Aberdeen Plant Materials Center

2015-2016 Annual Technical Report

United States
Department of
Agriculture

**Natural Resources
Conservation Service**

Aberdeen, Idaho

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Helping People Help the Land

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Tilley, D. 2015. Seed production and field establishment of hoary tansyaster (*Machaeranthera canescens*). Native Plants Journal. 16(1): 61-66.

Simonson, D. and D. Tilley. 2016. A low-cost modification to a flail-vac harvester for collecting lightweight, wind-dispersed seed. Native Plants Journal. 17(2): 103-108.

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INTRODUCTION

INTRODUCTION

The Plant Materials Center at Aberdeen is part of a national plant materials program operated by the United States Department of Agriculture, Natural Resources Conservation Service. The purpose of the Plant Materials Center is to develop and communicate new technology for the use and management of plants to solve natural resource concerns. We also assemble, evaluate and release plant materials for conservation use and develop new techniques for establishment of conservation plants.

The Aberdeen Plant Materials Center was established in 1939 and currently maintains 14 cultivars and 5 pre-variety (Selected Class) releases. The Aberdeen Plant Materials Center serves portions of Nevada, Utah, Oregon, Wyoming and Idaho. This document is a compilation of progress reports for activities by the Aberdeen Plant Materials Center during FY 2015 and 2016.

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Note: *Trade names are used solely to provide specific information and should not be considered a recommendation or endorsement by the Natural Resources Conservation Service.*

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ON-CENTER STUDIES

FOUNDATION SEED PRODUCTION AT ABERDEEN PLANT MATERIALS CENTER

A major responsibility of the Aberdeen Plant Materials Center is the production of Foundation quality seed of the plant releases from the Center. Foundation seed is made available to the University of Idaho Agricultural Experiment Station, Idaho Crop Improvement Association, Utah Crop Improvement Association, other plant materials centers and cooperating agencies. Seed is distributed as provided for by allocation and exchange or other written agreements. Foundation seed of recent releases may also be provided to soil conservation districts for registered or certified seed production under the District Seed Increase (DSI) program.

The following table illustrates seed shipments from the Aberdeen Plant Materials Center for Fiscal year 2007 through 2015:

Cultivar	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL POUNDS
				POUNDS PLS						
Anatone bluebunch wheatgrass	400	775	450	155	125	80	640	150	314	3089
Appar blue flax	150	150	200	120	175	150	200	175	500	1820
Bannock thickspike wheatgrass	240	150	-	-	100	850	1369	200	340	3249
Delar small burnet	100	1225	-	-	300	-	1200	200	300	3325
Ephraim crested wheatgrass	300	500	605	-	-	300	350	-	800	2855
Goldar bluebunch wheatgrass	250	450	300	250	100	400	200	150	150	2250
Magnar basin wildrye	490	50	-	50	-	150	225	-	650	1615
Maple Grove lewis flax	-	-	-	-	-	65	15	20	100	200
Nezpar Indian ricegrass	700	150	100	-	-	200	200	-	150	1500
P-27 Siberian wheatgrass [1/]	200	200	-	-	-	-	-	-	-	400
Clearwater selection penstemon	-	-	1	4	20	-	25	-	-	50
Richfield selection penstemon	6	4	11	9	5	10	5	-	15	65
Paiute orchardgrass	200	50	300	-	-	-	-	-	-	550
Recovery western wheatgrass	-	-	400	-	450	425	950	200	150	2575
Regar meadow brome	50	400	-	50	100	100	100	-	-	800
Rush intermediate wheatgrass	500	-	-	-	-	50	725	400	1160	2835
S.R.P. fourwing saltbush [2/]	-	-	-	-	-	-	-	-	-	-
Sodar streambank wheatgrass	250	400	50	-	-	300	800	600	300	2700
Tegmar dwarf intermediate wheatgrass	-	-	250	250	150	-	500	-	-	1150
Northern Cold Desert winterfat [2/]	4	-	-	2	-	-	-	-	-	6
Vavilov II Siberian wheatgrass	-	600	300	635	320	230	366	100	150	2701
TOTAL POUNDS	3840	5104	2967	1525	1845	3310	7870	2195	5085	33735

[1/] Release discontinued in 2009.
[2/] Release discontinued in 2012.

FOUNDATION SEED PRODUCTION AT ABERDEEN PLANT MATERIALS CENTER

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The following table illustrates seed shipments from the Aberdeen Plant Materials Center for Fiscal year 2008 through 2016:

Cultivar	2008	2009	2010	2011	2012	2013	2014	2015	2016	TOTAL POUNDS
					POUNDS PLS					
Anatone bluebunch wheatgrass	775	450	155	125	80	640	150	314	-	2689
Appar blue flax	150	200	120	175	150	200	175	500	150	1820
Bannock thickspike wheatgrass	150	-	-	100	850	1369	200	340	-	3009
Delar small burnet	1225	-	-	300	-	1200	200	300	150	3375
Ephraim crested wheatgrass	500	605	-	-	300	350	-	800	100	2655
Goldar bluebunch wheatgrass	450	300	250	100	400	200	150	150	75	2075
Magnar basin wildrye	50	-	50	-	150	225	-	650	90	1215
Maple Grove lewis flax	-	-	-	-	65	15	20	100	65	265
Nezpar Indian ricegrass	150	100	-	-	200	200	-	150	100	900
P-27 Siberian wheatgrass [1/]	200	-	-	-	-	-	-	-	-	200
Clearwater selection penstemon	-	1	4	20	-	25	-	-	-	50
Richfield selection penstemon	4	11	9	5	10	5	-	15	-	59
Paiute orchardgrass	50	300	-	-	-	-	-	-	200	550
Recovery western wheatgrass	-	400	-	450	425	950	200	150	-	2575
Regar meadow brome	400	-	50	100	100	100	-	-	-	750
Rush intermediate wheatgrass	-	-	-	-	50	725	400	1160	-	2335
S.R.P. fourwing saltbush [2/]	-	-	-	-	-	-	-	-	-	-
Sodar streambank wheatgrass	400	50	-	-	300	800	600	300	150	2600
Tegmar dwarf intermediate wheatgrass	-	250	250	150	-	500	-	-	-	1150
Northern Cold Desert winterfat [2/]	-	-	2	-	-	-	-	-	-	2
Vavilov II Siberian wheatgrass	600	300	635	320	230	366	100	150	250	2951
TOTAL POUNDS	5104	2967	1525	1845	3310	7870	2195	5079	1330	31225

[1/] Release discontinued in 2009.
[2/] Release discontinued in 2012.

Aberdeen Plant Materials Center
2015 Field Annual Plan of Operation
Home Farm

Field	Acres	Crop	Operation
1	1.7	Radish Seed (2015)	Establish and harvest common seed
2E	1.3	Tegmar Breeder (2014)	Manage for certified seed production
2W	0.5	Cover Crop termination (2015)	Wheat (spring); replicated CC trial (Aug) for termination 2016
3E	0.9	Tansyaster (2014)	Manage for certified seed production
3W	0.9	Tansyaster (2015)	Establish and manage for certified seed production
4	1.4	Constructed wetland ponds	Control weeds
5	2.4	Anatone (2012)	Manage for certified seed production
6	2.4	Regar (2012)	Manage for certified seed production
7N	1.2	Potatoes (2015)	Manage for UI
7S	2.0	Cover crop (2015)	Wheat in spring, fall CC mix
8	3.2	Cover crop (2015); Anatone (2015)	CC mix for tours in spring, terminate after tour; Establish Anatone for certified production
9	3.2	Vavilov II (2013)	Manage for certified seed production
10	3.2	Anatone (2013)	Manage for certified seed production
11B	1.4	Anatone (2014)	Manage for certified seed production
12A		Buckwheat (2013) (2)	Manage for certified seed production
12B		Buckwheat (2014) (1)	Manage for certified seed production
12C		Dusty Maiden (2013)(1)	Terminate dustymaiden and fallow
12D		Buckwheat (2015) or fallow	Establish buckwheat if seed/plants available
12E		Fallow (2015)	Terminate globemallow and fallow
12F		Buckwheat (2015) (3)	Establish and manage for certified seed production
13A	0.6	Fallow (2014)	Prep for fabric and irrigation
13B	0.2	Venus Penstemon (2003)	Maintain for pollinator habitat
13C	0.6	Anatone G0 (2013)	Maintain and harvest G1
14	1.2	Woody display nursery	Maintain display of wood conservation plants. Manage Durar/Cover cover.
14S	0.3	Richfield Penstemon (2013)	Manage for certified seed production
15	1.4	Field windbreak (2000)	Maintain Simon poplar windbreak
16	1.0	Anatone Zeolite (2014)	Non-replicated trial of zeolite/humate
17	0.5	Hybrid Poplars	Manage for long-term survival evaluation
18-19	0.9	Fourwing and winterfat (1999)	Maintain cover
20	1.5	Display Nursery (2012)	Manage for display

2015 Field Annual Plan of Operation
Fish and Game Farm

Field	Acres	Crop	Operation
21W	0.7	Bozoisky Cover (2013)	Maintain for permanent cover
21W	0.3	Forage Kochia trial (2012)	Manage/evaluate according to study plan
21W	0.3	Corn (2015)	Establish and maintain for food plot
21M	1.3	Wheat (2015)	Establish and maintain for food plot
21E	1.4	Pipe Yard (2004)	Maintain permanent yard for pipe storage
21N	1.3	Bozoisky cover (1985)	Maintain for permanent cover
22W	4.1	Alfalfa (2008)	Manage for hay production and wildlife
22E	1.3	Willow IEP (1984)	Maintain for wildlife cover
23W	2.4	Bozoisky Cover (2007)	Maintain for permanent cover
23M		Windbreak	Maintain and irrigate as needed
23E	2.2	Goldar (2011)	Manage for certified seed production
24W	1.1	Windbreaks	Maintain and irrigate as needed
24M	2.2	Maple Grove (2013)	Manage for certified seed production
24E	1.5	Goldar (2014)	Manage for certified seed production
25W	1.5	Goldar (2014)	Manage for certified seed production
25E	3.5	Goldar (2009)	Manage for certified seed production
26W	1.0	Bozoisky Cover (2005)	Maintain for permanent cover
26E	2.7	Willow Cutting Nursery (1994)	Maintain as needed
27W	2.2	Bozoisky Cover (2005)	Maintain for permanent cover
27M	1.2	Bozoisky Cover (2007)	Maintain for permanent cover
27E	1.0	Grand Teton Forbs (2015) Oneflower sunflower (1) Sulphur buckwheat (1) Showy goldeneye (1)	Install fabric, establish plants using greenhouse stock; maintain for seed production
28W	0.2	Wheat (2015)	Establish and maintain for food plot
28M	0.2	Pollinator mix trial (2013)	Maintain and evaluate
28E	5.0	Pollinator Plot (2011)	Maintain and evaluate
29W	1.3	Willows (1994)	Manage for cuttings
29E	3.7	Alfalfa (2008)	Manage for hay production and wildlife
30W	0.7	Windbreak	Maintain and irrigate as needed
30E	4.8	Alfalfa (2010)	Manage for hay production and wildlife
31W	1.5	Alfalfa (2010)	Manage for hay production and wildlife
31M	2.0	Idaho Fescue (2015), Grand Teton	Establish and manage for seed production
31E	2.0	Mountain Brome (2015), Grand Teton	Establish and manage for seed production
32	6.2	Windbreak IEP (1982)	Maintain as needed

Any hay grown will not be cut prior to June 15 and not after September 1. Hay will be irrigated after last cut to first fall frost to achieve regrowth prior to winter dormancy.

Irrigated, permanent grass cover seedings will not be mowed prior to July 1 and not after August 1 and will be irrigated a minimum of 3 times. Non-irrigated grass cover seedings will not be mowed. Early mowing or mowing of non-irrigated grass cover requires notification to and inspection by Fish and Game.

Aberdeen Plant Materials Center

2015 Field Annual Plan of Operation
Pearl Farm

Field	Acres	Crop	Operation
P1W	2.5	Delar (2014)	Manage for certified seed production
P1E	2.5	Bannock (2014)	Manage for certified seed production
P2W	2.5	Bluebunch (2013) YNP	Manage for seed production
P2E	2.5	Sandberg (2013) YNP	Manage for seed production
P3	5.0	Alfalfa (2006)	Maintain for hay harvest; Roundup in fall
P4	2.0	Blue wildrye (2015) GT	Establish and manage for seed production
P5W	2.5	Alfalfa (2007)	Manage for hay production and soil building
P5E	2.5	Alfalfa (2012)	Manage for hay production and soil building
P6	5.0	Alfalfa (2012)	Manage for hay production and soil building
P7W	2.5	Alfalfa (2014)	Manage for hay production and soil building
P7M	1.0	Idaho Fescue (2012) Grand Teton	Manage for seed production
P7E	1.5	Recovery (2015)	Establish and manage for certified seed production
P8	2.2	ARS test plots	Manage according to ARS guidelines

Maintain two-row windbreak (Rocky Mountain Juniper and Simon Poplar) established on south and west farm borders. Maintain Bozoisky cover.

Aberdeen Plant Materials Center
2016 Field Annual Plan of Operation
Home Farm

Field	Acres	Crop	Operation
1	1.7	Fallow/spuds/wheat	UI potatoes, wheat in rest
2E	1.3	Tegmar Breeder (2014)	Manage for certified seed production
2W	0.5	Cover Crop termination (2015)	Manage for herbicide trial and evaluation
3E	0.9	Tansyaster (2014)	Manage for certified seed production
3W	0.9	Tansyaster (2015)	Manage for certified seed production
4	1.4	Constructed wetland ponds	Control weeds
5	2.4	Anatone (2012)	Manage for certified seed production
6	2.4	Regar (2012)	Manage for certified seed production
7N	1.2	Sodar (2016)	Establish and manage for seed production
8	3.2	Anatone (2015)	Manage for certified seed production
9	3.2	Vavilov II (2013)	Manage for certified seed production
10	3.2	Alfalfa (2015)	Manage for hay and soil health
11	1.4	Anatone (2014)	Manage for certified seed production-possibly take out if too weedy
12A		Buckwheat (2013) (2)	Manage for certified seed production
12B		Buckwheat (2014) (1)	Manage for certified seed production
12C-F		Buckwheat (2016) (3-4 rows)	Establish and manage for seed production
12D-13		Fabric and wheat	Wheat fallow for future forbs
14	1.2	Woody display nursery	Maintain display of wood conservation plants. Manage Durar/Cover cover.
14S	0.3	Richfield Penstemon (2013)	Manage for certified seed production
15	1.4	Field windbreak (2000)	Maintain Simon poplar windbreak
16	1.0	Anatone Zeolite (2014)	Non-replicated trial of zeolite/humate
17	0.5	Hybrid Poplars	Manage for long-term survival evaluation
18-19	0.9	Fallow	Fallow for future planting
20	1.5	Display Nursery (2012)	Manage for display

Aberdeen Plant Materials Center
2016 Field Annual Plan of Operation
Fish and Game Farm

Field	Acres	Crop	Operation
21W	0.7	Fallow, weed control (2016)	Prep for Alternate row trial
21E	1.4	Pipe Yard (2004)	Maintain permanent yard for pipe storage
21N	1.3	Bozoisky cover (1985)	Maintain for permanent cover
22W	4.1	Goldar (2016)	Manage for hay production and wildlife
22E	1.3	Willow IEP (1984)	Maintain for wildlife cover
23W	2.4	Bozoisky Cover (2007)	Maintain for permanent cover
23M		Windbreak	Maintain and irrigate as needed
23E	2.2	Wheat (2016)	Establish and maintain for food plot
24W	1.1	Windbreaks	Maintain and irrigate as needed
24M	2.2	Wheat (2016)	Establish and maintain for food plot
24E	1.5	Alfalfa (2015)	Manage for hay and soil health
25W	1.5	Alfalfa (2015)	Manage for hay and soil health
25E	3.5	Goldar (2009)	Manage for certified seed production
26W	1.0	Bozoisky Cover (2005)	Maintain for permanent cover
26E	2.7	Willow Cutting Nursery (1994)	Maintain as needed
27W	2.2	Bozoisky Cover (2005)	Maintain for permanent cover
27M	1.2	Bozoisky Cover (2007)	Maintain for permanent cover
27E	1.0	Grand Teton Forbs (2015) Oneflower sunflower (1) Sulphur buckwheat (1) Showy goldeneye (1)	Install fabric, establish plants using greenhouse stock; maintain for seed production
28W	0.2	Wheat (2015)	Establish and maintain for food plot
28M	0.2	Pollinator mix trial (2013)	Maintain and evaluate, mow spring
28E	5.0	Pollinator Plot (2011)	Maintain and evaluate
29W	1.3	Willows (1994)	Manage for cuttings
29E	3.7	Maple Grove (2016)	Establish and manage for hay production and wildlife
30W	0.7	Windbreak	Maintain and irrigate as needed
30E	4.8	Alfalfa (2010)	Manage for hay production and wildlife
31W	1.5	Alfalfa (2010)	Manage for hay production and wildlife
31M	2.0	Idaho Fescue (2015), Grand Teton	manage for seed production
31E	2.0	Mountain Brome (2015), Grand Teton	manage for seed production
32	6.2	Windbreak IEP (1982)	Maintain as needed

Any hay grown will not be cut prior to June 15 and not after September 1. Hay will be irrigated after last cut to first fall frost to achieve regrowth prior to winter dormancy.

Irrigated, permanent grass cover seedings will not be mowed prior to July 1 and not after August 1 and will be irrigated a minimum of 3 times. Non-irrigated grass cover seedings will not be mowed. Early mowing or mowing of non-irrigated grass cover requires notification to and inspection by Fish and Game.

Aberdeen Plant Materials Center
2016 Field Annual Plan of Operation
Pearl Farm

Field	Acres	Crop	Operation
P1W	2.5	Delar (2014)	Manage for certified seed production
P1E	2.5	Bannock (2014)	Manage for certified seed production
P2W	2.5	Bluebunch (2013) YNP	Manage for seed production
P2E	2.5	Sandberg (2013) YNP	Manage for seed production
P3W	5.0	Ephraim (2016)	Establish and manage for seed production
P3E		Rush (2016)	Establish and manage for seed production
P4	2.0	Blue wildrye (2015) GT	Establish and manage for seed production
P5W	2.5	CC var trial (2016)	Establish and evaluate
P5E	2.5	Magnar (2016)	Establish and manage for seed production
P6	5.0	Alfalfa (2012)	Manage for hay production and soil building
P7W	2.5	Alfalfa (2014)	Manage for hay production and soil building
P7M	1.0	Idaho Fescue (2012) Grand Teton	Manage for seed production
P7E	1.5	Recovery (2015)	Establish and manage for certified seed production
P8	2.2	Alfalfa (2015)	Manage for hay and soil health

Maintain two-row windbreak (Rocky Mountain Juniper and Simon Poplar) established on south and west farm borders. Maintain Bozoisky cover.

Project Title: Aberdeen Plant Materials Center Report of Activities

Project Agreement No: 11-1A-11221632-004

Principal Investigators and Contact Information:

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Highlights:

- Release of Amethyst Germplasm Hoary Tansyaster
- Progress towards release of Wyeth buckwheat
- Development of NRCS Plant Guides

Project Description:

Hoary tansyaster

Nine accessions of hoary tansyaster (*Machaeranthera canescens*) were evaluated from 2009 through 2011 for establishment, plant growth and seed production. Accession 9076670 had the best establishment and stands for 2009 and 2010. It also had the best rated vigor in 2010. This accession also had the tallest plants in the study. The population for 9076670 is located near the St. Anthony Sand Dunes in Fremont County, Idaho at 5,000 ft. elevation. The site has sandy soils and supports a bitterbrush, Indian ricegrass, rabbitbrush, and scurfpea plant community. The location receives between 10 and 15 inches of mean annual precipitation. In 2014, accession 9076670 was officially released as Amethyst Germplasm hoary tansyaster.

G1 and G2 seed of Amethyst Germplasm hoary tansyaster will be maintained by the USDA Natural Resources Conservation Service, Aberdeen Plant Materials Center. Seed through the G5 generation will be eligible for certification. G1 and G2 seed will be made available to commercial growers for distribution by the University of Idaho Foundation Seed Program and Utah Crop Improvement Association. Small quantities of seed will be provided to researchers by request to the Plant Materials Center.

Wyeth or whorled buckwheat

Thirty-nine accessions of Wyeth and sulphurflower buckwheat (*Eriogonum heracleoides* and *E. umbellatum*) were compared in a common garden study from 2007 through 2011. Accession 9076546 Wyeth buckwheat showed good establishment, seed production, and longevity compared with the other accessions.

Initial seed increase of accession 9076546 is ongoing. Release documentation is being developed, and official release will occur once the PMC has produced a sufficient amount of early generation seed.

Plant Guides

The Aberdeen PMC is gathering information on selected plant species to create NRCS plant guides. Plant guides offer the most recent information on plant establishment, management and seed and plant production information. General information for the species can also be found in our plant guides, including information on potential uses, ethnobotanical significance, adaptation, pests, and potential problems. In 2014 plant guides were completed or revised for Rocky Mountain Penstemon (*Penstemon strictus*) and Hoary tansyaster (*Machaeranthera canescens*). Plant guides are available at the PLANTS database, www.plants.usda.gov, and at the Aberdeen Plant Materials Center website: www.id.nrcs.usda.gov/programs/plant.html.

Publications:

St. John, Loren (editor). 2014. Plant Guide for Rocky Mountain penstemon (*Penstemon strictus*). Aberdeen, ID: U.S. Department of Agriculture, Natural Resources Conservation Service, Aberdeen Plant Materials Center. Revised January, 2014.

Tilley, Derek; Ogle, Dan; St. John, Loren. 2014. Plant Guide for hoary tansyaster (*Machaeranthera canescens)*. Aberdeen, ID: U.S. Department of Agriculture, Natural Resources Conservation Service, Aberdeen Plant Materials Center. 4 p.

Tilley, Derek. 2014. Release Brochure for Amethyst Germplasm Hoary Tansyaster (*Machaeranthera canescens*). Aberdeen, ID: U.S. Department of Agriculture, Natural Resources Conservation Service, Aberdeen Plant Materials Center. 2 p.

Products:

1. Revised Plant Guides are available for Rocky Mountain penstemon and hoary tansyaster.

2. Early generation certified seed of hoary tansyaster is in production, and allocations have been made to Utah Crop Improvement and Idaho Foundation Seed Program.

3. Early generation certified seed of Wyeth buckwheat is being produced and will be available through Utah Crop Improvement and University of Idaho Foundation Seed Program when release is approved.

Project Title **Native Plant Selection, Release Development, and Information Transfer (Final Report)**

Project Agreement No 11-1A-11221632-004

Principal Investigators and Contact Information

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Highlights

- Release of Amethyst Germplasm Hoary Tansyaster
- Progress towards release of Wyeth buckwheat
- Development of 21 NRCS Plant Guides
- Development of 7 Propagation Protocols
- Modification to the Flail-Vac ® harvester for light airborne seed

Project Description

The Aberdeen Plant Materials Center (PMC) was involved with the testing and selecting of accessions of native forbs for commercial release, and with developing protocols for plant and seed production. The PMC also developed NRCS Plant Guides for select species.

Hoary Tansyaster

Nine accessions of hoary tansyaster (*Machaeranthera canescens*) were evaluated from 2009 through 2011 for establishment, plant growth and seed production. Accession 9076670 had the best establishment and stands for 2009 and 2010. It also had the best rated vigor in 2010. This accession also had the tallest plants in the study. The population for 9076670 is located near the St. Anthony Sand Dunes in Fremont County, Idaho at 1,524 m (5,000 ft) elevation. The site has sandy soils and supports a bitterbrush (*Purshia tridentata*), Indian ricegrass (*Achnatherum hymenoides*), rabbitbrush (*Ericameria nauseosa*), and scurfpea (*Psoralidium* sp.) plant community. The location receives between 250 and 380 mm (10 to 15 in) of mean annual precipitation. In 2014, accession 9076670 was officially released as Amethyst Germplasm hoary tansyaster.

G1 and G2 seed of Amethyst Germplasm hoary tansyaster will be maintained by the USDA Natural Resources Conservation Service, Aberdeen Plant Materials Center. Seed through the G5 generation will be eligible for certification. G1 and G2 seed will be made available to commercial growers for distribution by the University of Idaho Foundation Seed Program and Utah Crop Improvement Association. Small quantities of seed will be provided to researchers by request to the Plant Materials Center.

Wyeth or Whorled Buckwheat

Thirty-nine accessions of Wyeth and sulphurflower buckwheat (*Eriogonum heracleoides* and *E. umbellatum*) were compared in a common garden study from 2007 through 2011. Accession 9076546 Wyeth buckwheat showed good establishment, seed production, and longevity compared with the other accessions.

Initial seed increase of accession 9076546 is ongoing. Release documentation is being developed, and official release will occur once the PMC has produced a sufficient amount of early generation seed. This year, the PMC produced a good quantity of seed which should be enough to supply initial demand.

Douglas Dustymaiden

Fifteen accessions of Douglas' dustymaiden (*Chaenactis douglasii*) were evaluated at Aberdeen PMC from 2009 to 2010 for establishment, growth and seed production. Following evaluation, accession 9076577 was chosen for further production and possible release. Accession 9076577 was originally collected in Boise County, Idaho near Arrow Rock and Lucky Peak Reservoirs. The site is a mountain big sagebrush/bitterbrush community in coarse granitic soils at 960 m (3,150 ft) elevation. Accession 9076577 ranked at or near the top in percent establishment, plant vigor, height, flower production and seed yield.

Seed increase plots of accession 9076577 were established at the PMC for early generation certified seed production in 2011, 2012 and 2013 with the intent to make a selected class germplasm release once the PMC had produced a sufficient amount of early generation seed. Due to repeated low establishment in seed production plantings the Douglas dustymaiden project was discontinued.

Flail-Vac Modifications

We have examined several techniques for harvesting light airborne seed such as that of hoary tansyaster. Direct combining takes relatively little time in the field; however this method yields correspondingly less seed due to the limitation of only getting a single harvest. Additionally it requires significantly more time to clean the seed compared to other methods because of the large amounts of inert matter collected.

In 2013 we harvested hoary tansyaster using a standard Woodward Flail-Vac seed stripper. The Flail-Vac was set to harvest approximately the top 20 to 30 cm (8 to12 in) of the plants. We got two harvests using the Flail-Vac which yielded a total of 3.3 kg (7.3 lb), equivalent to 13.7 kg/ha (12.2 lb/ac). Only two harvests were possible because of the destructive nature of the Flail-Vac brush on the plants.

In 2015 we experimented with two modifications to the standard Flail-Vac harvester in an attempt to increase seed yields. We compared rigid pipes mounted to the Flail-Vac hood which penetrated into the plant canopy, to loops of chain that could be dragged through the plants. The Flail-Vac head itself was elevated above the plants so the brush did not come in contact with the flowers. The pipes or chains agitated the plants causing the release of seed into the air, while the airflow created by the Flail-Vac brushes sucked the light seed through and into the collection bin.

There were significant differences in performance of the two methods, though both were more effective than the standard Flail-Vac. Rigid pipes were more damaging to the plants than desirable. Plants got hung up on the pipes and pulled until they were uprooted or broken. We had to stop the tractor regularly to lift the arms and remove broken stems and plants from the front of the Flail-Vac; however, the seed yields were promising. The pipes effectively agitated the plant canopy and shook loose, ripe seed from the flowers and left non-ripe flowers and vegetation intact. The chain had enough weight to fall into the canopy and displace seed, but was less rigid and caused very little, if any, damage. We experienced no broken stems or uprooted plants using the chain method.

Best results for hoary tansyaster occurred driving the tractor very slowly, between 0.87 and 1.1 km/h (1.4 and 1.8 mph) with the Flail-Vac set at 400 rpm. Lower brush speeds resulted in insufficient air flow, while higher speeds caused increasing amounts of seed to be sucked completely through the Flail-Vac and blown out the exhaust opening.

We were able to run the chain-modified Flail-Vac eight times through a 0.4 ha (1 ac) hoary tansyaster field. Each harvest was run in the opposite direction as the previous. Immediately after a Flail-Vac pass the plants were left leaning over from the weight of the heavy chain, but after a day or two they had regained their upright attitude. From our eight harvests we collected a total of 29 kg (64 lb) of clean seed, a 500% increase compared to the non-modified Flail-Vac.

Plant Guides

NRCS Plant Guides have been developed for 21 species of forbs and grasses native to the Intermountain West. Plant Guides offer the most recent information on plant establishment, management and seed and plant production information. General information for the species can also be found in our Plant Guides, including information on potential uses, ethnobotanical significance, adaptation, pests, and potential problems. Plant guides are available at the PLANTS database, www.plants.usda.gov, and at the Aberdeen Plant Materials Center website: www.id.nrcs.usda.gov/programs/plant.html.

Propagation Protocols

Seed production information obtained during collection evaluation and seed increase of native forb species was used to develop propagation protocols for Douglas' dustymaiden, hoary tansyaster, nineleaf biscuitroot, fernleaf biscuitroot and Gray's biscuitroot and Searls' prairie clover. These protocols provide information on seed collection, planting, management, harvest and cleaning. Propagation protocols are available at http://www.nativeplantnetwork.org.

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Additional Products

- Early generation certified seed of Amethyst Germplasm hoary tansyaster is in production, and allocations have been made to Utah Crop Improvement and Idaho Foundation Seed Program.
- Early generation certified seed of Wyeth buckwheat is being produced and will be available through Utah Crop Improvement and University of Idaho Foundation Seed Program when release is approved.

GRAND TETON NATIONAL PARK

FY2014 Annual Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
ABERDEEN, IDAHO

INTRODUCTION - The Aberdeen Plant Materials Center (PMC) entered into an interagency agreement with Grand Teton National Park (GTNP) in 2006 to produce seed of four native grasses for use in revegetation of disturbed areas following road construction. Seed fields of slender wheatgrass (*Elymus trachycaulus*), Sandberg bluegrass (*Poa secunda*), blue wildrye (*Elymus glaucus*) and mountain brome (*Bromus marginatus*) were planted in 2006, and seed was harvested in 2007 and 2008. Fields of Idaho fescue (*Festuca idahonensis*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) were planted in May, 2008. Seed from the bluebunch wheatgrass fields was harvested in 2009 and 2010, and the field was then discontinued in late 2010 because of poor seed yield. The original Idaho fescue field was harvested from 2009 to 2014. In 2010, a second field of mountain brome was planted for seed harvests in 2011 and 2012. A new Idaho fescue field (1 ac) was established in 2012 for seed production in 2013 through 2014.

ACCOMPLISHMENTS – Seed fields are sprinkler irrigated to supplement natural precipitation to approximate 18 to 20 inches of total annual moisture. Weeds were controlled during the growing season. Table 1 lists the species grown and seed harvests through 2014. Table 2 shows information from seed shipments and current inventory. To date, PMC has delivered 7668 lbs of seed to GTNP in this project.

Table 1. Seed yields by field and species from 2007 through 2014.

				Seed Yield (Lbs. Bulk)							
Species	Field	Acres	Year Installed	2007	2008	2009	2010	2011	2012	2013	2014
Mt. brome	2W	1.0	2006	172	176						
Mt. brome	P7W	2.5	2010					2294	2286		
Blue wildrye	P7	2.7	2006	1052	417						
Blue wildrye	27E	1.0	2006	1031	429	520					
ID Fescue	21W	0.3	2008			11	109	95	72	97	24
ID Fescue	P7E	1.0	2012							82	500
Sandberg bluegrass	13	0.25	2006	13	16	7					
Bluebunch wheatgrass	21	1.0	2008			0.5	3				

Table 2. Shipment and inventory information.

		Lbs. Shipped							Current Inventory	
Species	Field	2008	2009	2010	2011	2012	2013	2014	Lbs. PLS	Test Date
Mt. brome	2W	150	198						0	
Mt. brome	P7W				2289		1084		1000	2/1/2013
Blue wildrye	P7		232		116		416	708	0	
Blue wildrye	27E	50	50	319	605		1045		0	
ID Fescue	21W			11	109		166	82	84	1/23/2014
ID Fescue	P7E								475	1/23/2015
Sandberg bluegrass	13		15		20				0	
Bluebunch wheatgrass	21				3				29	2/29/2012

PHOTOS

Grand Teton National Park new Idaho fescue seed increase field at Aberdeen PMC. April, 2013.

Grand Teton National Park Idaho fescue seed harvest at Aberdeen PMC. July 2013.

GRAND TETON NATIONAL PARK-GRASS SEED PRODUCTION

FY2015 Annual Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
ABERDEEN, IDAHO

INTRODUCTION - The Aberdeen Plant Materials Center (PMC) entered into an interagency agreement with Grand Teton National Park (GTNP) in 2006 to produce seed of four native grasses for use in revegetation of disturbed areas following road construction. Since that time several modifications have been made to the agreement to extend production fields or add new species.

ACCOMPLISHMENTS – Seed fields of slender wheatgrass (*Elymus trachycaulus*), Sandberg bluegrass (*Poa secunda*), blue wildrye (*Elymus glaucus*) and mountain brome (*Bromus marginatus*) were planted in 2006, and seed was harvested in 2007 and 2008. Fields of Idaho fescue (*Festuca idahonensis*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) were planted in May, 2008. Seed from the bluebunch wheatgrass fields was harvested in 2009 and 2010, and the field was then discontinued in late 2010 because of poor seed yield. The original Idaho fescue field was harvested from 2009 to 2014. In 2010, a second field of mountain brome was planted for seed harvests in 2011 and 2012. A new Idaho fescue field (1 ac) was established in 2012 for seed production in 2013 through 2014, but was extended to 2015. In 2015 we established 2 acres each of mountain brome and Idaho fescue, and a 1 acre field of blue wildrye. We also installed 500 x 6 ft rows of Sulphur buckwheat (*Eriogonum umbellatum*), showy goldeneye (*Heliomeris multiflora*), and one-flower sunflower (*Helianthella uniflora*) using greenhouse grown materials. Sulphur buckwheat had excellent establishment. Showy goldeneye had fair establishment from the transplants and a small amount of seed was harvested in 2015. One-flower sunflower did not appear to establish well from transplants, but it is possible that live root systems will yet produce plants. We over-seeded into open spaces in the sunflower and goldeneye rows in November 2015.

Table 1. Seed yields by field and species from 2007 through 2015.

				Seed Yield (Lbs. Bulk)								
Species	Field	Acres	Year Installed	2007	2008	2009	2010	2011	2012	2013	2014	2015
Mt. brome	2W	1.0	2006	172	176							
Mt. brome	P7W	2.5	2010					2294	2286			
Blue wildrye	P7	2.7	2006	1052	417							
Blue wildrye	27E	1.0	2006	1031	429	520						
ID Fescue	21W	0.3	2008			11	109	95	72	97	24	
ID Fescue	P7E	1.0	2012							82	500	283
Sandberg bluegrass	13	0.25	2006	13	16	7						
Bluebunch wheatgrass	21	1.0	2008			0.5	3					
ID Fescue	31W	2.0	2015									
Mt. brome	31E	2.0	2015									
Blue wildrye	P4	1.0	2015									
Showy goldeneye	27E	0.07	2015									0.68
Sulphur buckwheat	27E	0.07	2015									
One-flower sunflower	27E	0.07	2015									

Table 2 shows information from seed shipments and current inventory. To date, PMC has delivered 7,668 lbs of seed to GTNP in this project. The PMC currently has 1,000 lbs of mountain brome, 865 lbs of Idaho fescue, and 0.68 lbs of showy goldeneye in inventory (not including the originally provided seed or the 2015 harvest).

Table 2. Shipment and inventory information.

		Lbs. Shipped								Current Inventory
Species	Field	2008	2009	2010	2011	2012	2013	2014	2015	Lbs. PLS
Mt. brome	2W	150	198							0
Mt. brome	P7W				2289		1084			1000
Blue wildrye	P7		232		116		416	708		0
Blue wildrye	27E	50	50	319	605		1045			0
ID Fescue	21W			11	109		166	82		23
ID Fescue	P7E									561 [a]
Sandberg bluegrass	13		15		20					0
Bluebunch wheatgrass	21				3					0

[a] Does not include 2015 harvests because seed analysis has not been completed

PHOTOS

Grand Teton National Park Idaho fescue, 2015.

Grand Teton National Park showy goldeneye, 2015.

