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FINAL STUDY REPORT
Pullman Plant Materials Center, Pullman, WA

Establishing Native Forbs in Existing CRP Using No-Till Techniques in Northern Idaho: Comparison of Drills and Seedbed Preparations

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ABSTRACT

Habitat for pollinators, upland birds and other wildlife can be improved by diversification of existing Conservation Reserve Program (CRP) fields. Additional conservation benefits can be achieved if diverse plant species are established without tillage, particularly on the steep slopes in the Palouse region of northern Idaho. A study was conducted to determine if native forbs can be established with no-till techniques and if there are differences in drill type and seedbed preparation methods. The study was planted on three herbicide-treated CRP field sites in Latah County, Idaho, including one 20-year-old stand of intermediate wheatgrass [*Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey] and two 7-year-old stands of native bunch grasses dominated by bluebunch wheatgrass [*Pseudoroegneria spicata* (Pursh) Á. Löve] and Idaho fescue (*Festuca idahoensis* Elmer). Sixteen species of native Palouse Prairie forbs were seeded at the three sites in October 2010 with two no-till drills (a Cross Slot® and a Great Plains® double disk) and two seedbed preparations (mowed and not mowed) in a split-plot design. Forb density increased in all plots at all sites from Year 1 to Year 3 and all plots met CRP certification requirements by Year 3. Forbs established more rapidly in the 20-year-old intermediate wheatgrass stand than in the 7-year-old native grass stands. There were no consistent differences among drill types used, and no overall effect of mowing as a seedbed preparation method. The results suggest no-till techniques may be used to establish native forbs, and three or more years may be required before determining stand success.

INTRODUCTION

Native forbs in a landscape provide many ecological benefits to various species of upland wildlife and surrounding agricultural fields (Altieri, 1999; Wratten et al., 2012; Blaauw and Isaacs, 2014). Small mammals, game birds, migratory birds and beneficial insects such as pollinators depend on forbs for shelter and a source of high-quality forage in the form of nectar, pollen, seeds and leaves (Harper, 2007; Mader et al., 2011; Wratten et al., 2012). There is a desire by many state, federal, and non-profit agencies in the Inland Northwest to improve upland diversity by establishing native forbs in perennial landscapes (Weddell, 2001; Palazzolo, 2011). In the Palouse region of north-central Idaho, characterized by steep, rolling slopes, there is also a desire to establish forbs while maintaining perennial grass stubble and preventing soil erosion. This is the first study conducted in this region to evaluate the establishment of forbs into existing perennial grass stands.
The objectives of this study were to:

1) Determine if no-till techniques can be used to successfully establish native forbs into existing CRP fields.
2) Determine if mowing as a seedbed preparation method has an effect on forb seedling establishment.
3) Determine if drill type has an effect on forb seedling establishment.

MATERIALS AND METHODS

Study Sites

The study was conducted on three existing CRP fields on the southeast-facing slope of Paradise Ridge south of Moscow in Latah County, Idaho. Site 1 and Site 3 were 7-year-old stands of native bunch grasses dominated by bluebunch wheatgrass [*Pseudoroegneria spicata* (Pursh) Á. Löve] and Idaho fescue (*Festuca idahoensis* Elmer) on Southwick silt loam soil and with southern aspects. Site 2 was a 20-year-old stand of intermediate wheatgrass [*Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey] on Driscoll-Larkin silt loam soil with an eastern aspect. The area receives an average of 24 inches annual precipitation and has an average temperature of 47.4 °F (115-yr averages from University of Idaho Parker Research Farm). Precipitation per month during the study period is presented in Table 1 and average high and low daily temperatures are presented in Table 2.

Table 1. Monthly precipitation per year (in) at the University of Idaho Parker Research Farm near the study sites in Latah County, ID.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2010	2.93	1.60	2.11	3.75	2.76	3.84	0.32	0.01	1.97	3.15	2.84	3.54	**28.82**
2011	3.84	2.55	4.78	3.36	4.47	1.04	0.60	0.17	0.25	2.51	3.19	2.08	**28.84**
2012	3.92	2.55	7.84	4.24	1.27	2.65	0.50	0.00	0.05	3.59	4.56	3.53	**34.70**
2013	2.09	1.74	1.46	3.46	1.01	2.47	0.07	0.67	3.16	0.54	3.05	1.92	**21.64**

Table 2. Average daily high and low temperatures per year at the University of Idaho Parker Research Farm near the study sites in Latah County, ID.

Year	Ave Daily High	Ave Daily Low
	----------°F ----------	
2010	58.4	37.1
2011	57.1	34.9
2012	59.2	36.4
2013	59.2	35.7

Site Preparation and Post-Planting Weed Management

All study sites were treated with 1.1 lb ae (acid equivalent)/ac glyphosate in June 2010 to kill or suppress the existing grass vegetation. In mid-October, half of each site was mowed for the mowing seedbed preparation treatment. A few days after mowing, all plots at all sites were treated again with 1.1 lb ae/ac glyphosate. To control annual grass weeds and suppress the re-growing perennial grasses after planting, all sites were sprayed with 0.09 lb ai (active ingredient)/ac clethodim in spring 2011 and spring 2012. Sites 1 and 3 were mowed in the spring and late summer 2011, and Site 2 was mowed in late summer 2011 to control broadleaf weeds. Sites 2 and 3 were sprayed with 11.25 oz ai/ac sulfosulfuron in fall 2012 to control annual grass weeds.

