TECHNICAL NOTE

USDA – Natural Resources Conservation Service

Boise, Idaho - Pullman, Washington

PLANT MATERIALS NO. 54 OCTOBER 2010

Evaluation of Planting Time and Survivability of 16 Forb and 2 Grass Species Native to the Inland Northwest

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2009 Photo of forbs planted in late fall 2002, David M. Skinner

Summary of Key Points:

1) Based on the results of this study, the following species have the highest likelihood of successful establishment and survival in conservation plantings and are recommended for the Major Land Resource Area (MLRA) 9:

Common name	**Scientific Name**
Western yarrow	*Achillea millefolium*
Bigflower agoseris	*Agoseris grandiflora*
Idaho fescue	*Festuca idahoensis*
Blanketflower	*Gaillardia aristata*
False/Little sunflower	*Helianthella uniflora*
Fernleaf biscuitroot	*Lomatium dissectum*
Velvet lupine	*Lupinus leucophyllus*
Yellow Penstemon	*Penstemon confertus*
Tall cinquefoil	*Potentilla arguta*
Slender cinquefoil	*Potentilla gracilis*
Palouse goldenweed	*Pyrrocoma liatriformis* (Palouse Prairie only)
Bluebunch wheatgrass	*Pseudoroegneria spicata*
Missouri goldenrod	*Solidago missouriensis*
Western mountain aster	*Symphyotrichum spathulatum*

2) Fifteen out of eighteen species in this study had better seedling establishment when planted in early or late fall as opposed to spring. Management strategies to overcome challenges associated with fall planting include: minimizing weed pressure and the weed seed bank prior planting, delaying planting as late as possible, drilling the seed, and increasing the seeding rate if broadcast seeding.

3) For any planting, the following guidelines should be used:
   a) Plant at appropriate time
   b) Create a firm, weed free seed bed
   c) Drill the seed into the soil to a depth of ¼ - ½ inch
   d) Eliminate weeds prior to planting
   e) Manage weeds after planting
   f) Increase the seeding rate
   g) Group forbs into small blocks scattered throughout the landscape if forb seed is limited by availability or price, or to facilitate weed management.

Introduction

There is a substantial amount of interest in using native forbs and grasses for conservation plantings in the Inland Northwest. Native plants have experienced a surge in popularity due to improved awareness of their positive attributes. These attributes include being better adapted to the local climate, and providing habitat and forage for native birds, insects and upland wildlife species. Also, many people advocate for native plants based on the principle of restoring land to the condition it was in prior to being invaded by alien species or converted to another use. To date, however, establishing native vegetation in the Inland Northwest has proven more difficult than establishing introduced vegetation. Plantings may fail to establish for many reasons, some of which are listed below:

- Inherent biology of the plants
  - Slow growth rate
  - Weak growth form during first 1-2 years (relative to weeds or other introduced species)
  - Inability to utilize high soil nitrogen
- Species selected are not well adapted to the site
- Inappropriate planting techniques
  - Poor seedbed conditions
  - Improper depth
  - Poor seed-to-soil contact
  - Improper seeding time
  - Poor understanding of seed dormancy/germination requirements
- Lack of weed management
  - Weeds not eliminated prior to planting
  - Weeds not managed after planting
- Climatic conditions
  - Frost damage
  - Lack of or excess precipitation

In order for a planting of native vegetation to be successful, the above-mentioned challenges must be well understood and overcome. Unfortunately, published scientific studies evaluating techniques for establishing and maintaining native plantings in the Inland Northwest are extremely lacking.

The objectives of this study were to:

1) Determine the optimum planting time and survivability of 16 native forb and 2 native grass species.
2) Generate basic establishment guidelines for use by conservationists, land managers and commercial seed producers.

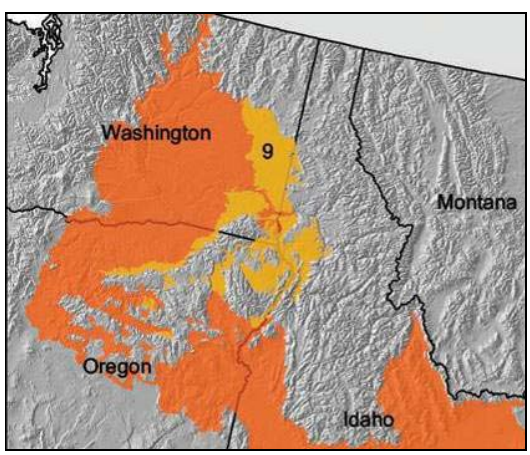
Materials and Methods
This study was conducted at the USDA-NRCS Plant Materials Center (PMC) in Pullman, WA. The PMC receives an average of 20 inches of precipitation per year, most of which occurs during the winter and spring months. The study field was comprised of Palouse silt loam and Tucannon silt loam, both of which are deep, well drained soils. The field had a 15% slope and south-facing aspect.

Planting began in fall of 2002 and continued until spring of 2007. Sixteen perennial forb species were planted every year during the study. Two perennial grass species were added to the study during the second year.

