mixes that have inherently small seeds based on the dominant reference plant community, such as wetland seed mixes with many small-seeded sedges and rushes.

To confirm our preliminary results and more fully understand the long-term effects of seeding methods used in prairie restoration, follow-up is needed in future years. Our small sample size prevented us from drawing especially robust statistical conclusions about differences in seeding methods, though our results are promising and suggest an expanded experimental design would be powerful enough to draw more definitive conclusions. Continued monitoring of this study for at least two more years is warranted so that we can understand what post-establishment conclusions can be drawn about seeding methods at the Prairie on Farms Research Station.

Acknowledgments

We thank Alec Glidden and Jared Randall for field support in data collection and research plot management. This report was prepared by Justin Meissen under Grant No. 2019-12 from the Iowa Nutrient Research Center. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the Iowa Nutrient Research Center.

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Appendix 1. Study seed mix planted at the Prairie on Farms Research and Demonstration Area.

Common Name	*Scientific Name*	*Seed Size Class*	*Seeds/ m²*
Cool-season graminoids			
arctic brome	*Bromus kalmii*	large	10.76
bluejoint	*Calamagrostis canadensis*	small	53.82
Canada wildrye	*Elymus canadensis*	large	10.76
fowl mannagrass	*Glyceria striata*	small	43.06
prairie wedgescale	*Sphenopholis obtusata*	small	43.06
Warm-season graminoids			
big bluestem	*Andropogon gerardii*	large	10.76
sideoats grama	*Bouteloua curtipendula*	large	10.76
Mexican muhly	*Muhlenbergia mexicana*	small	43.06
Indiangrass	*Sorghastrum nutans*	large	10.76
composite dropseed	*Sporobolus compositus*	small	43.06
Spring forbs			
Richardson's alumroot	*Heuchera richardsonii*	small	53.82
foxglove beardtongue	*Penstemon digitalis*	small	32.29
Summer forbs			
common milkweed	*Asclepias syriaca*	large	2.15
largeleaf wild indigo	*Baptisia lactea*	large	1.08
partridge pea	*Chamaecrista fasciculata*	large	2.15
showy ticktrefoil	*Desmodium canadense*	large	2.15
tall cinquefoil	*Drymocallis arguta*	small	32.29
pale purple coneflower	*Echinacea pallida*	large	2.15
smooth oxeye	*Heliopsis helianthoides*	large	2.15
roundhead lespedeza	*Lespedeza capitata*	large	2.15
biennial beeblossom	*Oenothera gaura*	large	2.15
wild quinine	*Parthenium integrifolium*	large	2.15
Virginia mountainmint	*Pycnanthemum virginianum*	small	32.29
blackeyed Susan	*Rudbeckia hirta*	small	21.53
wholeleaf rosinweed	*Silphium integrifolium*	large	1.08
Culver's root	*Veronicastrum virginicum*	small	53.82
Fall forbs			
white sagebrush	*Artemisia ludoviciana*	small	32.29
flat-top goldentop	*Euthamia graminifolia*	small	32.29
closed bottle gentian	*Gentiana andrewsii*	small	32.29
stiff sunflower	*Helianthus pauciflorus ssp. pauciflorus*	large	2.15
great blue lobelia	*Lobelia siphilitica*	small	53.82