Drills

Two drill types were compared: an experimental-sized Cross-Slot® drill (Cross Slot No-Tillage Systems, Fielding, New Zealand) and an experimental-sized Great Plains® double disk with coulters (Great Plains Manufacturing, Salina, KS) (Figures 1 and 2). The cross slot drill was 10 foot wide, with 12 openers at 10 inch spacing. The double disk drill was 8 foot wide, with 12 openers at 7.5 inch spacing. Both drills were set at a target seeding depth of ¼ inch.

Figure 1. Seeding native forbs with a Cross Slot drill on October 21, 2010 in Latah County, ID

Figure 2. Seeding native forbs with a Great Plains double disk drill on October 21, 2010 in Latah County, ID.

Experimental Design

The experimental design was a spilt plot with two seedbed preparation methods (whole plot):

1) spring application of glyphosate + mow + fall application of glyphosate + drill
2) spring application of glyphosate + fall application of glyphosate + drill (not mowed)

And two drill types (sub plot):

1) cross-slot no-till drill
2) double disk no-till drill

The total plot area at each study site was 80 ft wide and 80 ft long. Individual plots were 40 ft long and 10 ft wide. There was a total of 4 treatment combinations and each treatment combination was replicated 4 times in the configuration shown below (Figure 3).

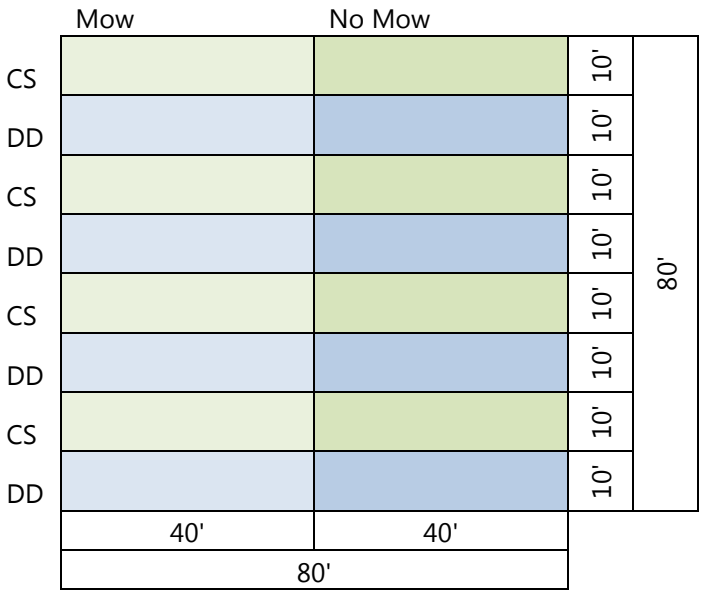

Figure 3. Plot layout at each site in Latah County, Idaho. CS = Cross Slot; DD = Double Disk drill.

Seeding

Plots were planted on October 21, 2010. After seeding Site 1, it was determined the drills may have been set too deep (>1/4"), so depth was reduced for Sites 2 and 3.

Forb Species and Seeding Rates

Seed for the study was mixture of 14 perennial, 1 short-lived perennial/annual, and 1 annual native forb species. All species were seeded at the same pure live seeds (PLS) per linear foot rate (3.1 PLS/linear ft) except four species due to limited availability (Table 3). The total target seeding rate was 40 PLS/linear ft. Percent PLS was estimated to be 75%, which resulted in a bulk seeding rate of 53.3 seeds/linear ft.

Table 3. Forb species seeded in October 2010 with seeds per pound, Pure Live Seed (PLS) and bulk seeding rates, and target number of seeds per linear foot in Latah County, Idaho.

	Common Name	Scientific name	Code	Life Cycle	Seeds/lb	PLS Mixed Rate (lb/ac)	Bulk Mixed Rate (lb/Ac) (75% PLS)	PLS/linear ft	Bulk seeds/ linear ft
1	Western yarrow	*Achillea millefolium*	ACMI	perennial	2,835,000	0.08	0.11	3.1	4.1
2	Arrowleaf balsamroot	*Balsamorhiza sagittata*	BASA	perennial	61,630	3.65	4.87	3.1	4.1
3	Grand collomia	*Collomia grandiflora*	COGR	annual	146,986	1.53	2.04	3.1	4.1
4	Wyeth's buckwheat	*Eriogonum heracleoides*	ERHE	perennial	145,720	0.62	0.82	1.2	1.6
5	Oregon sunshine	*Eriophyllum lanatum*	ERLA	per/ann[1/]	818,000	0.28	0.37	3.1	4.1
6	Blanketflower	*Gaillardia aristata*	GAAR	perennial	186,436	1.21	1.61	3.1	4.1
7	Sticky purple geranium	*Geranium viscosissimum*	GEVI	perennial	54,809	0.41	0.55	0.3	0.4
8	Prairie smoke	*Geum triflorum*	GETR	perennial	450,000	0.20	0.27	1.2	1.6
9	Little sunflower	*Helianthella uniflora*	HEUN	perennial	41,087	5.48	7.30	3.1	4.1
10	Nine-leaf lomatium	*Lomatium triternatum*	LOTR	perennial	63,812	3.53	4.70	3.1	4.1
11	Lupines	*Lupinus* spp.	LU sp	perennial	12,900	1.74	2.32	0.3	0.4
12	Taper-leaf penstemon	*Penstemon attenuatus*	PEAT	perennial	3,000,000	0.08	0.10	3.1	4.1
13	Tall cinquefoil	*Potentilla arguta*	POAR	perennial	4,403,883	0.05	0.07	3.1	4.1
14	Slender cinquefoil	*Potentilla gracilis*	POGR	perennial	1,711,698	0.13	0.18	3.1	4.1
15	Missouri goldenrod	*Solidago missouriensis*	SOMI	perennial	1,988,238	0.11	0.15	3.1	4.1
16	Western aster	*Symphyotrichum spathulatum*	SYSP	perennial	1,292,309	0.17	0.23	3.1	4.1
		TOTALS				19.27	25.7	40.0	53.3

1/ Oregon sunshine can be a short-lived perennial or annual, depending on environmental conditions.