Three treatments were compared:
1) early fall seeding (mid September)
2) fall-dormant seeding (late October)
3) early spring seeding (mid to late April)

To prepare the plots for seeding in fall 2002, existing grain stubble was chiseled and disked. In the years following, chiseling of fall plots was omitted. Spring seeded plots were chiseled the preceding fall and cultivated and rod-weeded in the spring. Immediately prior to planting each treatment, the plots were cultivated with a Glencoe cultivator and packed with a Brillion roller.

Seeds for this study were obtained from an Initial Seed Increase (ISI) planting at the Plant Materials Center. The ISI was established from locally collected seed on or near the PMC. The species selected for evaluation are forb and grass components of the Palouse and Nez Perce Prairies (which include the Zumwalt and Camas Prairies) of eastern Washington, northeastern Oregon and north-central Idaho. This area encompasses the Major Land Resource Area (MLRA) 9, shown in gold on the map below.



Location of MRLA 9 (gold) within Land Resource Region B (orange)

Species evaluated in this study were:

Common name	**Scientific Name**
Western yarrow	*Achillea millefolium*
Bigflower agoseris	*Agoseris grandiflora*
Idaho fescue	*Festuca idahoensis*
Blanketflower	*Gaillardia aristata*
Northern bedstraw	*Galium boreale*
Prairie smoke	*Geum triflorum*
False/Little sunflower	*Helianthella uniflora*
Roundleaf alumroot	*Heuchera cylindrica*
Fernleaf biscuitroot	*Lomatium dissectum*
Velvet lupine	*Lupinus leucophyllus*
Yellow Penstemon	*Penstemon confertus*
Tall cinquefoil	*Potentilla arguta*
Slender cinquefoil	*Potentilla gracilis*
Bluebunch wheatgrass	*Pseudoroegneria spicata*
Palouse goldenweed	*Pyrrocoma liatriformis*
Oregon checkermallow	*Sidalcea oregana*
Missouri goldenrod	*Solidago missouriensis*
Western mountain aster	*Symphyotrichum spathulatum*

Species were seeded in single plots for each treatment using a Hege 1000 plot seeder. Each plot contained four 20 foot long rows. Small seeded species were planted at a rate of 40 seeds per linear foot, and large seed species at 20 seeds per linear foot. (The large seeded species in this study were fernleaf biscuitroot and velvet lupine.) All species were seeded no more than ½ inch deep. Plots were randomized within and between treatments. Limited seed supply, space and labor prevented replicating the plots for each treatment; however data was collected from each of the four rows within each plot separately.

During the initial growing season of all plots, seedling counts were taken in May for the fall plantings and in June for the spring plantings. Counts were taken per linear foot at intervals of 4, 8, 12, and 16 feet in each row. A total of 16 counts were taken per plot. Percent cover estimations were also made in July 2003, 2007 and 2009.

Results for each species were analyzed statistically by using a split plot design. Homogenous groups for time of seeding were determined by using LSD all-pairwise comparison tests. Regression analyses were also conducted to determine the correlations between initial seedling establishment and cumulative precipitation at time of planting, between initial seedling establishment and cumulative precipitation in April, and between initial seedling establishment and percent stand cover after 2 or 3 years.

Results

Precipitation

Annual precipitation during the study period (September 2002 – August 2009) was slightly below normal, with an average of 18.93 inches and a range of 16.31 – 22.30 inches. The growing seasons of 04/05 and 08/09 were the driest, with only 16.32 and 16.31 inches of precipitation, respectively. Table 1 shows monthly cumulative precipitation per growing season.

Table 1

Cumulative precipitation per growing season in Pullman, WA 2002 - 2009 (in)

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
02/03	0.37	1.06	2.02	4.24	9.67	11.65	15.90	17.40	19.17	19.36	19.44	20.08
03/04	0.88	1.55	4.18	7.19	10.08	11.78	13.10	14.14	17.53	18.13	18.38	20.53
04/05	1.01	2.98	5.14	6.68	7.69	7.85	10.31	12.08	14.52	15.82	16.15	16.32
05/06	1.04	3.10	5.00	8.19	13.31	14.80	16.77	19.06	20.68	22.20	22.20	22.30
06/07	0.58	1.50	6.19	8.22	10.52	12.55	13.97	15.19	16.21	17.14	17.28	17.85
07/08	0.14	1.80	4.44	8.29	10.99	12.25	14.19	14.92	16.11	17.52	17.76	19.11
08/09	0.20	0.58	2.44	3.33	5.46	6.57	9.15	10.83	12.94	13.59	15.34	16.31
AVE	0.60	1.80	4.20	6.59	9.67	11.06	13.34	14.80	16.74	17.68	18.08	18.93

Summary of Results by Species

Western Yarrow (*Achillea millefolium*) established moderately well, with a 33% success rate based on initial year seedling count. There was no significant difference between fall and spring seeding. In the years following establishment, yarrow increased in density and spread by seed into neighboring plots, and became one of the most dominant and successful plants in the study.