YELLOWSTONE NATIONAL PARK – GRASS SEED PRODUCTION

FY2014 Annual Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
ABERDEEN, IDAHO

INTRODUCTION - In 2008, the Natural Resources Conservation Service (NRCS), Plant Materials Center (PMC), Aberdeen, Idaho entered into an interagency agreement with the National Park Service (NPS), Yellowstone National Park (YNP) to produce seed of Sandberg bluegrass (*Poa secunda*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and needle-and-thread (*Hesperostipa comata* ssp. *comata*) for use on restoration sites at YNP. The needle-and-thread was harvested as hay mulch and baled for transport in 2010 through 2012. Seed was harvested from the Sandberg bluegrass field in 2010 through 2013 and bluebunch wheatgrass field in 2011 to 2013. New, 2.5 acre seed fields of Sandberg bluegrass and bluebunch wheatgrass were planted in May, 2013 to produce seed in 2014 and 2015. Average annual precipitation is 9.39 inches and seed fields are sprinkler irrigated to supplement natural precipitation to approximate 18 to 20 inches total annual precipitation.

ACCOMPLISHMENTS –In 2011 we shipped 2520 lbs of needle-and-thread in 9 bales (approximately 280 lbs/bale). In 2012 we shipped 2400 lbs in 10 bales (240 lbs/bale). Literature suggests that needle-and-thread produces an estimated 150 lbs PLS/ac seed under irrigation. With one irrigated acre in production, one can estimate approximately 16 lbs of seed per bale. To date, PMC has shipped 449 lbs of processed seed to YNP from this project.

Table 1. Seed yields by field and species from 2010 through 2014.

				Seed Yield (Lbs. Bulk)				
Species	Field	Acres	Year Installed	2010	2011	2012	2013	2014
Sandberg bluegrass	2	1.0	2009	81	153		93	
Sandberg bluegrass	P2E	2.5	2013					405
Bluebunch wheatgrass	410W	1.0	2009		107	125	117	
Bluebunch wheatgrass	P2W	2.5	2013					250
Needle-and- thread	410E	1.0	2009		150*	150*		

*Estimated seed yield based on literature

Table 2. Shipment and inventory information.

		Lbs. Shipped				Current Inventory	
Species	Field	2011	2012	2013	2014	Lbs. PLS	Test Date
Sandberg bluegrass	2			265	0	17	5/13/2014
Sandberg bluegrass	P2E				0	253	2/2/2015
Bluebunch wheatgrass	410W			184	0	29	2/29/2012
Bluebunch wheatgrass	P2W					190	1/23/2015
Needle-and-thread	410E	2520*	2400*			0	

*Needle-and-thread shipped in bales

PHOTOS

YNP Sandberg bluegrass seed harvest drying on floor at Aberdeen PMC, 2013.

Harvesting YNP bluebunch wheatgrass at Aberdeen PMC, 2013.

YELLOWSTONE NATIONAL PARK – GRASS SEED PRODUCTION

FY2015 Annual Report
Prepared by

NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
ABERDEEN, IDAHO

INTRODUCTION - In 2008, the Natural Resources Conservation Service (NRCS), Plant Materials Center (PMC), Aberdeen, Idaho entered into an interagency agreement with the National Park Service (NPS), Yellowstone National Park (YNP) to produce seed of Sandberg bluegrass (*Poa secunda*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and needle-and-thread (*Hesperostipa comata* ssp. *comata*) for use on restoration sites at YNP.

ACCOMPLISHMENTS – The needle-and-thread was harvested as hay mulch and baled for transport in 2010 through 2012. Seed was harvested from the Sandberg bluegrass field in 2010 through 2013, and bluebunch wheatgrass field in 2011 to 2013. New, 2.5 acre seed fields of Sandberg bluegrass and bluebunch wheatgrass were planted in May, 2013 to produce seed in 2014 and 2015.

Table 1. Seed yields by field and species from 2010 through 2015.

				Seed Yield (Lbs. Bulk)					
Species	Field	Acres	Year Installed	2010	2011	2012	2013	2014	2015
Sandberg bluegrass	2	1.0	2009	81	153		93		
Sandberg bluegrass	P2E	2.5	2013					405	76
Bluebunch wheatgrass	410W	1.0	2009		107	125	117		
Bluebunch wheatgrass	P2W	2.5	2013					250	107
Needle-and- thread	410E	1.0	2009		150[a]	150[a]			

[a] Estimated seed yield based on literature

In 2011 we shipped 2520 lbs of needle-and-thread in 9 bales (approximately 280 lbs/bale). In 2012 we shipped 2400 lbs in 10 bales (240 lbs/bale). Literature suggests that needle-and-thread produces an estimated 150 lbs PLS/ac seed under irrigation. With one irrigated acre in production, one can estimate approximately 16 lbs of seed per bale. To date, PMC has shipped 816 lbs of processed seed to YNP from this project. We currently have 253 lbs PLS of Sandberg bluegrass and 29 lbs PLS of bluebunch wheatgrass in inventory not including seed from the 2015 harvest.

Table 2. Shipment and inventory information.

Species	Field	Lbs. Shipped 2011	2012	2013	2014	2015	Current Inventory Lbs. PLS
Sandberg bluegrass	2			265	0		0
Sandberg bluegrass	P2E				0		253 [b]
Bluebunch wheatgrass	410W			184	0	117	29
Bluebunch wheatgrass	P2W					250	0 [b]
Needle-and-thread	410E	2520 [a]	2400 [a]				0

[a] Needle-and-thread shipped in bales
[b] Does not include 2015 harvests because seed analysis has not been completed

PHOTOS

Yellowstone National Park Sandberg bluegrass, 2015.

Yellowstone National Park bluebunch wheatgrass, 2015.

2011 Pollinator Planting, 2014 Progress Report
Fish and Game Farm, Field 28

Derek J. Tilley, PMC Agronomist
Natural Resources Conservation Service
Plant Materials Center
Aberdeen, Idaho

Introduction

The Conservation Reserve program of the 2008 USDA Farm Bill promotes the establishment of pollinator friendly habitat. The desired goal in these pollinator plantings is to establish a variety pollinator species with some flowering in each of the three flowering periods – early, mid and late growing season. The mixture can also include native grasses not to exceed 25% of the total mixture.

Establishment of grasses and grass-dominant plantings including forbs and shrubs are common and largely successful; however, pollinator plantings consisting predominantly of forbs pose problems not typically encountered with grass plantings. Forbs, especially native forbs, are in many cases not competitive against weed species. Forb plantings also severely limit the herbicides available for controlling broadleaf weeds.

Healthy rangeland in the Intermountain West consists of approximately 5 to 25% shrub cover, 40 to 60% grasses and 5 to 20% forbs. There is concern that the 25% grass composition requirement may not provide the necessary competitive ability needed to persist in weed prone sites. More information is needed to understand pollinator planting dynamics and management.

Materials and Methods

In 2011, the PMC established 5 acres of pollinator habitat for display and to research management requirements involved in pollinator friendly plantings. The planting was established in field 28 of the PMC Fish and Game farm 5 miles northeast of Aberdeen. Soil at the planting site is a Declo silt loam with pH of 7.4 to 8.4. Average annual precipitation is 9.39 inches.

In 2010, the year prior to planting, the field was planted to field corn and managed for wildlife habitat. The stubble was mowed spring 2011. The field was irrigated in early spring to get weed seeds to germinate. The field was then sprayed with 64 oz Glyphosate/ac on May 11 prior to planting on May 18. The western 2.5 acres of the field were planted to a mixture consisting of 25% grasses (mix 1), while the eastern 2.5 acres were planted to a mixture of 50% grasses (mix 2).The field was irrigated through the growing seasons of 2011, 2012 and 2013 to approximate 14 to 16 inches of annual precipitation, the suitable range for the species in the seed mixture. The planting was not irrigated in 2014. In 2011, the establishment year, the fields were mowed three times after planting to prevent weeds from going to seed. In 2012, 2013 and 2014 noxious weeds

(broadleaf pepperweed, musk thistle, burdock, Canada thistle, and field bindweed) were spot-treated with 64 oz Glyphosate/ac.

The two pollinator mixes were developed to compare forb establishment and persistence with varying grass composition. The mixes were designed to provide blossoms for foraging insects in all three flowering periods (table 1). Each mixture has the same species components, but they have different proportions of forbs and grasses. The first mix follows NRCS guidelines and contains a 25% grass component and 75% forbs (Tables 2). The second mix is designed to more closely approximate natural healthy rangeland conditions. This mix contains the same species components, but the grasses are doubled to comprise 50% of the total mix, and the forb amounts are halved. The mixtures contain only 7 pollinator species. This reflects the limited number of available forb species suitable for use in arid to semi-arid environments, especially those with late summer bloom periods.

Table 1. Pollinator planting mixture components

			Bloom Color and Time			
Scientific Name	Common Name	Variety	spring	summer	late summer	Origin
Pseudoroegneria spicata	Bluebunch wheatgrass	Anatone				Native
Leymus cinereus	Basin wildrye	Magnar				Native
Poa ampla	Big bluegrass	Sherman				Native
Achillea millifolium	Western yarrow	Great Northern				Native
Linum perenne	Blue flax	Appar				Introduced
Medicago sativa ssp. *falcata*	Falcate alfalfa	Don				Introduced
Sanguisorba minor	Small burnet	Delar				Introduced
Onobrychis vicaeifolia	Sainfoin	Common				Introduced
Helianthus annuus	Sunflower	Common				Native
Machaerranthera canescens	Hoary tansyaster	Common				Native

The mixes were separated according to seeding depth, one mix for drilling seed at 1/4 to 1/2 inch and a broadcast mix for shallow (0 to 1/8 inch) seeding. Because the planting was done using a Truax Rough Rider range drill with alternate row seeding capabilities, the standard seeding rates (Ogle and others, 2011b) were also cut in half. By doing an alternate row seeding, the number of rows planted is effectively halved and seeding rates are therefore adjusted. Seeding rates and drill calibrations are shown in the appendix. All seed was mixed with rice hulls as an inert carrier to facilitate flow through seeding equipment using specifications found in St. John and others (2005).

Table 2. Seed mixture percentages

#	Variety	Common Name	25% grass	50% grass
			% of mix	% of mix
1	Anatone	Bluebunch wheatgrass	5	10
2	Magnar	Basin wildrye	5	10
3	Sherman	Big bluegrass	15	30
4	Great Northern	Western yarrow	5	2.5
5	Appar	Blue flax	10	7.5
6	Don	Falcate alfalfa	10	5
7	Delar	Small burnet	15	7.5
8	Eski	Sainfoin	20	10
9	Common	Sunflower	10	5
10	Common	Tansyaster	5	2.5

Evaluations took place on July 12, 2011, June 15, 2012, June 17, 2013 and May 13, 2014. A 200 ft transect was laid diagonally in each field beginning 100 ft from the southwest corner. Plant densities of target species were measured using a frequency grid based on that described by Vogel and Masters (2001). The grid measured approximately 40 x 41 inches, having four ten inch columns (to incorporate 1 drill row per column) and five rows, totaling 20 cells. Counts were made of the cells that contained at least one plant. Evaluations were made at 20 foot intervals making a total of 10 frames evaluated per seed mixture. The total cells were added for each species to determine average plants/ft². It is important to note that because cells with plants were counted and not number of plants per cell, the best possible score is 200 hits per ten frames which converts to 1.85 plants/ft^2. Actual plant density may be higher than the numbers indicated below.

It was difficult to find target species in the masses of weeds at the time of the first season evaluation. The native grasses were particularly difficult to find and were not counted in the evaluation. In 2012 and 2013 target grass species were more easily identified and were included in the evaluation.

Results

2011

In 2011, the 25% grass seed mix produced approximately 2 times more total forbs than the 50% grass mixture (Table 3). However, overall weed densities were similar for both planting mixes. These differences are to be expected early in the first growing season as the seeded plants are generally not big enough to cause direct competition for resources. Few

Figure 1. A solid stand of witchgrass. The planting was mowed 3 times to reduce the risk of weeds setting seed. Photo take July 20, 2011.

target grasses were observed, as young grass leaves are easily missed in the thick weeds.

Despite previous farming practices and weed control efforts, there was an abundance of annual weeds present in both fields. The most prevalent weed species in 2011 included witchgrass (*Panicum capilare*), shepherd's purse (*Capsella bursa-pastoris*), field bindweed (*Convolvulus arvensis*), volunteer wheat (*Triticum aestivum*), lamb's quarters (*Chenopodium album*), prickly lettuce (*Lactuca serriola*), red-root pigweed (*Amaranthus retroflexus*), prostrate pigweed (*A. blitoides*), nightshade, (*Solanum* sp.) and tumble mustard (*Sisymbrium altissimum*). Mowing provided fair control of annual broadleaf weeds, but witchgrass continued to dominate the fields throughout the season (Figure 1). In late summer, sunflowers covered the field with a thick understory of witchgrass (Figure 2).

2012

Densities of all seeded species stayed the same or increased from 2011 to 2012. The plants were likely more numerous from volunteering, and were also larger and easier to find. Overall densities of target species were not different between the 25% and 50% grass plots in 2012. In 2012 total target species densities were 4 times greater in the 25% grass mix and 9 times greater in the 50% grass mix compared to 2011, with much of the increase being accounted for by the establishment and observation of grasses in 2012. Grass densities were 2 times higher in the 50% grass mix than the 25% grass mix as expected. There were approximately 2 times more alfalfa and sainfoin plants observed in the 25% grass plots than in the 50% grass plots. Sunflower and blue flax densities were essentially equal between the two treatments in 2012 as volunteers from seed shed the previous year (especially from sunflower) eliminated the original proportions. Yarrow densities were 7 times greater in the 25% grass plots than the 50% grass plots. Hoary tansyaster was observed in the planting but not encountered in the evaluated transects.

Figure 2. Despite mowing, sunflowers persisted and produced flowers in the first growing season. Photo taken September 12, 2011.

Total weed density was 40% lower in 2012 than 2011; however weed densities were not significantly different between the 25 and 50% grass treatments. The most abundant weed species encountered in 2012 was spear saltbush (*Atriplex patula*). This species may have mistaken for lamb's quarters in 2011. Other weed species encountered in 2012 included Canada thistle (*Cirsium arvense*), dandelion (*Taraxacum officinale*), kochia (*Bassia scoparia*), sowthistle (*Sonchus* sp.), cheatgrass (*Bromus tectorum*), yellow salsify (*Tragopogon dubius*), and biennial cinquefoil (*Potentilla biennis*). Other species seen in the planting but not in the evaluated

transects included hound's tongue (*Cynoglossum officinale*), bull thistle (*Cirsium vulgare*), musk thistle (*Carduus nutans*), and catnip (*Nepeta cataria*).

2013

The planting composition changed dramatically from 2012 to 2013. Grass and forb target species densities declined in the both plantings. In the 25% grass mixture, grass densities decreased from 0.15 plants/ft² to 0.04 plants/ft². Similarly, in the 50% grass planting, densities decreased from 0.30 to 0.14 plants/ft². Forb densities decreased in the 25% grass seeding from 2.49 to 1.01 plants/ft², a 60% reduction, and from 2.83 plants/ft² to 1.28 plants/ft² in the 50% grass seeding, a decrease of 55%. Many species including falcate alfalfa, small burnet and sainfoin decreased between 33 and 50% from the previous year. Annual sunflower declined as much as 60% from 2012, which explains the majority of the decrease in total target species density for the year.

Most weed species had similar densities compared to 2012 with the exception of prickly lettuce which increased approximately 300%. Prickly lettuce densities increased from 0.5 plants/ft² to 1.75 plants/ft² in the 25% grass planting and 0.45 plants/ft² to 1.45 plants/ft² in the 50% grass planting.

2014

In 2014 spring precipitation caused a flush of new seedlings, most notably of Appar blue flax. Approximately 2 times more forbs were recorded in the 25% grass mix compared to the 50% grass mix. Similarly grass densities in the 50% grass mix were double those of the 25% grass mix. Additionally, a significant reduction of weeds was observed in the 50% grass mix compared to the 25% grass mix, indicating that the increased grass percentage is at least somewhat effective at competing against non-target species. Prickly lettuce densities stayed at approximately the same level as last year. This continues to be a problem late in the season when the lettuce overtops many of the flowering target species.

Figure 3. Falcate alfalfa, small burnet, blue flax and basin wildrye can be seen. June 20, 2014.

Discussion

Acceptable establishment densities for NRCS plantings range from 1 to 2 plants/ft² (Ogle et al., 2011a). In 2011, the evaluated plant densities fell short of this standard; however this is likely due to the grasses not being included in the evaluation. In 2012 both treatments averaged more than 2 plants/ft². In 2013 plant densities of target species had decreased to nearly 1 plant/ft².

In the first growing season we saw little pollinator value in the two fields planted as most perennial forbs are not expected to blossom during the first growing season. Additionally, annual weeds forced multiple mowing treatments which removed the majority of flowers available for foraging insects. Annual sunflower persisted and blossomed despite the mowing; however, and provided food for foraging bumblebees in late summer and early fall. In 2012 there was no mowing and the perennial forbs were allowed to flower. Abundant pollinator activity was witnessed at the time of evaluation. Very little tansyaster was seen at the evaluation time; however more was observed later in the season, but was largely overshadowed by sunflower. Sunflower plants were small in June, with the majority of plants showing 2 to 4 true leaves, approximately 3 inches tall. In September the sunflower had formed a dense stand with plants averaging 3 to 8 feet tall.

During the second year the planting appeared to be an excellent pollinator resource. Native and European bees were observed foraging on all of the target forb species. The planting also provided excellent cover and forage for wildlife. Deer were observed in the planting and grazing was observed on sainfoin, small burnet, and prickly lettuce. Birds were also abundant in the planting.

Figure 4. Native bee (bottom left) and bee fly (right) visiting yarrow flowers in June, 2013.

In 2013 and 2014 target forbs and grasses were less prevalent than in 2012. Numerous blooms were still available however, and pollinator visitation was observed for all target forbs (figure 4). In the second half of the season the planting site was densely crowded with prickly lettuce which overtopped most of the target species (figure 5).

Weed species present a serious impediment to successful long-term pollinator plantings. Weedy species like prickly lettuce can overtop target forbs potentially making them less visible from the air and reducing pollinator visits. Weeds also compete for resources with target species reducing desired forb densities over time.

Noxious weeds are also a concern. Idaho state noxious weeds observed within the pollinator planting include musk thistle, Canada thistle, field bindweed, broadleaf pepperweed, and hound's tongue. Spot treatments of herbicides may be necessary to control and prevent the spread of noxious weeds. Farming practices and field history indicate that many of these species were not present prior to the planting and may have been introduced with non-certified seed. Use of certified seed is highly recommended to ensure seed quality.

Figure 5. Prickly lettuce dominates the pollinator planting in mid-summer, 2013.

Very few options exist for controlling broadleaf weeds in forb plantings. Hand rogueing and spot spraying are only feasible for small, concentrated infestations. Conversion of forb/pollinator plantings to weed dominated ground seems likely.

Future evaluations are scheduled to take place in 2015 to monitor plant persistence and long term trends in species densities. However, if noxious weeds continue to be a problem, the planting will be terminated.

Table 3. Pollinator planting plant densities (plants/ft²) from July 2011 through June 2013.

Target species	2011 25% Grass	2011 50% Grass	2012 25% Grass	2012 50% Grass	2013 25% Grass	2013 50% Grass	2014 25% Grass	2014 50% Grass
	----------Plants/ft²----------							
Bluebunch wheatgrass			0.06	0.11		0.02	0.01	0.05
Basin wildrye.			0.06	0.13	0.03	0.08	0.05	0.07
Big bluegrass			0.03	0.06	0.01	0.04		0.05
Total grasses	0.00	0.00	0.15	0.30	0.04	0.14	0.06	0.17
Western yarrow	0.02	0.02	0.07	0.01	0	0.02	0.02	0.02
Blue flax	0.07	0.03	0.07	0.15	0.09	0.17	0.49	0.46
Falcate alfalfa	0.07	0.02	0.28	0.20	0.16	0.15	0.29	0.09
Small burnet	0.19	0.07	0.17	0.16	0.07	0.04	0.04	0.01
Sainfoin	0.08	0.09	0.29	0.15	0.09	0.06	0.27	0.05
Sunflower	0.16	0.05	1.61	1.86	0.60	0.70	0.72	0.39
Tansyaster								
Total forbs	0.59	0.28	2.49	2.53	1.01	1.14	1.83	1.02
Total target species	0.59	0.28	2.61	2.83	1.05	1.28	1.89	1.19
Weed species								
Witchgrass	1.86	1.78			0.03	0.04		
Shepherd's purse	0.36	0.23	0.06	0.07	0.04	0.03		
Field bindweed		0.01				0.01	0.03	
Wheat	0.04	0.14						
Lamb's quarters	0.19	0.07						
Prickly lettuce	0.04	0.01	0.5	0.45	1.75	1.45	1.81	1.51
Redroot pigweed	0.25	0.16				0.04		
Prostrate pigweed	0.02							
Nightshade	0.01			0.01				
Tumble mustard		0.01		0.01				
Spear saltbush			1.0	0.88	0.05	0.02	0.31	0.23
Canada thistle			0.01		0.02	0.01	0.17	
Dandelion			0.04	0.02	0.01	0.05	0.08	0.05
Kochia			0.10		0.03	0.01	0.03	
Sow thistle			0.04	0.02				
Cheatgrass			0.01					
Salsify			0.01	0.01				
Cinquefoil				0.01				
Total weed species	2.77	2.41	1.76	1.48	1.93	1.66	2.43	1.79

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Appendix. Drill Calibrations

Mix 1 drill

Variety	Common Name	% of mix	Pure stand rate* lb PLS/acre	% PLS	lb/bu**	lb PLS/ac PLS*% of mix	bulk seed (lb/ac) PLS/%PLS*100	volume (% of bu) bulk seed/lb/bu*100
Anatone	bluebunch wg	5	4.00	84.60	21.70	0.20	0.24	1.09
Magnar	basin wildrye	5	4.00	92.70	18.50	0.20	0.22	1.17
Delar	small burnet	15	10.00	94.00	23.10	1.50	1.60	6.91
sainfoin	Sainfoin	20	17.00	90.00	28.60	3.40	3.78	13.21
sunflower	sunflower	10	11.50	90.00	23.00	1.15	1.28	5.56

Mix 1 broadcast

Variety	Common Name	% of mix	Pure stand rate* lb PLS/acre	% PLS	lb/bu**	lb PLS/ac PLS*% of mix	bulk seed (lb/ac) PLS/%PLS*100	volume (% of bu) bulk seed/lb/bu*100
						0.00	0.00	0.00
						0.00	0.00	0.00
Sherman	big bluegrass	15	1.00	90.00	17.90	0.15	0.17	0.93
Great Northern	yarrow	5	0.25	90.00	20.60	0.01	0.01	0.07
Appar	blue flax	15	2.00	97.00	46.10	0.30	0.31	0.67
Don	yellow alfalfa	10	2.50	90.00	60.00	0.25	0.28	0.46
tansyaster		5	1.00	35.00	12.00	0.05	0.14	1.19

* 1/2 of rate in Ogle and others, 2011b

** St. John and others, 2005

Mix 2 drill

Variety	Common Name	% of mix	Pure stand rate* lb PLS/acre	% PLS	lb/bu**	lb PLS/ac PLS*% of mix	bulk seed (lb/ac) PLS/%PLS*100	volume (% of bu) bulk seed/lb/bu*100
Anatone	bluebunch wg	10	4.00	84.60	21.70	0.40	0.47	2.18
Magnar	basin wildrye	10	4.00	92.70	18.50	0.40	0.43	2.33
Delar	small burnet	7.5	10.00	94.00	23.10	0.75	0.80	3.45
eski	Sainfoin	10	17.00	90.00	28.60	1.70	1.89	6.60
sunflower	sunflower	5	11.50	90.00	23.00	0.58	0.64	2.78

Mix 2 broadcast

Variety	Common Name	% of mix	Pure stand rate* lb PLS/acre	% PLS	lb/bu**	lb PLS/ac PLS*% of mix	bulk seed (lb/ac) PLS/%PLS*100	volume (% of bu) bulk seed/lb/bu*100
Sherman	big bluegrass	30	1.00	90.00	17.90	0.30	0.33	1.86
great northern	yarrow	2.5	0.25	90.00	37.00	0.01	0.01	0.02
Appar	blue flax	7.5	2.00	97.00	46.10	0.15	0.15	0.34
Don	yellow alfalfa	5	2.50	90.00	60.00	0.13	0.14	0.23
tansyaster	common	2.5	1.00	35.00	12.00	0.03	0.07	0.60

* 1/2 of rate in Ogle and others, 2011b

** St. John and others, 2005

COMMERCIAL WILDFLOWER SEED MIX EVALUATION, 2014 PROGRESS REPORT

Derek J. Tilley, PMC Manager

INTRODUCTION

Commercially produced wildflower seed mixes are commonly available and broadly used for attracting pollinators and adding beauty to small gardens and landscapes. These mixtures are popular with landowners because they are pre-mixed and eliminate the guess work of designing custom mixtures. They also eliminate the need to search for and purchase individual species from multiple vendors to create a seed mix.

Most commercial seed mixtures are created to cover a wide range of adaptation and may include plants adapted to extremely low precipitation areas (<9" mean annual precipitation) and plants adapted to wetter environments (>18" mean annual precipitation). This range provides some insurance that at least some of the species in the mixture are adapted to a specific site and may thrive. The problem however is that a significant portion of the species in the mixture is less likely to be adapted to the planting site and thus represent an unnecessary expense.

The species in the mixtures are selected for their attractiveness to bees, butterflies and other pollinators and are purportedly composed of species well adapted to specific regions or environments. Despite these advantages, suitability of many of the species in the mixes to pollinator plantings for CRP or other NRCS programs is largely unknown. Many species are from North America outside of the Intermountain West; still others are of Eurasian or African origin. Additionally, some commercial mixes may contain plant species that can become invasive, or the mix may not contain appropriate species to provide pollinator forage throughout the year, or may contain plant species that are attractive to humans but provide little value to the target pollinators. Establishment, persistence, and suitability of many of these species to pollinator plantings are poorly understood in this context. These issues need to be examined before NRCS can recommend commercially designed seed mixes for conservation practices.

MATERIALS AND METHODS

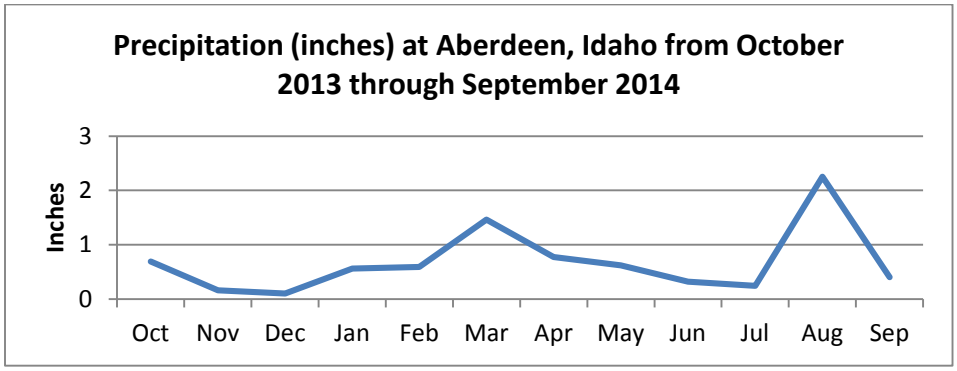
This trial was conducted on the Aberdeen Plant Materials Center Fish and Game Farm located 5 miles northeast of Aberdeen, Idaho. Soil at the site is a Declo silt loam with pH of 7.4 to 8.4. Average annual precipitation is 9.39 inches. The field had previously been planted to a crop of small grains left standing for wildlife food and cover.

We planted six commercially available wildflower seed mixes designed for use in western North America into non-replicated 90 x 20 ft plots. The mixtures selected were chosen based on their dissimilarity with other mixes in the trial to include the widest possible variety of species (see appendix). Each mix contained between 15 and 25 species. Prices of the mixtures ranged from

$23/lb to $60/lb plus shipping. Mention of a specific mixture or company is not an endorsement by the NRCS.

In mid-May, 2013 the field was mowed to knock down the standing small grain cover and was treated with 64 oz glyphosate per acre to control volunteer grains and emerging annual weeds. On May 23, 2013 the trial was planted using a 3 ft Truax® broadcast seeder pulled by an ATV followed with a packer roller. Recommended seeding rates for the various mixes range from 6 to 20 lbs/acre depending on the desired density of the stand. Each plot in this trial was seeded at a target rate of 10 lbs/ac to obtain a uniform density between the plots. The trial was irrigated approximately 8 hours (2 inches) every ten days during the establishment phase in 2013. Irrigation was discontinued on August 1. On July 10, 2013 the site was sprayed with 1 pt/ac sethoxydim to control annual grasses.

To see how the various species performed under limited water conditions, no supplemental irrigation was applied during the 2014 growing season. Precipitation totals were below average for most of the 2014 water year. Summer rains (2.25 inches in August) brought the total for the year to 8.16 inches.



Plots were evaluated to determine which species were well adapted to conditions in the PMC service area including the Intermountain and Rocky Mountain Regions and contributed to pollinator foraging. Plant density was evaluated on August 8, 2013 using a 1 m² frame placed in the center of the plots 5 paces and 10 paces into the plot. Plots were also visited periodically in 2013 and 2014 to observe blooming and insect visitation.

The trial will be evaluated again in 2015 and 2016 to observe changes in species composition and to identify any potential management problems that may be associated with using commercial pollinator seed mixes.

RESULTS AND DISCUSSION

Initial Density

Plant density was recorded early in the season on August 8, 2013 when plants could be easily counted (Table 1). Some species documented flowering in the later evaluations were not present at the early density evaluation. These were either located outside of the evaluated frames, or could have germinated later in the season or were unidentifiable at early life stages. Many

perennials listed here did not flower the first season and some of the perennial species require a winter stratification period and were not expected to germinate until spring 2014.

Early plant densities were largely composed of annual species that had no stratification requirement. Seed mixtures with a large component of annuals seemed in most cases better equipped to compete against weed species.

Table 1. Initial density (plants per meter^2) of target and weed species from each commercial seed mix evaluated August 8, 2013.

	AM Dry Area	AM Xeriscape	AM Native	Outside Pride	Applewood	Eden Bros.
Target species	----------plants/m²----------					
Cornflower	1.5			2.5	1.5	3.5
Plains coreopsis	1.0			0.5	1.5	2.0
Wild cosmos	0.5					
Baby snapdragon	0.5					
CA poppy	2.5	4.5		3.0	4.0	
Corn poppy	1.0			4.5	4.0	1.0
Siberian wallflower	0.5			0.5		
Sweet alyssum	1.0				3.5	
Indian blanket	1.0	0.5	2.5		1.5	
Birdsfoot trefoil	0.5					
Tidytips		2.5				
Bird’s eye		1.5				
Greenthread		0.5				
Blue flax		0.5				0.5
Arroyo lupine		0.5				
Farewell to spring			2.0	0.5	0.5	
Candy tuft				3.0		
Total target	10.0	10.5	4.5	14.5	16.5	7.0
Weed species						
Volunteer millet	0.5	0.5	1.0		1.0	1.0
Green foxtail	3.5	4.0	2.0		3.5	9.0
Lambsquarters	0.5					0.5
Witchgrass	1.5	4.5	7.0	3.5	1.5	
Barnyardgrass	0.5		2.5	1.0	5.0	4.0
Shepherd’s purse		1.0	0.5	1.0		0.5
Prickly lettuce			0.5			
Total weed	6.5	10.0	13.5	5.5	11.0	15.0

American Meadows Dry Area

American meadows Dry Area mix contains 25, primarily introduced species. Of the 25, 14 are annual, 2 biennial and 9 perennial. Eighteen of the 25 included species are not native to the Intermountain or Rocky Mountain west. Nineteen species bloomed during the first growing season beginning in early August and continuing through the end of September. Fourteen of the 18 species that bloomed during 2013 were annuals (Table 2). This mix showed the greatest floral and color diversity during the first growing season.

Several species in the Dry Area mix showed excellent vigor and flower persistence. Most of the species present began blooming in August and continued to bloom through late September. Many of the species were highly favored by European honey bees including California poppy, corn poppy, cornflower, wild cosmos and plains coreopsis. Despite being not native to the region, these species were also observed being visited readily by native bees and butterflies.

Table 2. American Meadows Dry Area Mix flowering color and duration, 2013. Colored bars indicate flower color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
California poppy	Ann.						
Corn poppy	Ann.						
Cornflower	Ann.						
Sweet alyssum	Ann.						
Plains coreopsis	Ann.						
Wild cosmos	Ann.						
Blackeyed susan	Per.						
Indian blanket	Ann.						
African daisy	Ann.						
Baby snapdragon	Ann.						
Evening primrose	Bi.						
Catchfly	Ann.						
Prairie coneflower	Per.						
Siberian wallflower	Ann.						
Shasta daisy	Rhiz per.						
Sulphur cosmos	Ann.						
Gloriosa daisy	Per.						
Garland chrysanthemum	Ann.						
Yarrow	Per.						
Sweet William	Bi.						
Blanketflower	Per.						
Baby’s breath	Ann.						
Blue flax	Per.						
Bird’sfoot trefoil	Per.						
Rocky Mountain penstemon	Per.						

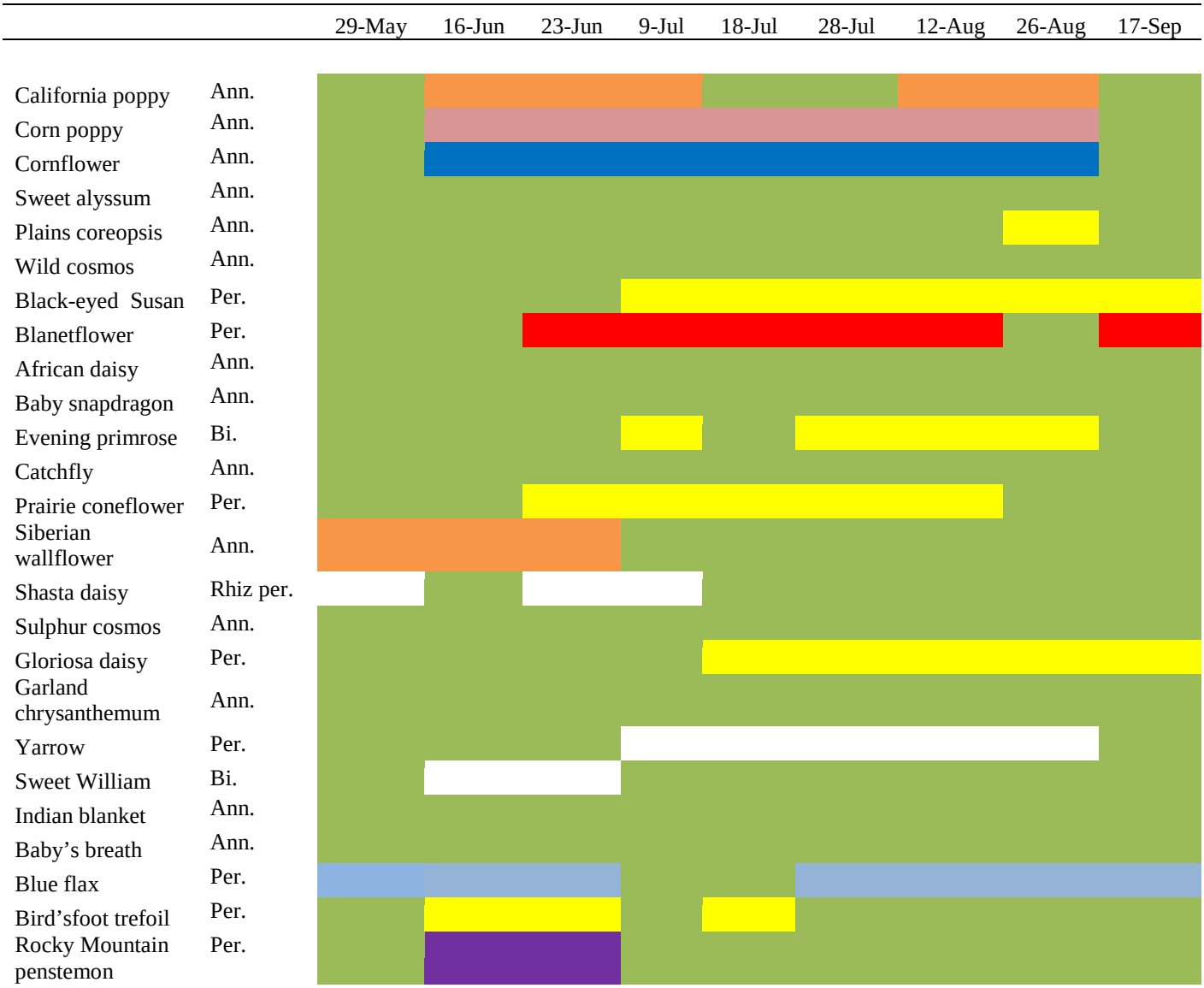
American Meadows Dry Area

July 22, 2013

August 29, 2013

Sixteen species in the American Meadows Dry Area mix flowered in 2014. In all, 5 annuals, 2 biennials and 9 perennials flowered during the second season indicating a shift from annuals to longer lived species. Black-eyed Susan, blanket flower, prairie coneflower, yarrow and blue flax all had long flowering durations. Cornflower and California poppy, both introduced annuals also provided significantly to the floral display. This mix again provided the greatest diversity of the evaluated mixes.