Forb Density

In late June 2011 (Year 1), forb seedlings were counted in 2 linear foot increments four times in each plot. In late June through early July in 2012 (Year 2) and 2013 (Year 3), forb plants were counted in a 9 ft^2 frame in each plot. All plants per 9 ft^2 plot measurements were converted to plants per linear foot by dividing by a factor of 10.8 for the cross slot plots (3.6 rows/subplot x 3 linear feet) and 14.4 for the double disk drill plots (4.8 rows/subplot x 3 linear feet).

Figure 4. Assessing seedling establishment on May 10, 2011 in Latah County, Idaho.

Forb density data was statistically analyzed with Statistix 8 software (Analytical Software, Tallahassee, FL) to determine significant mowing effect, drill effect and mowing x drill interaction using split-plot analysis of variance and Tukey's All-Pairwise Comparison test.

Percent Cover

At the same time as collecting forb density measurements in 2012 (Year 2) and 2013 (Year 3), ocular estimates, rounded to the nearest 5%, were made for forb, weed, and bare ground or litter percent cover.

RESULTS AND DISCUSSION

Mowing Effect

Plots that were not mowed had significantly more plants than the mowed plots in Year 2 at Site 2 ($p<.05$), however in Year 3 the difference was no longer significant (Table 4). There was no significant mow effect at any of the other sites.

Table 4. Effect of mowing as a seedbed preparation technique on forb plants per linear foot per site per year in Latah County, Idaho.

	Site 1			Site 2			Site 3		
	Yr 1	Yr 2	Yr 3	Yr 1	Yr 2	Yr 3	Yr 1	Yr 2	Yr 3
Treatment	----------Plants per linear foot----------								
Mow	0.73	1.65	11.15	5.3	8.85*[1/]	33.26	0.95	4.40	9.27
No Mow	1.27	2.49	13.04	3.56	29.88*	32.95	0.84	3.82	14.44

1/ Means with an asterisk (*) within the same year and site are significantly different in Tukey HSD comparisons at α=.05.

Drill Effect

There was a significant (p<.05) drill effect in Year 3 at Site 1 and in Years 2 and 3 at Site 3, however the drill type results varied among sites (Table 5). At Site 1, the plots with significantly higher forb counts were seeded with the cross slot drill, and at Site 3, the plots with higher forb counts were seeded with the double disk drill.

Table 5. Effect of drill type on forb plants per linear foot per site per year in Latah County, Idaho.

	Site 1			Site 2			Site 3		
	Yr 1	Yr 2	Yr 3	Yr 1	Yr 2	Yr 3	Yr 1	Yr 2	Yr 3
Treatment	----------Plants per linear foot----------								
Cross Slot	0.94	2.23	15.59*[1/]	4.58	21.41	36.27	0.53	2.82*	5.36*
Double Disk	1.06	1.91	8.60*	4.28	17.32	29.94	1.27	5.39*	18.37*

1/ Means with an asterisk (*) within the same year and site are significantly different in Tukey HSD comparisons at α=.05.

Combined Mowing and Drill Effect

There was no significant mowing treatment x drill type interaction effect (p<.05) at any of the sites during the first year of establishment (Figure 5). In Year 2, the un-mowed plots at Site 2 had significantly more forbs than the mowed plots, which may have resulted from more annual forbs reseeding into bare patches. Thatch in the mowed plots may have prevented new seedling establishment. In Year 3 at Site 2, there were no longer significant differences in number of forbs among the treatment combinations. In Year 3 at Site 3, the un-mowed plots seeded with a double disk drill had significantly more forbs than the mowed and un-mowed plots seeded with a cross slot drill. Plant counts in all plots at all sites increased from Year 1 to Year 3.

Forbs established more quickly at Site 2, with the 20 year-old stand of introduced rhizomatous grass (intermediate wheatgrass) than the other two sites with 7 year-old stands of native bunchgrasses. This may have been a result of more consistent drill depth at Site 2, as well as less weed pressure due to the stand being older and having fewer interplant spaces.

When perennials only (all species except grand collomia, COGR) are analyzed, differences among treatment combinations become less apparent, except at Site 3 in Year 3 (Figure 6). The perennials at all sites exhibited the same trend of increasing in number over time.