Bigflower agoseris (*Agoseris grandiflora*): Late fall seeding of bigflower agoseris was significantly higher than spring seeding, but not significantly higher than early fall seeding. Initial year seedling count was exceptional; 80% of the plantings were considered to be successful. However, in time, bigflower agoseris proved to be short-lived, with virtually no plants remaining 2 to 3 years following establishment.

Idaho fescue (*Festuca idahoensis*) had significantly higher seedling establishment with late fall seeding compared to early fall or spring, however all seedings were fairly poor. During the four years of evaluation, only one out of twelve seedings was considered to be successful based on initial year seedling count. Over time, stand density generally increased. In contrast to this study's findings, years of experience at the PMC show spring seedings of Idaho fescue produce better stands than fall seedings.

Blanketflower (*Gaillardia aristata*) had variable initial year seedling counts, and 73% of the plantings were successful. There was no significant difference among planting times. Stand density of most plots increased over time.

Northern Bedstraw (*Galium boreale*) had very poor initial seedling establishment for all planting times. As a result, no planting time was significantly higher than another, nor was there any measurable cover 2 to 3 years after establishment.

Prairie Smoke (*Geum triflorum*) had variable initial year seedling establishment, and no planting time was significantly better than another. Only 13% of plantings were successful. Over time, some stands increased in percent cover and some declined.

False/Little Sunflower (*Helianthella uniflora*) had significantly higher initial year establishment with seedings in early and late fall compared to spring. Virtually no seedlings established with spring seedings. Based on initial year seedling count, no stands were considered to be successful. Stand density of all plots, however, increased over time.

Roundleaf alumroot *(Heuchera cylindrica)* had very poor initial-year seedling establishment. No seedings were successful and no plants remained after 2 to 3 years.

Fernleaf bisuitroot (*Lomatium dissectum*) established poorly in the initial year, and no seedlings resulted from spring seedings. Stand density among the few plants that that established increased dramatically over time.

Velvet lupine (*Lupinus leucophyllus*) had significantly higher seedling count from early fall seeding compared to late fall, and both fall planted seedling counts were significantly higher than spring. During the first year of establishment, 27% of the plantings were considered to be successful, and stand density of all plots increased over time.

Yellow penstemon (*Penstemon confertus*) established relatively well during the initial year; 33% of the plantings resulted in successful stands. Late fall seedling count was significantly higher than early fall, and no seedlings resulted from spring plantings. Over time, stand density of the plots remained fairly constant.

Tall cinquefoil (*Potentilla arguta*) had significantly higher initial year seedling count with a late fall planting compared to early fall or spring plantings. Successful stands were established 33% of the time. Over the years, stand density increased in all plots.

Slender cinquefoil (*Potentilla gracilis*) had significantly higher seedling counts in stands planted in the early and late fall compared to spring. Successful stands were established 33% of the time, and throughout the years, stand density generally increased.

Bluebunch wheatgrass (*Pseudoroegneria spicata*) only produced a successful stand in one out of 12 total plantings, and this planting was in the late fall. Stand density of most of the plots increased over time. In contrast to this study's findings, years of experience at the PMC show spring seedings of bluebunch wheatgrass produce better stands than fall seedings.

Palouse Goldenweed (*Pyrrocoma liatriformis*) had significantly higher seedling counts from fall plantings compared to spring, however no plantings were considered to be successful. Among the few plants that established, stand density increased throughout time. **This is a rare endemic Palouse Prairie species, and should only be planted within the Palouse.**

Oregon checkermallow (*Sidalcea oregana*) had very poor initial year seedling count from fall plantings, and virtually no plants established from spring plantings. No plantings were considered to be successful. The few plants that established survived for the first 2 – 3 years, but did not generally increase in density or number.

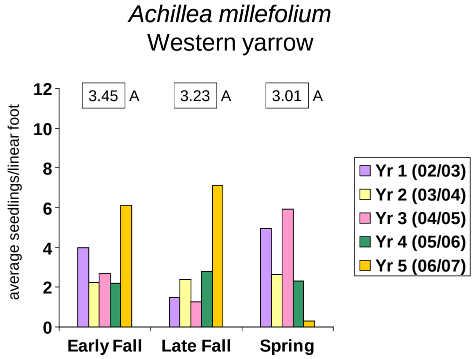
Missouri Goldenrod (*Solidago missouriensis*) had significantly higher seedling establishment from early and fall seedings compared to spring, and 40% of the plantings were successful. Stand density increased dramatically over time.

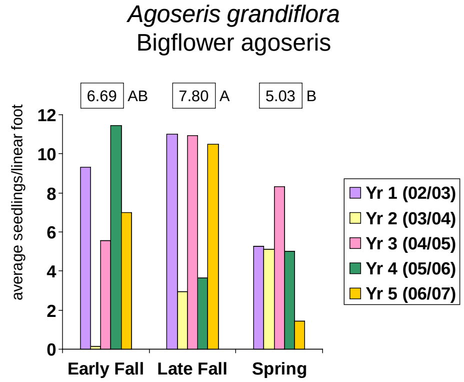
Western mountain aster (*Symphyotrichum spathulatum*) had significantly higher initial year seedling establishment from early and late fall plantings compared to spring, and 53% of all plantings were considered to be successful. Over time, stand density generally increased.