Table 3. American Meadows Dry Area Mix flowering color and duration 2014. Colored bars indicate flower color. Green indicates no flowers in bloom.



American Meadows Western Xeriscape

American Meadows Western Xeriscape mix contains 24 species, mostly native to the PMC service area with some plants being introduced from California. This mix is the closest to what might be recommended for pollinator plantings by the PMC. It contains 12 annuals 10 perennials and 2 biennials.

Nine species in the Xeriscape mix flowered during the first growing season (Table 4). This mixture contained a large percentage of tidytips and California poppy and provided a very yellow dominant appearance. Blanketflower was also present in good numbers. All flowering in the first season was done by annuals and the perennial blanketflower. Tidytips and blanketflower appeared highly attractive to small native bees. California bluebell, greenthread, arroyo lupine and blazingstar were present, but not in large numbers; most were represented by one or two plants.

Table 4. American meadows Western Xeriscape Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

	Longevity	8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
California poppy	Annual						
Tidytips	Annual						
Blanketflower	Perennial						
Bird's eye	Annual						
California bluebell	Annual						
Greenthread	Annual						
Arroyo lupine	Annual						
Prairie aster	Biennial						
Blazingstar	Annual						
Desert marigold	Ann., Bi.						
Deerhorn clarkia	Annual						
Common wooly sunflower	Perennial						
Blue flax	Perennial						
Five spot	Annual						
Pale evening primrose	Biennial						
Palmer penstemon	Perennial						
Rocky Mountain penstemon	Perennial						
Prairie coneflower	Perennial						
Gooseberryleaf globemallow	Perennial						
Baby blue-eyes	Annual						
Soapwort	Perennial						
Creeping thyme	Perennial						
Strawberry clover	Perennial						
Johnny jump-up	Annual						

American Meadows Western Xeriscape

July 22, 2013

August 29, 2013

American Meadows Western Xeriscape mix had somewhat less floral diversity than the Dry Area mix. Ten species flowered in 2014 including 5 annuals, one biennial and 4 perennials. Two annual California natives, tidytips and California poppy showed well. Green thread, which is native to the east slope of the Rocky Mountains and into the Plains States, also provided a strong floral display. Blue flax, blanket flower and Rocky Mountain penstemon are native to the region. Prairie aster added to the late season color in August and September.

Table 5. American Meadows Western Xeriscape Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		29-May	16-Jun	23-Jun	9-Jul	18-Jul	28-Jul	12-Aug	26-Aug	17-Sep
California poppy	Ann.									
Tidytips	Ann									
Blanketflower	Per.									
Bird's eye	Ann									
California bluebell	Ann									
Greenthread	Ann									
Arroyo lupine	Ann									
Prairie aster	Bi.									
Blazingstar	Ann									
Desert marigold	Ann., Bi.									
Deerhorn clarkia	Ann									
Common wooly sunflower	Per.									
Blue flax	Per.									
Five spot	Ann									
Pale evening primrose	Bi.									
Palmer penstemon	Per.									
Rocky Mountain penstemon	Per.									
Prairie coneflower	Per.									
Gooseberryleaf globemallow	Per.									
Baby blue-eyes	Ann									
Soapwort	Per.									
Creeping thyme	Per.									
Strawberry clover	Per.									
Johnny jump-up	Ann									

American Meadows Native West

American Meadows Native West mix is composed of 19 species, 7 annuals, 1 biennial and 11 perennials all native to North America (Table 6). However it does contain many species that would not be considered native to the Intermountain or Rocky Mountain Region. Some come from eastern US, coastal western US or from the Southwest, all areas that are very dissimilar from conditions found in our region.

The lack of introduced annuals in the mixture significantly reduced the number of species flowering during the first growing season. Only five species blossomed in 2013, 3 annuals and 2 perennials. The All Native mix was highly red color dominant in 2013 due to the large numbers of Indian blanket. Other prominent species in the floral composition were blackeyed Susan and showy goldeneye.

Table 6. American Meadows Native West Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
Indian blanket	Ann.						
Farewell to spring	Ann						
Blackeyed Susan	Per.						
Tidytips	Ann						
Showy goldeneye	Per.						
Blue columbine	Per.						
Smooth aster	Per.						
Prairie aster	Bi.						
Deerhorn clarkia	Ann						
Rocky Mountain beeflower	Ann						
Plains coreopsis	Ann						
Fleabane daisy	Per.						
Blanketflower	Per.						
Globe gilia	Ann						
Blue flax	Per.						
Rocky Mountain penstemon	Per.						
Purple prairie clover	Per.						
Prairie coneflower	Per.						
White evening primrose	Per.						

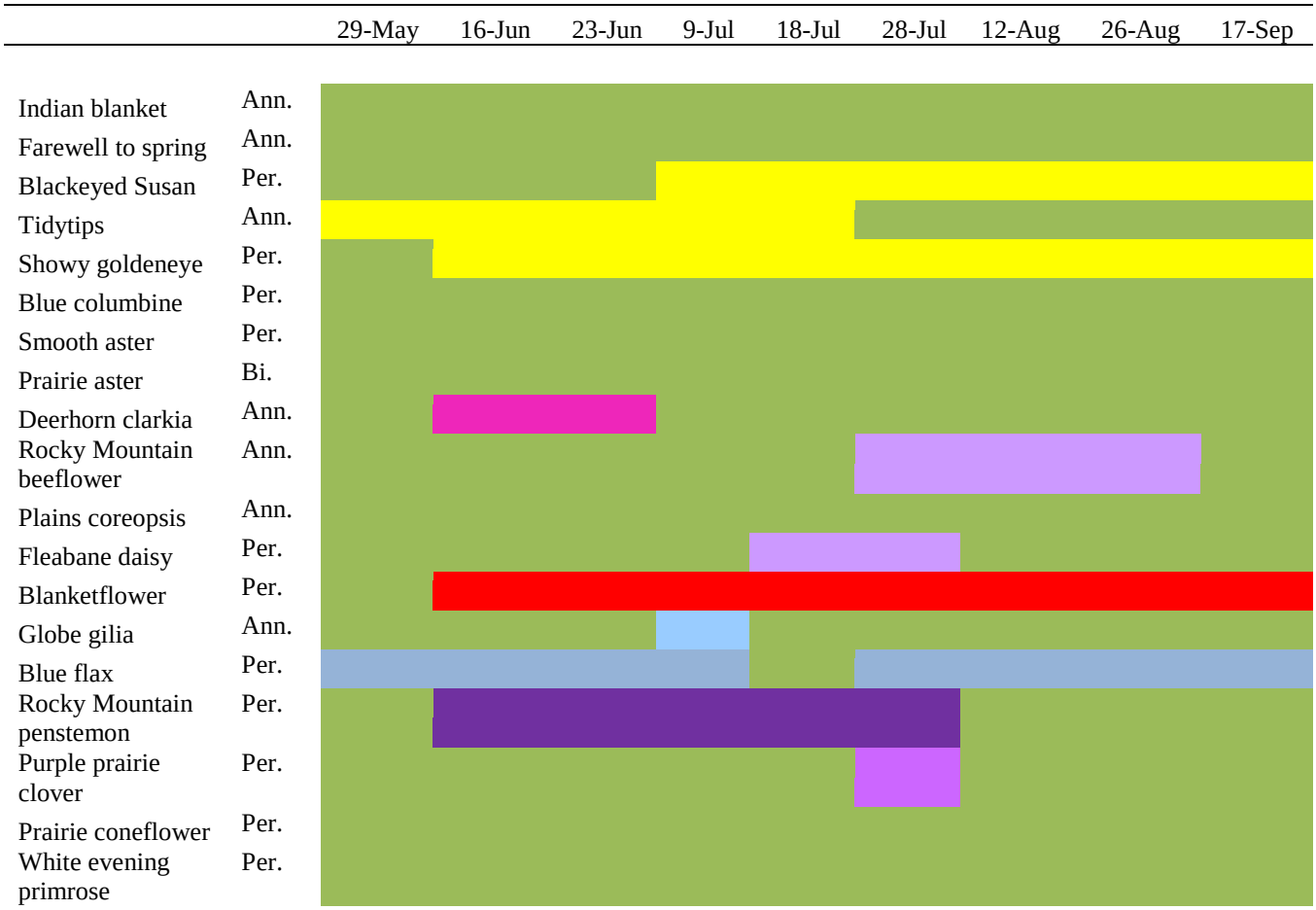
American Meadows Native West

July 22, 2013

August 29, 2013

The American Meadows Native West mix improved in floral diversity in 2014 adding flowers from several perennial species (Table 7). Eleven species flowered in 2014, 4 annuals and 7 perennials. Black-eyed Susan, showy goldeneye, blanket flower, blue flax and Rocky Mountain Penstemon all did well and flowered through most of the season. Tidytips had sustained blooming for most of the mid-summer. The slow development of the perennials last year allowed weedy annual species like prickly lettuce to proliferate.

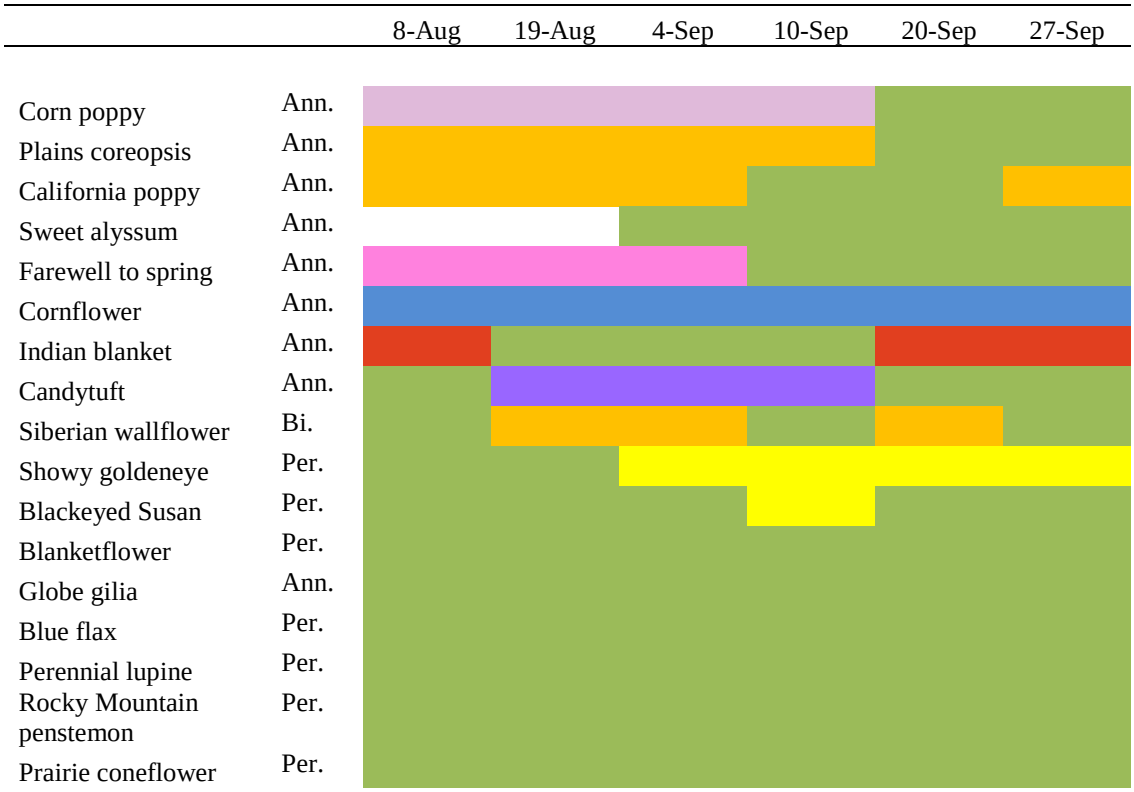
Table 7. American Meadows Native West Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.



Outside Pride Western Wildflower

Outside Pride Western Wildflower Mix consists of 17 native and introduced species with 9 annuals and 8 perennials (Table 8). Of these, 11 flowered in the first growing season, 8 of which were annuals. California poppy, plains coreopsis, corn poppy and cornflower were frequently visited by European honeybees. Indian blanket and showy goldeneye, both native species, were also visited by native pollinators.

Table 8. Outside Pride Western Wildflower Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.



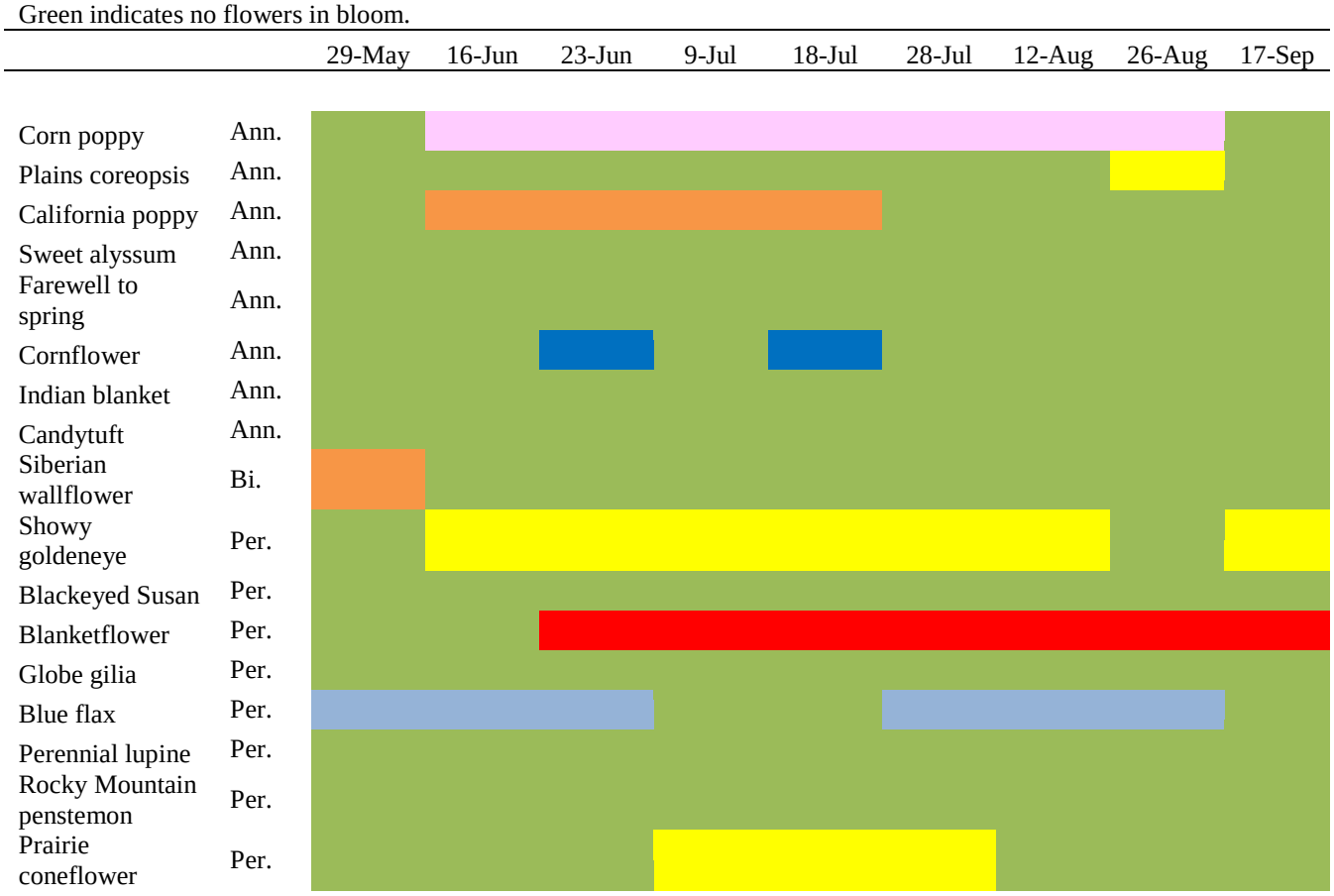
Outside Pride Western Wildflower

July 22, 2013

August 29, 2013

Outside Pride's Western Wildflower mix contains a mixture of native and introduced species. Introduced annuals like corn poppy and California poppy were abundant in 2014. Native perennials showy goldeneye, blanket flower and blue flax flowered through most of the season. In total 4 annuals, 1 biennial, and 4 perennials flowered in 2014.

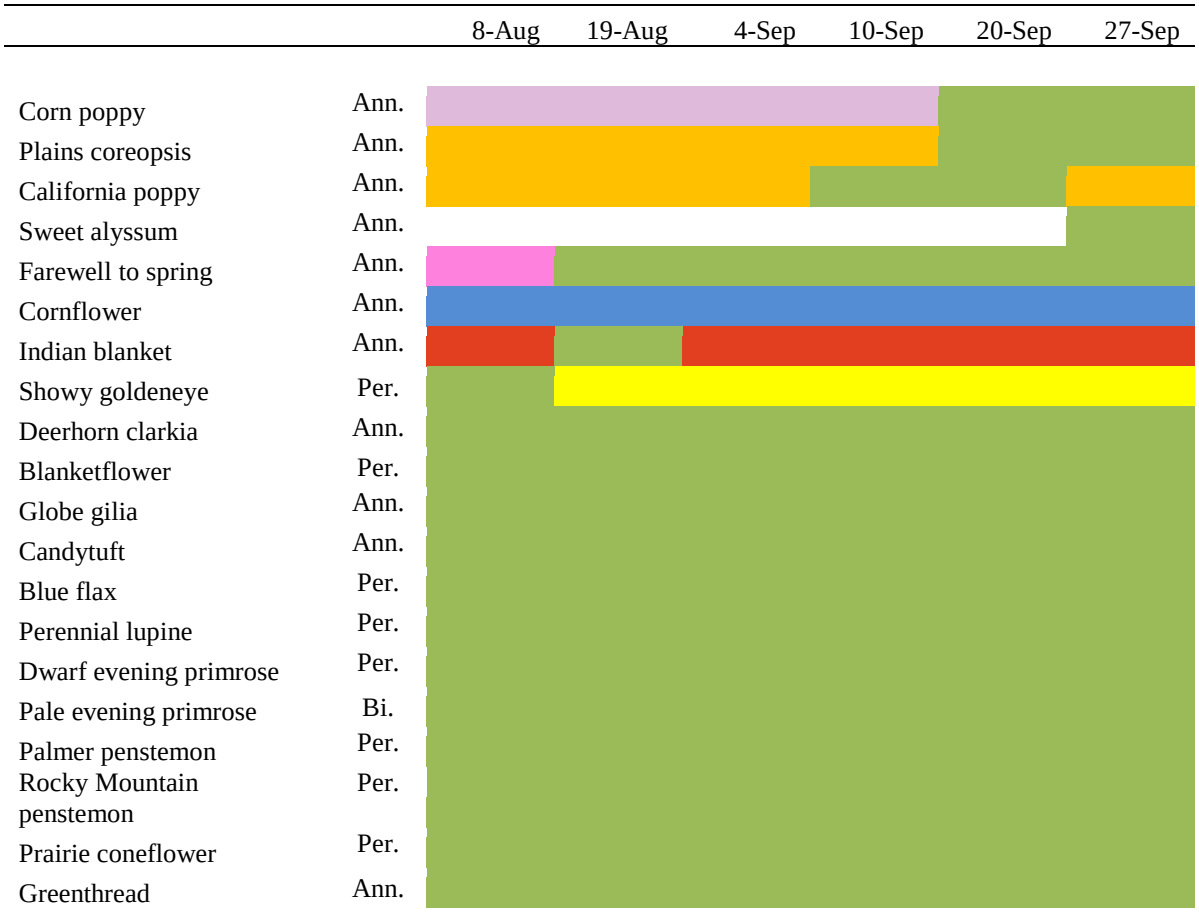
Table 9. Outside Pride Western Wildflower Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.



Applewood Western Mix

Applewood Seed's Western Mix consists of 20 species, 11 annuals 8 perennials and 1 biennial (Table 10). This mixture has a similar composition to the Outside Pride Western Wildflower mix and contains primarily introduced species. Eight species flowered the first season. Showy goldeneye was the only perennial to flower in 2013.

Table 10. Applewood Western Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.



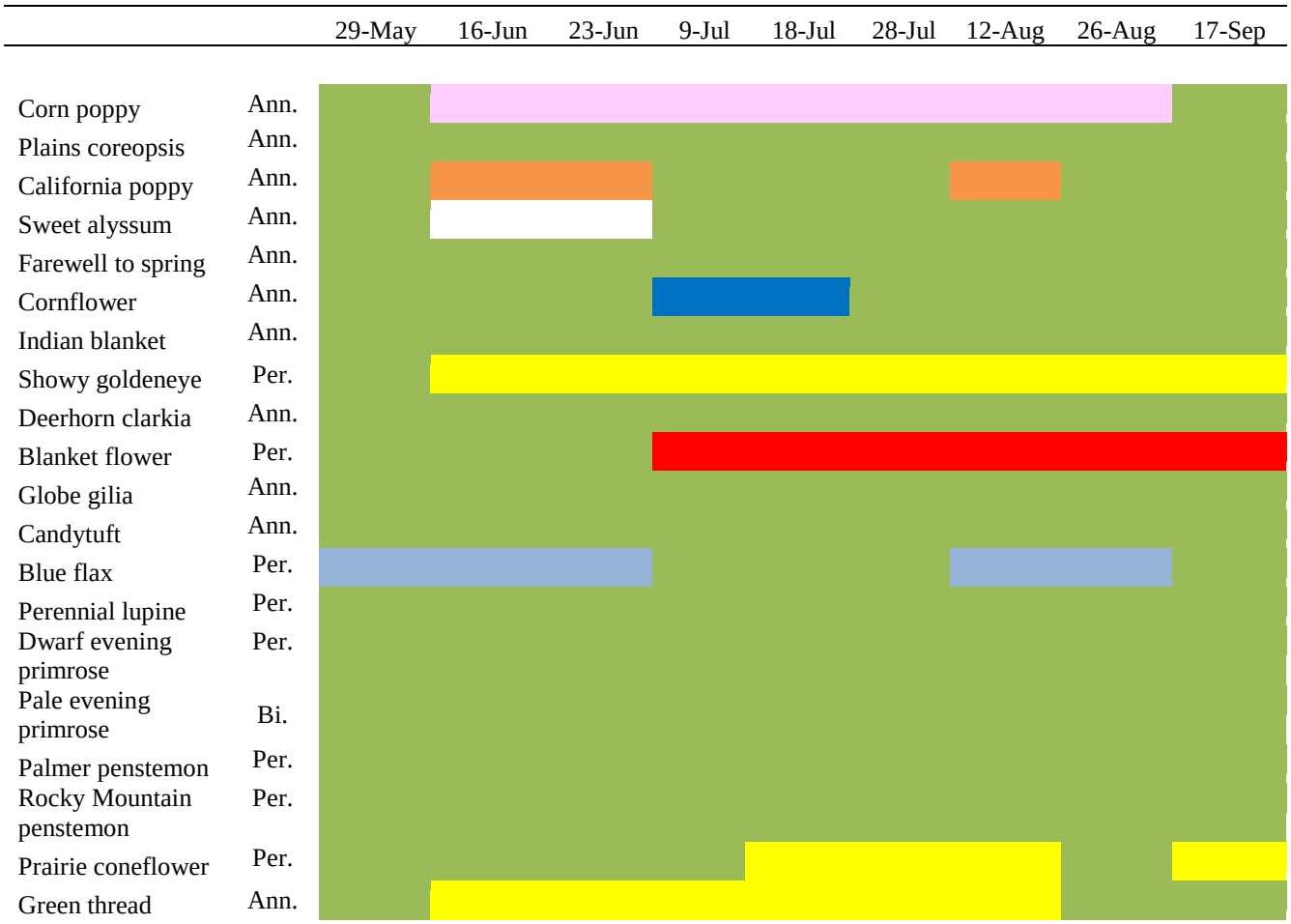
Applewood Western Mix

July 22, 2013

August 29, 2013

Similar to other mixes, the Applewood Western mix had an assortment of perennial natives and introduced annuals. Nine total species flowered in 2014 including 5 annuals and 4 perennials. Blanket flower, showy goldeneye, blue flax, and prairie coneflower flowered consistently in 2014. Corn poppy, California poppy, corn flower and green thread were annuals that returned for the second season from dropped seed.

Table 11. Applewood Western Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.



Eden Brothers Western Wildflower Mix

The Western Wildflower Mix from Eden Brothers contains 24 species, 12 annuals, 1 biennial and 11 perennials (Table 12). Flowering during the first season was similar to other mixes containing corn poppy, cornflower, plains coreopsis and wild cosmos. Surprisingly, we did not observe any flowering from California poppy during this season in the Eden Brothers mix.

Table 12. Eden Brothers Western Wildflower Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
Corn poppy	Ann.						
Cornflower	Ann.						
California poppy	Ann.						
Plains coreopsis	Ann.						
Wild cosmos	Ann.						
Lemon mint	Ann.						
Prairie coneflower	Per.						
Blackeyed Susan	Per.						
Baby's breath	Ann.						
Indian blanket	Ann.						
Sulphur cosmos	Ann.						
Blue columbine	Per.						
Siberian wallflower	Bi.						
Lanceleaf coreopsis	Per.						
Purple coneflower	Per.						
Blanketflower	Per.						
Scarlet flax	Ann.						
Blue flax	Per.						
Perennial lupine	Per.						
Russel lupine	Per.						
Five spot	Ann.						
Rocky Mountain penstemon	Per.						
Drummond phlox	Ann.						
Gloriosa daisy	Per.						

Eden Brothers Western Wildflower Mix

July 22, 2013

August 29, 2013

Ten species in total flowered during 2014 in the Eden Brothers Western Wildflower mix. Four annuals and 6 perennials were represented.

Table 13. Eden Brothers Western Wildflower Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.

CONCLUSIONS

Weedy annual species were common throughout the plots. Annual grasses can be significantly reduced by using grass selective herbicides; however we were not able to remove them entirely with a single treatment of sethoxydim. Broadleaf weeds are extremely difficult to control in wildflower plantings, as herbicides used to treat broadleaf weeds will also affect many of the target species in the seed mixtures. Lambs quarters and shepherd's purse were common annual weeds in the plots during 2013, but these decreased significantly in density in 2014 as the target species had become more competitive. Prickly lettuce however increased in density in 2014, especially in those mixes that contained few competitive annual wildflower species.

Of the total 62 species included in the trial, 30 flowered in the first growing season. The vast majority (22 of 30) were annuals, the remainder being 2 biennials and 6 perennials. Flowering was not observed until early August, approximately 11 weeks after planting. Most species had long sustained flowers due to supplemental irrigation and late summer rains. The first frost of the season came on September 19, and all plants had ceased flowering by October 17.

The inclusion of annuals is a good way to get blooms during the first growing season. It is especially important to include annuals in post-fire rehabilitation seed mixtures to provide food for native pollinators that have relatively short foraging ranges and might not be able to reach undisturbed plant communities (Cane 2008).

Insect visitation varied between plots due to species composition and density. Overall, corn poppy, California poppy, cornflower, plains coreopsis, and wild cosmos were very attractive to European honeybees. Tidytips and blanketflower were heavily visited by native bees. Hunt's bumblebee was observed frequently visiting wild cosmos. Butterflies were observed on Indian blanket and blanketflower. All of the flowering species were observed being visited at least once by pollinators.

Eleven of the 62 species planted are cited in the literature as having weedy tendencies (USDA NRCS 2013). Of these, Cornflower, soapwort and Rocky Mountain bee flower are listed as being weedy in western states (Whitson et al 1996). The others are primarily western species that express weedy behavior in the Midwest and eastern US. Rocky Mountain bee flower is native to the PMC service area. It can invade and spread into ditch banks and along roadsides where moisture accumulates. Cornflower and California poppy are a concern. These species are known to escape from "wildflower" seedings and spread.

In addition to inappropriate target species, wildflower mixes can also contain accidental inclusions of noxious weed seed. Seed used for commerce is not to have any prohibited noxious weeds listed in the state the seed is shipped to or used. However, restricted noxious weed seeds may be included as state seed law allows. The best way to know if noxious weed seed is in a mix is with an accurate purity test and seed tag.

A small number of plants evaluated in the trial have known or suspected toxic properties. Three species, yarrow, desert marigold, and soapwort have been shown to cause disease in sheep when consumed in large volumes (Burrows and Tyrl 2001). Yarrow and desert marigold are native and

are commonly present in rangelands used for sheep grazing; however these species should be avoided or used with caution in areas where they might pose a risk to livestock.

In order to prevent the establishment and spread of noxious weeds and other invasive plant species, one must be careful about what seeds are planted. The best way to do this is to use a custom seed mix. If a commercial wildflower mix is used, the mix selected should be appropriate to the region; native species are recommended when possible. Mixes including known invasive or aggressive species such as cornflower should be avoided. Seed mixes should be tested for purity and come with an accurate seed tag. Mixtures should also be clearly labeled with scientific names included, as confusion and uncertainty can arise from the use of common names. Following these steps will help ensure that only appropriate species are planted.

During the second season of our trial, perennial species made up the majority of the floral display. Black-eyed Susan, blanket flower, prairie coneflower, yarrow, blue flax, Rocky Mountain penstemon, and showy goldeneye had numerous flowers and lasted for much of the second season. Flowering began in late May and ended with freezing temperatures in mid-September. Other perennials such as fleabane daisy, and prairie aster had blossom periods limited to late summer. Twelve annual species, California poppy, corn poppy, corn flower, plains coreopsis, Siberian wallflower, tidytips, bird'seye, Green thread, deerhorn clarkia, Rocky Mountain bee flower, globe gilia, and sweet alyssum also returned in 2014. Several species in the various mixes showed no flowering in the first or second year of the trial.

In 2014 there was evidence of volunteering of plants into adjacent plots. Tidytips and corn poppy had spread as much as 30 feet from their original location the previous year.

Use in NRCS Programs

Approximately two-thirds of the original species (39 of 62) flowered in 2013 or 2014 indicating at least moderate adaptation to 14 to 18 inch precipitation sites in southeastern Idaho. Those that did not flower add to the cost of the seed mix and may be being used at the exclusion of more appropriate species. Careful selection of adapted species can reduce the cost of seed mixes as maladapted species are avoided.

The NRCS funds or cost-shares approved pollinator plantings which meet agency specifications. These specifications include seed mixture composition percentages and the rate at which the seed is planted (lb/ac or seeds/ft). To accurately calculate seeding rates, one needs to know: % of each species in the mix by weight, purity of each species, germination or viability of each species and the average number of seeds/lb for each species (Tilley and St. John 2013). This information is commonly lacking in commercial seed mixtures. Of the six mixtures evaluated, only two included percentage information.

Using rough estimates for purity and viability we calculated approximate seeds/ft for the two mixtures where percentages of each species were available based on seeding 10 lbs bulk seed per acre. Based on our calculations, Applewood Seed Western Mix was seeded at approximately 128 seeds/ft and Outside Pride Western Wildflower Mix had 93 seeds/ft. NRCS specifications stipulate a target seeding rate of 75 to 100 seeds/ft for broadcast seeding of small seeded species. These numbers suggest that the recommended rate of 10 lbs/ac closely aligns with NRCS

broadcast seeding rates. Species component percentages must be available to determine whether or not seeding mixtures meet NRCS standards. Mixtures not providing percentages of species components should not be used for NRCS funded seedings.

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Appendix. Mix and species information

Common Name	Scientific Name	Origin	Longevity	Eden Brothers Western Wildflower Mix	Applewood Seed Western Mix	Outside Pride Western Wildflower Mix	American Meadows Native West	American Meadows Dry Area Mix	American Meadows Western Xeriscape Mix
				$27/lb	$26/lb	$23/lb	$60/lb	$27/lb	$40/lb
					% of mix	% of mix			
Yarrow	*Achillea milliefolium*	N. Am.	Perennial					x	
Blue columbine	*Aquilegia coerulea*	IMW[1] and RMW[2]	Perennial	x			x		
Smooth aster	*Aster laevis*	Eastern US	Perennial				x		
Priarie aster	*Machaerranthera tanacetifolius*	Western US (not PNW[3])	biennial				x		x
Desert marigold	*Baileya multiradiata*	SW	Ann., bi, per.						x
Cornflower	*Centaurea cyanus*	N. Am.	annual	x	7.3	8.13		x	
Siberian wallflower	*Cheiranthus allionii*	Eurasia	Biennial	x		12.19		x	
Garland chrysanthemum	*Chrysanthemum coronarium*	Mediterranean	Annual					x	
Shasta daisy	*Chrysanthemum maximum*	Europe	Rhiz-perr.					x	
Deerhorn clarkia	*Clarkia pulchella*	PNW	Annual		0.92		x		x
Farewell to spring	*Clarkia unguiculata*	California	Annual		1.83	1.34			
Rocky Mountain bee flower	*Cleome serrulata*	N. Am (not SE)	Annual				x		
Lanceleaf coreopsis	*Coreopsis lanceolata*	N. Am (not IMW)	Perennial	x					
Plains coreopsis	*Coreopsis tinctoria*	N. Am (not IMW)	ann, bi, per	x	0.73	1.02	x	x	
Wild cosmos	*Cosmos bipinnatus*	Central Am.	Annual	x				x	
Sulphur cosmos	*Cosmos sulphureus*	Central am.	Annual	x				x	
Purple prairie clover	*Dalea purpurea*	Midwestern US	Perennial				x		
Sweet william	*Dianthus barbatus*	Eurasia	Biennial					x	
African daisy	*Dimorphotheca sinuata*	Africa	Annual					x	
Purple coneflower	*Echinacea purpurea*	Eastern US	Perennial	x					
Fleabane daisy	*Erigeron speciosus*	Western US	Perennial				x		
Common woolly sunflower	*Eriophyllum lanatum*	Western US	Perennial						x
California poppy	*Eschscholzia californica*	California	Annual	x	11	12.19		x	x

Appendix (cont.)

Common Name	Scientific Name	Origin	Longevity	Eden Brothers Western Wildflower Mix	Applewood Seed Western Mix % of mix	Outside Pride Western Wildflower Mix % of mix	American Meadows Native West	American Meadows Dry Area Mix	American Meadows Western Xeriscape Mix
Blanketflower	*Gaillardia aristata*	Western US	Perennial	x	12.83	8.13	x	x	x
Indian blanket	*Gaillardia pulchella*	Eastern US	Annual		3.67	4.06	x	x	
Globe gilia	*Gilia capitata*	Western US	Annual		1.83	1.34	x		
Bird's eye	*Gilia tricolor*	California	Annual						x
Baby's breath	*Gypsophila elegans*	Eurasia	Annual	x				x	
Showy goldeneye	*Heliomeris multiflora*	Western US (not PNW)	Perennial		1.21	0.81	x		
Candy tuft	*Iberis umbellata*	Mediterranean	Annual		11	16.25			
Tidytips	*Layia platyglossa*	CA, AZ, UT	Annual						x
Baby snapdragon	*Linaria maroccana*	Morocco	Annual					x	
Scarlet flax	*Linum grandiflorum*	Algeria	Annual	x					
Blue flax	*Linum perenne*	Europe	Perennial	x	7.33	12.19	x	x	x
Sweet alyssum	*Lobularia maritima*	Mediterranean	Annual					x	
Birdsfoot trefoil	*Lotus corniculatus*	Eurasia	Perennial					x	
Perennial lupine	*Lupinus perennis*	Eastern US	Perennial	x	14.65	16.25			
Russel lupine	*Lupinus polyphyllus*	Western US	Perennial	x					
Arroyo lupine	*Lupinus succulentus*	California	Annual						x
Blazingstar	*Mentzelia lindleyi*	California	Annual						x
Lemon mint	*Monarda citriodora*	Southern US	Annual	x					
Five spot	*Nemophila maculata*	California	Annual	x					x
Baby blue-eyes	*Nemophila menziesii*	California	Annual						x
White evening primrose	*Oenothera caespitosa*	Western US	Perennial				x		
Evening primrose	*Oenothera lamarckiana*	Europe	biennial					x	
Dwarf eve primrose	*Oenothera missouriensis*	Southern US	Perennial		1.83				
Pale eve primrose	*Oenothera pallida*	Western US	biennial		1.83				x

Appendix (cont.)