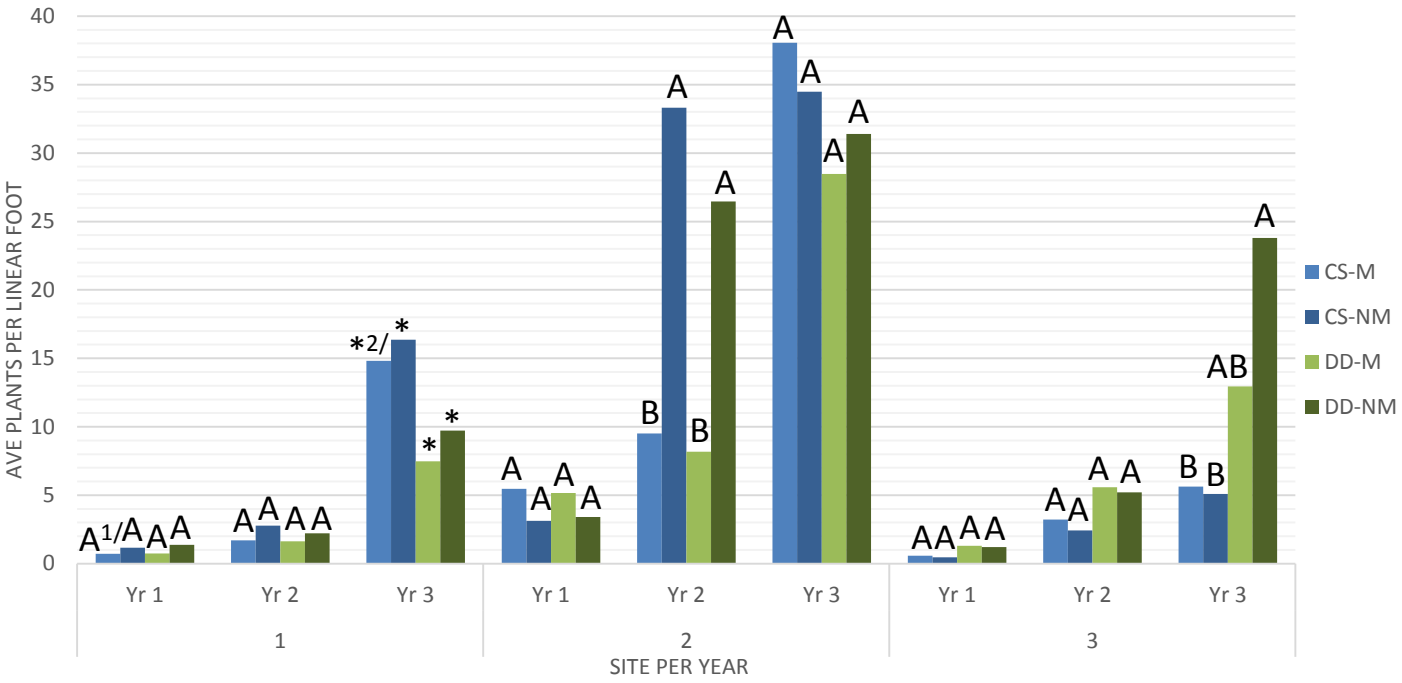

Figure 5. Drill type x mowing treatment effects on average forb plants per linear foot per site per year in Latah County, ID. CS = Cross Slot; DD = Double Disk; M= Mow; NM = No Mow. 1/ Means with the same letter within the same year and site are not significantly different in Tukey HSD comparisons at α=.05. 2/ Homogeneous groups cannot be used because of the pattern of significant differences.

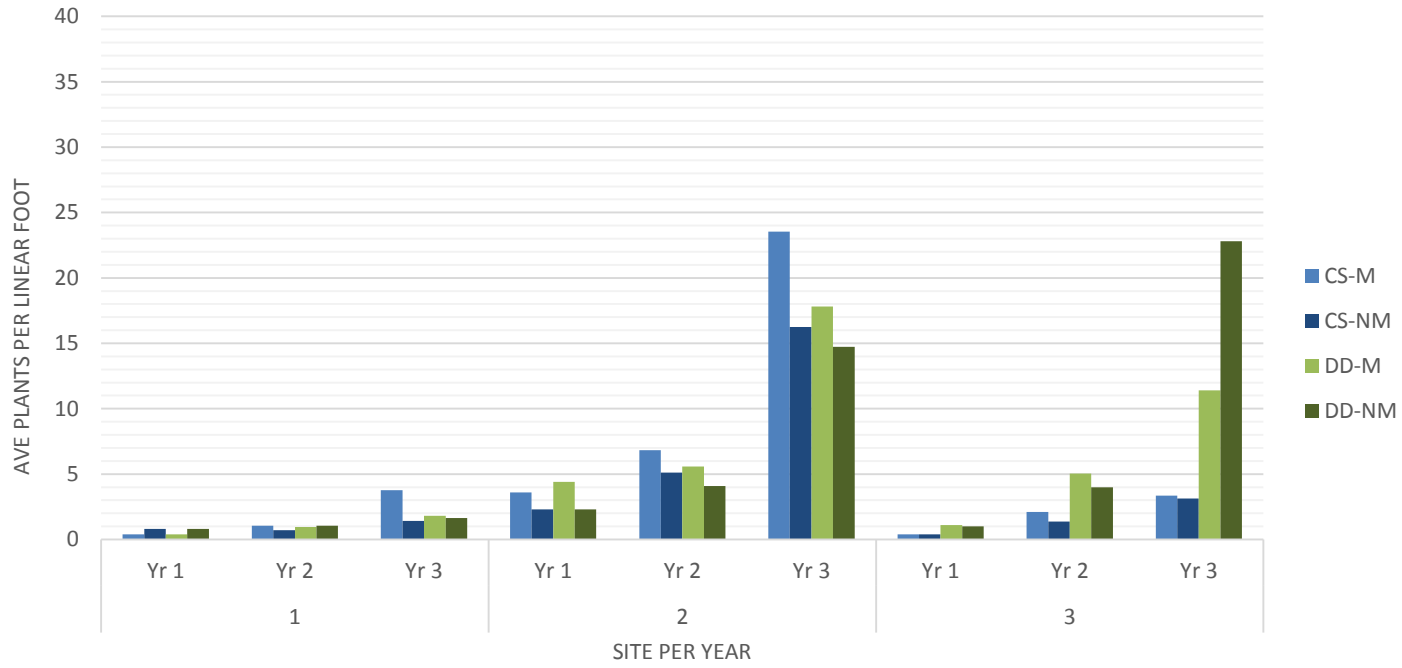

Figure 6. Drill type x mowing treatment effects on average perennial forb plants per linear foot per site per year (all species except grand collomia (*Collomia grandiflora*)) in Latah County, ID. CS = Cross Slot; DD = Double Disk; M= Mow; NM = No Mow.