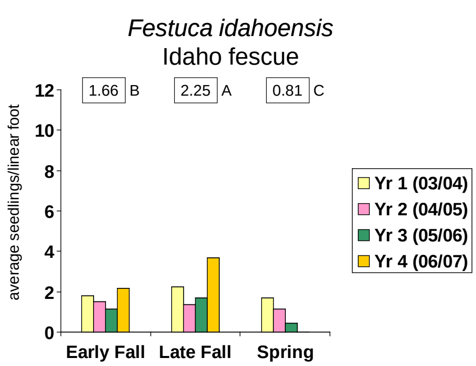
Seedling establishment

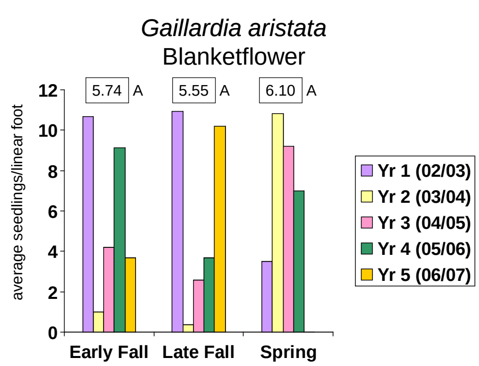
As expected, seedling establishment varied considerably. Variation was exhibited between species, between treatments and between years.

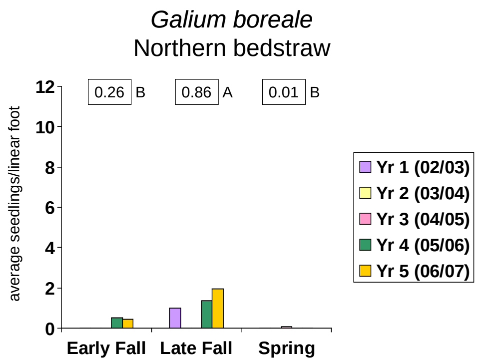
The charts below show average seedling count per linear foot (Y axis) for each year and each planting time (X axis). The 5-year average seedling count is shown in boxes above each planting time. Letters indicate homogenous groups (different letters indicate a statistical difference among groups). Year 1 for all forbs was 2002/2003. Year 1 for the two grasses was 2003/2004. Each graph uses a standard maximum of 12 seedlings/linear foot with the exception of Missouri goldenrod and western mountain aster. These two species had a few incidences of exceptionally high seedling counts.

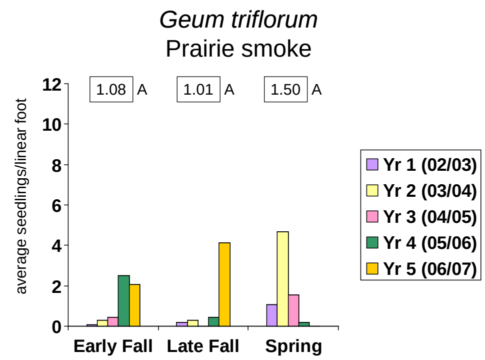


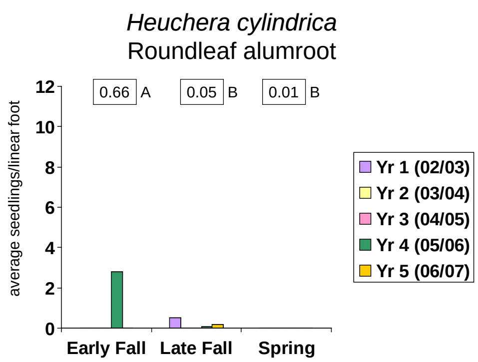


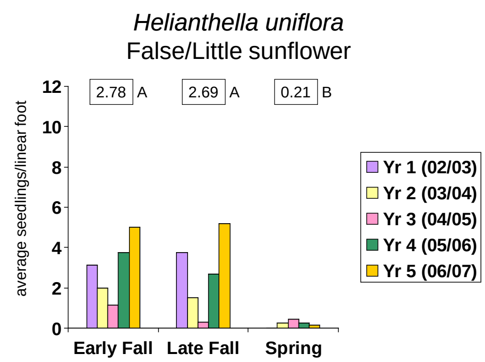


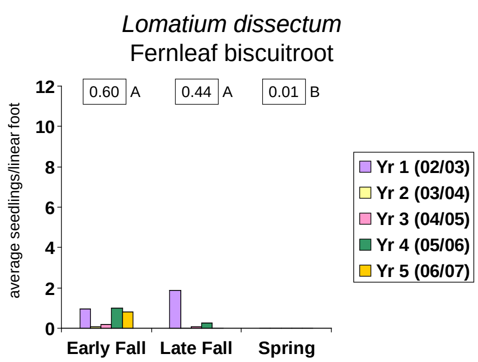


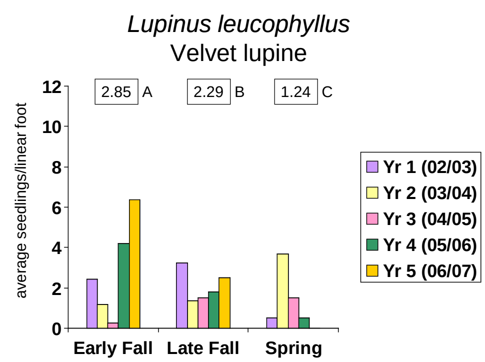

Galium boreale
Northern bedstraw
0.26 B
0.86 A
0.01 B
average seedlings/linear foot
12
10
8
6
4
2
0
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)