Common Name	Scientific Name	Origin	Longevity	Eden Brothers Western Wildflower Mix	Applewood Seed Western Mix % of mix	Outside Pride Western Wildflower Mix % of mix	American Meadows Native West	American Meadows Dry Area Mix	American Meadows Western Xeriscape Mix
Corn poppy	*Papaver rhoeas*	Europe	Annual	x	7.33	2.03		x	
Palmer penstemon	*Penstemon palmeri*	SW	Perennial		1.83				x
Rocky Mountain penstemon	*Penstemon strictus*	Rocky Mtns	Perennial	x	3.67	2.03	x	x	x
California bluebell	*Phacelia campanularia*	California	Annual						x
Drummond phlox	*Phlox drummondii*	Eastern US	Annual	x					
Prairie coneflower	*Ratibida columnaris*	Midwestern US	Perennial	x	1.84	2.03	x	x	x
Gloriosa daisy	*Rudbeckia gloriosa*	Eastern US	Perennial	x				x	
Blackeyed susan	*Rudbeckia hirta*	N. am (not SW)	ann, bi, per	x			x	x	
Soapwort	*Saponaria officinalis*	Eurasia	Perennial						x
Ccatchfly	*Silene armeria*	Europe	Annual					x	
Gooseberryleaf globemallow	*Sphaeralcea grossulariifolia*	Western US	Perennial						x
Greenthread	*Thelesperma filifolium*	Midwestern US	Annual		7.33				x
Creeping thyme	*Thymus praecox*	Eurasia	Perennial						x
Strawberry clover	*Trifolium fragiferum*	Eurasia	Perennial						x
Johnny jump-up	*Viola tricolor*	Eurasia	Annual						x

[1] Intermountain West
[2] Rocky Mountain West
[3] Pacific Northwest

COMMERCIAL WILDFLOWER SEED MIX EVALUATION, 2015 PROGRESS REPORT

Derek J. Tilley, PMC Manager

INTRODUCTION

Commercially produced wildflower seed mixes are readily available and broadly used for attracting pollinators and adding beauty to small gardens and landscapes. These mixtures are popular with landowners because they are pre-mixed and eliminate the guess work of designing custom mixtures. They also eliminate the need to search for and purchase individual species from multiple vendors to create a seed mix.

Most commercial seed mixtures are created to cover a wide range of adaptation and may include plants adapted to extremely low precipitation areas (<9" mean annual precipitation) and plants adapted to wetter environments (>18" mean annual precipitation). This range provides some insurance that at least some of the species in the mixture are adapted to a specific site and may thrive. The problem however is that a significant number of the species in the mixture are less likely to be adapted to the planting site and thus represent an unnecessary expense.

The species in the mixtures are selected for their attractiveness to bees, butterflies and other pollinators and are purportedly composed of species well adapted to specific regions or environments. Despite these advantages, suitability of many of the species in the mixes to pollinator plantings for CRP or other NRCS programs is largely unknown. Many species are from North America outside of the Intermountain West; still others are of Eurasian or African origin. Additionally, some commercial mixes may contain plant species that can become invasive, or the mix may not contain appropriate species to provide pollinator forage throughout the year, or may contain plant species that are attractive to humans but provide little value to the target pollinators. Establishment, persistence, and suitability of many of these species to pollinator plantings are poorly understood in this context. These issues need to be examined before NRCS can recommend commercially designed seed mixes for conservation practices.

MATERIALS AND METHODS

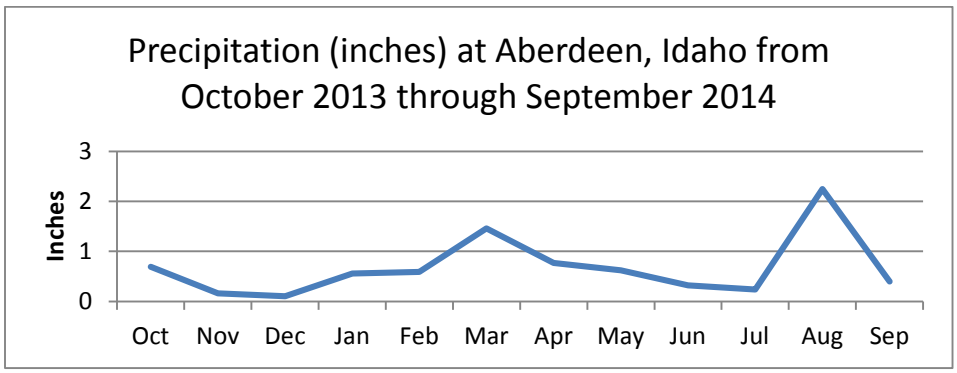
This trial was conducted on the Aberdeen Plant Materials Center Fish and Game Farm located 5 miles northeast of Aberdeen, Idaho. Soil at the site is a Declo silt loam with pH of 7.4 to 8.4. Average annual precipitation is 9.39 inches. The field had previously been planted to a crop of small grains left standing for wildlife food and cover.

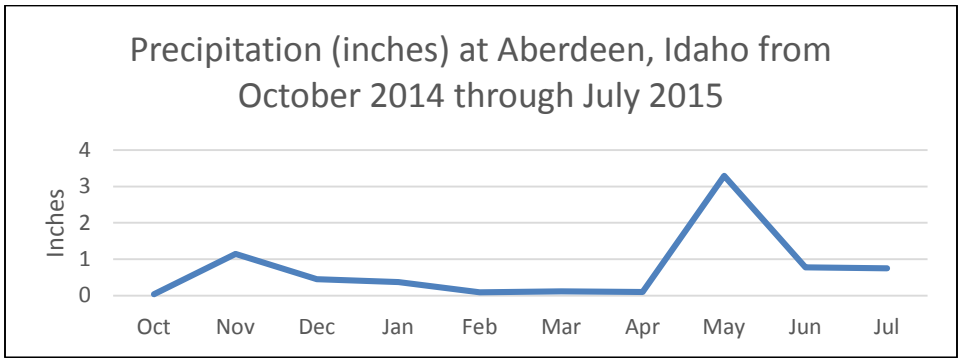
We planted six commercially available wildflower seed mixes designed for use in western North America into non-replicated 90 x 20 ft plots. The mixtures selected were chosen based on their dissimilarity with other mixes in the trial to include the widest possible variety of species (see appendix). Each mix contained between 15 and 25 species. Prices of the mixtures ranged from

$23/lb to $60/lb plus shipping. Mention of a specific mixture or company is not an endorsement by the NRCS.

In mid-May, 2013 the field was mowed to knock down the standing small grain cover and was treated with 64 oz glyphosate per acre to control volunteer grains and emerging annual weeds. On May 23, 2013 the trial was planted using a 3 ft Truax® broadcast seeder pulled by an ATV followed with a packer roller. Recommended seeding rates for the various mixes range from 6 to 20 lbs/acre depending on the desired density of the stand. Each plot in this trial was seeded at a target rate of 10 lbs/ac to obtain a uniform density between the plots. The trial was irrigated approximately 8 hours (2 inches) every ten days during the establishment phase in 2013. Irrigation was discontinued on August 1. On July 10, 2013 the site was sprayed with 1 pt/ac sethoxydim to control annual grasses. The plots were mowed to eliminate standing residue in early spring of 2014 and 2015.

To see how the various species performed under limited water conditions, no supplemental irrigation was applied during the 2014 or 2015 growing seasons. Precipitation totals were below average for most of the 2014 water year. Summer rains (2.25 inches in August) brought the total for the year to 8.16 inches. Fall of 2014 and spring of 2015 brought minimal amounts of precipitation; however 3.3 inches in May and approximately 0.75 inches in June and July supported plant growth and flowering.





Plots were evaluated to determine which species were well adapted to conditions in the PMC service area including the Intermountain and Rocky Mountain Regions, and contributed to pollinator foraging. Plant density was evaluated on August 8, 2013 using a 1 m² frame placed in

the center of the plots 5 paces and 10 paces into the plot. Plots were also visited periodically in 2013 and 2014 to observe blooming and insect visitation.

The plots were evaluated for cover frequency on June 15, 2015 using an 80 ft line-intercept transect running diagonally across the length of the plot. Readings were taken every foot. Cover frequencies were generated for the categories: percent bare ground, broadleaf weeds, grass weeds, and the various target species intercepted.

The trial will be evaluated again in 2016 to observe long-term changes in species composition and to identify any potential management problems that may be associated with using commercial pollinator seed mixes.

RESULTS AND DISCUSSION

Initial Density

Plant density was recorded early in the season on August 8, 2013 when plants could be easily counted (Table 1). Some species documented flowering in the later evaluations were not present at the early density evaluation. These were either located outside of the evaluated frames, or could have germinated later in the season, or were unidentifiable at early life stages. Many perennials listed here did not flower the first season, and some of the perennial species require a winter stratification period and were not expected to germinate until spring 2014.

Early plant densities were largely composed of annual species that had no stratification requirement. Seed mixtures with a large component of annuals seemed in most cases better equipped to compete against weed species.

Table 1. Initial density (plants per meter^2) of target and weed species from each commercial seed mix evaluated August 8, 2013.

	AM Dry Area	AM Xeriscape	AM Native	Outside Pride	Applewood	Eden Bros.
Target species	----------plants/m²----------					
Cornflower	1.5			2.5	1.5	3.5
Plains coreopsis	1.0			0.5	1.5	2.0
Wild cosmos	0.5					
Baby snapdragon	0.5					
CA poppy	2.5	4.5		3.0	4.0	
Corn poppy	1.0			4.5	4.0	1.0
Siberian wallflower	0.5			0.5		
Sweet alyssum	1.0				3.5	
Indian blanket	1.0	0.5	2.5		1.5	
Birdsfoot trefoil	0.5					
Tidytips		2.5				
Bird's eye		1.5				
Greenthread		0.5				
Blue flax		0.5				0.5
Arroyo lupine		0.5				
Farewell to spring			2.0	0.5	0.5	
Candy tuft				3.0		
Total target	10.0	10.5	4.5	14.5	16.5	7.0
Weed species						
Volunteer millet	0.5	0.5	1.0		1.0	1.0
Green foxtail	3.5	4.0	2.0		3.5	9.0
Lambsquarters	0.5					0.5
Witchgrass	1.5	4.5	7.0	3.5	1.5	
Barnyardgrass	0.5		2.5	1.0	5.0	4.0
Shepherd's purse		1.0	0.5	1.0		0.5
Prickly lettuce			0.5			
Total weed	6.5	10.0	13.5	5.5	11.0	15.0

American Meadows Dry Area

American meadows Dry Area mix contains 25, primarily introduced species. Of the 25, 14 are annual, 2 biennial and 9 perennial. Eighteen of the 25 included species are not native to the Intermountain or Rocky Mountain west. Nineteen species bloomed during the first growing season beginning in early August and continuing through the end of September. Fourteen of the 18 species that bloomed during 2013 were annuals (Table 2). This mix showed the greatest floral and color diversity during the first growing season.

Several species in the Dry Area mix showed excellent vigor and flower persistence. Most of the species present began blooming in August and continued to bloom through late September. Many of the species were highly favored by European honey bees including California poppy, corn poppy, cornflower, wild cosmos and plains coreopsis. Despite being not native to the region, these species were also observed being visited readily by native bees and butterflies.

Table 2. American Meadows Dry Area Mix flowering color and duration, 2013. Colored bars indicate flower color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
California poppy	Ann.						
Corn poppy	Ann.						
Cornflower	Ann.						
Sweet alyssum	Ann.						
Plains coreopsis	Ann.						
Wild cosmos	Ann.						
Black-eyed susan	Per.						
Indian blanket	Ann.						
African daisy	Ann.						
Baby snapdragon	Ann.						
Evening primrose	Bi.						
Catchfly	Ann.						
Prairie coneflower	Per.						
Siberian wallflower	Ann.						
Shasta daisy	Rhiz per.						
Sulphur cosmos	Ann.						
Gloriosa daisy	Per.						
Garland chrysanthemum	Ann.						

American Meadows Dry Area, July 22, 2013

American Meadows Dry Area, August 29, 2013

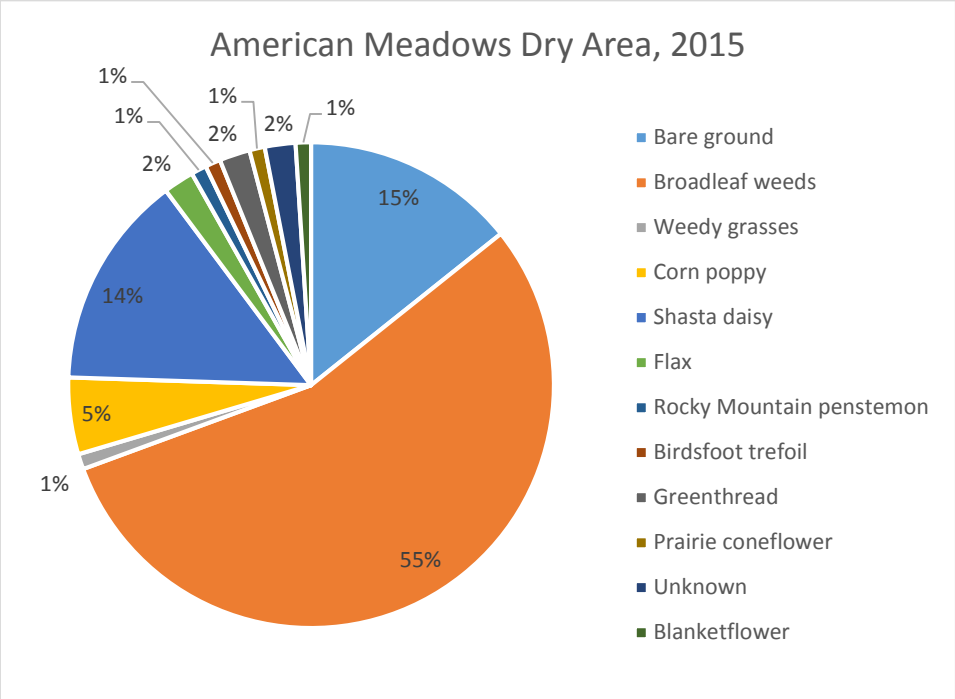
Sixteen species in the American Meadows Dry Area mix flowered in 2014. In all, 5 annuals, 2 biennials and 9 perennials flowered during the second season indicating a shift from annuals to longer lived species. Black-eyed Susan, blanket flower, prairie coneflower, yarrow and blue flax all had long flowering durations. Cornflower and California poppy, both introduced annuals, also provided significantly to the floral display. This mix again provided the greatest diversity of the evaluated mixes.

Table 3. American Meadows Dry Area Mix flowering color and duration 2014. Colored bars indicate flower color. Green indicates no flowers in bloom.

		29-May	16-Jun	23-Jun	9-Jul	18-Jul	28-Jul	12-Aug	26-Aug	17-Sep
California poppy	Ann.									
Corn poppy	Ann.									
Cornflower	Ann.									
Plains coreopsis	Ann.									
Black-eyed Susan	Per.									
Blanetflower	Per.									
Evening primrose	Bi.									
Prairie coneflower	Per.									
Siberian wallflower	Ann.									
Shasta daisy	Rhiz per.									
Gloriosa daisy	Per.									
Yarrow	Per.									
Sweet William	Bi.									
Blue flax	Per.									
Bird'sfoot trefoil	Per.									
Rocky Mtn penstemon	Per.									

In 2015, plant cover frequency evaluations showed that over half of the American Meadows Dry Area plot was covered in broadleaf weeds, and another 15% of the cover was attributed to weedy grass species. Eight target species were recorded in the evaluation with the largest component of

target species coming from Shasta daisy followed by the introduced annual, corn poppy. All other target species made up 2% or less of the total cover each.



American Meadows Western Xeriscape

American Meadows Western Xeriscape mix contains 24 species, mostly native to the PMC service area with some plants being introduced from California. This mix is the closest to what might be recommended for pollinator plantings by the PMC. It contains 12 annuals 10 perennials and 2 biennials.

Nine species in the Xeriscape mix flowered during the first growing season (Table 4). This mixture contained a large percentage of tidytips and California poppy and provided a very yellow dominant appearance. Blanket flower was also present in good numbers. All flowering in the first season was done by annuals and the perennial blanket flower. Tidytips and blanket flower appeared highly attractive to small native bees. California bluebell, greenthread, arroyo lupine and blazingstar were present, but not in large numbers; most were represented by one or two plants.

Table 4. American meadows Western Xeriscape Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
California poppy	Ann.						
Tidytips	Ann.						
Blanket flower	Per.						
Bird's eye	Ann.						
California bluebell	Ann.						
Greenthread	Ann.						
Arroyo lupine	Ann.						
Prairie aster	Bi.						
Blazingstar	Ann.						

American Meadows Western Xeriscape, July 22, 2013

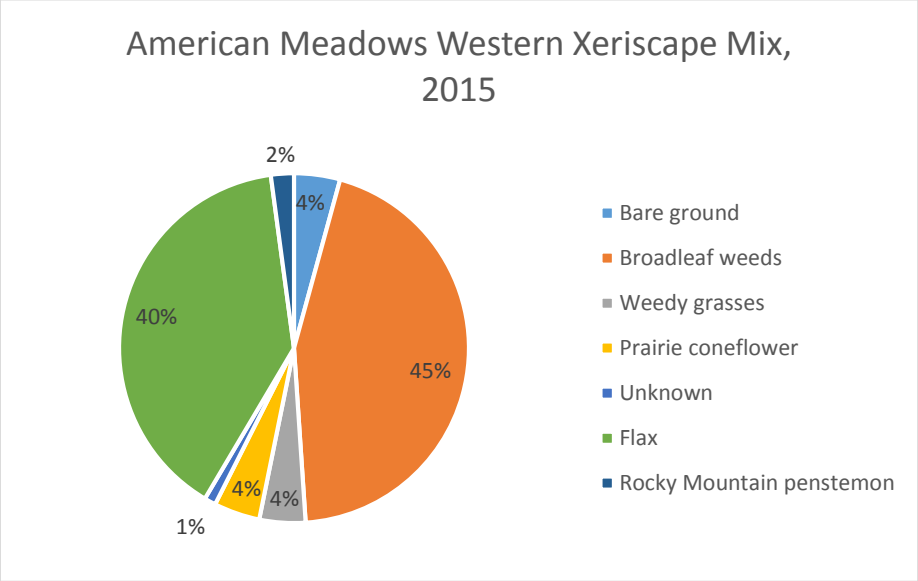
American Meadows Western Xeriscape, August 29, 2013

American Meadows Western Xeriscape mix had somewhat less floral diversity than the Dry Area mix in 2014. Ten species flowered in 2014 including 5 annuals, one biennial and 4 perennials. Two annual California natives, tidytips and California poppy, showed well. Green thread, which is native to the east slope of the Rocky Mountains and into the Plains States, also provided a strong floral display. Blue flax, blanket flower and Rocky Mountain penstemon are native to the region. Prairie aster added to the late season color in August and September.

Table 5. American Meadows Western Xeriscape Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		29-May	16-Jun	23-Jun	9-Jul	18-Jul	28-Jul	12-Aug	26-Aug	17-Sep
California poppy	Ann.									
Tidytips	Ann									
Blanket flower	Per.									
Bird's eye	Ann									
Greenthread	Ann									
Prairie aster	Bi.									
Deerhorn clarkia	Ann									
Blue flax	Per.									
Rocky Mtn pen	Per.									
Prairie coneflower	Per.									

The American Meadows Western Xeriscape Mix plot contained a very high proportion of perennial flax in 2015 (40% cover), which was by far the greatest percentage of any of the target species. Broadleaf weeds composed the majority of the cover with 45%. Few other target species were present; prairie coneflower and Rocky Mountain penstemon were recorded at 4% and 2% respectively.

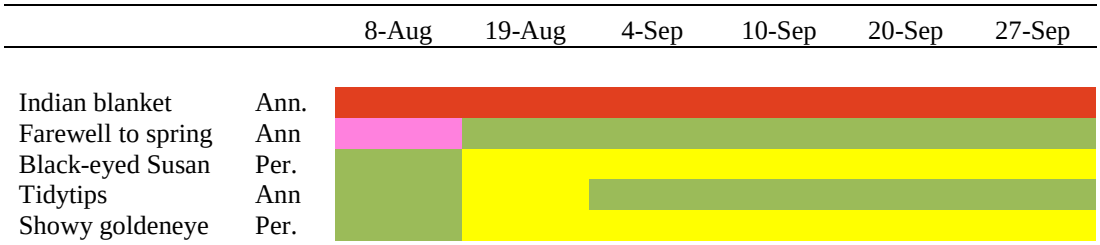


American Meadows Native West

American Meadows Native West mix is composed of 19 species, 7 annuals, 1 biennial and 11 perennials all native to North America (Table 6). However it does contain many species that would not be considered native to the Intermountain or Rocky Mountain Region. Some come from eastern US, coastal western US or from the Southwest, all areas that are very dissimilar from conditions found in our region.

The lack of introduced annuals in the mixture significantly reduced the number of species flowering during the first growing season. Only five species blossomed in 2013, 3 annuals and 2 perennials. The All Native mix was highly red color dominant in 2013 due to the large numbers of Indian blanket. Other prominent species in the floral composition were black-eyed Susan and showy goldeneye.

Table 6. American Meadows Native West Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

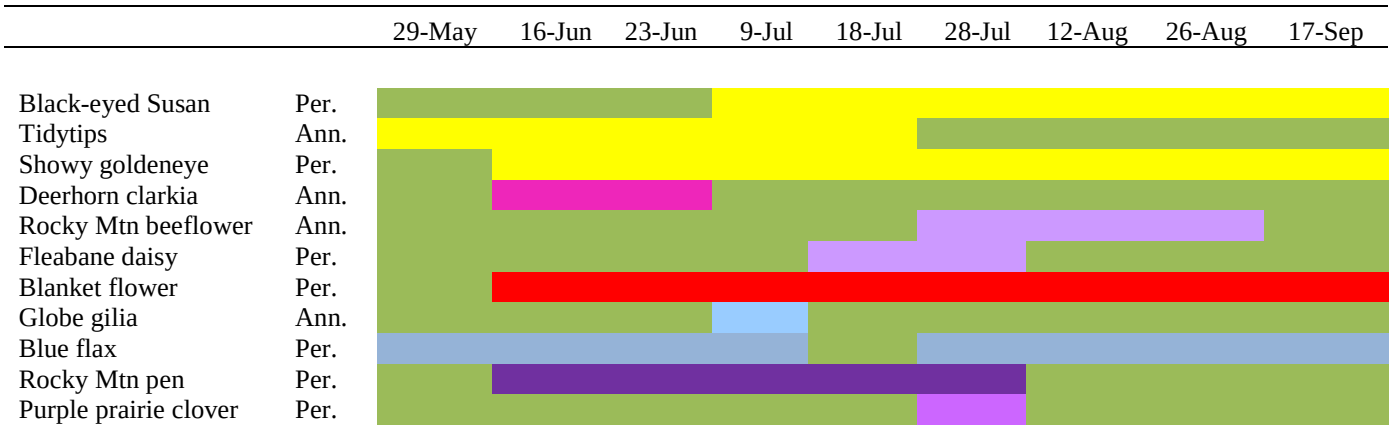


American Meadows Native West, July 22, 2013

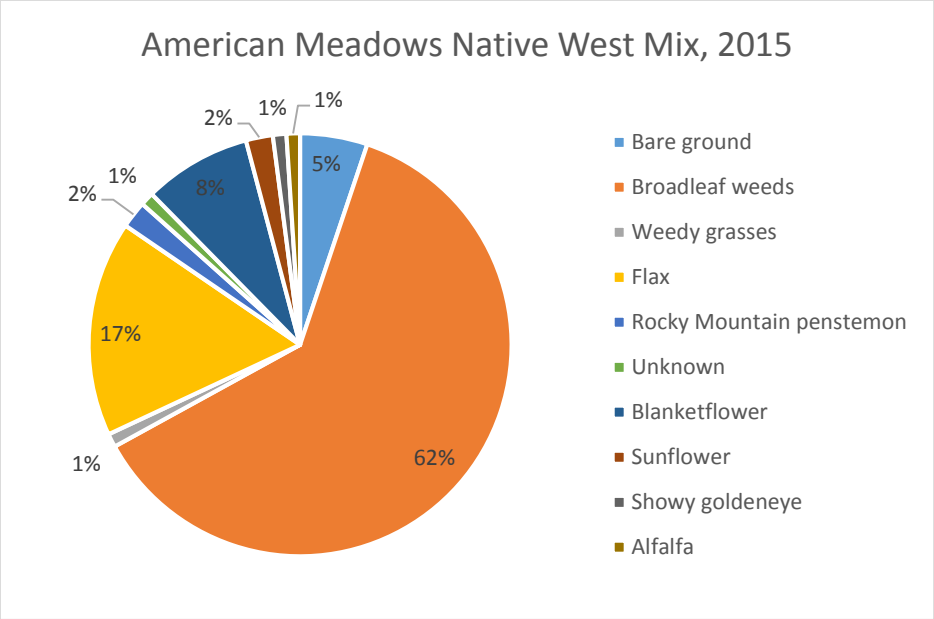
American Meadows Native West, August 29, 2013

The American Meadows Native West mix improved in floral diversity in 2014 adding flowers from several perennial species (Table 7). Eleven species flowered in 2014, 4 annuals and 7 perennials. Black-eyed Susan, showy goldeneye, blanket flower, blue flax and Rocky Mountain Penstemon all did well and flowered through most of the season. Tidytips had sustained blooming for most of the mid-summer. The slow development of the perennials in the establishment year allowed weedy annual species like prickly lettuce to proliferate.

Table 7. American Meadows Native West Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.



The American Meadows Native West Mix had the largest proportion of weeds of any of the evaluated mixes with broadleaf weeds comprising 62% of the total cover in 2015. Perennial flax provided the majority of cover from the target species with 17% followed by blanket flower with 8% cover. Other species like Rocky Mountain penstemon, sunflower, and showy goldeneye were present in small percentages.



Outside Pride Western Wildflower

Outside Pride Western Wildflower Mix consists of 17 native and introduced species with 9 annuals and 8 perennials (Table 8). Of these, 11 flowered in the first growing season, 8 of which were annuals. California poppy, plains coreopsis, corn poppy and cornflower were frequently visited by European honeybees. Indian blanket and showy goldeneye, both native species, were also visited by native pollinators.

Table 8. Outside Pride Western Wildflower Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

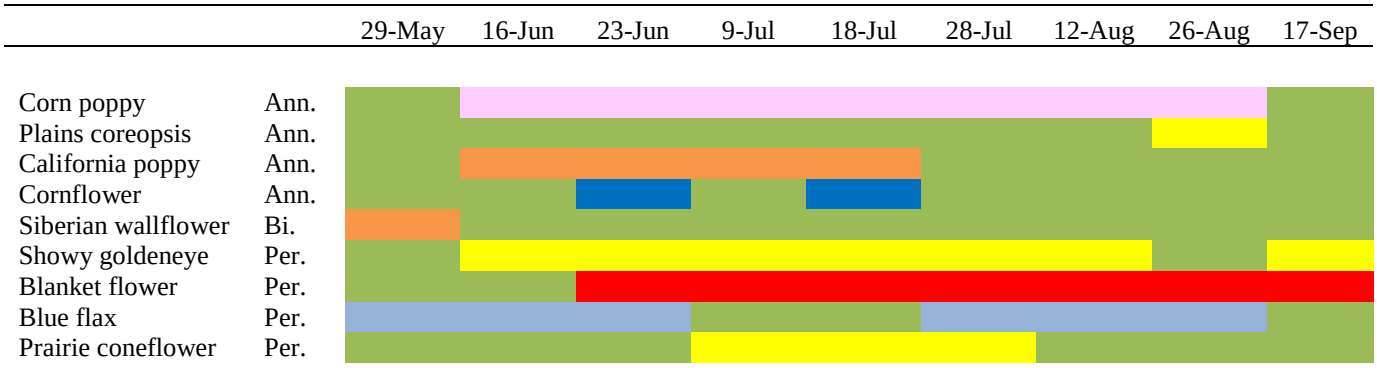
		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
Corn poppy	Ann.						
Plains coreopsis	Ann.						
California poppy	Ann.						
Sweet alyssum	Ann.						
Farewell to spring	Ann.						
Cornflower	Ann.						
Indian blanket	Ann.						
Candytuft	Ann.						
Siberian wallflower	Bi.						
Showy goldeneye	Per.						
Black-eyed Susan	Per.						

Outside Pride Western Wildflower, July 22, 2013

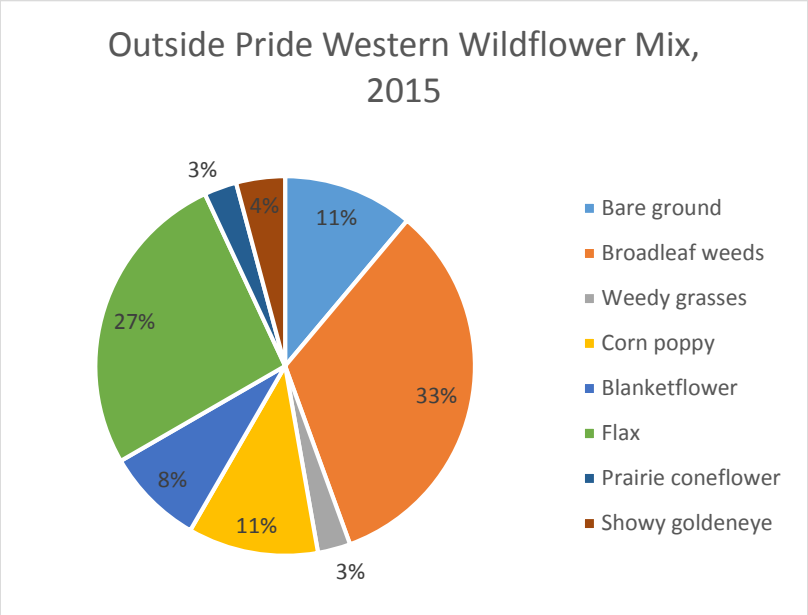
Outside Pride Western Wildflower, August 29, 2013

Outside Pride's Western Wildflower mix contains a mixture of native and introduced species. Introduced annuals like corn poppy and California poppy were abundant in 2014. Native perennials showy goldeneye, blanket flower and blue flax flowered through most of the season. In total 4 annuals, 1 biennial, and 4 perennials flowered in 2014.

Table 9. Outside Pride Western Wildflower Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.



In 2015, the Outside Pride Mix had 5 target species appearing in somewhat balanced proportions. Perennial flax made up 27% of the cover, followed by corn poppy (11%), blanket flower (8%), showy goldeneye (4%), and prairie coneflower (3%). Broadleaf weeds created 33% of the total cover; while grass weeds and bare ground accounted for 3% and 11% respectively.



Applewood Western Mix

Applewood Seed's Western Mix consists of 20 species, 11 annuals 8 perennials and 1 biennial (Table 10). This mixture has a similar composition to the Outside Pride Western Wildflower mix and contains primarily introduced species. Eight species flowered the first season. Showy goldeneye was the only perennial to flower in 2013.

Table 10. Applewood Western Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

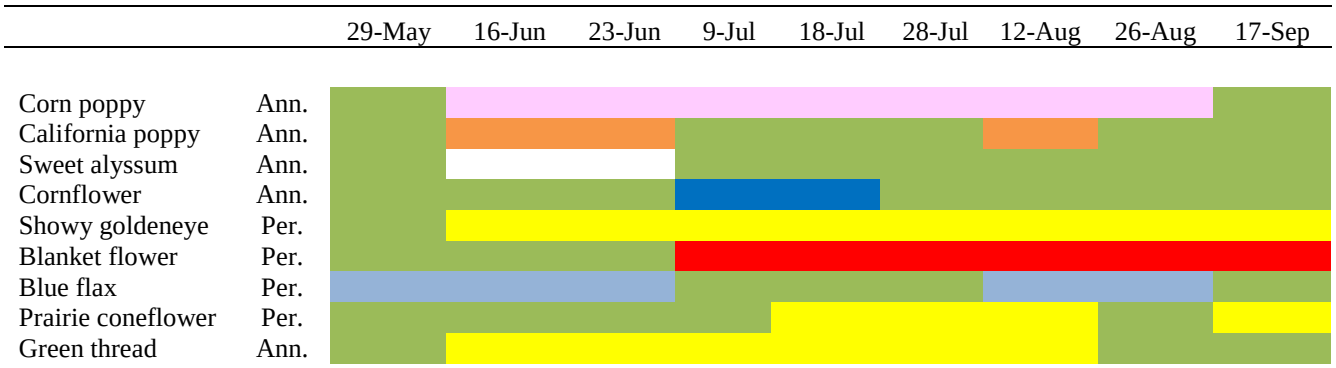
		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
Corn poppy	Ann.						
Plains coreopsis	Ann.						
California poppy	Ann.						
Sweet alyssum	Ann.						
Farewell to spring	Ann.						
Cornflower	Ann.						
Indian blanket	Ann.						
Showy goldeneye	Per.						

Applewood Western Mix, July 22, 2013

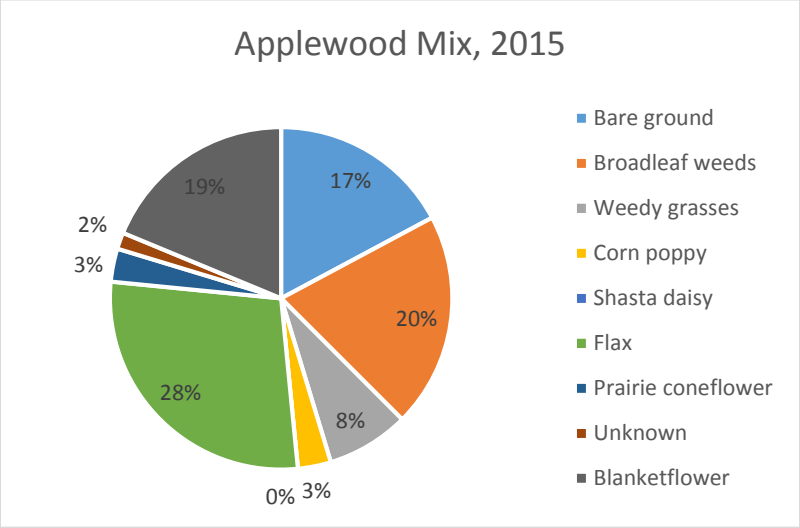
Applewood Western Mix, August 29, 2013

Similar to other mixes, the Applewood Western mix had an assortment of perennial natives and introduced annuals. Nine total species flowered in 2014 including 5 annuals and 4 perennials. Blanket flower, showy goldeneye, blue flax, and prairie coneflower flowered consistently in 2014. Corn poppy, California poppy, corn flower and green thread were annuals that returned for the second season from dropped seed.

Table 11. Applewood Western Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.



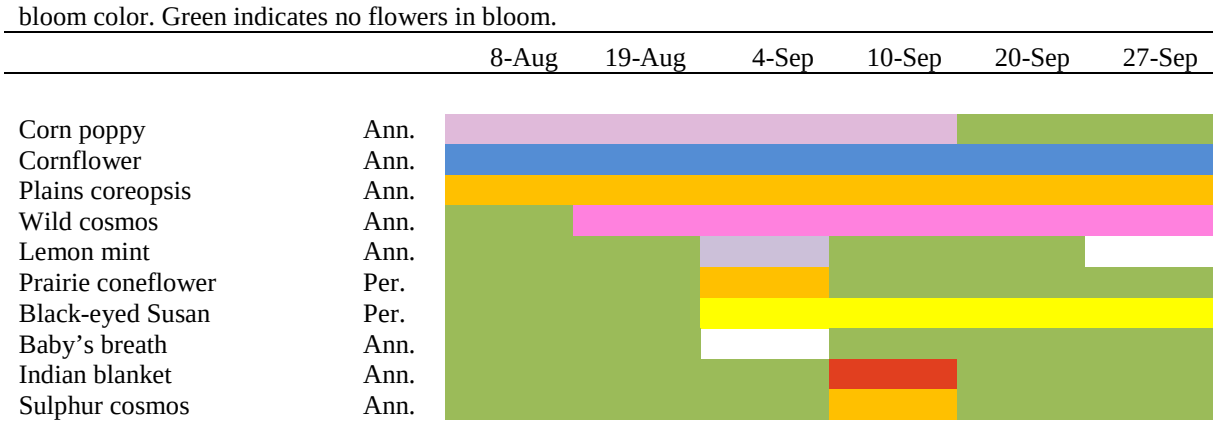
In 2015 the Applewood Mix showed a considerable amount of bare ground which made up 17% of the total cover. Broadleaf weeds created less of the cover than in other mixes at 20%, but weedy grasses were present at higher rates composing 8% of the total cover. Perennial flax and blanket flower made up the majority of the target species cover with 28% and 19% cover respectively. Other target species had lower presence. Corn poppy, Shasta daisy, and prairie coneflower all had percent cover below 5%.