Individual Species

By Year 3, 14 of the 16 species planted were present at Site 1, all 16 species were present at Site 2, and 15 of the 16 species were present at Site 3 (Figures 7 – 12). The species with the most successful establishment in Year 1 were the annual, grand collomia (COGR) and the perennials little sunflower (HEUN) and nine-leaf lomatium (LOTR) (Figures 7 and 10). Throughout the study, the forbs with the highest establishment rates were the annual, grand collomia (COGR) and short-lived perennial, Oregon sunshine (ERLA), and the perennials little sunflower (HEUN), nine-leaf lomatium (LOTR), yarrow (ACMI), lupines (LU sp), arrowleaf balsamroot (BASA), and blanketflower (GAAR) (Figures 7 – 12).

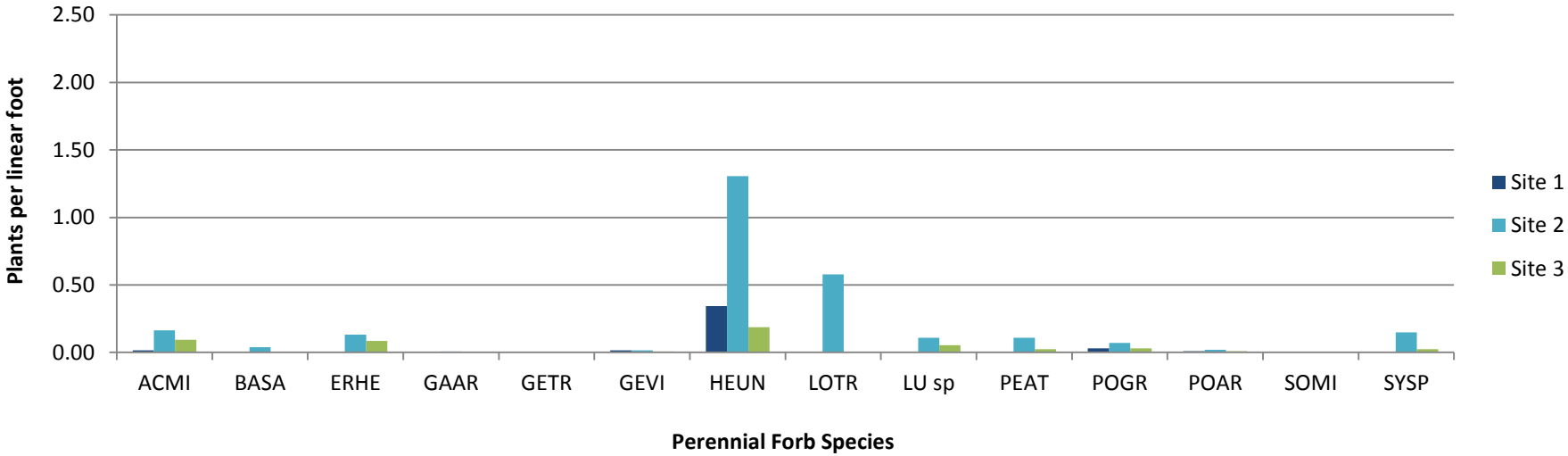

Figure 7. Perennial forb species per linear foot at each site in Year 1 in Latah County, Idaho. For species codes, see Table 3.