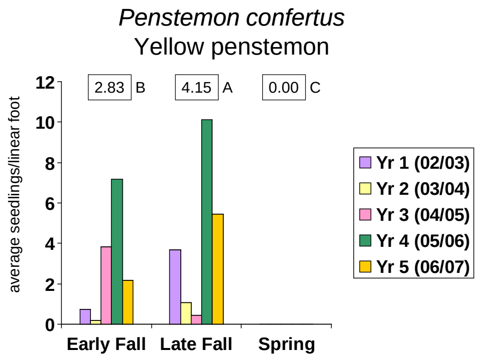

Geum triflorum
Prairie smoke
1.08 A
1.01 A
1.50 A
average seedlings/linear foot
12
10
8
6
4
2
0
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)

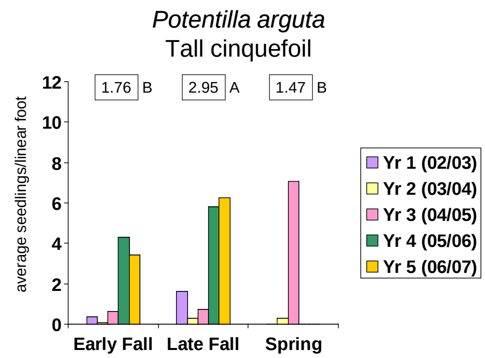

Heuchera cylindrica
Roundleaf alumroot
0.66 A
0.05 B
0.01 B
average seedlings/linear foot
12
10
8
6
4
2
0
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)

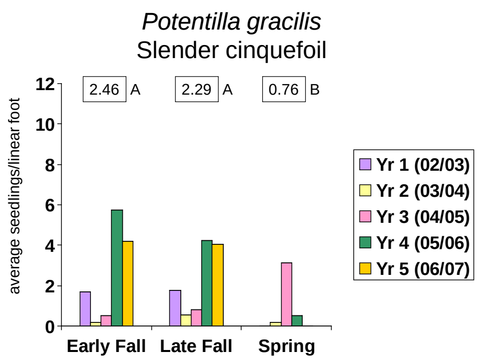

Helianthella uniflora
False/Little sunflower
2.78 A
2.69 A
0.21 B
average seedlings/linear foot
12
10
8
6
4
2
0
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)

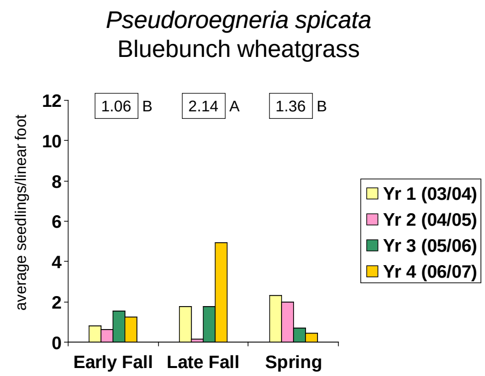

Lomatium dissectum
Fernleaf biscuitroot
0.60 A
0.44 A
0.01 B
average seedlings/linear foot
12
10
8
6
4
2
0
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)

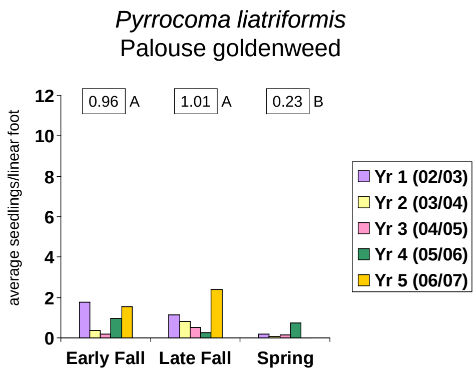

Lupinus leucophyllus
Velvet lupine
2.85 A
2.29 B
1.24 C
average seedlings/linear foot
12
10
8
6
4
2
0
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)

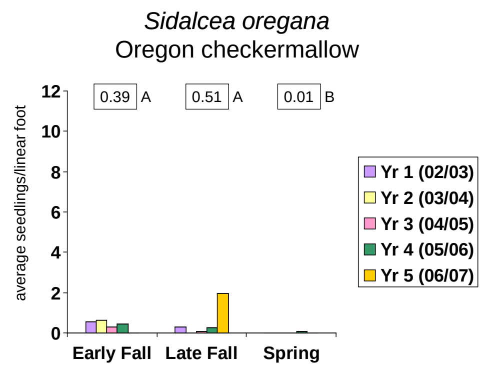

Penstemon confertus
Yellow penstemon
average seedlings/linear foot
2.83 B
4.15 A
0.00 C
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)