Eden Brothers Western Wildflower Mix

The Western Wildflower Mix from Eden Brothers contains 24 species, 12 annuals, 1 biennial and 11 perennials (Table 12). Flowering during the first season was similar to other mixes containing corn poppy, cornflower, plains coreopsis and wild cosmos. Surprisingly, we did not observe any flowering from California poppy during the 2013 season in the Eden Brothers mix.

Table 12. Eden Brothers Western Wildflower Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.



Eden Brothers Western Wildflower Mix, July 22, 2013

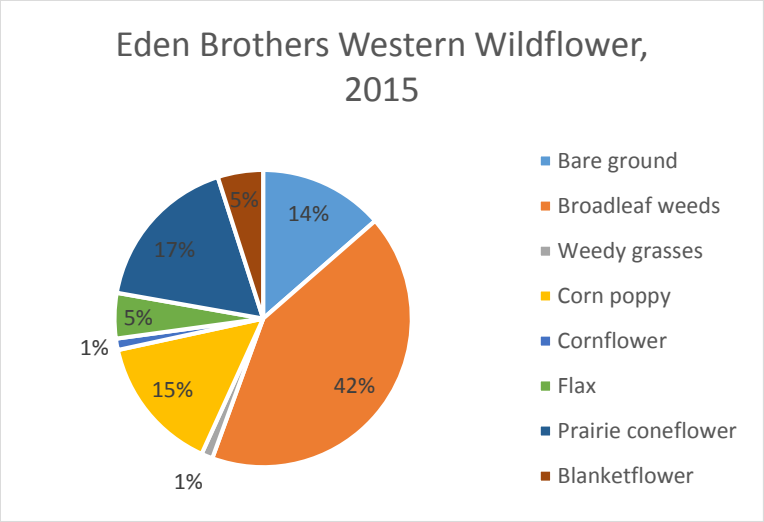
Eden Brothers Western Wildflower Mix, August 29, 2013

Ten species in total flowered during 2014 in the Eden Brothers Western Wildflower mix. Four annuals and 6 perennials were represented. The successful species were similar to those of other mixes.

Table 13. Eden Brothers Western Wildflower Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		29-May	16-Jun	23-Jun	9-Jul	18-Jul	28-Jul	12-Aug	26-Aug	17-Sep
Corn poppy	Ann.									
Cornflower	Ann.									
California poppy	Ann.									
Plains coreopsis	Ann.									
Prairie coneflower	Per.									
Black-eyed Susan	Per.									
Blanket flower	Per.									
Blue flax	Per.									
Rocky Mtn penstemon	Per.									
Gloriosa daisy	Per.									

Broadleaf weeds created 42% of the cover in the Eden Brothers Mix. Introduced species, cornflower and corn poppy both ranked high among the target species with 17% and 15% cover respectively. Perennial flax and blanket flower made up 5% each of the cover, followed by prairie coneflower at 1%.



CONCLUSIONS

Weedy annual species were common throughout the plots for all years. Annual grasses can be significantly reduced by using grass selective herbicides; however we were not able to remove them entirely with a single treatment of sethoxydim. Broadleaf weeds are extremely difficult to control in wildflower plantings, as herbicides used to treat broadleaf weeds will also affect many of the target species in the seed mixtures. Lambs quarters and shepherd's purse were common annual weeds in the plots during 2013, but these decreased significantly in density in 2014 as the target species had become more competitive. Prickly lettuce however increased in density in 2014 and 2015, especially in those mixes that contained few competitive annual wildflower species.

Of the total 62 species included in the trial, 30 flowered in the first growing season. The vast majority (22 of 30) were annuals, the remainder being 2 biennials and 6 perennials. Flowering was not observed until early August, approximately 11 weeks after planting. Most species had long sustained flowers due to supplemental irrigation and late summer rains. The first frost of the season came on September 19, and all plants had ceased flowering by October 17.

The inclusion of annuals is a good way to get blooms during the first growing season. It is especially important to include annuals in post-fire rehabilitation seed mixtures to provide food for native pollinators that have relatively short foraging ranges and might not be able to reach undisturbed plant communities (Cane 2008).

Insect visitation varied between plots due to species composition and density. Overall, corn poppy, California poppy, cornflower, plains coreopsis, and wild cosmos were very attractive to European honeybees. Tidytips and blanket flower were heavily visited by native bees. Hunt's bumblebee was observed frequently visiting wild cosmos. Butterflies were observed on Indian blanket and blanket flower. All of the flowering species were observed being visited at least once by pollinators.

Eleven of the 62 species planted are cited in the literature as having weedy tendencies (USDA NRCS 2013). Of these, Cornflower, soapwort and Rocky Mountain bee flower are listed as being weedy in western states (Whitson et al 1996). The others are primarily western species that express weedy behavior in the Midwest and eastern US. Rocky Mountain bee flower is native to the PMC service area where it can invade and spread into ditch banks and along roadsides where moisture accumulates. Cornflower and California poppy are a concern. These species are known to escape from "wildflower" seedings and spread.

In addition to inappropriate target species, wildflower mixes can also contain accidental inclusions of noxious weed seed. Seed used for commerce is not to have any prohibited noxious weeds listed in the state the seed is shipped to or used. However, restricted noxious weed seeds may be included as state seed law allows. The best way to know if noxious weed seed is in a mix is with an accurate purity test and seed tag.

A small number of plants evaluated in the trial have known or suspected toxic properties. Three species, yarrow, desert marigold, and soapwort have been shown to cause disease in sheep when consumed in large volumes (Burrows and Tyrl 2001). Yarrow and desert marigold are native and are commonly present in rangelands used for sheep grazing; however these species should be avoided or used with caution in areas where they might pose a risk to livestock.

In order to prevent the establishment and spread of noxious weeds and other invasive plant species, one must be careful about what seeds are planted. The best way to do this is to use a custom seed mix. If a commercial wildflower mix is used, the mix selected should be appropriate to the region; native species are recommended when possible. Mixes including known invasive or aggressive species such as cornflower should be avoided. Seed mixes should be tested for purity and come with an accurate seed tag. Mixtures should also be clearly labeled with scientific names included, as confusion and uncertainty can arise from the use of common names. Following these steps will help ensure that only appropriate species are planted.

During the second season of our trial, perennial species made up the majority of the floral display. Black-eyed Susan, blanket flower, prairie coneflower, yarrow, blue flax, Rocky Mountain penstemon, and showy goldeneye had numerous flowers and lasted for much of the second season. Flowering began in late May and ended with freezing temperatures in mid-September. Other perennials such as fleabane daisy, and prairie aster had blossom periods limited to late summer. Twelve annual species, California poppy, corn poppy, corn flower, plains coreopsis, Siberian wallflower, tidytips, bird'seye, Green thread, deerhorn clarkia, Rocky Mountain bee flower, globe gilia, and sweet alyssum also returned in 2014. Several species in the various mixes showed no flowering in the first or second year of the trial.

In 2014 and 2015 there was evidence of volunteering of plants into adjacent plots and should be taken into account. Tidytips and corn poppy had spread as much as 30 feet from their original location the previous year. Movement of species that were included in two adjacent plots was impossible to distinguish, but is considered likely. Wind dispersal and seed shatter from spring mowing are the likely mechanisms for transfer.

Species frequencies have shifted from large amounts of annuals in the establishment year to predominantly perennials in year three. Weed cover in all mixes is high (30 to over 50%), with the most abundant weed being prickly lettuce. Broadleaf weeds are very difficult to control in pollinator mixes, and may need to be accepted as cost of doing business. Pollinator plantings may serve as weed seed sources that could contaminate nearby cropland and fields. However despite heavy weed pressure, the pollinator plantings appear to be functional at supporting diverse insects. Most mixes have narrowed down to a few species. Some of the more dominant species include perennial flax, blanket flower, corn poppy and prairie coneflower.

Use in NRCS Programs

Approximately two-thirds of the original species (39 of 62) flowered in 2013 or 2014 indicating at least moderate adaptation to 14 to 18 inch precipitation sites in southeastern Idaho. Those that did not flower add to the cost of the seed mix and may be being used at the exclusion of more appropriate species. Careful selection of adapted species can reduce the cost of seed mixes as maladapted species are avoided.

The NRCS funds or cost-shares approved pollinator plantings which meet agency specifications. These specifications include seed mixture composition percentages and the rate at which the seed is planted (lb/ac or seeds/ft). To accurately calculate seeding rates, one needs to know: % of each species in the mix by weight, purity of each species, germination or viability of each species and the average number of seeds/lb for each species (Tilley and St. John 2013). This information is commonly lacking in commercial seed mixtures. Of the six mixtures evaluated, only two included percentage information.

Using rough estimates for purity and viability we calculated approximate seeds/ft for the two mixtures where percentages of each species were available based on seeding 10 lbs bulk seed per acre. Based on our calculations, Applewood Seed Western Mix was seeded at approximately 128 seeds/ft and Outside Pride Western Wildflower Mix had approximately 93 seeds/ft. NRCS specifications stipulate a target seeding rate of 75 to 100 seeds/ft for broadcast seeding of small seeded species. These numbers suggest that the recommended rate of 10 lbs/ac closely aligns with NRCS broadcast seeding rates. Species component percentages must be available to determine whether or not seeding mixtures meet NRCS standards. Mixtures not providing percentages of species components should not be used for NRCS funded seedings.

LITERATURE CITED

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Appendix. Mix and species information

Common Name	Scientific Name	Origin	Longevity	Eden Brothers Western Wildflower Mix	Applewood Seed Western Mix	Outside Pride Western Wildflower Mix	American Meadows Native West	American Meadows Dry Area Mix	American Meadows Western Xeriscape Mix
				$27/lb	$26/lb	$23/lb	$60/lb	$27/lb	$40/lb
					% of mix	% of mix			
Yarrow	*Achillea milliefolium*	N. Am.	Perennial					x	
Blue columbine	*Aquilegia coerulea*	IMW[1] and RMW[2]	Perennial	x			x		
Smooth aster	*Aster laevis*	Eastern US	Perennial				x		
Priarie aster	*Machaerranthera tanacetifolius*	Western US (not PNW[3])	biennial				x		x
Desert marigold	*Baileya multiradiata*	SW	Ann., bi, per.						x
Cornflower	*Centaurea cyanus*	N. Am.	annual	x	7.3	8.13		x	
Siberian wallflower	*Cheiranthus allionii*	Eurasia	Biennial	x		12.19		x	
Garland chrysanthemum	*Chrysanthemum coronarium*	Mediterranean	Annual					x	
Shasta daisy	*Chrysanthemum maximum*	Europe	Rhiz-perr.					x	
Deerhorn clarkia	*Clarkia pulchella*	PNW	Annual		0.92		x		x
Farewell to spring	*Clarkia unguiculata*	California	Annual		1.83	1.34			
Rocky Mountain bee flower	*Cleome serrulata*	N. Am (not SE)	Annual				x		
Lanceleaf coreopsis	*Coreopsis lanceolata*	N. Am (not IMW)	Perennial	x					
Plains coreopsis	*Coreopsis tinctoria*	N. Am (not IMW)	ann, bi, per	x	0.73	1.02	x	x	
Wild cosmos	*Cosmos bipinnatus*	Central Am.	Annual	x				x	
Sulphur cosmos	*Cosmos sulphureus*	Central am.	Annual	x				x	
Purple prairie clover	*Dalea purpurea*	Midwestern US	Perennial				x		
Sweet william	*Dianthus barbatus*	Eurasia	Biennial					x	
African daisy	*Dimorphotheca sinuata*	Africa	Annual					x	
Purple coneflower	*Echinacea purpurea*	Eastern US	Perennial	x					
Fleabane daisy	*Erigeron speciosus*	Western US	Perennial				x		
Common woolly sunflower	*Eriophyllum lanatum*	Western US	Perennial						x
California poppy	*Eschscholzia californica*	California	Annual	x	11	12.19		x	x

Appendix (cont.)

Common Name	Scientific Name	Origin	Longevity	Eden Brothers Western Wildflower Mix	Applewood Seed Western Mix % of mix	Outside Pride Western Wildflower Mix % of mix	American Meadows Native West	American Meadows Dry Area Mix	American Meadows Western Xeriscape Mix
Blanket flower	*Gaillardia aristata*	Western US	Perennial	x	12.83	8.13	x	x	x
Indian blanket	*Gaillardia pulchella*	Eastern US	Annual		3.67	4.06	x	x	
Globe gilia	*Gilia capitata*	Western US	Annual		1.83	1.34	x		
Bird's eye	*Gilia tricolor*	California	Annual						x
Baby's breath	*Gypsophila elegans*	Eurasia	Annual	x				x	
Showy goldeneye	*Heliomeris multiflora*	Western US (not PNW)	Perennial		1.21	0.81	x		
Candy tuft	*Iberis umbellata*	Mediterranean	Annual		11	16.25			
Tidytips	*Layia platyglossa*	CA, AZ, UT	Annual						x
Baby snapdragon	*Linaria maroccana*	Morocco	Annual					x	
Scarlet flax	*Linum grandiflorum*	Algeria	Annual	x					
Blue flax	*Linum perenne*	Europe	Perennial	x	7.33	12.19	x	x	x
Sweet alyssum	*Lobularia maritima*	Mediterranean	Annual					x	
Birdsfoot trefoil	*Lotus corniculatus*	Eurasia	Perennial					x	
Perennial lupine	*Lupinus perennis*	Eastern US	Perennial	x	14.65	16.25			
Russel lupine	*Lupinus polyphyllus*	Western US	Perennial	x					
Arroyo lupine	*Lupinus succulentus*	California	Annual						x
Blazingstar	*Mentzelia lindleyi*	California	Annual						x
Lemon mint	*Monarda citriodora*	Southern US	Annual	x					
Five spot	*Nemophila maculata*	California	Annual	x					x
Baby blue-eyes	*Nemophila menziesii*	California	Annual						x
White evening primrose	*Oenothera caespitosa*	Western US	Perennial				x		
Evening primrose	*Oenothera lamarckiana*	Europe	biennial					x	
Dwarf eve primrose	*Oenothera missouriensis*	Southern US	Perennial		1.83				
Pale eve primrose	*Oenothera pallida*	Western US	biennial		1.83				x

Appendix (cont.)

Common Name	Scientific Name	Origin	Longevity	Eden Brothers Western Wildflower Mix	Applewood Seed Western Mix % of mix	Outside Pride Western Wildflower Mix % of mix	American Meadows Native West	American Meadows Dry Area Mix	American Meadows Western Xeriscape Mix
Corn poppy	*Papaver rhoeas*	Europe	Annual	x	7.33	2.03		x	
Palmer penstemon	*Penstemon palmeri*	SW	Perennial		1.83				x
Rocky Mountain penstemon	*Penstemon strictus*	Rocky Mtns	Perennial	x	3.67	2.03	x	x	x
California bluebell	*Phacelia campanularia*	California	Annual						x
Drummond phlox	*Phlox drummondii*	Eastern US	Annual	x					
Prairie coneflower	*Ratibida columnaris*	Midwestern US	Perennial	x	1.84	2.03	x	x	x
Gloriosa daisy	*Rudbeckia gloriosa*	Eastern US	Perennial	x				x	
Black-eyed susan	*Rudbeckia hirta*	N. am (not SW)	ann, bi, per	x			x	x	
Soapwort	*Saponaria officinalis*	Eurasia	Perennial						x
Ccatchfly	*Silene armeria*	Europe	Annual					x	
Gooseberryleaf globemallow	*Sphaeralcea grossulariifolia*	Western US	Perennial						x
Greenthread	*Thelesperma filifolium*	Midwestern US	Annual		7.33				x
Creeping thyme	*Thymus praecox*	Eurasia	Perennial						x
Strawberry clover	*Trifolium fragiferum*	Eurasia	Perennial						x
Johnny jump-up	*Viola tricolor*	Eurasia	Annual						x

[1] Intermountain West
[2] Rocky Mountain West
[3] Pacific Northwest

United States Department of Agriculture

2014 STUDY REPORT
Aberdeen Plant Materials Center, Aberdeen, ID

2014 COVER CROP DEMONSTRATION

Derek Tilley, PMC Manager

INTRODUCTION

The use of cover crops to build soil health is gaining traction in the U.S.; however many of the species used in cover cropping are not familiar to Idaho farmers or NRCS field office personnel. Likewise, many cover crop species are poorly understood in Idaho as to their adaptation, growth habit, and production value. Display plantings of commonly used cover crop varieties are a useful tool in educating conservation-minded individuals on the many available species and how they might fit into their farming rotation.

The purpose of the display is to allow the public and NRCS staff to view a wide variety of species with potential for cover cropping practices and to gather biomass production data to help determine species applicability.

MATERIALS AND METHODS

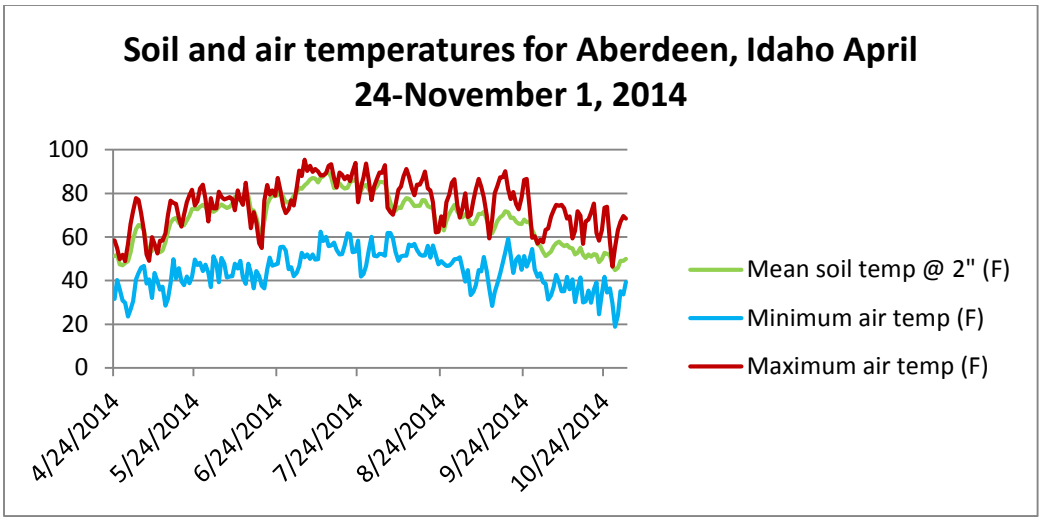
The display included 35 accessions divided into 6 functional plant groups: cool season grasses, cool season broadleaf plants with weak taproots, cool season broadleaf plants with a large taproot, legumes, warm season broadleaf plants, and warm season grasses (see Appendix). Because cover crops can be planted at different times of year depending on crop rotation, the cover crop display was planted on April 24 and again on August 19, 2014. The April planting was scheduled to simulate a full-season cover crop/fallow period while the August planting was scheduled to follow a typical grain harvest in southeast Idaho.

Soil on the farm is a Declo silt loam. The plots were watered regularly throughout the season. No fertilizer was applied to the demonstration. A cover crop cocktail mixture consisting of barley, spring pea, lentil, turnip, radish, hairy vetch, rape, oat and red clover was planted in the areas immediately surrounding the demonstration plots. Seeding rates are shown in the appendix.

The majority of the spring planted display was evaluated on July 5 (72 days after planting). Some species however (arugula, buckwheat, mustard and radish) flowered earlier than the rest of the display, and these were evaluated on June 20 (57 days after planting) prior to chemical termination to prevent seed set. The summer planting was evaluated on October 6 (48 days after planting). For each evaluation three, 0.25 m^2 samples were taken from each plot. The samples were air dried and weights averaged and extrapolated to lbs/ac.

Soil temperatures at the time of the spring planting were just reaching 50° F with air temperatures dropping below freezing for six days in late April and early May. High temperatures reached the low 90's during July and August. The first fall frost occurred on October 3.

Authors name, title, address, contact information



RESULTS AND DISCUSSION

Small grains were the dominant biomass producers in the spring planting with barley, oat, ryegrass and winter wheat all scoring in the top ten. Spring barley produced the most biomass in the spring planting with over 4 tons of dried material. Several mustard species (rape, mustard, radish and turnip) also had high biomass production ranging from 3360 to 6720 lbs/ac. Many legumes had intermediate production with the exception of spring pea which produced 4600 lbs. Warm season broadleaf plants and grasses all fared poorly in the spring planting with several not establishing in large enough quantities to warrant evaluation.

Biomass totals were significantly reduced in the summer planting for most accessions due to the shorter growing period. Small grains and mustards again topped the list. A few warm season species had better establishment from the summer planting. Sunflower, chicory and pearl millet benefitted from warmer soil temperatures and longer days.

Table 1. Aboveground biomass of all species listed highest to lowest production lbs/ac.

	Spring		Summer
Spring barley	8550	Hunter hybrid turnip	2960
Rape	6720	Spring barley	2400
Winter oat	5940	Winter oat	2300
Ryegrass	5730	Radish (Daikon)	2080
Mustard	5090	Ryegrass	1810
Spring pea	4600	Purple top turnip	1600
Cocktail mix	4230	Sunflower	1560
Triticale	3980	Winter wheat	1450
Winter wheat	3840	Mustard	1430
Lentil	3460	Cocktail mix	1410
Radish (Daikon)	3370	Collards	1380
Purple top turnip	3360	Arugula	1380
Collards	3170	Triticale	1370
Phacelia	2860	Lentil	1170
Hunter hybrid turnip	2750	Austrian winter pea	1110
Wildflower mix	2700	Safflower	980
Chickling vetch	2670	Wildflower mix	850
Hairy vetch	2570	Rape	850
Common vetch	2150	Spring pea	810
Austrian winter pea	2070	Phacelia	690
Safflower	1700	Common vetch	670
Arugula	1640	Hairy vetch	600
Beet	1350	Beet	530
Flax	1290	Red clover	520
Proso millet	1110	Chickling vetch	500
Chickpea	960	Proso millet	490
Red clover	930	Chicory	440
Buckwheat	850	Chickpea	400
Crimson clover	590	Pearl millet	320
Sorghun/Sudangrass	590	Sorghum/sudangrass	300
Sunflower	510	Crimson clover	290
Chicory	390	Flax	120
Cowpea	0	Buckwheat	0
Field corn	0	Cowpea	0
Grazing corn	0	Field corn	0
Pearl millet	0	Grazing corn	0

Spring barley had the greatest biomass production of all the cool season grasses for both the spring and summer planting with 8500 and 2400 lbs respectively. The winter grains (oat, wheat and triticale) had excellent biomass production. Most of the growth from the winter grains was low-lying and would be effective at reducing erosion but would not be optimal for grazing.

Table 2. Aboveground biomass of cool season grasses listed high to low from spring planting.

	Spring	Summer
Barley	8550	2400
Winter oat	5940	2300
Ryegrass	5730	1800
Triticale	3980	1370
Wheat	3840	1450

Of the broadleaf plants with weak taproots, rape and mustard showed excellent biomass production from the spring planting. Rape however did not produce well from the summer planting yielding only 850 lbs biomass/acre. Phacelia, a wildflower planted to attract pollinators, also showed good growth from the spring planting and was in full flower at the time of evaluation. The summer planting of phacelia did not flower. Flax biomass production was limited producing less than 1300 lbs/acre from the spring planting and only 120 lbs/acre from the summer planting.

Table 3. Aboveground biomass of weak rooted broadleaf plants listed high to low from spring planting.

	Spring	Summer
Rape	6720	850
Mustard	5090	1430
Phacelia	2860	690
Arugula	1640	1380
Flax	1290	120

The strong taprooted broadleaf plants (all in the mustard family with the exception of beets) had moderate aboveground biomass production. It should be noted that the taproot of purple top turnip sits largely above ground, but was not included in the biomass evaluation. Hunter hybrid turnip generally produces more leaf matter than standard turnip as shown in the summer evaluation. Beets had poor production compared to the other species in the category.

Table 4. Aboveground biomass of broadleaf plants with strong taproots listed high to low from spring planting.

	Spring	Summer
Turnip (purple top)	3360	1600
Radish (Daikon)	3370	2080
Collards	3170	1380
Hunter hybrid turnip	2750	2960
Beet	1350	530

Many legumes responded favorably to a spring planting with several species producing between one and two tons per acre. Spring pea had the highest production from the spring planting with 4600 lbs/acre. Lentil and Austrian winter pea were the top performers from the summer planting, both with over 1000 lbs/acre. Cowpea, a warm season legume, established in limited numbers in spring and summer and was not harvested for evaluation.

Table 5. Aboveground biomass of legumes listed high to low from spring planting.

	Spring	Summer
Spring pea	4600	810
Lentil	3460	1170
Chickling vetch	2670	500
Hairy vetch	2570	600
Common vetch	2150	670
Austrian winter pea	2070	1110
Chickpea	960	400
Red clover	930	520
Crimson clover	590	290
Cowpea	0	0

Although the wildflower mix was included in the warm season broadleaf category, the precise species included in the planted mix were not provided. Cornflower (*Centaurea cyanus*) was the most abundant species observed and accounted for more than 90% of the harvested biomass. Of the remaining warm season broadleaf species, safflower had significantly greater production than all others from the spring planting. Safflower is grown in southeast Idaho in dryland wheat rotations and is proven to be adapted to our region. Annual sunflower did not establish well from the spring planting, but the summer seeding produced over 1500 lbs of biomass per acre. The summer planting did not, however, have enough growing time to produce flowers.

Table 6. Aboveground biomass of warm season broadleaf plants listed high to low from spring planting.

	Spring	Summer
Wildflower mix	2700	850
Safflower	1700	980
Buckwheat	850	0
Sunflower	510	1560
Chicory	390	440

Warm season grasses struggled to establish and produce significant biomass. Proso millet produced 1100 lbs/ac from the spring planting and nearly 500 lbs/ac from the summer planting. Sorghum/sudangrass had 590 and 300 lbs/ac in the spring and summer planting respectively, while pearl millet produced 320 lbs from the summer planting, but failed to establish in the spring. Field and grazing corn establishment was spotty and did not produce enough plants to evaluate.

Table 7. Aboveground biomass of warm season grasses listed high to low from spring planting.

	Spring	Summer
Proso millet	1110	490
Sorghum/Sudangrass	590	300
Pearl millet	0	320
Field corn	0	0
Grazing corn	0	0

CONCLUSION

Temperatures at the time of the spring seeding likely affected the germination of the warm season species resulting in low establishment rates and minimal biomass production with the exception of proso millet. Summer planting of warm season species had noticeably better establishment; however the short season (48 days) and relatively low temperatures failed to produce high yields.

The multi-species cocktail mix (rates shown in Table 8) produced 4200 lbs of biomass per acre from the spring planting and 1400 lbs/ac from the summer planting. While not as productive as solid stands of grains or mustards, the cocktail mix adds above and below-ground diversity to promote soil health and reduce erosion.

Table 8. Cocktail mix seeding rates.

	Lb/ac
Barley	10
Spring pea	15
Lentil	5
Turnip	1
Radish	2
Hairy vetch	3
Rape	1
Oat	5
Red clover	1
Total	43

In our display, the cool season broadleaf species were separated into groups based on root size; however it also valuable to understand the familial relationship between species. Plants in the mustard family (Brassicaceae) including mustard, rape, turnip, arugula and collards do not create mycorrhizal associations and thus do not support soil aggregation. The large taproot of some species however is valuable in breaking hard pan layers and creating water infiltration sites. Non-mustard broadleaf species such as flax or phacelia should not be dismissed. Although they often produce less biomass than mustards, they will form mycorrhizal associations, so they might be a good choice in addition to a large-taprooted mustard.

None of the plants in the wildflower mix flowered from either planting. Most commercially available wildflower mixes contain a large component of perennial species that would not be suitable for a single-season cover crop application. To effectively provide nectar or pollen to beneficial insects, wildflower mixes should contain primarily annual species known to emerge and flower quickly.

Seeding rates used in the design of this demonstration were recommendations pooled from multiple sources. Some may be too high and could be reduced. Doing so would lower costs and decrease within-row competition, potentially resulting in an increase in overall biomass production.

Appendix. Species plot map and seeding rate (lbs/ac).

Cool Season Grass		Cool Season BL		Cool Season BL (large taproot)		Legumes		Legumes		Warm Season BL		Warm Season Grass
Winter oat (75)		Arugula (3)		Turnip (10)		Spring pea (100)		Chickling vetch (50)		Buckwheat (50)		Sorghum/sudan grass (35)
Spring barley (75)		Flax (4)		Hunter forage turnip (10)		Common vetch (20)		Chickpea (95)		Safflower (20)		Pearl millet (25)
Winter wheat (60)		Rape/canola (15)		Collards (2)		Hairy vetch (25)		Lentil (80)		Chicory (3)		Proso millet (35)
Triticale (60)		Brown mustard (15)		Beet (4)		Crimson clover (20)		Austrian winter pea (70)		Sunflower (4)		Field corn (25)
Ryegrass (15)		Phacelia (10)		Daikon radish (12)		Red clover (10)		Cowpea (30)		Wildflower mix (10)		Grazing corn (25)

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OFF-CENTER STUDIES

CURLEW NATIONAL GRASSLAND OFF-CENTER EVALUATION: 2014 PROGRESS REPORT

Derek J. Tilley, PMC Manager

ABSTRACT

In 2010, 63 accessions of 35 species of native and introduced grasses, forbs and shrubs were planted in a replicated display nursery at the Curlew National Grassland in Oneida County, Idaho. Introduced bunchgrasses, such as Russian wildrye (*Psathrostachys juncea*), Siberian wheatgrass (*Agropyron fragile*), and crested wheatgrass (*A. cristatum*), exhibited superior establishment and persistence over native grass species. However, several native grasses including bottlebrush squirreltail (*Elymus elymoides*) had fair to good establishment. Native and introduced forbs had poor establishment and plant densities decreased over time. The locally collected Bonneville big sagebrush had the highest rated stand establishment and persistence of all evaluated shrub entries. Volunteer crested wheatgrass densities decreased with higher establishment rates of target species; however no difference in density of annual bromes could be detected regardless of target species density.

INTRODUCTION

In November of 2010, the Aberdeen Plant Materials Center (PMC) installed a multi-species planting at an off-center test site located on the USDA-Forest Service Curlew National Grassland located approximately 30 miles south of American Falls, Idaho in cooperation with the Caribou/Targhee National Forest. The trial contains 63 accessions of 35 species of native and introduced grasses, forbs and shrubs adapted for use in MLRA 13 Eastern Idaho Plateaus (13 to 18-inch plus precipitation areas (Table 1). The goal of this trial is to evaluate the adaptability of new conservation releases in mid-elevation big sagebrush/grass ecosystems and compare their establishment, production, and longevity against traditionally recommended released plant materials. The site will also serve as a display nursery for the Forest Service and other conservation practitioners to view plant species and releases in a natural setting.

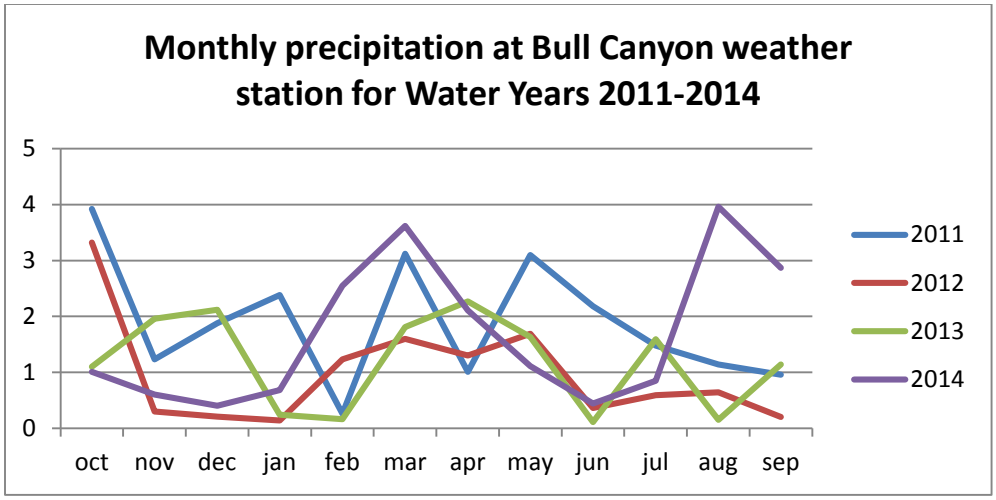
The Curlew test site historically supported a Bonneville big sagebrush/bluebunch wheatgrass plant community. For several decades, however, it has been dominated by crested wheatgrass and bulbous bluegrass. Climatic conditions are semi-arid with mean annual precipitation ranging from 12 to 25 inches The frost free period is approximately 90 days or less. The soil at the site is classified as a Samaria-Pollynot complex, 4 to 12 percent slopes, silt loam, well-drained and deep (> 80 inches to limiting layer). The elevation is 5,216 ft.

Weather

There are no weather stations located near the Curlew site or in nearby locations with similar elevation and conditions. The closest weather station is the Bull Canyon weather station located 11 miles north of the Curlew study site at an elevation of 6,418 ft. During water year 2011, Bull Canyon recorded 22.7 inches of precipitation. The Curlew study site, being lower in elevation,

probably received less precipitation than Bull Canyon, but the Curlew test site received normal to above normal precipitation for the year (University of Utah, 2012).

Precipitation was very low throughout the Intermountain West in 2012. The Bull Canyon weather station recorded below average precipitation with a cumulative total of 11.58 inches through September, 2012. Water year 2013 was somewhat better for precipitation in the region with a cumulative total of 14.3 inches through September 4, 2013 at the Bull Canyon station. During 2014 the Bull Canyon station reported 20.2 inches of precipitation, much of that coming from an abnormally wet August in which the region received nearly four inches of rain.



MATERIALS AND METHODS

The study area was burned by wildfire in 2006. In the fall of 2009 the study site was plowed and packed, followed by applications of 16 oz/ac 2, 4-D and 64 oz/ac glyphosate on June 18, 2010 and July 29, 2010. The trial was planted on November 17, 2010 using a modified Tye® seed drill with a width of 80 inches (8 rows at 10 inch spacing). Experimental design is a randomized complete block with three replications. Appendix 1 is a plot map of the planting. Each plot is one drill width wide (80 in) and 20 ft long. Seeding depths are dependent on species and were planted according to Ogle et al (2010). Species were seeded at a target rate of 20 to 30 pure live seeds (PLS) per ft^2 for large seeded species (<500,000 seeds per pound) and 40 to 50 PLS/ft^2 for smaller seeded species (>500,000 seeds/lb). Pure live seed values were determined by seed lab results or best estimates when lab results were not available. All seed was mixed with rice hulls as an inert carrier to improve seed flow according to St. John et al (2005).

Disturbed areas adjacent to the trial were planted to seed mixture consisting of 40% Anatone bluebunch wheatgrass, 20% Sherman big bluegrass, 15% Bannock thickspike wheatgrass, 10 percent Magnar basin wildrye, 5% Maple Grove Lewis flax, 5% Richfield firecracker penstemon, 5% Great Northern western yarrow, and 0.25 lbs/ac Snake River Plains fourwing saltbush.

The plots were mowed to a height of approximately four inches on September 29, 2011 for weed control.

Plant Density

Plant densities of target species were measured using a frequency grid based on that described by Vogel and Masters (2001). The grid measured approximately 40 x 41 inches, having four ten-inch columns (to incorporate 1 drill row per column) and five rows, totaling 20 cells. The first grid was laid on the rows approximately one grid length (40 inches) into the plot. Counts were made of the cells that contained at least one plant. The grid was then flipped repeatedly into the plot and densities recorded four more times for a total of five. Total area for one grid is approximately $1m^2$. Total area evaluated is therefore approximately $5m^2$. A conservative estimate of plant density (plants/m^2) is the total number of cells containing at least one plant divided by five. It is important to note that because cells with plants were counted and not the number of plants per cell, the best possible score is 100 hits per five frames which converts to 20 plants/m^2 or 1.85 plants/ft^2. Actual plant density may be higher than the numbers indicated below. For plants/ft^2, divide by 10.76.

Data were analyzed using the Statistix 8 Analytical software and subjected to an analysis of variance with a significance level of $p<0.05$. In cases where significance was detected, means were separated using a Least Significant Difference (LSD) all pairwise comparison. Analyses were broken into five groups: 1) all species, 2) native grasses, 3) introduced grasses, 4) forbs, and 5) shrubs. All tables have been arranged with accessions ranked from highest to lowest plant density at the time of the 2011 evaluation.

Initial plant establishment was measured on July 11, 2011. Plant density data were also collected on June 14, 2012, June 20, 2013 and June 27, 2014. Seeded crested wheatgrass plots were not evaluated in 2014, as it had become too difficult to discern target plants from volunteers.