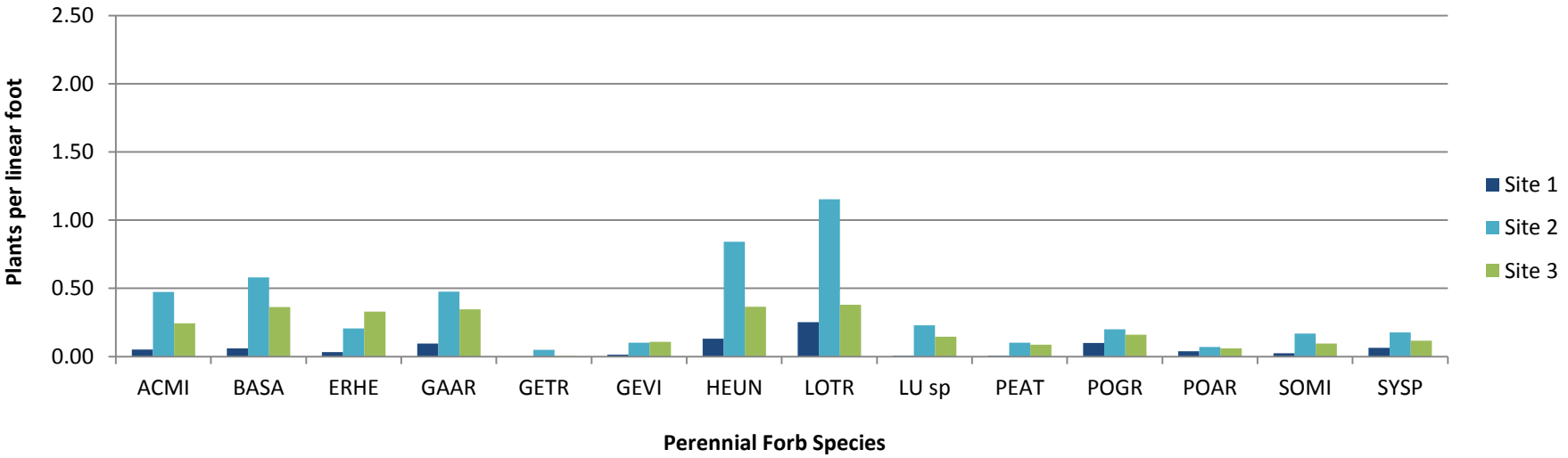

Figure 8. Perennial forb species per linear foot at each site in Year 2 in Latah County, Idaho. For species codes, see Table 3.

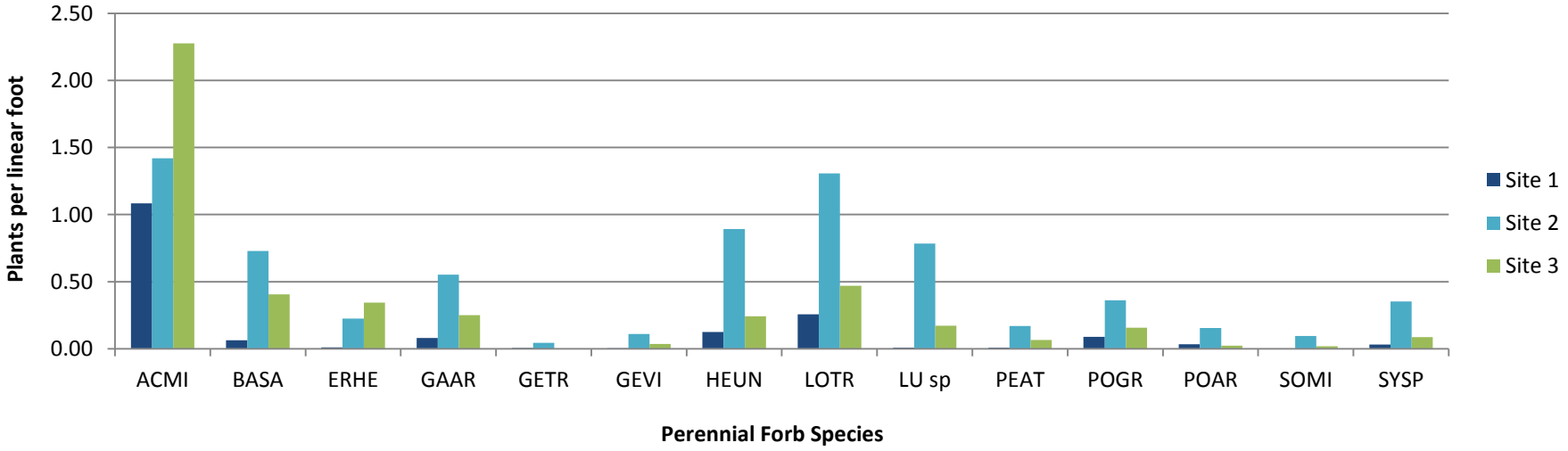

Figure 9. Perennial forb species per linear foot at each site in Year 3 in Latah County, Idaho. For species codes, see Table 3.

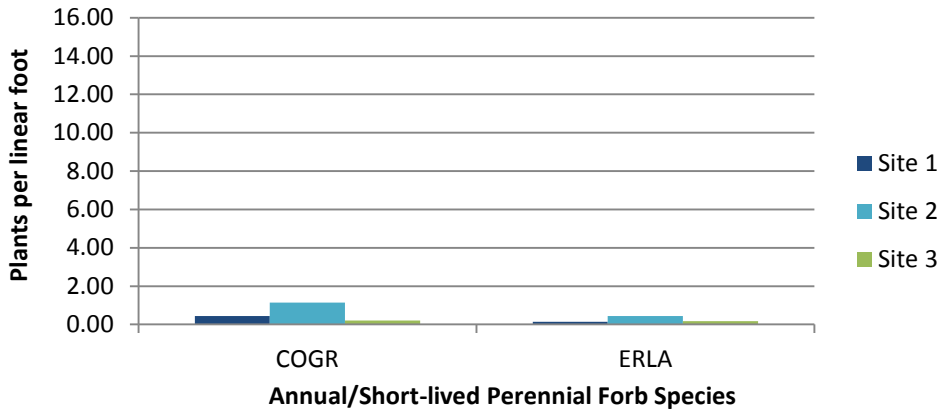

Figure 10. Annual and short-lived perennial forb species per linear foot at each site in Year 1 in Latah County, Idaho. For species codes, see Table 3.