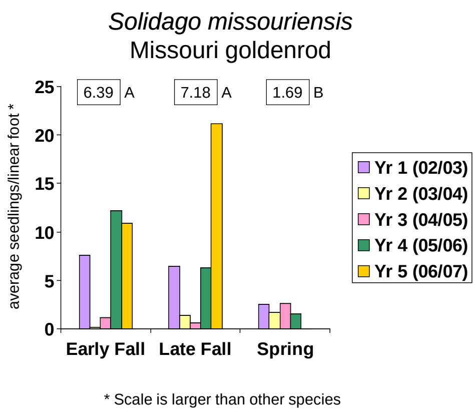

Potentilla arguta
Tall cinquefoil
average seedlings/linear foot
1.76 B
2.95 A
1.47 B
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)

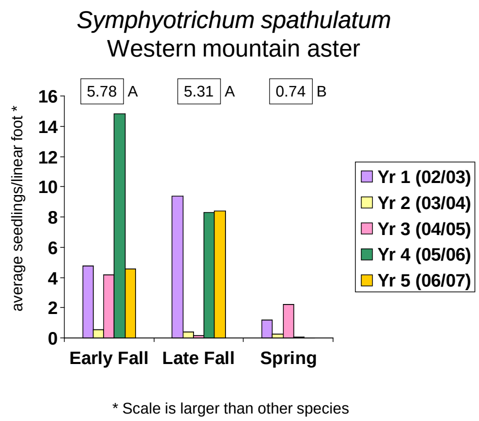

Potentilla gracilis
Slender cinquefoil
average seedlings/linear foot
2.46 A
2.29 A
0.76 B
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)


Pseudoroegneria spicata
Bluebunch wheatgrass
average seedlings/linear foot
1.06 B
2.14 A
1.36 B
Early Fall
Late Fall
Spring
Yr 1 (03/04)
Yr 2 (04/05)
Yr 3 (05/06)
Yr 4 (06/07)


Pyrrocoma liatriformis
Palouse goldenweed
average seedlings/linear foot
0.96 A
1.01 A
0.23 B
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)


Sidalcea oregana
Oregon checkermallow
average seedlings/linear foot
0.39 A
0.51 A
0.01 B
Early Fall
Late Fall
Spring
Yr 1 (02/03)
Yr 2 (03/04)
Yr 3 (04/05)
Yr 4 (05/06)
Yr 5 (06/07)





Planting Time

The optimal planting times for each species in this study are listed below. For fifteen out of the eighteen species, the highest initial-year seedling establishment resulted from early fall, late fall or early and late fall plantings.

Early and Late Fall

Bigflower agoseris
False sunflower
Fernleaf biscuitroot
Slender cinquefoil
Palouse goldenweed
Oregon checkermallow
Missouri goldenrod
Western mountain aster

Early Fall

Velvet lupine
Roundleaf alumroot

Late Fall

Idaho fescue
Northern bedstraw
Yellow penstemon
Tall cinquefoil
Bluebunch wheatgrass

Fall or Spring

Western yarrow
Blanketflower
Prairie smoke

Six species had very poor seedling establishment (less than an average of 1.5 plants per linear foot for all planting treatments). These were: fernleaf biscuitroot, Palouse goldenweed, Oregon checkermallow, northern bedstraw, roundleaf alumroot and prairie smoke.

Other experiences with Idaho fescue and bluebunch wheatgrass at the Pullman PMC have shown better seedling establishment with spring planting than with fall planting.

Planting success rate

A planting is generally considered successful if at least 3 to 4 seedlings per linear foot develop during the initial year of establishment. The table below (Table 2) shows the number of times initial year seedling count equaled or exceeded 3 seedlings per linear foot.

Table 2

Number of times initial year seedling count equaled or exceeded 3 seedlings per linear foot
(Total number of plantings in parentheses)

Species	Early Fall (5)	Late Fall (5)	Fall Success Rate	Spring (5)	Spring Success Rate	Fall and Spring (15)	Total Success Rate
Western yarrow	2	1	30%	2	40%	5	33%
Bigflower agoseris	4	4	80%	4	80%	12	80%
Blanketflower	4	3	70%	4	80%	11	73%
Northern bedstraw	0	0	0%	0	0%	0	0%
Prairie smoke	0	1	10%	1	20%	2	13%
False sunflower	0	0	0%	0	0%	0	0%
Roundleaf alumroot	0	0	0%	0	0%	0	0%
Fernleaf biscuitroot	0	0	0%	0	0%	0	0%
Velvet lupine	2	1	30%	1	20%	4	27%
Yellow penstemon	2	3	50%	0	0%	5	33%
Tall cinquefoil	2	2	40%	1	20%	5	33%
Slender cinquefoil	2	2	40%	1	20%	5	33%
Palouse goldenweed	0	0	0%	0	0%	0	0%
Oregon checkermallow	0	0	0%	0	0%	0	0%
Missouri goldenrod	3	3	60%	0	0%	6	40%
Wester mountain aster	4	3	70%	1	20%	8	53%
All Forb Species	27 (90)	25 (90)	30%	15 (90)	19%	67 (270)	25%