Densities of volunteer crested wheatgrass (*Agropyron cristatum*) and annual bromes (*Bromus* spp.) were evaluated in the test plots with frequency grids on August 13, 2012 and June 27, 2014. One density frame was evaluated for each accession in the center of the plots of replications 1 and 3. These data will be used to track long term persistence and competition of introduced perennial and annual grasses among the seeded species.

Establishment and performance of the cover crop seeding mixture was evaluated on August 14, 2012 and June 20, 2013. Eight density frames (two on each side of the planting) were evaluated. Cover class frequency data was also recorded on August 14, 2012 using a 60 meter (200 ft) line-intercept transect on each side of the planting.

Forage Production

On June 26, 2013, biomass clippings were taken from all accessions with densities greater than 5.4 plants/m^2 (0.5 plants/ft^2). Five representative plants were clipped from plots in each replication. The plants were air dried for 10 days and then weighed. Plant density values were then used to calculate lbs/acre (table 8).

Table 1. Species and accessions

Bluebunch wheatgrass (*Pseudoroegneria spicata*)

- Anatone
- Goldar
- P-7
- P-33

Snake River wheatgrass (*Elymus wawawaiensis*)

- Secar
- Discovery

Western wheatgrass (*Pascopyrum smithii*)

- Recovery
- Rosana
- Arriba

Slender wheatgrass (*Elymus trachycaulus*)

- First Strike
- Pryor

Basin wildrye (*Leymus cinereus*)

- Washoe
- Magnar
- Trailhead
- Continental

Bluegrass (*Poa* spp.)

- Sherman big bluegrass
- Opportunity Nevada bluegrass
- Mt. Home Sandberg bluegrass
- High Plains Sandberg bluegrass
- Reliable Sandberg bluegrass

Green needlegrass (*Nassella viridula*)

- Cucharas

Fescue (*Festuca* spp.)

- 9076469 Idaho fescue
- Covar sheep fescue
- Durar hard fescue

Streambank/Thickspike wheatgrass (*Elymus lanceolatus*)

- Sodar
- Bannock
- Critana

Squirreltail (*Elymus elymoides* and *E. multisetus*)

- Fish Creek bottlebrush squirreltail
- Sand Hollow big squirreltail
- Toe Jam Creek bottlebrush squirreltail
- Wapiti bottlebrush squirreltail
- 9019219 bottlebrush squirreltail
- 9092275 bottlebrush squirreltail

Forbs

- Maple Grove Lewis flax (*Linum lewisii*)
- Appar blue flax (*Linum perenne*)
- Richfield firecracker penstemon (*Penstemon eatonii*)
- Great Northern western yarrow (*Achillea millefolium*)
- Antelope prairie clover (*Dalea candida*)
- Silverleaf phacelia (*Phacelia hastata*)
- 9076577 Douglas' dustymaiden (*Chaenactis douglasii*)
- NBR-1 basalt milkvetch (*Astragalus filipes*)
- Don falcata alfalfa (*Medicago sativa* ssp. *falcata*)
- Timp northern (Utah) sweetvetch (*Hedysarum boreale*)
- Delar small burnet (*Sanguisorba minor*)
- Sainfoin (*Onobrychis viciifolia*)
- Lutana cicer milkvetch (*Astragalus cicer*)
- Stillwater prairie coneflower (*Ratibida columnifera*)

Shrubs

- Bonneville big sagebrush (*Artemisia tridentata* subsp. X *bonnevillensis*)
- Snake River Plains fourwing saltbush (*Atriplex canescens*)
- Wytana fourwing saltbush (*A. canescens*)
- Northern Cold Desert winterfat (*Krascheninnikovia lanata*)

Altai wildrye (*Leymus angustus*)

- Mustang

Crested wheatgrass (*Agropyron cristatum*)

- Ephraim
- Hycrest
- Hycrest II
- Nordan

Russian wildrye (*Psathrostachys juncea*)

- Bozoisky Select
- Bozoisky II

Siberian wheatgrass (*Agropyron fragile*)

- Vavilov
- Vavilov II

Meadow brome (*Bromus biebersteinii*)

- Regar
- Cache

RESULTS AND DISCUSSION

2011

Establishment densities ranged from essentially zero plants to 13 plants/m² in 2011 (Table 4). Eight out of the top ten species to establish were introduced grasses, four of which were crested wheatgrass accessions. The highest ranking native grasses were Fish Creek bottlebrush squirreltail and Pryor slender wheatgrass, both of which are short-lived perennials commonly used as a nurse crop with longer lived species in a seed mixture. In general, forbs had moderate establishment success, while the shrub accessions, with the exception of Bonneville big sagebrush, had low establishment numbers during the first year of evaluation.

Native grasses had a broad range of establishment densities (Table 5) ranging from 0.2 plants/m² for Sand Hollow Germplasm big squirreltail (*Elymus multisetus*) to 11.6 plants/m² for Fish Creek Germplasm bottlebrush squirreltail (*E. elymoides*) in 2011. Introduced grasses all had excellent establishment (Table 6). The lowest plant density recorded was 6.7 plants/m² from Bozoisky Russian wildrye. Cache meadow brome had the highest density with 13.0 plants/m². Forbs (Table 7) generally had lower establishment numbers than the grasses; however good stands were observed in many plots. All shrub species had low initial establishment (Table 8). No significant differences were detected between means.

2012

Despite drought conditions in 2012, plant densities of native grasses did not generally show dramatic decreases. Slender wheatgrass and squirreltail accessions, known to be short lived perennials, decreased or maintained 2011 densities. Bluebunch wheatgrass densities stayed essentially the same as 2011, with the exception of Anatone which increased in density from 7.6 to 9.5 plants/m². The rhizomatous grass species western wheatgrass, thickspike wheatgrass, and streambank wheatgrass all increased in density from 2011 to 2012.

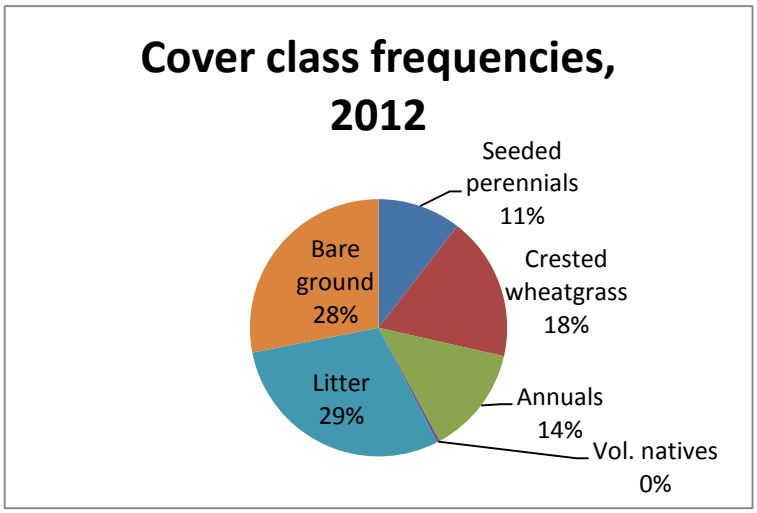
Introduced grass species accessions either increased or decreased in densities from 2011 to 2012. The highest densities were obtained by Hycrest II, Ephraim, and Hycrest crested wheatgrass with 14.1, 12.5 and 11.7 plants/m² respectively. However these numbers may be inflated due to volunteering from the existing soil seed bank. Cache and Regar meadow brome both decreased under drought stress although Cache maintained a good stand with 10.7 plants/m². Vavilov II Siberian wheatgrass maintained approximately 7 plants/m² while Vavilov decreased from 9.6 plants/m² to 4.2 plants/m².

Forb densities declined significantly from 2011 to 2012 with many accessions being nearly eliminated from the plots. Don falcate alfalfa and Appar blue flax (both introduced species) maintained the best stands with 3.3 and 3.2 plants/m² respectively.

Among the shrub entries, Bonneville big sagebrush and Snake River Plains fourwing saltbush had fair stands with 2.0 and 0.7 plants/m² respectively.

Densities of volunteer crested wheatgrass and annual bromes are listed in tables 5-8. These data will be used to track persistence and expansion of introduced species over time. The average density of crested wheatgrass and annuals bromes throughout all of the evaluated plots in 2012

was 7.0 plants/m² and 5.7 plants/m² respectively. No relationship between target species density and density of crested wheatgrass or annual bromes was discernable during 2012.



In the cover crop areas surrounding the test plots, seeded perennials made up 11% of the cover (6% bluebunch wheatgrass, 2% big bluegrass, 2% thickspike wheatgrass, and 1% blue flax) during 2012. Other seeded cover crop species were observed but not recorded in the line-intercept transects. Bare ground and litter made up the majority of the cover classes with 28 and 29% respectively. Volunteer crested wheatgrass accounted for 18% of the total cover. Annual grasses, including bulbous bluegrass (*Poa bulbosa*), cheatgrass (*Bromus tectorum*) and an unidentified annual brome comprised 14% of the ground cover. Incidental volunteer native forbs including tapertip hawksbeard (*Crepis acuminata*) and lesser rushy milkvetch (*Astragalus convallarius*) made up less than 1% of the total cover. Plant density measurements for the cover crop are provided in table 3.

Table 2. Dry forage biomass yields from the entries with the top 15 plant density values in 2013.

	June 26, 2013
	---(lbs/acre)---
Hycrest II	2,400 a
Vavilov II	1,480 b
Hycrest	1,480 b
Bozoisky II	1,280 b-c
Nordan	1,040 b-d
Bozoisky Select	1,020 b-d
Ephraim	940 c-d
Cache	560 d-e
Bannock	440 e
P-7	420 e
Anatone	400 e
Discovery	340 e
Fish Creek	300 e
Rosana	260 e
Arriba	120 e
LSD (0.05)	500

2013

Seven of the top ten recorded densities in 2013 were from introduced grasses. Crested wheatgrass and Russian wildrye varieties appear well-adapted to the site conditions. Most introduced grasses decreased slightly but seem to be well-established. The Russian wildrye

accessions, however, both increased in density from 2012 to 2013. This species is known to take time for establishment and increases over the first few years are expected.

Several native grasses appeared to be holding at acceptable densities. Fish Creek bottlebrush squirreltail continued to look good and had the highest plant density for native species followed by Rosana western wheatgrass and Anatone bluebunch wheatgrass. Short-lived perennials such as slender wheatgrass are steadily decreasing and giving way to longer lived species as would be expected. Rhizomatous perennials such as western wheatgrass and thickspike/streambank wheatgrass are increasing in density as plants spread.

Forbs continued to show low plant densities in general. Appar blue flax had the best density with 3.0 plants/m² in 2013, but due to high variability was not statistically different from other accessions.

In 2013 Bonneville big sagebrush had significantly greater plant density than all other shrubs with an average density of 2.9 plants/m², nearly five times the density of the next best shrub accession.

In total, eight introduced and seven native grasses had densities over 5.4 plants/m² (0.5 plants/ft²) and were clipped and weighed for forage yield (Table 2). The introduced grasses all had higher forage yields than the native grasses. Hycrest II crested wheatgrass had significantly greater forage produced than all other accessions with an average of 2,400 lbs/acre. In contrast, Bannock thickspike wheatgrass had the best forage yields among the native accessions with 440 lbs/acre.

The native seed mixture that was applied to the areas surrounding the test site was evaluated in 2011 and 2013. Crested wheatgrass densities decreased from 9.9 to 5.1 plants/m² between 2011 and 2013 (Table 3). Similarly, annual bromes decreased from 9.3 to 1.1 plants/m² in the same time period. Bulbous bluegrass densities remained essentially unchanged. Many of the seeded natives also showed decreases in density from 2011 to 2013; however two forbs, western yarrow and Lewis flax, both increased. Overall totals showed a large decrease in volunteer species from 2011 to 2013 (23.1 plants/m to 9.8 plants/m²). Seeded natives exhibited a much less dramatic decrease from 10.0 to 6.4 plants/m².

Table 3. Species densities (plants/m²) found in the seed mixture[1] planted area adjacent to the demonstration plots.

		Density[2]	
		July 11, 2011	June 20, 2013
Volunteer species		---------- (plants/m ²)---------	
	Crested wheatgrass	9.9	5.1
	Cheatgrass	9.3	1.1
	Bulbous bluegrass	3.4	3.6
	Bonneville big sagebrush	0.5	0.0
	Total	23.1	9.8
Seeded species			
	Bluebunch wheatgrass	5.3	2.6
	Big bluegrass	2.5	1.4
	Thickspike wheatgrass	2.0	1.1
	Western yarrow	0.1	0.9
	Douglas' dustymaiden	0.1	0.0
	Lewis flax	0.0	0.4
	Total	10.0	6.4

[1] Seeding mix included: 40% Anatone bluebunch wheatgrass, 20% Sherman big bluegrass, 15% Bannock thickspike wheatgrass, 10 percent Magnar basin wildrye, 5% Maple Grove Lewis flax, 5% Richfield firecracker penstemon, 5% Great Northern western yarrow, and 0.25 lbs/ac Snake River Plains fourwing saltbush.
[2] Not analyzed for statistical significance

2014

Fish creek bottlebrush squirreltail had highest plant density with 10.4 plants/m²; significantly greater than all other entries with the exception of Bozoisky II. Other native species accessions in the top ten densities included Discovery Snake River wheatgrass (6.1 plants/m²), Sodar streambank wheatgrass (5.8 plants/m²), Toe Jam Creek bottlebrush squirreltail (5.6 plants/m²), and Rosanna western wheatgrass (3.9 plants/m²). Almost all entries in the trial decreased in density from 2013 to 2014. Exceptions include two bottlebrush squirreltail accessions (Fish Creek and Toe Jam Creek), Discovery Snake River wheatgrass, and two sod-forming grasses (Sodar Streambank wheatgrass and Critana thickspike wheatgrass), which are expected to spread via rhizomes. Introduced cultivars of Russian wildrye and Siberian wildrye all scored in the top ten densities. Cache meadow brome continued to decline in density from 6.8 to 3.9 plants/m², but was still in the top ten.

Bonneville sagebrush again had significantly greater establishment density than all other shrub accessions (p=0.02). With a plant density of 2.9 plants/m it had not changed since 2013. Though not measured for statistical significance, Bonneville sagebrush plots had the lowest densities of annual bromes, approximately one-third as many plants/m as the remaining shrub entries. Densities of crested wheatgrass however, appeared to be comparable among the shrub plantings.

Forb densities were low with no significant differences detected. Maple Grove Lewis flax had the highest plant density with 0.8 plants/m². Six other accessions were observed with at least one plant in the evaluated frames: Appar blue flax, Timp northern sweetvetch, Great Northern yarrow, Delar small burnet, sainfoin and NBR-1 basalt milkvetch. Several entries had zero plants/m²: Antelope prairie clover, Douglas' dustymaiden, Don alfalfa, Lutana vetch, Phacelia, Richfield firecracker penstemon, and Stillwater prairie coneflower.

Significant differences in crested wheatgrass were detected when all species were compared, ($p=0.01$). In general, more established target species resulted in fewer crested wheatgrass plants/m. No significant differences were detected in annual brome establishment regardless of target species densities ($p=0.09$). However, six of the top ten target densities scored in the bottom ten annual brome densities.

Table 4. Plant density (plants/m²) for all entries from 2011-2014.

Accession	Density July 11, 2011	June 14, 2012	June 20, 2013	June 27, 2014	Accession (cont.)	Density July 11, 2011	June 14, 2012	June 20, 2013	June 27, 2014
	---------- (plants/m ²)----------					---------- (plants/m ²)----------			
Cache	13.0 a	10.7 a-d	6.8 a-f	3.9 c-h	Recovery	4.3 h-q	5.8 e-n	4.5 e-l	1.7 h-l
Hycrest II	12.1 a-b	14.1 a	9.9 a	--	NBR-1	4.0 i-q	0.0 q	0.5 o-p	0.1 l
Fish Creek	11.6 a-c	9.1 b-f	9.8 a	10.4 a	Durar	3.9 i-q	5.5 e-o	3.2 g-p	1.0 h-l
Nordan	11.6 a-c	8.7 b-g	6.5 a-g	--	9076469	3.8 i-q	2.9 i-q	0.1 p	0.0 l
Pryor	11.5 a-d	2.0 k-q	0.1 p	0.0 l	Bannock	3.6 j-q	6.5 d-k	6.1 b-h	3.1 d-l
Ephraim	11.1 a-e	12.5 a-b	9.7 a	--	Opportunity	3.5 j-q	4.4 f-q	0.3 o-p	0.1 l
Vavilov	9.6 a-f	4.2 g-q	4.7 d-k	6.7 b-c	Washoe	3.5 j-q	0.7 p-q	0.5 o-p	0.3 k-l
Bozoisky II	9.5 a-g	9.0 b-f	9.9 a	7.3 a-b	Phacelia	3.3 k-q	0.7 p-q	0.1 p	0.0 l
Hycrest	9.0 a-h	11.7 a-c	8.1 a-d	--	Secar	3.3 k-q	4.9 e-p	3.3 g-p	3.4 d-k
Covar	8.5 a-i	8.9 b-g	2.1 i-p	1.3 h-l	9019219	3.1 k-q	2.6 j-q	1.8 j-p	0.8 h-l
Delar	8.1 b-j	1.2 n-q	1.2 l-p	0.2 l	Sherman	3.1 k-q	4.2 g-q	1.7 j-p	1.1 h-l
Maple Grove	8.1 b-j	1.3 n-q	1.1 l-p	0.8 h-l	Trailhead	3.1 k-q	2.5 j-q	2.9 h-p	2.5 f-l
Anatone	7.6 b-k	9.5 a-e	6.9 a-f	3.8 c-j	Continental	2.4 l-q	1.8 l-q	2.8 h-p	2.5 f-l
Don	7.6 b-k	3.3 h-q	1.7 j-p	0.0 l	High Plains	2.4 l-q	2.5 j-q	3.2 g-p	2.6 f-l
Timp	7.6 b-k	0.6 p-q	1.2 l-p	0.4 k-l	9092275	2.3 l-q	0.9 o-q	0.1 p	0.0 l
Regar	7.5 b-k	4.5 f-q	2.5 i-p	0.3 k-l	Magnar	2.3 l-q	0.5 p-q	1.1 l-p	0.4 k-l
Vavilov II	7.5 b-k	7.7 c-h	9.1 a-b	5.1 b-g	Bonneville sage	1.5 m-q	2.0 k-q	2.9 h-p	2.9 d-l
Appar	7.0 c-l	3.2 h-q	3.0 h-p	0.5 k-l	Great Northern	1.5 n-q	0.9 o-q	0.9 m-p	0.3 k-l
Mustang	6.8 d-l	2.5 j-q	2.5 i-p	1.9 g-l	Richfield	1.5 n-q	0.4 p-q	0.5 o-p	0.0 l
Bozoisky	6.7 e-l	5.7 e-n	7.5 a-e	6.7 b-c	Wapiti	1.3 o-q	0.1 q	0.1 p	0.0 l
Sodar	6.7 e-l	7.4 c-i	3.9 f-n	5.8 b-e	Lutana	1.2 o-q	0.1 q	0.1 p	0.0 l
Critana	6.6 e-l	6.4 d-l	3.7 f-o	3.9 c-i	Stillwater	1.1 p-q	0.1 q	0.0 p	0.0 l
First Strike	6.3 f-m	2.0 k-q	0.6 n-p	0.0 l	Cucharas	0.9 q	0.5 p-q	0.2 p	0.9 h-l
P-7	6.2 f-n	6.7 d-j	5.5 c-i	2.7 e-l	Mt. Home	0.9 q	1.0 o-q	1.9 j-p	1.6 h-l
Sainfoin	5.9 f-o	0.5 p-q	0.7 n-p	0.2 l	Reliable	0.7 q	1.3 n-q	1.5 k-p	1.2 h-l
P-33	5.8 f-p	4.5 f-q	4.3 e-m	2.9 d-l	Snake River Plains	0.5 q	0.5 p-q	0.6 n-p	0.7 j-l
Goldar	4.7 g-q	6.1 d-m	2.7 i-p	1.2 h-l	Wytana	0.3 q	0.1 q	0.3 o-p	0.7 j-l
Rosana	4.5 h-q	8.2 b-g	8.7 a-c	3.9 c-h	Sand Hollow	0.2 q	0.0 q	0.0 p	0.1 l
Toe Jam	4.5 h-q	5.7 e-n	5.1 d-j	5.6 b-f	Antelope	0.1 q	0.0 q	0.0 p	0.0 l
Dustymaiden	4.4 h-q	1.7 l-q	0.3 o-p	0.0 l	NCD Winterfat	0.1q	0.1 q	0.0 p	0.0 l
Discovery	4.4 h-q	5.5 e-o	5.4 c-i	6.1 b-d					
Arriba	4.3 h-q	8.7 b-g	5.5 c-i	3.8 c-j					
LSD (0.05)	4.8	4.7	3.5	3.1					

Table 5. Plant density (plants/m²) for native grasses, volunteer crested wheatgrass and introduced annual bromes from 2011-2014.

	Target Species Density				Crested Wheatgrass Density[1]		Annual Brome Density[1]	
Accession	July 11, 2011	June 14, 2012	June 20, 2013	June 27, 2014	August 13, 2012	June 27, 2014	August 13, 2012	June 27, 2014
	---------- (plants/m ²)----------				-------- (plants/m ²)-------		------- (plants/m ²)-------	
Fish Creek	11.6 a	9.1 a	9.8 a	10.4 a	4	3.9	5.5	5.4
Pryor	11.5 a	2.0 c-h	0.1 j-k	0.0 d	2.5	8.1	3	12.9
Anatone	7.6 a-c	9.5 a	6.9 a-c	3.8 b-c	6	5.1	3.5	8.9
Sodar	6.7 a-d	7.4 a-c	3.9 c-i	5.8 b	7.5	6.5	2	11.3
Critana	6.6 a-d	6.4 a-e	3.7 c-j	3.9 b-c	5.5	4.6	9.5	9.9
First Strike	6.3 a-e	2.0 c-h	0.6 i-k	0.0 d	10.5	6.7	4.5	9.4
P-7	6.2 a-f	6.7 a-d	5.5 b-e	2.7 b-d	7	4.9	6.5	9.4
P-33	5.8 b-f	4.5 a-h	4.3 c-h	2.9 b-d	9.5	6.5	7.5	11.9
Goldar	5.7 b-g	6.1 a-f	2.7 d-k	1.2 c-d	11	7.9	4	11.3
Rosana	4.5 b-g	8.2 a-b	8.7 a-b	3.9 b-c	6.5	5.4	4	8.5
Toe Jam Creek	4.5 b-g	5.7 a-h	5.1 c-g	5.6 b	5	5.1	4.5	7.3
Discovery	4.4 b-g	5.5 a-h	5.4 b-f	6.1 b	7.5	6.1	2	10.5
Arriba	4.3 b-g	8.7 a	5.5 b-e	3.8 b-c	7	4.8	1	12.2
Recovery	4.3 b-g	5.8 a-g	4.5 c-h	1.7 c-d	5	5.7	4	10.0
9076469	3.8 b-g	2.9 b-h	0.1 k	0.0 d	9	6.2	8.5	12.2
Bannock	3.6 b-g	6.5 a-e	6.1 b-d	3.1 b-d	10	6.7	5	10.9
Opportunity	3.5 b-g	4.4 a-h	0.3 j-k	0.1 d	3.5	7.8	8.5	6.2
Secar	3.3 b-g	4.9 a-h	3.3 c-k	3.4 b-d	4.5	5.1	11	12.6
Sherman	3.1 b-g	4.2 a-h	1.7 g-k	1.1 c-d	8.5	6.9	2	10.5
9019219	3.1 b-g	2.6 b-h	1.8 g-k	0.8 c-d	6.5	5.9	10.5	12.3
High Plains	2.4 c-g	2.5 b-h	3.2 d-k	2.6 b-d	11.5	9.1	3	10.0
9092275	2.3 c-g	0.9 e-h	0.1 j-k	0.0 d	9	7.9	7	10.0
Wapiti	1.3 d-g	0.1 g-h	0.1 k	0.0 d	7	5.9	7.5	12.3
Cucharas	0.9 e-g	0.5 f-h	0.2 j-k	0.9 c-d	7.5	6.4	3	10.2
Mountain Home	0.9 e-g	1.0 d-h	1.9 f-k	1.6 c-d	6	5.1	11	13.8
Reliable	0.7 f-g	1.3 d-h	1.5 g-k	1.2 c-d	7	5.6	1.5	5.8
Sand Hollow	0.2 g	0.0 h	0.0 k	0.1 d	4.5	5.8	12.5	15.2
LSD (0.05)	5.5	5.7	3.5	3.6				

[1] Not analyzed for statistical significance

Table 6. Plant density (plants/m²) for introduced grasses, volunteer crested wheatgrass and introduced annual bromes from 2011-2014.

	Target Species Density				Crested Wheatgrass Density[1]		Annual Brome Density[1]	
Accession	July 11, 2011	June 14, 2012	June 20, 2013	June 27, 2014	August 13, 2012	June 27, 2014	August 13, 2012	June 27, 2014
	---------- (plants/m ²)----------				----- (plants/m ²)-----		----- (plants/m ²)-----	
Cache	13.0 a	10.7 a-c	6.8 a-c	3.9 a-c	2.5	4.1	2.5	6.3
Hycrest II	12.1 a-b	14.1 a	9.9 a	--	NA	--	5.5	--
Nordan	11.6 a-c	8.7 a-d	6.5 a-c	--	NA	--	2.5	--
Ephraim	11.1 a-c	12.5 a-b	9.7 a	--	NA	--	6.5	- -
Vavilov	9.6 a-c	4.2 d-e	4.5 b-c	6.7 a-b	0.5	3.5	2.5	5.1
Bozoisky II	9.5 a-c	9.0 a-d	9.9 a	7.3 a	2	1.3	3	2.0
Hycrest	9.0 a-c	11.7 a-b	8.1 a-b	--	NA	--	14	--
Covar	8.5 a-c	8.9 a-d	2.1 c	1.3 b-c	10	7.8	3	7.9
Regar	7.5 b-c	4.5 d-e	2.5 c	0.3 c	3.5	6.8	1.5	6.3
Vavilov II	7.5 b-c	7.7 b-e	9.1 a-b	5.1 a-c	NA	2.4	3	5.7
Mustang	6.8 c	2.5 e	2.5 c	1.9 b-c	8.5	4.7	4	11.2
Bozoisky	6.7 c	5.7 c-e	7.5 a-b	6.7 a-b	6.5	3.3	2	4.2
Durar	3.9 c	5.5 c-e	3.2 b-c	1.0 b-c	7	5.9	4	8.3
LSD (0.05)	5.0	5.7	4.8	5.1				

[1] Not analyzed for statistical significance

Table 7. Plant density (plants/m²) for all forbs, volunteer crested wheatgrass and introduced annual bromes from 2011-2014.

Accession	Target Species Density July 11, 2011	Target Species Density June 14, 2012	Target Species Density June 20, 2013	Target Species Density June 27, 2014	Crested Wheatgrass Density[1] August 13, 2012	Crested Wheatgrass Density[1] June 27, 2014	Annual Brome Density[1] August 13, 2012	Annual Brome Density[1] June 27, 2014
	---------- (plants/m ²)----------				----- (plants/m ²)----		----- (plants/m ²)----	
Delar	8.1 a	1.2	1.2	0.2	2	6.1	10.5	10.5
Maple Grove	8.1 a	1.3	1.1	0.8	5.5	4.1	12	17.9
Don	7.6 a-b	3.3	1.7	0.0	7.5	6.1	2	12.1
Timp	7.6 a-b	0.6	1.2	0.4	9.5	8.3	11	11.0
Appar	7.0 a-c	3.2	3.0	0.5	5	4.1	15	14.3
Sainfoin	5.9 a-d	0.5	0.7	0.2	10	8.1	12	7.5
Douglas' dustymaiden	4.4 b-e	1.7	0.3	0.0	6	10.2	1	9.0
NBR-1	4.0 c-e	0.0	0.5	0.1	10.5	7.2	2	12.5
Phacelia	3.3 d-f	0.7	0.1	0.0	10.5	7.3	4.5	8.5
Great Northern	1.5 e-f	0.9	0.9	0.3	7	5.5	8	16.6
Richfield	1.5 e-f	0.4	0.5	0.0	5	3.5	10.5	12.5
Lutana	1.2 e-f	0.1	0.1	0.0	3	5.1	14.5	12.1
Stillwater	1.1 e-f	0.1	0.0	0.0	7	4.8	3	12.4
Antelope	0.1 f	0.0	0.0	0.0	10	8.3	5	5.8
LSD (0.05)	3.4	N/A	N/A	N/A				

[1] Not analyzed for statistical significance

Table 8. Plant density (plants/m²) for shrubs, volunteer crested wheatgrass and introduced annual bromes from 2011-2014.

Accession	Target Species Density July 11, 2011	Target Species Density June 14, 2012	Target Species Density June 20, 2013	Target Species Density June 27, 2014	Crested Wheatgrass Density[1] August 13, 2012	Crested Wheatgrass Density[1] June 27, 2014	Annual Brome Density[1] August 13, 2012	Annual Brome Density[1] June 27, 2014
	---------- (plants/m ²)----------				------ (plants/m ²)------		------ (plants/m ²)------	
Bonneville big sagebrush	1.5	2.0	2.9 a	2.9 a	8.5	5.9	1.5	3.9
Snake River Plains	0.5	0.7	0.6 b	0.1 b	6.5	4.7	4.5	10.6
Wytana	0.3	0.1	0.3 b	0.7 b	5.5	7.1	6.5	11.6
Northern Cold Desert	0.1	0.1	0.0 b	0.0 b	10	6.4	1.5	10.5
LSD (0.05)	N/A	N/A	1.4	1.5				

[1] Not analyzed for statistical significance

CONCLUSION

High densities of volunteer crested wheatgrass at the Curlew seeding are noteworthy. A second year of chemical fallow prior to planting the test accessions to control crested wheatgrass and annual weeds may have significantly reduced competition and led to a more complete plant community conversion. However, deferring planting until the fall of 2011 may have resulted in decreased germination rates of seeded species due to inadequate moisture during the establishment period.

Introduced bunchgrasses have shown excellent establishment and persistence, but should only be recommended in highly-disturbed, critical area plantings.

Most native species did not perform as well as their introduced counterparts, but several grasses have performed well enough to be recommended. Fish Creek and Toe Jam Creek bottlebrush squirreltail both appear to be well-adapted to site conditions on Curlew National Grassland. Bottlebrush squirreltail is a short-lived, early-seral species which can be used in seeding mixtures to capture a site and allow slower growing species to establish. It should not be planted as a single species or as a large component of a seed mixture as the plants are expected to decrease over time. Other natives with fair performance include accessions of several bunchgrasses and rhizomatous sod-forming grasses.

Forbs have done poorly with low establishment and very little persistence with all forb species averaging less than 1 plant/m^2 in 2014. Locally collected Bonneville big sagebrush had excellent establishment and persistence and should be the most broadly recommended shrub. Other shrub species have fared poorly in this trial.

This progress report documents data from the first four growing seasons at the Curlew off-center evaluation. The site will be excluded from grazing and evaluated again in 2019.

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Anatone	9076469	Timp	Rosanna	Critana	Secar	Stillwater	Don	Magnar
Goldar	Covar	Delar	Antelope	Cucharas	Wapiti	NBR-1	Maple Grove	Hycrest
P-7	Sodar	Sainfoin	Sand Hollow	Don	Wytana	Sherman	Rosanna	Timp
P-33	Bannock	Lutana	N. C. Desert	Washoe	MACA	Antelope	Great Northern	Bozoisky Sel.
Secar	Critana	MACA	Pryor	Maple Grove	Magnar	High Plains	Secar	Sand Hollow
Discovery	Fish Creek	Stillwater	CHDO	Great Northern	Nordan	9076469	9019219	Wapiti
Recovery	Sand Hollow	WY big sage	Sherman	Anatone	Arriba	Sainfoin 2 bu	Mt. Home	P-7
Rosanna	Toe Jam	S. R. Plains	NBR-1	Trailhead	Durar	First Strike	Critana	S. R. Plains
Arriba	Wapiti	N. C. Desert	Reliable	Timp	Opportunity	Mustang 2 bu	Sodar	Pryor
First Strike	9019219	Wytana	Hycrest	Appar	Sainfoin	Goldar	Phacelia	Cucharas
Pryor	9092275	Mustang	P-33	9019219	P-7	Ephraim	Trailhead	Wytana
Washoe	Maple Grove	Ephraim	Sodar	Recovery	Covar	Bannock	Toe Jam	WY big sage
Magnar	Appar	Hycrest	Mustang	Phacelia	Bozoisky II	Appar	P-33	Discovery
Trailhead	Richfield	Hycrest II	High Plains	Mt. Home	Stillwater	Continental 2 bu	Opportunity	Vavilov
Continental	Great Northern	Nordan	Vavilov	WY big sage	Fish Creek	Hycrest II	Delar 2 bu	Lutana
Sherman	Durar	Bozoisky Sel.	9092275	First Strike	Bozoisky Sel.	Recovery	Anatone	Reliable
Opportunity	Antelope	Bozoisky II	Delar	Ephraim	Cache	Cache	Bozoisky II	Regar
Mt. Home	Phacelia	Vavilov	Discovery	9076469	Goldar	9092275	Richfield	Durar
High Plains	CHDO	Vavilov II	Richfield	Regar	S. R. Plains	N. C. Desert	Covar	CHDO
Reliable	NBR-1	Regar	Lutana	Toe Jam	Vavilov II	Vavilov II	Fish Creek	Arriba
Cucharas	Don	Cache	Bannock	Hycrest II	Continental	Washoe	MACA 2 bu	Nordan

Rep. 1 Rep. 2 Rep. 3

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Aberdeen Plant Materials Center

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PROGRESS REPORT
Aberdeen Plant Materials Center, Aberdeen, ID

SEEDING RATE EVALUATION FOR LOW PRECIPITATION SITES, 2015 PROGRESS REPORT

Derek J. Tilley, PMC Manager

INTRODUCTION

In arid sites in the Intermountain West, seeding efforts produce satisfactory stand densities only in exceptional water years. Anecdotal evidence suggests initial stands in average or below average moisture conditions may be improved with increased seeding rates. The aim of this study is to evaluate establishment and long-term stand densities using the standard seeding rate and a 2X rate. Aberdeen PMC installed two test plots, one in Skull Valley Utah, approximately 25 miles west of Tooele, in 2013, and the second at Coffee Point Idaho, approximately 25 miles northwest of Aberdeen, in 2015.

The Skull Valley Off-Center Test Site (approximately 1.5 acres) is located approximately 1 mile east of the Ensign North Ranch headquarters in the western foothills of the Stansbury Mountains. The soil at the test site is Hiko Peak gravelly loam soil series and historically supported a Wyoming big sage/bluebunch wheatgrass plant community. The typical soil profile is a very deep (>60 inch), well-drained gravelly loam. The site receives an average of 8 to 10 inches of precipitation annually. Elevation at the site is approximately 4600 feet.

The Coffee Point test site is located in the Snake River Plains of the Northwestern Wheat and Range region of the Intermountain West in what historically supported a Wyoming big sagebrush/bluebunch wheatgrass plant community. Climate conditions are very dry with mean annual precipitation from 8 to 12 inches. Soils at the site are a Splittop-Atomic complex with 2 to 8% slope and effective rooting depth of 20 to 40 inches and pH of 7.4 to 8.4. The elevation at the site is 4,850 ft.

MATERIALS AND METHODS

The Skull Valley seedbed was prepared with chemical treatments of 16 oz. 2, 4-D and 64 oz. glyphosate per acre applied on May 26, 2011; November 3, 2011; May 9, 2012; and April 19, 2013. No additional seed bed preparation was conducted. The trial was planted no-till fashion on November 20, 2013 with a modified Tye Drill with a width of 80 inches (8 spouts at 10” spacing). The design consisted of single plots, one drill width (7 ft) wide and 130 ft long. Standard rate and 2x rate plots for each species were laid adjacent to one another for easy visual comparisons. Eleven species were selected for the trial based on potential adaptation to the local site conditions. The trial included native and introduced grasses, as well as the native desert shrub, fourwing saltbush. Species and varieties are listed in table 1.

The Coffee Point site was treated on April 8, 2014 and again on May 16, 2014 with 64 oz. glyphosate per acre. In 2015, the site was mowed on April 13 followed by glyphosate treatments on April 24 and September 29. It was seeded on November 9, 2015 in the same manner as described above. Plots at Coffee Point were 1 drill width wide and 85 ft long. Species and varieties seeded at Coffee Point are shown below in Table 2.