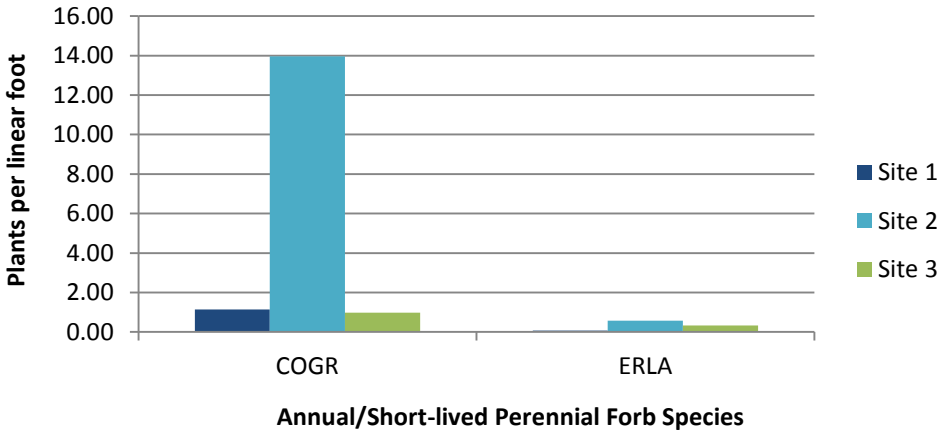

Figure 11. Annual and short-lived perennial forb species per linear foot at each site in Year 2 in Latah County, Idaho. For species codes, see Table 3.

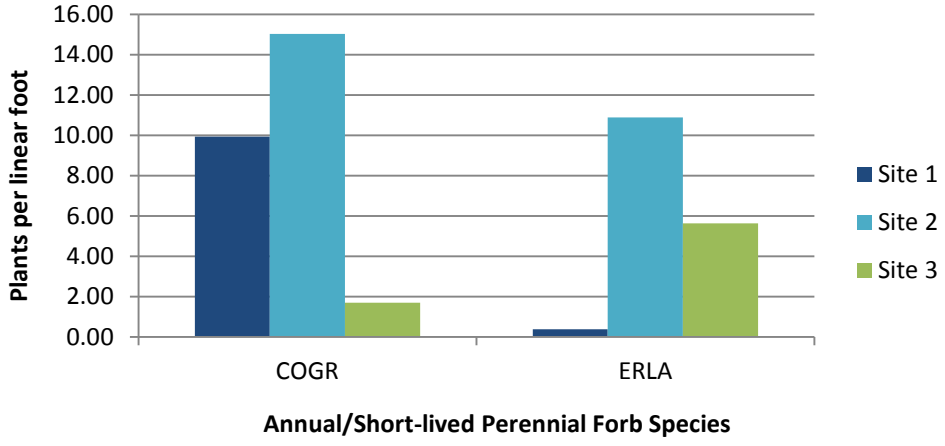

Figure 12. Annual and short-lived perennial forb species per linear foot at each site in Year 3 in Latah County, Idaho. For species codes, see Table 3.

Percent Cover

Average forb percent cover increased and weed percent cover decreased from Year 2 to Year 3 in all plots at all sites (Tables 6 – 8). Forb percent cover was highest both years at Site 2, with 43 to 55% cover in Year 2 and 51 to 78% cover in Year 3. Forb percent cover at Site 1 in Year 3 ranged from 39 to 46% and at Site 3 ranged from 33 to 69%.

Table 6. Forb, weed, and bare ground/litter percent cover at Site 1 in Years 2 (2012) and 3 (2013) in Latah County, ID.

	Yr 2			Yr 3		
	Forb	Weed	Bare/Litter	Forb	Weed	Bare/Litter
Drill-Mow Trtmt	% Cover					
Cross Slot - Mow	8	78	15	46	10	44
Cross Slot - No Mow	8	71	21	39	11	50
Double Disk - Mow	5	65	30	40	8	53
Double Disk - No Mow	6	66	28	41	18	41

Table 7. Forb, weed, and bare ground/litter percent cover at Site 2 in Years 2 (2012) and 3 (2013) in Latah County, ID.

	Yr 2			Yr 3		
	Forb	Weed	Bare/Litter	Forb	Weed	Bare/Litter
Drill-Mow Trtmt	% Cover					
Cross Slot - Mow	43	46	11	70	19	11
Cross Slot - No Mow	48	28	25	51	24	25
Double Disk - Mow	53	35	13	73	8	20
Double Disk - No Mow	55	28	18	78	8	15

Table 8. Forb, weed, and bare ground/litter percent cover at Site 3 in Years 2 (2012) and 3 (2013) in Latah County, ID.

	Yr 2			Yr 3		
	Forb	Weed	Bare/Litter	Forb	Weed	Bare/Litter
Drill-Mow Trtmt	% Cover					
Cross Slot - Mow	5	85	10	33	59	8
Cross Slot - No Mow	5	80	15	35	51	8
Double Disk - Mow	21	64	15	55	38	8
Double Disk - No Mow	31	49	20	69	23	10

Predominant weeds at Site 1 in Year 1 were ventenata [*Ventenata dubia* (Leers) Coss.] and prickly lettuce (*Latuca serriola* L.). In Years 2 and 3, the native Palouse annual, tall willowherb (*Epilobium brachycarpum* C. Presl) was also present. (Tall willowherb is an early-seral native species considered to be desirable, but was counted as a "weed" in this study since it was not part of the planted mix.) Site 2 in Year 1 had fiddleneck (*Amsinckia* sp.), bedstraw (*Galium aparine* L.) and pennycress (*Thlaspi arvense* L.). In Years 2 and 3 at Site 2, the only predominant plant not planted was tall willowherb. Site 3 in Year 1 had prickly lettuce, and in Years 2 and 3 prickly lettuce, tall willowherb and rattail fescue (*Vulpia myuros* (L.) C.C. Gmel).