Species	Early Fall (4)	Late Fall (4)	Fall Success Rate	Spring (4)	Spring Success Rate	Total (12)	Total Success Rate
Idaho fescue	0	1	13%	0	0%	1	8%
Bluebunch wheatgrass	0	1	13%	0	0%	1	8%
All Grass Species	0 (8)	2 (8)	13%	0 (8)	0%	2 (24)	8%

The species with the highest rates of success based on initial-year seedling establishment were: bigflower agoseris, blanketflower, western mountain aster and Missouri goldenrod. The species with no successful plantings based on initial-year seedling establishment were: northern bedstraw, false sunflower, roundleaf alumroot, fernleaf biscuitroot, Palouse goldenweed, and Oregon checkermallow.

Correlations between seedling establishment and precipitation

R-squared values generated in regression analyses comparing initial-year seedling establishment with cumulative precipitation at time of fall planting, and with cumulative precipitation in spring (time of spring planting) were rarely over 50%, indicating variation in seedling establishment was often caused by factors other than precipitation. The species with the highest correlation values were the two grasses, however the values differed substantially for early fall seeding. Seedling establishment of Idaho fescue planted in early and late fall was positively correlated with precipitation at time of planting 87% and 66% of the time, respectively, and minimally correlated with spring precipitation. Seedling establishment of bluebunch wheatgrass planted in early fall was not at all correlated with precipitation at time of planting but was positively correlated with spring precipitation 91% of the time. Despite the high correlation values, only 1 out of 12 plantings for each of the grass species was considered to be successful.

Survivability

Survivability is defined as the ability of a species to persist throughout time. To evaluate survivability of species in this study, percent stand cover assessments were made three times throughout the study period. A species was described as having good survivability if stand density increased over time and poor survivability if it decreased over time.

Good Survivability

Western yarrow
Idaho fescue
Blanketflower
False sunflower
Fernleaf biscuitroot
Velvet lupine
Yellow penstemon
Tall cinquefoil
Slender cinquefoil
Palouse goldenweed
Bluebunch wheatgrass
Missouri goldenrod
Western mountain aster

Poor Survivability

Bigflower agoseris

Prairie smoke, roundleaf alumroot, and Oregon checkermallow had low initial-year seedling establishment. The few plants of these species that did establish survived but did not generally spread by vegetative or reproductive means.

Species with the highest percent stand cover at the end of the study period included: western mountain aster, blanketflower, velvet lupine, and Missouri goldenrod. All of these species had high rates of initial-year seedling establishment.

Correlation between initial seedling establishment and percent stand cover after 2 to 3 years of growth

Regression analysis produced low correlation values for initial seedling establishment and percent stand cover after 2 or 3 years of growth for each treatment and for each species, demonstrating first-year establishment is often not an indicator of the species' ability to persist long-term. Short-lived perennials such as bigflower agoseris had low percent stand cover after 2 or 3 years of growth, even though initial seedling establishment was very high. Conversely, western yarrow, Idaho fescue, fernleaf biscuitroot and Palouse goldenweed had moderate to high percent stand cover after 2 or 3 years of growth, even though initial seedling establishment was low. Only one species, slender cinquefoil, had a high R^2 value (69%) signifying 69% of the time, initial-year seedling count was an indicator of percent stand cover after 2 to 3 years.

Discussion

Planting Time

Fifteen out of eighteen species in this study had significantly higher seedling establishment with early or late fall seedings compared to spring seedings. For many of these species, germination is enhanced with a cold moist stratification period, and for some, cold moist stratification is absolutely necessary in order to break dormancy. Unfortunately, there are challenges associated with planting in the fall. These include: increased weed pressure, frost heave and seed predation. To reduce weed pressure, fall plantings should be delayed until after winter annual weeds germinate and can be eliminated with a tillage operation or herbicide application. This time period is middle to late October for most of the Palouse and Nez Perce Prairies, and November for drier parts of the Inland Northwest. Due to the difficulty of eliminating the flushes of weeds in the spring, reducing the seed bank in previous years by fallowing or planting an interim crop will be helpful. In addition, delaying the planting as late as possible will help to ensure seeds will not germinate until spring, reducing the chances of frost heave damage. Loss of seed to predation may be overcome by increasing the seeding rate and drilling the seed rather than broadcasting.

John Schwendiman, who worked in the Plant Materials Program and the Pullman PMC service area for over 40 years, claimed that in areas of the Inland Northwest receiving 16 inches of mean annual precipitation or more, grasses should be planted in the spring. This statement has been confirmed by 22 years of additional experience at the PMC. Spring plantings, however, also involve risk. Early spring plantings are susceptible to soil crusting and late spring plantings are threatened by the chance of soil drying before the seedlings can establish. When seeding a mixture of grasses and forbs, one strategy that can be successful is planting grasses in the spring, and returning in the fall to plant forbs that require a stratification period. This allows for establishment of early cover and for additional opportunities to use broadleaf herbicides. In drier portions of the Inland Northwest receiving less than 16 inches of mean annual precipitation (MLRAs 7 and 8) forbs and grasses can be planted together in the fall.