Table 1. Species and seeding data for Skull Valley test site.		
Species	Variety	1X Seed rate (Lb/ac)
Bluebunch wheatgrass	Anatone	8
Streambank wheatgrass	Sodar	8
Thickspike wheatgrass	Bannock	8
Snake River wheatgrass	E-64	8
Big bluegrass	Sherman	2
Bottlebrush squirreltail	Rattlesnake	6
Indian ricegrass	Nezpar	8
Crested wheatgrass	Hycrest II	5
Russian wildrye	Bozoisky II	6
Siberian wheatgrass	Vavilov II	6
Fourwing saltbush	Snake River Plains	0.25

Table 2. Species and seeding data for Coffee Point test site.		
Species	Variety	1X Seed rate (Lb/ac)
Bluebunch wheatgrass	Anatone	8
Bluebunch wheatgrass	P7	8
Streambank wheatgrass	Sodar	8
Thickspike wheatgrass	Bannock	8
Lewis flax	Maple Grove	4
Basin wildrye	Magnar	8
Western wheatgrass	Recovery	8
Indian ricegrass	Nezpar	8
Crested wheatgrass	Hycrest II	5
Russian wildrye	Bozoisky II	6
Siberian wheatgrass	Vavilov II	6

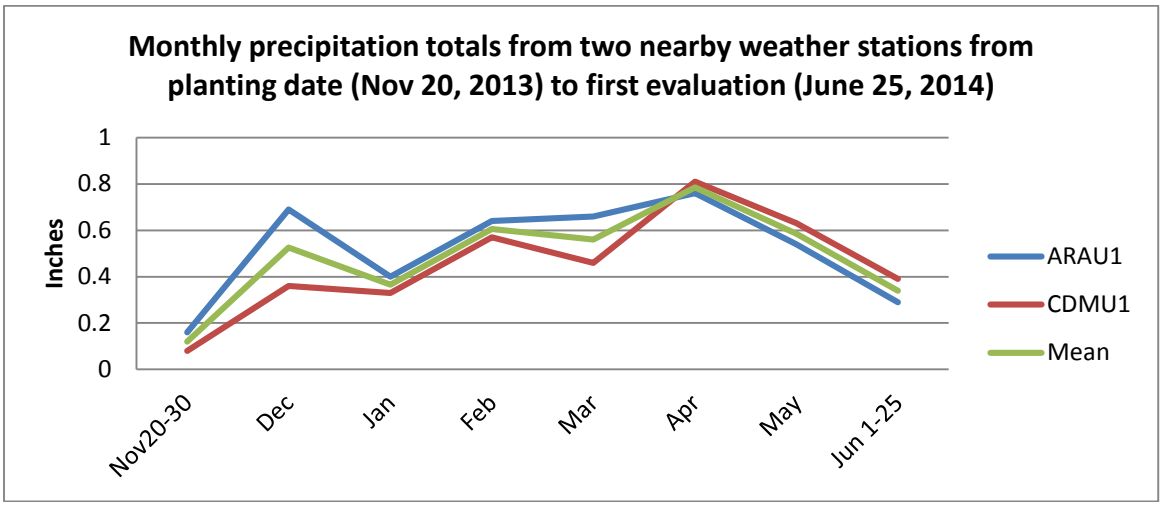
Seeding depths were based on recommendations found in Ogle et al. (2007). Species were seeded at a target rate of 20 to 30 pure live seeds (PLS) per ft^2 for large seeded species (<500,000 seeds per pound) and 40 to 50 PLS/ft^2 for smaller seeded species (>500,000 seeds/lb). All seed was mixed with rice hulls as an inert carrier to ensure better seed flow according to St. John et al (2005).

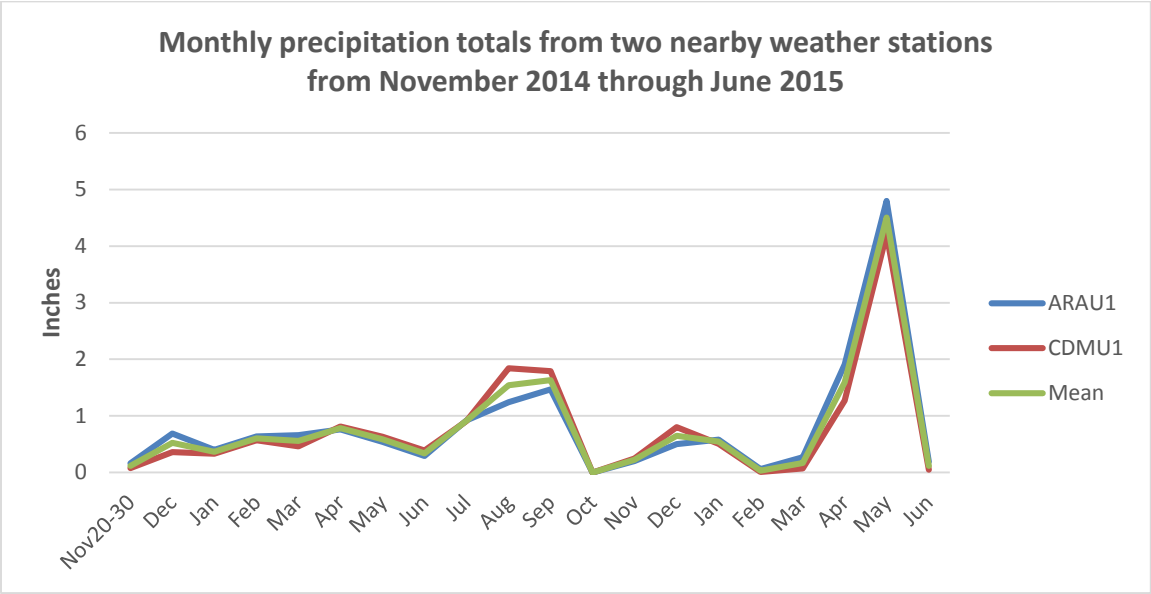
The Skull Valley plots were evaluated for initial establishment on June 25, 2014 using a frequency grid as described by Vogel and Masters (2001). The grid measured approximately 40 x 41 inches, having four 10-inch columns (to incorporate 1 drill row per column) and five rows, totaling 20 cells. The grid was placed ten times within the plot giving a total of 200 evaluated cells. Counts were made of the cells that contained at least one plant. An estimated number of plants/m^2 was determined for each grid placement, and the ten grids per plot were used as quasi-replications and averaged. The plots were evaluated again on May 5, 2015. Data were analyzed using the Statistix 8 Analytical software and subjected to an analysis of variance with a significance level of $p<0.05$.

Weather

The two closest weather stations to the Skull Valley site are the Aragonite (ARAU1) and Cedar Mountain (CDMU1) stations. Aragonite is located 16 miles WNW of the site at 40.5983, -113.0217 degrees and 5,030’ elevation. The Cedar Mountain station is approximately 15 miles S of the site at 40.3008, -112.7767 and 4,650’ elevation. Because of the differences in precipitation observed between

the two stations, monthly precipitation totals were taken from both sites. All weather data were obtained from MesoWest (2016). Total accumulated precipitation during the establishment period (November 20, 2014 through June 25, 2015) was 4.14 inches from the Aragonite weather station and 3.63 inches from the Cedar Mountain station. Total accumulated mean precipitation for both sites was 3.89 inches during the establishment period.





RESULTS AND DISCUSSION

Snake River Plains fourwing saltbush failed to establish at the Skull Valley site. All other species established to at least a minimal degree (Table 3). Two species, thickspike wheatgrass and Siberian wheatgrass, had greater establishment densities from the 1x rate than the 2x rate during the establishment year, though differences were not statistically significant. Of the remaining eight species, seven showed improved establishment with the 2x seed rate; however, a statistically significant difference was only observed with streambank wheatgrass where the 2x rate of streambank wheatgrass resulted in nearly three times greater plant density than the standard rate.

In the second year, the only species that showed significant differences in establishment was bottlebrush squirreltail with 4.4 plants/m^2 from the 1X rate and 7.0 plants/m^2 from the 2X rate. These data indicate that doubling the seeding rate does not consistently result in significantly greater establishment. Therefore the additional cost for the extra seed may not be justified by the results.

Table 3. Plant densities of 11 commonly used Intermountain restoration species seeded at the standard recommended rate and a 2x rate. Plots were evaluated on June 25, 2014 and May 5, 2015.

	2014			2015		
	1X	2X		1X	2X	
	--------Plants/m^2--------		p	--------Plants/m^2--------		p
Russian wildrye	14.6	15.9	0.46	13.0	14.4	0.46
Crested wheatgrass	9.6	12.4	0.10	7.5	9.8	0.27
Thickspike wheatgrass	9.4	8.9	0.85	4.9	3.5	0.27
Snake River wheatgrass	8.7	9.9	0.46	7.3	6.6	0.71
Siberian wheatgrass	7.5	6.3	0.54	7.2	4.9	0.06
Bluebunch wheatgrass	7.4	8.6	0.51	3.8	3.1	0.58
Streambank wheatgrass	3.7	9.9	0.004	3.8	5.5	0.38
Bottlebrush squirreltail	3.3	5.8	0.07	4.4	7.0	0.04
Indian ricegrass	0.7	0.8	0.80	1.6	2.5	0.46
Big bluegrass	0.1	0.2	0.59	0.3	0.1	0.44
Fourwing saltbush	0	0	NA	0	0	NA

The Coffee Point planting will be evaluated for establishment in 2016 and again in 2017. Long-term evaluations will be done at both sites periodically.

Hycrest II crested wheatgrass 1X (left) and 2X (right) at Skull Valley on June 25, 2015. No significant difference in establishment or second growing season densities were found.

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PLANT MATERIALS PUBLICATIONS

United States Department of Agriculture

NRCS Natural Resources Conservation Service

2014
Aberdeen Plant Materials Center
Progress Report of Activities
November 2014

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Aberdeen Plant Materials Center Home Farm

Who We Are

The mission of the USDA NRCS Plant Materials Program is to develop and transfer effective state-of-the art plant science technology to meet customer and resource needs. The Aberdeen Plant Materials Center (PMC) was established in 1939 to evaluate and select plant materials and techniques for establishment and management of plants for use in resource conservation activities in the Western United States.

There are 27 PMCs nationwide, each serving a specific geographic and ecological area. The Aberdeen PMC serves portions of the Intermountain West including southern Idaho, western Utah, northern Nevada, western Wyoming and eastern Oregon.

Following the direction of the new Plant Materials Center Improvement Effort, Aberdeen's primary areas of focus will be improving habitat for at-risk wildlife species such as sage-grouse. We will also continue our work on improving range and pasture productivity and increasing plant species diversity on Intermountain rangelands. A new role of the Aberdeen PMC will be investigating plants and technologies for improving soil health in Intermountain agricultural lands.

For more information on any PMC projects, please call or email the center with the information at the top of the page.

Staffing Changes

Loren St. John, Team Leader for the PMC, retired this May after 22 years at the PMC. Our thanks go to Loren for his vision and leadership that helped make Aberdeen a highly respected and recognized center for plant knowledge. As of October, the new PMC manager is Derek Tilley, our former PMC agronomist.

Native Forbs

We are pleased to announce the official release of Amethyst Germplasm hoary tansyaster (*Machaeranthera canescens*). This fall-blooming forb can be used in areas receiving less than 12 inches mean annual precipitation and will be useful in pollinator CRP and sage-grouse habitat plantings. Seed allocations are available through the University of Idaho Foundation Seed program and Utah Crop Improvement Association.

A green sweat bee foraging on Amethyst hoary tansyaster for pollen.

The PMC continues to increase early generation seed of Wyeth buckwheat (*Eriogonum heracleoides*). Also known as whorled buckwheat, it is a useful forb in sage-grouse and

pollinator habitat as well as rangeland restoration plantings. Once enough seed is produced, this accession will be named and officially released for commercial seed production.

Radish Bolting

One of the workhorse species for cover crop plantings is the radish. Radishes provide excellent cover and produce a large taproot capable of penetrating hard soil pans. Typical plantings in August produce good above ground growth and root development before being killed by frost in the winter; however if planted too early in the season, the radish will simply bolt and put out flowers instead of developing a robust plant. This year we evaluated five radish varieties to determine which may be amenable to earlier planting dates for use in full-season cover crop seedings. The final report for this study will be available this winter.

The plant on the left was seeded in late June and quickly put energy into flower and seed production, while the plant on the right was planted in early August and put energy into root growth.

Soil Health and Cover Crop Tour

In June, the PMC hosted a soil health and cover crop tour. Marlon Winger, NRCS Idaho State Agronomist spoke and demonstrated how to improve soil health in conjunction with Idaho agriculture. In the afternoon we toured the new PMC cover crop display planting to get a look at the many available species that can be used in our area. The display included 35 species arranged into blocks of cool season grasses, cool season broadleaf plants, legumes, warm season broadleaf plants, and warm season grasses.

Marlon Winger (Idaho State Agronomist) speaks at the PMC soil health tour.

Corn Interseeding

What is the best way to add cover crops to a corn field to improve post-harvest grazing? This summer the PMC addressed that question with a corn interseeding trial at the Fish and Game farm. A 4-way cover crop mix consisting of turnip, oat, red clover and field pea was seeded between rows of Roundup-ready corn using three techniques: drilled, broadcast at a standard rate, or broadcast at 2 times the standard rate. Above-ground forage samples were collected in late October to see how much forage each treatment provided. The data are currently being analyzed. For more information or for a copy of the final report, contact the PMC.

Turnip tops are visible between corn rows. Following corn harvest these cover crops create valuable forage in grazing systems.

Pollinator Plantings

In 2011, the PMC established 5 acres of pollinator habitat at the Fish and Game farm for display and to research management requirements involved in pollinator friendly plantings. Species planted included blue flax, small burnet, western yarrow, annual sunflower, hoary tansyaster, falcate alfalfa, and three native grasses. We observed fair establishment of the target species, but there was also significant weed pressure. In 2012 the field provided

excellent pollinator forage with all planted species present. Over the last two years however the planting has shown an increase in the presence of invasive weeds. The lack of herbicides available for use in pollinator plantings to control broadleaf weeds is a major concern. We are planning to maintain this planting through 2021 to follow trends in species composition.

Blue flax, sainfoin, yarrow and small burnet can be seen in this photo of the PMC pollinator planting in 2012.

In 2013 we planted six commercially available wildflower seed mixes designed for use in western North America into non-replicated plots to determine which species are well adapted to conditions in the PMC service area and contribute to pollinator foraging. As it turns out, not all mixes are created equally. Some have a variety of native and introduced annuals and perennials for a showy display. Others are designed to represent native western plant communities or to be highly drought tolerant. Clear objectives and an understanding of the species composition are vital to choosing the most appropriate mixture.

One of the wildflower mixes planted in 2013. Several native and introduced species can be seen.

Breeder, Foundation, and Cooperative Seed Production

The Aberdeen PMC produces the highest quality conservation seed available, and is responsible for the production of Breeder and Foundation seed of 18 plant releases. In 2014 the PMC had seed production fields of Anatone Select and 'Goldar' bluebunch wheatgrass, 'Delar' small burnet, 'Bannock' thickspike wheatgrass, 'Regar' meadow brome, 'Appar' blue flax, 'Vavilov II' Siberian wheatgrass, Amethyst hoary tansyaster, Richfield firecracker penstemon and Maple Grove Lewis flax. This year the PMC shipped 2,145 pounds of seed to commercial seed growers. Seed growers should contact the University of Idaho Foundation Seed program or the Utah Crop Improvement Association to request Foundation or early generation Certified seed.

'Regar' meadow brome seed production field.

The PMC has been working with Yellowstone National Park since 2009 to produce seed for restoration in the Park. In 2014 we produced seed of Sandberg bluegrass and bluebunch wheatgrass. The grasses are being used to restore lands within the Park that had previously been in production agriculture many years ago.

The PMC is similarly working with Grand Teton National Park to increase seed of source collections from the Park to be used for restoration projects. The PMC is currently growing Idaho fescue for the Park for restoring lands that were previously in production agriculture. Next year we will be installing new fields of blue wildrye, mountain brome and three native forbs, sulphurflower buckwheat, showy goldeneye and one-flower sunflower.

Forage Kochia

Rangeland wildfires are an ever-growing problem in the Intermountain West. The PMC recently installed a study to demonstrate and evaluate accessions of forage kochia (*Bassia prostrata*) in an alternate row seeding with Hycrest II crested wheatgrass in a simulated green stripping or fire break planting. 'Snowstorm' forage kochia was released in 2012 by the USDA Agricultural Research Service in Logan, Utah for improved stature, productivity, and nutritional content compared to 'Immigrant'. Five accessions including Snowstorm and Immigrant were planted in replicated plots in May 2012 at the PMC Fish and Game Farm. Evaluations are being made measuring plant vigor, density and height.

'Snowstorm' forage kochia.

Off-Center Testing

In November 2010 the PMC planted an off-center trial on the Curlew National Grassland in Southeastern Idaho in cooperation with the USDA Forest Service. The trial includes 63 accessions of native and introduced grasses, forbs, and shrubs adapted to the 12 to 16 inch precipitation zone in Southern Idaho and Northern Utah. This site is a valuable resource for Conservation District cooperators, NRCS field staff, Forest Service, BLM and other land managers to get a firsthand look at the plant releases available for conservation seedings on the eastern Idaho Plateaus. Contact the PMC for further information.

Fish Creek bottlebrush squirreltail at the Curlew Off-Center Test site.

In the fall of 2013 the PMC planted a seeding rate study at an off-center site at Skull Valley, Utah. The trial will evaluate the use of higher seeding rates in extreme arid conditions (less than 8" precipitation). Twelve native and introduced species were planted at the standard rate and a 2X rate in a side-by-side comparison. Early data indicate that doubling the seeding rate did not consistently result in significantly greater establishment. Therefore the additional cost for the extra seed may not be justified by the results. A second site is being prepared for a duplicate planting at Coffee Point, Idaho, 25 miles northwest of Aberdeen. This site will be planted in the fall of 2015.

Technology Transfer - New Publications

A number of new or revised publications were completed during the past year – a few are mentioned below:

Technical Notes

- Technical Note 62. Challis, Idaho Field Planting Summary: 1980-2013
- Technical Note 63. Evaluation of Perennial Grasses Used in Cross Wind Trap Strips in Easter Idaho
- Technical Note 65. Planning and Implementing a Seeding in Sage-Grouse Country

Plant Guides

- Leafy spurge
- Rocky Mountain penstemon
- Dahurian wildrye
- Meadow deathcamas
- Plains Pricklypear
- Purple three-awn
- Shadscale saltbush

Website

All Aberdeen PMC publications can be downloaded from the following web-sites:

http://www.id.nrcs.usda.gov/programs/plant.html
http://www.plant-materials.nrcs.usda.gov/idpmc/

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For more information on any PMC projects, please call or email the center with the information at the top of the page.

Native Forbs

The PMC is continuing its work to develop native forb releases for use in pollinator and sage-grouse habitat plantings. We are currently working towards the release of a whorled buckwheat (*Eriogonum heracleoides*) accession from southeast Idaho. This will be a valuable forb/subshrub in the sagebrush steppe and for pollinator plantings in basin and mountain sagebrush and bitterbrush ecological sites. This year, the PMC produced a good quantity of seed which should be enough to supply initial demand when the release is made. Look for the official release this summer or fall.

Whorled buckwheat flowers attract numerous native pollinators in the spring and summer. This plant is common in sagebrush and bitterbrush communities within the 12 to 18 inch precipitation zone.

Staffing Changes

After 35 with the Aberdeen PMC, Boyd Simonson has decided to retire. Boyd started his NRCS career in 1980 as a Bio Science Technician and quickly became an invaluable member of the PMC team. In addition to having a fine attention to detail with regards to PMC seed production, Boyd has made a name for himself as a master fabricator and developer. He has a profound ability to look at a problem and develop a mechanical solution. Over the years, Boyd has designed or improved several pieces of equipment used at the PMC including a machine to lay weed fabric, a machine to quickly fill greenhouse containers with soil, modifications to the Truax Rough Rider range drill, and modifications to the Woodward Flail-Vac seed stripper for harvesting light, airborne seed.

In 2010, Boyd advanced to the position of PMC Farm Foreman. His leadership has been crucial to making

Aberdeen one of the top PMCs in the nation. He has a truly superior work ethic and routinely put in extra hours to complete off-center seeding projects or maintenance of seed production fields. Boyd strongly believes in conservation of the land, and his dedication to the PMC is a testament to that belief. It has been a pleasure to work with and associate with Boyd; he will truly be missed.

Pollinator Plantings

In 2011, the PMC established 5 acres of pollinator habitat at the Fish and Game farm to research management requirements involved in pollinator friendly plantings. Species planted included blue flax, small burnet, western yarrow, annual sunflower, hoary tansyaster, falcate alfalfa, and three native grasses. In 2012, the field provided excellent pollinator forage with all planted species present. Over the years, however, the planting has shown an increase in the presence of invasive weeds. The lack of herbicides available for use in pollinator plantings to control broadleaf weeds is a major concern. We are planning to maintain this planting through 2021 to follow trends in species composition.

Blue flax, sainfoin, yarrow and small burnet can be seen in this photo of the PMC pollinator planting in 2012.

In 2013, we planted six commercially available wildflower seed mixes designed for use in western North America into non-replicated plots to determine which species are well adapted to conditions in the PMC service area and contribute to pollinator foraging. As it turns out, not all mixes are created equally. Some mixes have a variety of native and introduced annuals and perennials for a showy display. Others are designed to represent native western plant communities or to be highly drought tolerant. Clear objectives and an understanding of the species composition are vital to choosing the most appropriate mixture. The plots will be maintained for display and observation and as a food source for pollinators at the PMC.

One of the wildflower mixes planted in 2013. Several native and introduced species can be seen.

Breeder, Foundation, and Cooperative Seed Production

The Aberdeen PMC produces the highest quality conservation seed available and is responsible for the production of Breeder and Foundation seed of 18 plant releases. In 2015, the PMC had seed production fields of Tegmar intermediate wheatgrass, Amethyst hoary tansyaster, Anatone bluebunch wheatgrass, Regar meadow brome, Vavilov II Siberian wheatgrass, Goldar bluebunch wheatgrass, and Maple Grove Lewis flax. Seed growers should contact the University of Idaho Foundation Seed program or the Utah Crop Improvement Association to request Foundation or early generation Certified seed.

'Regar' meadow brome seed production field.

National Park Service

The PMC has been working with Yellowstone National Park since 2009 to produce seed for restoration efforts in the park. In 2015 we produced seed of Sandberg bluegrass and bluebunch wheatgrass. The grasses are being used to restore lands within the park that had previously been in production agriculture many years ago.

The PMC is similarly working with Grand Teton National Park to increase seed of source collections from the park to be used for restoration projects. The PMC is currently growing Idaho fescue, blue wildrye, mountain brome and three native forbs: sulphur-flower buckwheat, showy

goldeneye and one-flower sunflower, for restoring lands that were previously in production agriculture.

Showy goldeneye seed production for Grand Teton National Park.

This year, the PMC began a new project growing containerized rushes and sedges for Yosemite National Park. The park is relocating a parking lot currently located in the floodplain of the Merced River. Approximately 4 acres of former parking lot site area is to be restored to black oak woodland and palustrine wetland within the riparian buffer.

Flail-Vac Modification for Forb Seed

Two obstacles to native forb seed production are the characteristics of indeterminate ripening and light airborne seed that evolved for easy wind dispersal. For optimum seed yields, indeterminately ripening species require multiple harvests to capture seed as it ripens and before it disarticulates from the flower and falls to the ground. Light seeded species such as hoary tansyaster are particularly difficult to harvest without losing significant amounts of seed to shatter and wind. This year, the PMC modified a Woodward Flail-Vac Seed Stripper by adding loops of heavy chain to the front that agitate ripe seed off of the flowers without damaging the plants or immature seed heads. This simple modification dramatically increased yields in our hoary tansyaster fields, and it should be applicable to a wide range of species with similar characteristics.

Drop chains added to the front of a Flail-Vac Seed Stripper release light airborne seed into the air and into the harvester. The plants remain undamaged for subsequent harvests.

Seeding Rate Study

In fall 2013, the PMC planted a seeding rate study at an off-center site in Skull Valley, Utah. The trial was designed to evaluate the use of higher seeding rates in arid conditions (less than 10” precipitation). Twelve native and introduced species were planted at the standard rate as well as a 2X rate in a side-by-side comparison. Early data indicate that doubling the seeding rate did not consistently result in significantly greater establishment; therefore the additional cost for the extra seed may not be justified by the results. However, this result may have been due to an exceptionally wet spring at Skull Valley. A replication of this planting was installed at Coffee Point, Idaho, 25 miles northwest of Aberdeen in the fall of 2015 to see if the results were repeatable.

Bozoisky Russian wildrye planted at 6 lbs PLS/ac (left) and 12 lbs PLS/ac (right).

Forb Island Study

New technologies have become available that may improve establishment rates of native forbs by trapping available moisture. The Hollow Frame Fence System (HFFS)

incorporates two parallel, specially designed snow fences that trap snow in uniform, dense drifts that slowly melt and extend soil water availability. N-Sulate fabric is a medium-weight, permeable, UV-treated, and re-usable fabric designed to protect nursery ground beds and vegetable gardens from freezing temperatures and rapid drying of the soil surface. These technologies have the potential to be used to establish forb islands (distinct focal areas where forbs are established). These forb islands could be sources of seed for the colonization of adjacent rangeland areas in subsequent years.

The PMC is cooperating in a study with the FS Shrub Science Lab, ARS Forage and Range Research Lab, Utah State University and Brigham Young University to determine if the patented Hollow Frame Snow System or N-Sulate fabric in combination with seed enhancement technology can be used to successfully establish important Great Basin forbs in islands at three sites in Utah and Idaho.

Hollow Frame Snow Fence and N-Sulate fabric are designed to trap moisture and enhance seed establishment.

Cover Crop Variety Trial

Aberdeen is participating in a multi-PMC trial of several varieties of commonly used cover crop species in an effort to develop accurate recommendations for different regions. Species being tested at Aberdeen include hairy vetch, balansa clover, red clover, crimson clover, radish and black oat. The initial trial was established in the spring of 2015, and a second replication will be planted in 2016.

Cover Crop Herbicide Study

A major concern with the use of fall cover crops is whether it will overwinter and become a problem in the following crop. Species selected for their winter kill attributes can survive if temperatures don't drop sufficiently, or their cold tolerance is not adequately understood. This fall, the PMC planted several plots of cover crop species with potential to overwinter in Aberdeen in order to conduct herbicide trials next spring. Pam Hutchinson (UI Extension) and Marlon Winger (NRCS Regional Soil Health Specialist) will be assisting with the trial.

Training

This past summer, the PMC cooperated with Utah State Rangeland Management Specialist Shane Greene, and Utah State Biologist Casey Burns to provide a training course regarding plantings in arid sites in Utah. The Arid Lands Course was held for five days at the USFS Desert Experimental Range in Millard County, Utah. Staff from NRCS field offices and other agencies participated in in-class training, brainstorming sessions, visited test plots, and developed seeding plans for various scenarios. A special thanks to Stan Kitchen of the USFS Shrub Science Lab for being such a gracious host.

Technology Transfer - New Publications

A number of new or revised publications were completed during the past year – a few are mentioned below:

Technical Notes

- Technical Note 64. Review of the Lawson Aerator for Brush Management

Plant Guides

- American Vetch

Journal Articles

- Seed production and field establishment of hoary tansyaster (*Machaeranthera canescens*). Native Plants Journal.

- Notice of release of Amethyst Germplasm Hoary Tansyaster: Selected Class of Natural Germplasm. Native Plants Journal.

Website

All Aberdeen PMC publications can be downloaded from the following web-sites:

http://www.id.nrcs.usda.gov/programs/plant.html
http://www.plant-materials.nrcs.usda.gov/idpmc/

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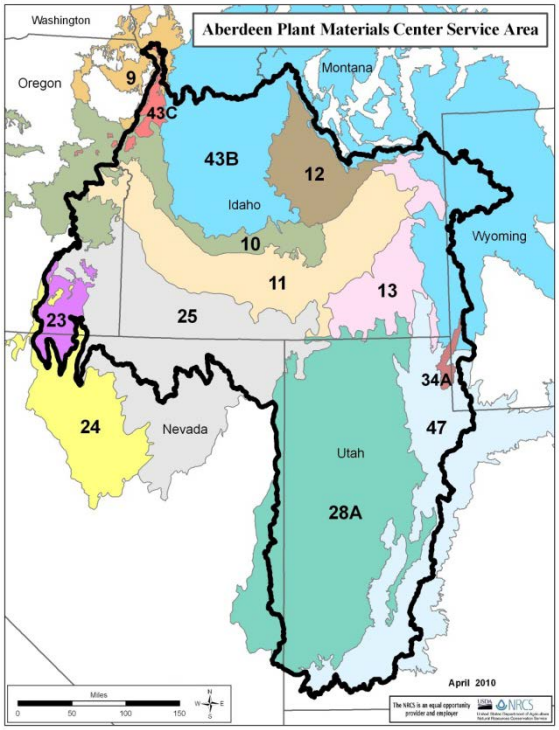
ABERDEEN PLANT MATERIALS CENTER

INTERMOUNTAIN PLANT NOTES

A newsletter to inform you about activities at the Aberdeen Plant Materials Center

The Aberdeen Plant Materials Center (PMC) was established in 1939 to develop plant materials and techniques for establishment and management of plants for use in resource conservation activities in the Western United States. There are 27 Plant Materials Centers nationwide, each serving specific geographic and ecological areas. The Aberdeen PMC service area covers 83 million acres of the Intermountain West encompassing southern Idaho, western Utah and parts of northern Nevada, western Wyoming and eastern Oregon.



PMC service area map with overlay of Major Land Resource Areas (MLRAs).

In March, the NRCS National Plant Materials Program announced a new Plant Materials Center Improvement Effort. It was determined that in order to address budget challenges, PMC operations would be stratified into different tiers for contributing to agency priorities. Nine PMCs, including Aberdeen, will be designated Tier A centers with a staff of 4-5 Full Time Employees (FTEs). The remaining PMCs will be Tier B PMCs with 2-3 FTEs.

PMCs have also been assigned areas of focus to insure that the limited staff and resources are utilized to their fullest efficacy. Aberdeen's primary focus will be improving habitat for at-risk wildlife species such as sage-grouse. The second study area will be grazing land health to improve range and pasture productivity and increase plant species diversity.

We look forward to implementing the new Improvement Effort and continuing our efforts to conserve the natural resources in the Intermountain West.

Foundation/Early Generation Certified Seed Production

A major responsibility of the PMC is the production of Foundation and early generation Certified Seed of the plant releases made by the Center. The releases currently in production are: Anatone and 'Goldar' bluebunch wheatgrass, 'Regar' meadow brome, 'Appar' blue flax, Maple Grove Lewis flax, 'Vavilov II' Siberian wheatgrass, Richfield select firecracker penstemon, 'Delar' small burnet and 'Bannock' thickspike wheatgrass. Seed growers may contact the University of Idaho Foundation Seed Program or the Utah Crop Improvement Association to request Foundation or early generation Certified seed.

Display Plantings

Pollinator Display

In May of 2011, the PMC planted 5 acres of pollinator habitat at the PMC Fish and Game Farm. The planting contains a mixture of forbs chosen to provide a variety of flower shapes and colors throughout the growing season. The whole planting is irrigated to simulate a 14 to 16 inch

precipitation area. The display is being evaluated to develop management strategies for use in pollinator and wildlife friendly plantings. It is also a good visual tool for NRCS field office staff and other land managers.

Curlew National Grassland

In the fall of 2010, PMC staff planted a multi-species off-center evaluation on the USDA-Forest Service, Curlew National Grassland located 30 miles south of American Falls, Idaho in cooperation with the Caribou/Targhee National Forest. The trial includes over 60 accessions of primarily native grasses, forbs and shrubs adapted for use in MLRA 13 Eastern Idaho Plateaus (13 to 18 inch plus precipitation areas). The PMC is evaluating the plots for establishment and performance. For more information or to arrange a site visit, contact the PMC.

Plant Selection and Development

The PMC is in the early stages of seed production prior to the official release of Douglas' dustymaiden, hoary tansyaster and whorled buckwheat. The initial evaluations for these species were completed in 2010 and the best rated accessions were identified for seed increase and release. These native forbs are important food sources for pollinators and will benefit sage-grouse habitat restoration. These accessions will be officially released to growers when the PMC has bulked up enough seed to satisfy expected demands.

Soil Health

Soil Health and Cover Crop Tour

On June 12, we will be hosting a soil health and cover crop tour. Marlon Winger, NRCS Idaho State Agronomist will be speaking and showing demonstrations on how to improve soil health in conjunction with Idaho agriculture. In the afternoon we will be touring the new cover crop display planting to get a look at the many available species that can be used in our area. Presentations start at 9:00 am at the PMC office. Call Derek Tilley at 397-4133 for more information.

Cover Crop Display

In late April the PMC planted a cover crop display at the Home Farm that includes 40 species. The new display is arranged into blocks of cool season grasses, cool season broadleaf plants, legumes, warm season broadleaf plants and warm season grasses. When developing a cover crop seeding mixture, it is important to include as many functional groups as possible to increase diversity and fill above and below ground niches to support the greatest species richness of microorganisms. Contact the PMC for a map or to arrange a visit. We also plan to install an additional display of the same species this summer to observe how they overwinter.

Cover Crops for Wind Erosion Protection

Wind erosion is a major problem throughout the Aberdeen PMC service area. Wind erosion removes the most fertile part of the soil (organic matter, clay, and silt) and lowers soil productivity. Cover crops and crop residues reduce wind erosion by reducing the wind velocity at the soil surface and by increasing the size of soil aggregates. Last August, we installed a trial to evaluate the cover value of several cover crop species. Nine individual species were planted along with a cocktail mix composed of the same nine species.

Each of the functional groups examined filled a specific niche in providing soil protection. Mustards provided early dense cover in the fall and developed a protective coating of leaf tissue in the spring. Small grains like wheat and oat, with their vertical stature, added moderate amounts of cover but also added height in the fall and spring to reduce surface wind speed. Legumes, while limited in their fall cover value, added soil nitrogen for growth. Over wintering legumes such as hairy vetch also provided spring cover and a living root system which feeds the soil micro-fauna. The cocktail mix did not provide the best ranking of any of the three evaluated characters, but did offer a combination of traits not available from a single species.

Cocktail mix 30 days after planting.

Legume Winter Kill Evaluation

Cover crops have been shown to mediate soil erosion, increase water infiltration, improve soil biodiversity, and increase organic matter. Additionally, legumes in a symbiotic relationship with Rhizobium bacteria have the further benefit of fixing soil nitrogen into a form useable by other plants. To better ascertain which legume cover crops naturally winter kill and which overwinter and require termination in our region, the Aberdeen PMC installed a multi-species trial of several legumes suggested for use in Idaho. Nine commonly used legume cover crop species were planted last August including chickling vetch, sun hemp, chickpea, berseem clover, spring pea, cowpea, lentil crimson clover and hairy vetch.

All species with the exception of chickpea and berseem clover established good stands. At 70 days after planting (October 16) the sun hemp had already died from early frosts. On March 24, the following spring, only hairy vetch and crimson clover were still alive. Hairy vetch produced 3300 lbs/ac of above ground biomass and crimson clover produced 1500 lbs/ac of biomass.

Crimson clover plants showing frost damage in early March. By the end of the month, these plants had mostly recovered and were actively producing nitrogen.

Radish Bolting

One of the workhorse species for cover crop plantings is radish. Radishes provide excellent cover and produce a large taproot capable of penetrating hard soil pans. Typical plantings in August produce good above ground growth and root development before going dormant in the fall; however if planted too early in the season, the radish will simply bolt and put out flowers instead of developing a robust plant. This year we are evaluating five radish varieties to determine which may be amenable to earlier planting dates for use in full-season cover crop seedings. Small plots of each variety are being seeded each month and evaluated for root growth, above ground biomass and date of flowering.

This radish was planted late in the season and did not flower before the first frost.

Technology Development

Seeding rate studies

There is some old wisdom that says in lower precipitation areas you should plant fewer seeds than the standard rate. The reason being that there is less moisture to go around and every rain drop or snowflake should be allocated to fewer competitors. The other side to this debate says higher seeding rates means more chances for establishment and if a plant doesn't establish then competition really doesn't matter. To test these ideas we installed a seeding rate study at Skull Valley, Utah in a 6 to 8 inch precipitation area. The site was planted last year to 12 species at 1X and 2X the standard drill rates. A twin trial will be planted at Coffee Point northwest of Aberdeen this fall. We will be monitoring these plantings for the next few years to evaluate establishment and persistence and hopefully come to some conclusion regarding seeding rates for low precipitation areas.

Cooperative Seed and Plant Production Projects

IDARNG Globemallow

In 2011 the PMC installed a planting of

globemallow to produce seed for the Idaho Army National Guard for revegetating their rangeland training areas. Seed was harvested in 2012 and 2013 and will be harvested one last time this year.