Plants per Square Foot and CRP Certification Requirements

A minimum of 3 to 5 desirable plants per square foot is required to meet CRP certification standards in Latah County. In this study, a conversion factor of 1.2 can be used to convert plants per linear foot to square foot for the plots seeded with the Cross Slot drill, and 1.6 for the plots seeded with the double disk drill. All plots at Site 2 met certification requirements in Year 1 (Table 10). At Site 1, both of the unmowed plots met certification requirements in Year 2 (Table 9), and at Site 3, all plots except the unmowed Cross Slot plots met requirements

in Year 2 (Table 11). By Year 3, all plots at all sites met certification requirements. If the annual forb species, grand collomia, is not counted, all plots at Sites 2 and 3 still met certification requirements by Year 3, as did the mowed Cross Slot plots at Site 1.

Table 9. Forb plants per square foot 2011 – 2013 at Site 1 in Latah County, ID.

		2011		2012		2013	
		All Spp	Per Only[1/]	All Spp	Per Only	All Spp	Per Only
Drill	Mow	plants/sq ft					
cs	mow	0.9	0.5	2.0	1.3	17.8	4.5
cs	nomow	1.4	0.9	3.3	0.9	19.6	1.7
dd	mow	1.2	0.6	2.6	1.5	12.0	2.9
dd	nomow	2.2	1.2	3.5	1.7	15.6	2.6

1/ All species except grand collomia (*Collomia grandiflora*, COGR)

Table 10. Forb plants per square foot 2011 – 2013 at Site 2 in Latah County, ID.

		2011		2012		2013	
		All Spp	Per Only[1/]	All Spp	Per Only	All Spp	Per Only
Drill	Mow	plants/sq ft					
cs	mow	6.6	4.2	11.4	8.1	45.7	28.3
cs	nomow	3.8	2.8	40.0	6.1	41.4	19.5
dd	mow	8.3	7.0	13.1	8.9	45.6	28.5
dd	nomow	5.5	3.8	42.3	6.5	50.3	23.6

1/ All species except grand collomia (*Collomia grandiflora,* COGR)

Table 11. Forb plants per square foot 2011 – 2013 at Site 3 in Latah County, ID.

		2011		2012		2013	
		All Spp	Per Only[1/]	All Spp	Per Only	All Spp	Per Only
Drill	Mow	plants/sq ft					
cs	mow	0.7	0.3	3.9	2.5	6.8	4.0
cs	nomow	0.6	0.5	2.9	1.6	6.1	3.8
dd	mow	2.1	1.9	8.9	8.1	20.7	18.3
dd	nomow	2.0	1.6	8.3	6.4	38.0	36.5

1/ All species except grand collomia (*Collomia grandiflora,* COGR)

Follow-Up Site Visits

All sites were visited and visually assessed in 2014 (Year 4) and 2015 (Year 5). Forb density appeared to continue to increase or remain constant at all sites, which is evident in the photo documentation in Figures 13-25.

Photo Documentation

Site 1

Figure 13. Year 2 forbs at Site 1, July 2, 2012, in Latah County, ID.

Figure 14. Year 3 forbs at Site 1, June 27, 2013, in Latah County, ID.

Figure 15. Year 4 forbs at Site 1, July 1, 2014, in Latah County, ID.

Figure 16. Year 5 forbs at Site 1, June 22, 2015, in Latah County, ID.

Site 2

Figure 17. Year 1 forbs at Site 2, June 30, 2011 in Latah County, ID.

Figure 18. Year 2 forbs at Site 2, June 27, 2012 in Latah County, ID.

Figure 19. Year 3 forbs at Site 2, June 27, 2013 in Latah County, ID.

Figure 20. Year 4 forbs at Site 2, July 1, 2014 in Latah County, ID.

Figure 21. Year 5 forbs at Site 2, June 22, 2015 in Latah County, ID.

Site 3

Figure 22. Year 2 forbs at Site 3, July 2, 2012, in Latah County, ID.

Figure 23. Assessing Year 3 forb density at Site 3, June 27, 2013 in Latah County, ID.

Figure 24. Year 4 forbs at Site 3, July 1, 2014, in Latah County, ID.

Figure 25. Year 5 forbs at Site 3, June 22, 2015, in Latah County, ID.

CONCLUSIONS

The results of this study demonstrate no-till techniques can be used for successful establishment of native forbs in the Palouse region of northern Idaho. There were no consistent differences among drill types used, and no overall effect of mowing as a seedbed preparation method, indicating either drill type and seedbed preparation method may be appropriate. Seedlings established more quickly at Site 2, with the 20 year-old stand of the introduced rhizomatous grass than the two sites with 7 year-old-stands of native bunch grasses, which may have been the result of more consistent drill depth in the rhizomatous grass plots. In the native bunch grass plots, seeds may have been planted too deep in the interspaces between grass plants. Another contributing factor may have been less weed pressure in the older rhizomatous grass plots compared to the younger, native grass plots. Planting native forbs into stands with native bunch grasses may require more attention to drill depth, and more intensive seedbed preparation and weed management after seeding to ensure successful establishment.

Forb density increased in all plots at all sites from Year 1 to Year 3 and forb percent cover increased in all plots at all sites from Year 2 to Year 3. All plots at Site 2 met CRP certification requirements in Year 1, and all plots at Sites 1 and 3 met CRP requirements by Year 3. Of the 16 native forb species planted, 14 were present at Site 1 by Year 3, all 16 were present at Site 2, and 15 were present at Site 3. The species with the most successful establishment were the annual: grand collomia and annual/short-lived perennial: Oregon sunshine, and the perennials: little sunflower, nine-leaf lomatium, yarrow, lupine, arrowleaf balsamroot, and blanketflower. Vigilant weed control during and after forb establishment, which included mowing and application of selective herbicides, was essential for forb establishment success.

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