Native Grass and Forb Survivability
Most of the species in this study with high initial seedling establishment survived for many years and increased in stand density. The one species with high initial seedling establishment that did not survive for many years was bigflower agoseris. It is considered to be an early seral species, and it could be included in seedling mixtures to provide initial cover.

Seedling Establishment Success
Eight out of eighteen species in this study had initial year establishment success rates over 33%, and three out of eighteen species had initial year establishment success rates over 50%. Rates of success for many species are higher if only fall plantings are considered. Rates of success would also likely be higher in a real-world setting where species are seeded in mixtures rather than in single-species plots, particularly if the mix contains species with high establishment rates.

The variability in seedling establishment in this study was rarely correlated with cumulative fall or spring precipitation. Other environmental and mechanical factors that influenced seedling establishment include: timing of precipitation, frost damage, soil crusting or drying, weed pressure, and equipment malfunctions.

The chances of successfully establishing native forbs and grasses are improved with:
- Appropriate planting time
- Proper seedbed preparation
- Drilling the seed
- Eliminating weeds before and after planting
- Increasing the seeding rate

The Seedbed
The best stands of native forbs and grasses are achieved when a clean, weed-free seed bed is prepared and the seed is planted with a drill. A firm seed bed holds moisture in the seed zone and assures accurate seed placement. Seed should be placed between ¼ and ½ inch deep. Often due to the difficulty of accessing a site with equipment such as a drill, land managers attempt to interseed native forbs into an existing stand of vegetation by broadcasting or harrowing. With this practice little seed-to-soil contact is achieved, significantly reducing the seed's ability to germinate and grow, and if a harrow is used, existing vegetation can be severely damaged.

Use of Herbicides
No herbicides were used in this study, however pre- and post-emergent herbicides can be used to significantly reduce weed pressure before and after a planting. Consult your local agricultural extension agent to learn what herbicides work best in your area and how to use them properly.

Forb Block Planting

Chances of successfully establishing a stand of native forbs can be improved by increasing the seeding rate. However, the ability to do this is often restricted by limited seed supply and high price of the seed. If it is not possible to increase the forb seeding rate for these reasons, it is better to concentrate the forb seed in several small areas rather than in a mix that covers the entire area at a low rate. In a natural environment, plant species are rarely evenly distributed throughout a broad landscape; rather they occur in clusters and are positioned where growing conditions are most favorable. Forbs planted in this manner can serve as sources of seed that spread into adjacent areas.

Block planting is currently a strategy that is allowed by the USDA Farm Services Agency for establishing forbs in the Conservation Reserve Program (CRP) in Washington. This strategy was developed to improve forb establishment and facilitate weed management. By separating forbs into blocks along the edges or scattered throughout the stand, broadleaf herbicides can be used on the majority of the stand while still improving diversity and wildlife habitat.

Seed Sources

Local seed producers have been responding to the demand for native forb seed by increasing production, which has reduced concerns of availability and price. A few species in this study, including Palouse goldenweed, Oregon checkermallow and roundleaf alumroot have very limited availability. Consult the following sources for seed vendor information:

Washington Plant Materials Vendor List at
http://efotg.nrcs.usda.gov/references/public/WA/TN3_VendorList_revised_0309.pdf

Idaho Plant Materials Vendor List at
ftp://ftp-fc.sc.egov.usda.gov/ID/programs/technotes/tn33_vendors.pdf

Oregon Plant Materials Vendor List at
http://www.or.nrcs.usda.gov/technical/ecs/plants/plants-technotes.html

The Native Seed Network at www.nativeseednetwork.org

Photo credits

Achillea millefolium, J.S. Peterson, USDA NRCS Plants Database
Agoseris grandiflora, David M. Skinner, USDA NRCS
Festuca idahoensis, Gary A. Monroe, USDA NRCS Plants Database
Gaillardia aristata, Pamela L. Scheinost, USDA NRCS
Galium boreale, W. Carl Taylor, USDA NRCS Plants Database
Geum triflorum, Gary A. Monroe, USDA NRCS Plants Database
Helianthella uniflora, Susan McDougall, USDA NRCS Plants Database
Heuchera cylindrica, Margaret Williams, USDA NRCS Plants Database
Lomatium dissectum, David M. Skinner, USDA NRCS

Lupinus leucophyllus, US Forest Service
Penstemon confertus, Emma Elliott, Wild Ginger Farm
Potentilla arguta, Larry Alain, USDA NRCS Plants Database
Potentilla gracilis, J.S. Peterson, USDA NRCS Plants Database
Pseudoroegneria spicata, British Columbia Ministry of Agriculture and Lands
Pyrrocoma liatriformis, David M. Skinner, USDA NRCS
Sidalcea oregana, Gary A. Monroe, USDA NRCS Plants Database
Solidago missouriensis, National Park Service
Symphyotrichum spathulatum, David M. Skinner, USDA NRCS

Weather data

Skinner, David M. 2009. Personal communication.

Ag Weather Net (www.weather.wsu.edu) [online: cited 22 September 2009]. Washington State University, Prosser, WA.