Globemallow grown in weed barrier fabric.

Yellowstone and Grand Teton National Parks

The PMC is producing seed for the conversion of historical agricultural lands in Yellowstone National Park back to native rangeland. Seed production fields of Sandberg bluegrass, bluebunch wheatgrass and needle-and-thread were planted in 2009 and harvested for seed in 2010 -2012. New fields for bluebunch wheatgrass and Sandberg bluegrass were planted in 2013 and will be harvested this year. The PMC is also currently producing Idaho fescue seed for use in restoration projects in Grand Teton National Park. The PMC has worked with Grand Teton NP since 2006 to produce slender wheatgrass, Sandberg bluegrass, blue wildrye and mountain brome seed.

Public Information Activities

New, Revised or Updated PM Technical Notes

- TN-62 Challis, Idaho Demonstration Plantings Summary
- TN-63 Evaluation of Perennial Grasses Used in Cross Wind Trap Strips in Eastern Idaho
- TN-57 cutting Storage (update)
- Planning and Implementing a Seeding in Sage-Grouse Country (in review)
- What to do with Pivot Corners (in review)

Plant Guides

- Rydberg's Penstemon
- Thickleaf Penstemon
- Palmer's Penstemon
- Rocky Mountain Penstemon
- Plains Pricklypear Cactus
- Purple Three-awn
- Leafy Spurge
- Shadscale Saltbush
- Meadow Deathcamas
- Dahurian Wildrye

Presentations

- Fundamentals of Rangeland Seeding: Emphasis on Sage-Grouse Habitat & Sagebrush Ecosystems
- Developing Seed Mixes for Sage-Grouse Habitat Restoration
- Great Basin Native Plant Project
- Idaho Rare Plant Conference

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TECHNICAL NOTE

USDA - Natural Resources Conservation Service
Boise, Idaho

Plant Materials Technical Note No. 64 **July 2015**

Review of the Lawson Aerator for Brush Management

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Brendan Brazee, NRCS State Rangeland Management Specialist, Boise, Idaho
Scott Engle, NRCS Area Range Conservationist, Pocatello, Idaho
Rusty Norrie, NRCS Rangeland Management Specialist, Weiser, Idaho

A Lawson Aerator used to reduce sagebrush cover. Photo from USDI-BLM.

This Technical Note provides a review of the Lawson Pasture Aerator® for use in rangeland brush management practices. The Aerator has been shown to be effective at reducing sagebrush cover and opening spaces for grasses and forbs to increase. The Lawson Aerator creates less ground disturbance or soil erosion than other methods and provides an aesthetically pleasing finished treatment. This does not constitute an endorsement from NRCS. Other brands may exist which perform similarly.

Uses

- Brush control
- Pasture/Hay field aeration
- Reseeding of perennial grasses

Requirements

- 120-350 horsepower tractor (depending on size and weight of aerator, tree/shrub size and terrain)

Advantages

- Less ground disturbance or soil erosion than other methods
- Aesthetically pleasing (does not look disturbed one year post-treatment)
- Effective with trees and shrubs with stems <6 inches in diameter
- Creates catchments for water infiltration
- Increases herbaceous cover and available forage
- Creates good seeding conditions for perennial grasses (when competition is minimal)
- Can stimulate new growth of certain shrub species

Disadvantages

- Less effective on rocky ground
- Retreatment required periodically to maintain desired shrub densities
- Not effective to introduce forbs via seeding

A Lawson Aerator treating sagebrush in Nevada. Photo by NRCS Nevada.

Introduction

Historical overgrazing of sagebrush steppe habitat has led to reductions in cool-season perennial grasses and forbs and increases in sagebrush cover. The result in some cases is a dense stand of similarly-aged sagebrush with little understory. Proper management of shrub communities targets an assortment of shrubs, forbs and perennial grasses selected to support a diversity of wildlife. In these instances, it is desirable to introduce prescribed disturbance into sagebrush stands to create openings for forbs and grasses and for the revitalization of the shrub component.

Fire has been used historically to treat large areas of sagebrush steppe; however recovery can take many decades (Bunting et al. 1987). Chemical treatment is also a suitable alternative and is often more cost effective than mechanical control (Dahlgren et al, 2006; Greenwood, 2004). This paper focuses on the Lawson Pasture Aerator as a means for reduction of shrub cover with the intent of increasing forage value and plant diversity.

Spiral-Blade Choppers

The use of spiral-blade choppers, often called aerators or renovators, has gained popularity since the 1990s, especially in brush-dominated landscapes. They are commonly used as alternatives to chaining, harrowing or herbicide treatment for reduction of shrub cover and for increasing grass or forb components. They are also used in pasture settings to increase water infiltration and reduce soil compaction.

The Lawson Pasture Aerator features one or two drums mounted on a frame similar to an offset disk. Spiral-blade choppers differ from conventional roller choppers in that they use small blades welded to the heavy drums in a staggered, spiral pattern around the drum rather than the elongated, longitudinally mounted blades. Drum diameters vary from 18 to 42 inches and can be filled with water to provide additional weight. The standard width is 12 feet, but options are available to increase widths.

Hand-sized blades on the roller drums of the Lawson Pasture Aerator cut brush and roots. They also aerate the soil and create pockets to catch seed and moisture. Photo by Derek Tilley.

Most aerators are equipped with rubber tires allowing for easy transportation from site to site. Spiral-blade choppers are pulled by a crawler tractor or a four-wheel drive tractor with special tire protection. Tractor horsepower requirements vary between 120 and 350 hp and depend on

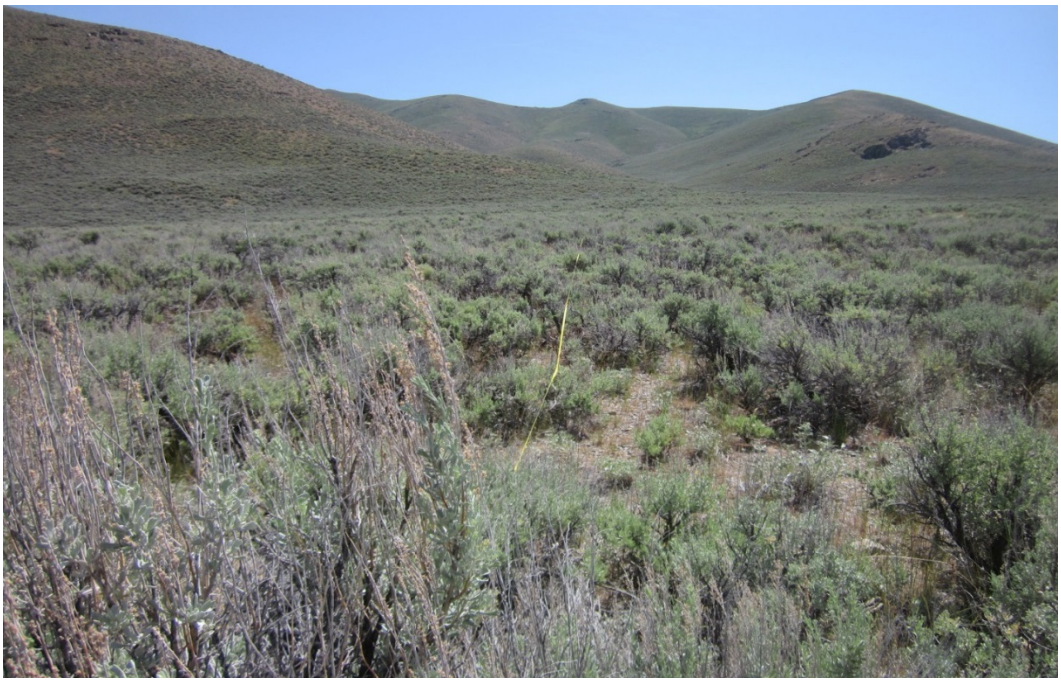
the size and weight of the unit, tree/shrub size, and type of terrain (Cox, 2015). Blade wear can be a problem, especially when used in rocky and sandy soils (Cox, 2015).

Aerators can be equipped with an optional seed box. Seeding is typically used to increase the presence of perennial grasses and forbs; however, most of the increase in herbaceous species results from the reduction of canopy cover, allowing growth of plants in the existing seedbank. Thus seeding may, in many cases, be unnecessary. Introducing seed into areas without adequately controlling or reducing competition can cause problems and lead to poor stands. In sites with a long history of a diminished understory, however, seeding may be required to establish the desired suite of species.

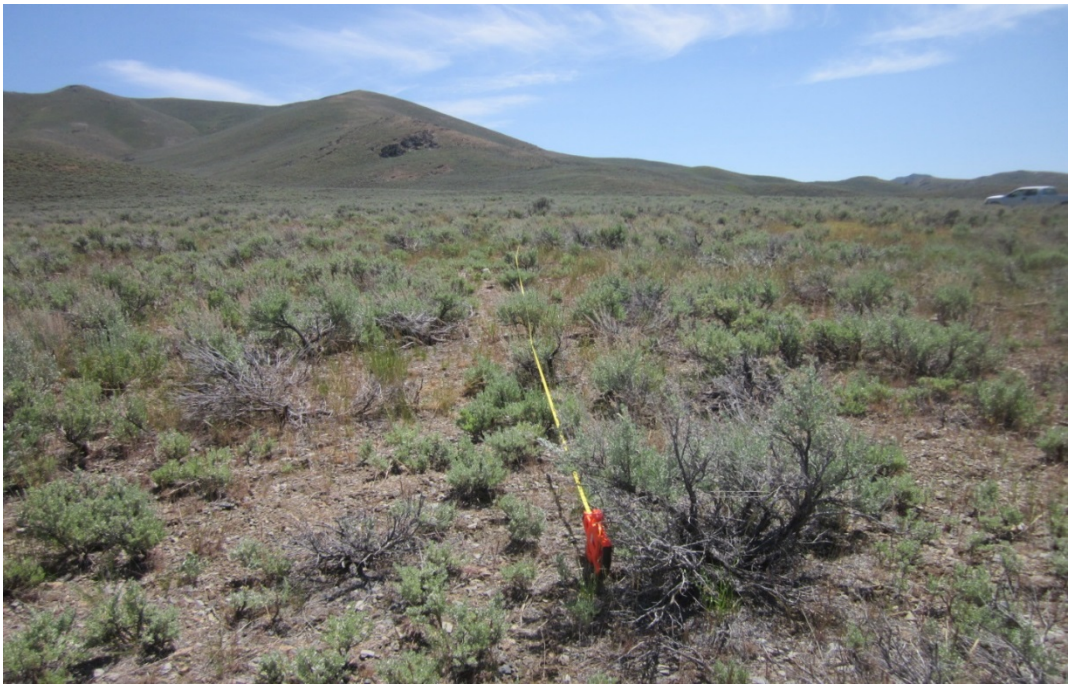
Double-drum Lawson Aerator with optional seed box. Seed is placed into the divots created by the first drum and then pressed in with the second roller. Photo by Derek Tilley.

Passes of an aerator crush sagebrush and other shrubs leaving some plants or partial plants alive (Dahlgren et al, 2006). Dixie harrows, chains and other control methods, in comparison, rip brush out of the ground leaving exposed soil. Aerators thus can provide brush control over relatively large expanses while conserving soil by leaving the residue behind. Bitterbrush plants respond positively to aerator treatment and produce many young shoots. Aerator treatments also leave enough cover and standing brush to provide a more aesthetically pleasing image than many other brush control measures.

Costs for brush control depend largely on the horsepower equipment required to operate the machinery. Dahlgren et al (2006) estimated the cost of running a double drum Lawson Aerator at $30/ac. In comparison, a Dixie Harrow costs between $25 and $30/acre to operate (Dahlgren et al, 2006; Greenwood, 2004). Chemical treatments may be cheaper on a per acre basis. Tebuthiuron applications cost approximately $19/acre (Dahlgren et al, 2006).



Lava Lake, Idaho site untreated area. Photo by Scott Engle.



Lava Lake site, three years post-treatment. Note that the site appears relatively undisturbed. Photo by Scott Engle.

Case Study Results

Pahsimeroi Valley, East-Central Idaho

Yeo (2012) reported data from an experimental treatment of a Wyoming big sage/bluebunch wheatgrass community in central Idaho. Mechanical crushing of sagebrush and other shrubs was accomplished by two passes of a Lawson Aerator during November 2003 after snow had fallen. A rangeland drill was used to seed a mixture of 90% bluebunch wheatgrass and 10% Indian ricegrass at a rate of 10-12 lbs/acre immediately after crushing was completed.

Mechanical crushing with an aerator reduced Wyoming big sagebrush cover 63% from an average of 19% in 2003 to an average of 7% in 2005. By 2012, nine growing seasons post-treatment, average sagebrush cover had increased to 11% cover. Crushing and seeding resulted in substantial increases in bluebunch wheatgrass cover from about 1-2% cover in 2003 to an average of 33% in 2012. The reduction in competition from sagebrush also resulted in increases in squirreltail and needle-and-thread cover, particularly in areas open to livestock grazing. As these grasses were not seeded, their increase is due solely to the reduction of the over story cover.

The percentage of exposed soil in areas treated with crushing fell below pretreatment levels on most treatments (except controls open to livestock grazing) with increased vegetative cover. Biological crusts suffered limited impact from crushing and increased cover with protection from livestock grazing.

Yeo's recommendations for using a mechanical crushing and seeding approach for range improvement in depauperate Wyoming big sagebrush/bluebunch wheatgrass communities include the following: (1) provide a period of nonuse of ~ 4-5 years following crushing and seeding (even longer if special circumstances occur such as drought),(2) institute conservative livestock management for the first 10 years or more, that prioritizes recovery and establishment of vigorous native plant communities in treated areas (e.g. light grazing in mid to late summer following seed set of bluebunch wheatgrass), and (3) in areas where cheatgrass invasion is a concern, managers should consider not implementing this restoration approach unless other methods are available for controlling cheatgrass.

Parker Mountain, South-Central Utah

Dahlgren et al (2006) compared treatments by a Lawson Aerator treatment, Dixie harrow and chemical treatment of Tebuthiuron in a mountain big sagebrush community. Mechanical treatments occurred in autumn 2001. Aerator treatments reduced shrub cover from 39 to 15% after four years, while Dixie Harrow treatment reduced shrub cover from 38 to 19%. The Dixie harrow was more effective than the Lawson Aerator at improving forb cover. Dahlgren et al concluded that the aerator was less effective on rocky soil as the drums "bounced" across the surface. They also noted that the aerator equipment was damaged due to the large rocks encountered.

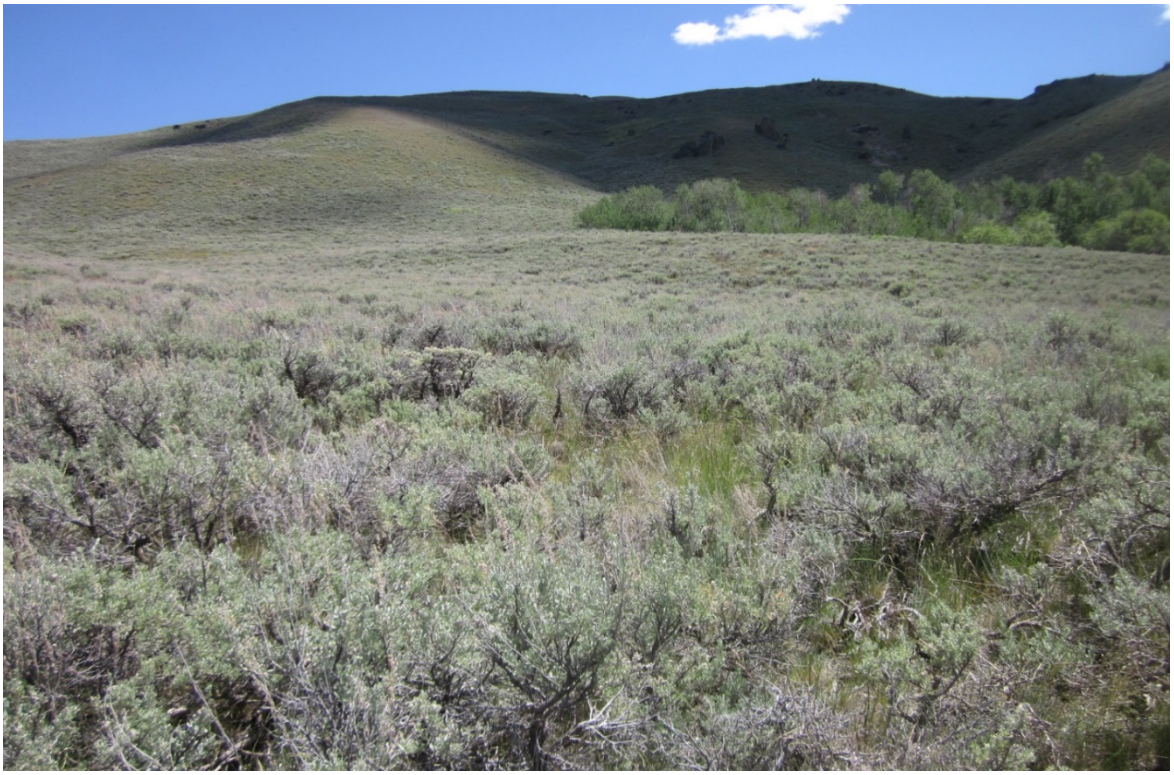
Multiple Sites, Utah
Utah Division of Natural Resources has monitoring data for several aerator treated sites throughout the state of Utah (Gunnel, 2015). Six of those sites had pretreatment shrub cover exceeding 20% and met NRCS standards from shrub treatment. Three of the six sites were dominated by big sagebrush. The remaining sites were dominated by: yellow rabbitbrush, black sagebrush, or greasewood. The sites were all treated with simultaneous aerating and seeding. Averaged across all sites, shrub cover decreased two years post treatment from an average of 32% cover to 16%. After seven years, shrub cover had increased slightly to 19%.

Perennial grasses increased after the Lawson and seeding treatment from 7% to 14% after two yrs. By year seven, the grasses maintained an average of 12% cover. Annual grasses increased 10x in two years after treatment going from 0.1% to 1%. Annual grass cover was still at 1% after seven years. Perennial forbs increased slightly from 3% to 4% after two years and increased slightly to 5% at year seven. Annual forbs increased from 2% cover to 6% cover in two years after treatment but by year seven had decreased back to 2% cover.

Lava Lake, South-Central Idaho
In 2011 NRCS treated a mountain sagebrush site with a double-drum Lawson Pasture Aerator in Blaine County, ID. The site received an average of approximately 16 inches of annual precipitation in gravelly soil. Prior to treatment, the site was recorded as having 32% living sagebrush cover, 10% dead sagebrush cover, 25% perennial herbaceous cover (15% of which was Sandberg bluegrass). No forbs were recorded in the evaluation. The treatment included simultaneous seeding with a forb mix consisting of alfalfa, sainfoin, yarrow, small burnet and flax.

Three years after treatment and seeding, mountain sagebrush live canopy cover was measured at 17%, a 50% decrease. Mountain sagebrush dead canopy cover remained the same at 10% cover. Perennial herbaceous cover increased to 35%, while Sandberg bluegrass cover remained essentially unchanged at 18%.

Very few seeded forbs were seen established in the following years, presumably due to the competition from existing plants. Gains in forage and perennial grasses resulted largely from the opening of the sagebrush canopy. However there was enough competition from the surviving sagebrush and existing forbs and grasses to exclude seeded forbs from establishing.



Lava Lake, Blaine County Idaho untreated. Photo by Scott Engle.

Lava Lake, Blaine County Idaho 3 years after treatment and forb seeding. Photo by Scott Engle.

Conclusions and Considerations

Several options for mechanical brush treatment exist. Know your objectives before selecting which tool to apply, as each option has different limitations and advantages. The selected equipment should be suited to the treatment site. Before any treatment there are several items to consider including, but not limited to: wildlife nesting/brooding, pollinator use, the condition and composition of the herbaceous understory, and the possibility of invasion or spread of cheatgrass, medusahead or other exotic annuals. Steep slopes should be avoided and are generally not recommended for treatment. NRCS Brush Management standards recommend treating areas with slopes of less than 25%.

Brush treatment in sage-grouse habitat requires additional consideration. NRCS practice standards indicate that, for areas of native rangeland identified as sage-grouse habitat, brush management will not be considered for any woody species, unless the percent composition of the target species within the present plant community significantly exceeds that listed as potential on the associated ecological site description, and/or the percent cover using line-point intercept exceeds 25 percent. To provide optimum breeding and brood rearing habitat for sage-grouse, treatments should be designed to thin the sagebrush canopy; remove patches of sagebrush to provide a mosaic of early seral vegetation within mature sagebrush stands; reduce the competition between mature sagebrush and the herbaceous understory; and increase the vigor, productivity, and diversity of herbaceous species. When planning within sage-grouse habitat, NRCS will utilize guidelines identified in the Idaho State Sage-grouse Plan.

To minimize unwanted negative effects on wildlife nesting, fawning or calving, most land managers recommend conducting brush control treatments in the fall (Greenwood, 2004). Fall treatments can broadcast and plant mature seed from on-site grasses and forbs, and it is the recommended time for additional seeding. NRCS standards prescribe conducting treatments during periods of the year that accommodate reproduction and other life-cycle requirements of target wildlife and pollinator species. Treatments must also be in accordance with specifications developed for Wetland Wildlife Habitat Management and Upland Wildlife Habitat Management. In areas of sage-grouse leks, nesting, and brood rearing habitat, mechanical treatments will only be conducted in the fall or early winter.

Mechanical disturbance of sagebrush communities for wildlife habitat should be done in a mosaic pattern. Sage-grouse favor edges, where plant communities change from dense shrub cover to open areas with abundant forbs and grasses. Dahlgren et al (2006) recommends treated swaths 30-160 m wide and untreated swaths 30-80 m wide for sage-grouse habitat. Greenwood (2004) recommends 50:50 or 60:40 treated to untreated ratios to meet multiple use values. Similarly, Yeo (2012) recommends 30 m treated and 30 m untreated swaths.

Choose a method of control that results in the least amount of soil disturbance if soil erosion potential is high and revegetation is slow or uncertain leaving the site vulnerable to long-term exposure to soil loss. Use Ecological Site Description (ESD) State and Transition models to determine if proposed actions are ecologically sound and defensible.

Disturbance and revitalization are only partial measures. Adjustments in management are often required to produce long-term changes in plant community composition. Without changes in management, treated sagebrush will likely slowly revert back to dense stands in several years.

Appendix 1. Comparison of brush removal equipment

	Lawson Pasture Aerator	Dixie Harrow	Anchor Chains	Offset Disks	Brush Mowers	Flail Shredders and Masticators
Tree removal			X			Depends on size (6+ in)
Brush removal	X	X	Ely and disk *	X	X	X
Land smoothing			X	X		
Seedbed prep	X	X	X	X		
Aeration	X			X		
Tractor	Single tractor or crawler	Single tractor or crawler	Two Crawlers	Single tractor or crawler	Single tractor	Single tractor
Required HP	120-350	45-425	140-350	70-350	35-150+	35-150+
Effective treatment width	12-16 ft	27-43 ft	100-200 ft	8-15 ft	5-20 ft	
Limitations	Not effective on rocky ground	Poor control of flexible shrubs	Non-selective treatments of large areas	Not good with excessive timber or rocks; highly destructive	Generally limited to brush <6 in in diameter	
Positive Points	Aeration; simultaneous seeding; selective treatment	Removes small shrubs; selective treatment	Tree removal; good on uneven terrain	Excellent seedbed preparation		
Comparative Ground disturbance (1-10)*	2	5	3 (smooth); 5-8 (Ely)	5-10	1	1

*Anchor chains come in three varieties: smooth or non-modified chains, Ely chains with small sections of railroad iron welded on every other segment, and disk chains with agricultural disks welded to the segments.
**1 minimal disturbance, 10 severe disturbance.

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United States Department of Agriculture

Natural Resources Conservation Service

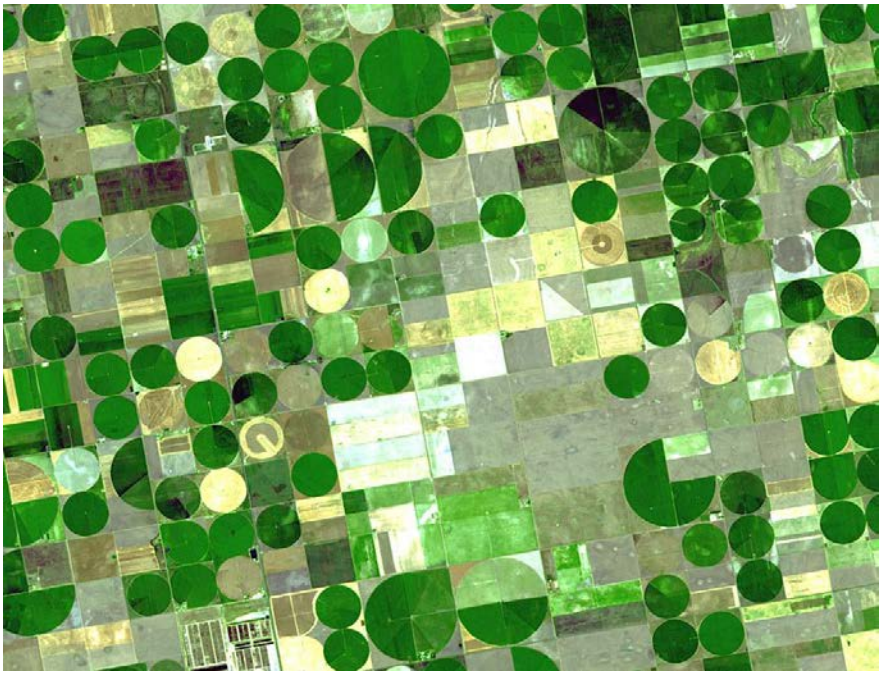
West National Technology Support Center

Plant Materials Program

March 2016

Plant Materials Technical Note No. 1

What To Do With Irrigation Pivot Corners



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Acknowledgements

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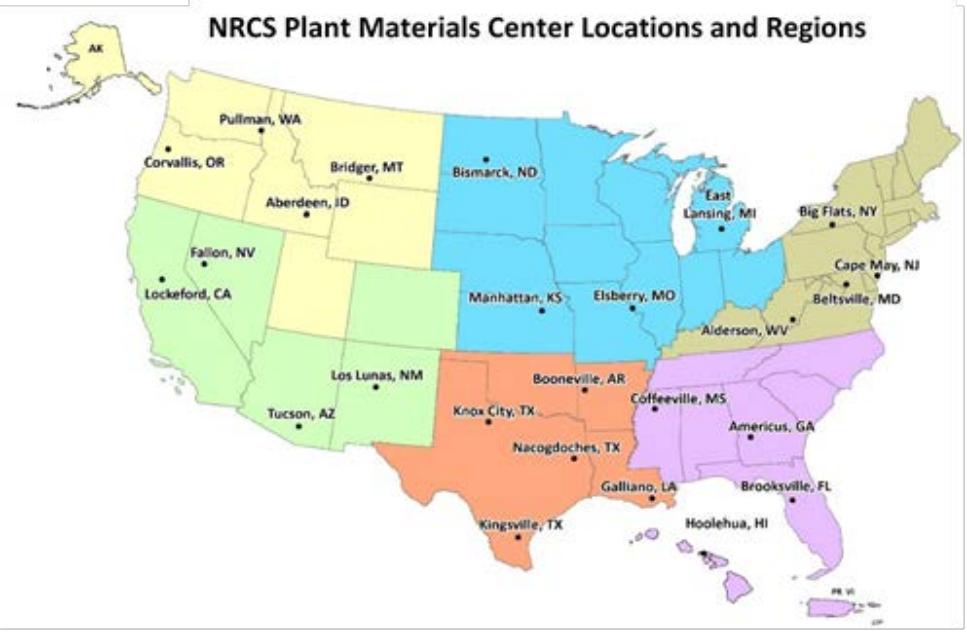
Preface

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Plant Materials Program has been involved in the evaluation of conservation plants and planting technology for more than 75 years. Unused irrigation pivot corners represent a substantial loss of useable acreage. These often neglected areas can be utilized in a variety of ways that can be beneficial to the land owner and to the land. Pivot corners may be used for alternate crops, as filters to trap sediment and nutrients, and for pollinator and wildlife habitat. Plant Materials Centers in the western US have developed technical information and species recommendations which are useful when considering what to plant in pivot corners.

For additional information on specific species of plants mentioned in this publication, please see the USDA PLANTS database at: (http://plants.usda.gov/java/) or contact the nearest Plant Materials Center or plant materials specialist (http://plant-materials.nrcs.usda.gov/contact/) and/or the Land Grant Universities that serves the State. For specific information on soils and soil health, please see USDA NRCS soils website at: (http://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/). Also, see technical resources on the National Plant Materials Program Web site at: (http://www.plant-materials.nrcs.usda.gov/).



What To Do With Irrigation Pivot Corners

In 1948, center pivot irrigation was invented as a means to improve water distribution in crop fields. This was a great improvement in water distribution compared to flood irrigation, however, center pivots have created a new dilemma: the pivot corner. Pivot corners are troublesome. Square parcels with a circular system leave unused corners that can amount to 15 to 20% of the available area in a square parcel. The result is a large portion of unused ground that could be used to help bring in pollinators, insects, wind breaks or other beneficial practices.

The most common solution to pivot corners is to leave it empty or ignored. Unaddressed corners can be difficult to manage and can quickly become a weed patch and a source of contamination to the surrounding fields. Mechanical and/or chemical fallow practices can be used to control weeds, but these are time consuming and expensive, causing the farmer to spend valuable resources managing ground with no production value or benefit.

Standard pivot circle (left) next to a pivot with a swing arm (right) near Aberdeen, Idaho. Image from Google Maps.

Technological innovations have provided a few additional options to get value out of pivot corners. Linear or lateral move irrigation systems are designed for rectangular parcels of land. End guns and swing arms extend the reach of the center pivot system into the corners bringing more land under production. The equipment for these systems is expensive, but the additional expense involved may be recouped with the increased available acreage of high value crops. Portable hand lines, wheel lines, drip irrigations systems and pod systems can also be installed into pivot corners to work in conjunction with the pivot.

An additional option is the use of smaller pivots to fill the corners and interspaces. Smaller circles situated in the corners left by larger circles effectively fill unused space providing more farmable land. Smaller pivots also eliminate the need for swing arms and provide more uniform water distribution.

Small pivot circles fill the gaps between large center pivots near St. Anthony, Idaho. Image from Google Maps.

Alternative Crops

Pivot corners can also be used to produce alternative crops that do not have as strict requirements as the primary crop. In Utah, unused pivot corners are used to grow alfalfa and alfalfa-grass hay and pasture using pod irrigation systems and hand lines. In the Mid-Western states, pivot corners are being seeded to

perennial grass production for biofuels. Grass seed production may also be an option in certain areas.

Pollinator Habitat

Unused pivot corners are an ideal location for pollinator plantings. Pollinator plantings rich in wildflowers are known to provide nectar and pollen for bees, butterflies, wasps and other insects. Many of the world's crop species benefit from insect pollination; in North America, bees pollinate billions of dollars' worth of crops annually. Nearly one quarter of our diet comes from crops whose production benefits from pollinating bees.

A diverse wildflower mix can provide food and habitat to pollinators, beneficial insects and other wildlife. Photo by Derek Tilley, USDA-NRCS.

Pollinators, including bees, moths, flies, beetles, wasps, desert bats, hummingbirds, and butterflies, are critical to the function of terrestrial ecosystems because they enhance plant reproduction. Despite their importance, pollinators are threatened world-wide by habitat loss, habitat fragmentation, improper pesticide use, disease and parasites. This has serious economic implications for humans and for maintaining ecosystem diversity and stability.

Effective pollinator plantings contain a diversity of flowers that bloom through the entire growing season to provide a steady supply of nectar and pollen. This means having flowers of different colors, shapes and sizes that blossom in the spring, midsummer and late summer to early fall.

Insectaries

Insectary plantings are similar to pollinator plantings but are used as a component of integrated pest management (IPM). These plantings are specifically designed to attract beneficial insects like lacewings, ladybird beetles, parasitoid and predatory wasps and flies to the adjacent crop for biological control of crop pests. Buckwheat, for example, has been shown to attract beneficial predatory insects that can be used to control Colorado potato beetle. Mints, daisies, Queen Anne's lace, alyssum and milkweed are also known to attract beneficial insects. Diverse floral mixtures should be used to attract a broadest array of beneficial insects.

A ladybug eating an aphid. Photo from NSF.gov

Cover Habitat and Permanent Cover

Pivot corners can be used to support other types of wildlife in addition to beneficial insects. A mixture of perennial grasses, forbs and shrubs can provide much needed habitat to support wildlife including upland birds and mammals in an ever expanding sea of agriculture. Tall-statured bunch grasses like basin wildrye and tall wheatgrass provide excellent cover for game birds such as pheasants. Trees can also be planted to provide wind protection and to serve as sheltered areas for wildlife.

Tall wheatgrass borders a wheat field providing soil stability as well as cover for wildlife. Photo by Howard Johnson.

In highly erosive soils, a permanent cover of perennial grasses can reduce wind erosion by providing a protective layer over the soil and by supporting the below ground life needed for healthy soil. Areas of permanent cover require little if any management once established. Drought tolerant grasses like crested wheatgrass, Siberian wheatgrass and intermediate wheatgrass are very effective at protecting loose soils in areas that get little to no supplemental irrigation. A mixture of bunch grasses and sod forming grasses provide structural diversity and decreases the amount of bare ground susceptible to erosion. Low growing grasses such as sheep fescue can create a clean aesthetically pleasing look with low maintenance.

Tree plantings, similar to the multi-species windbreak above, can reduce wind speeds and decrease soil erosion. They also serve as cover and nesting sites for birds. Photo by Dan Ogle.

Considerations

When working with pivot corners it is important to consider the surrounding areas. Any species planted in pivot corners should be compatible with the management strategies of the primary crops. For example, plants that serve as hosts to diseases or pests that might affect adjacent crops should be avoided. It is also important to understand the prevailing wind direction and how that will influence water availability. Downwind corners may be suitable for a certain suite of species, while upwind corners may need more drought tolerant options.

Site Preparation

Site preparation is a critical and often overlooked step in plant establishment, especially in non-irrigated systems. In the western United States, inspection of hundreds of plantings in the past 65 to 70 years have shown the most common cause of conservation seeding failures is from poor seedbed preparation. How it is approached depends on variables such as topography, project scope, site disturbance, likelihood of weed invasion, and cost. On smaller, more intensively managed landscapes like pivot corners, conventional agronomic site preparation such as disking and plowing may be advisable. Good site preparation measures will improve seed to soil contact and stand establishment.

Typical Protocols for Preparing a Seedbed on non-irrigated ground.

1) Shred or burn existing litter 2) Apply herbicides 1st spring, again in fall if green-up occurs 3) Apply herbicides 2nd spring, again in fall if green-up occurs 4) Plant new seed mixture as a dormant planting	OR	1) Plow 1st spring 2) Disk 1st fall 3) Disk 2nd spring 4) Disk 2nd fall and mechanically prepare final seedbed 5) Plant new seed mixture as a dormant planting

A firm seed bed (left) leaves a boot print approximately ½ inch deep, while a loose seed bed (right) leaves a much deeper print and needs additional firming with a packing implement. Photos by Derek Tilley, USDA-NRCS.

It is important to remember that these are starting recommendations. Each situation is different and may require variations to this starter recommendation. The ideal seedbed is uniformly firm, has soil moisture near the surface, is free from competing vegetation and is well-packed underneath with small surface clods or a light mulch of residue to prevent erosion.

See Idaho Plant Materials Tech Note 10: Pasture and Range Seedings Planning-Installation-Evaluation and Management, or Washington Tech Note 6: Seedbed Preparation and Seed to Soil Contact, for information on planning and implementing seeding projects.

Weed Control

For successful establishment, seeding fields with significant weed populations must be delayed until weeds are controlled. Refer to the Pacific Northwest Weed Management for information on herbicides that can be used for weed control during seedbed preparation and establishment. Other sources of information include extension specialists, county weed control supervisors and chemical dealers. Guidelines for Integrated Pest Management are available in the electronic Field Office Technical Guide (EFOTG) section IV, Practice Standards. Always read and follow label instructions when applying herbicides.

Species Selection

Species selection depends on a number of factors. These include the desired use (erosion control, upland bird cover, and pollinator habitat), normal annual precipitation (how much and when, or if supplemental irrigation is available), soil features and yearly high and low temperatures.

Understanding these differences is key to choosing species that are adapted and are likely to establish and persist. Contact your local Plant Materials Center or Specialist or check the following references for suggestions on adapted plants in your area. Note that documents from one State may be useful for some areas in adjacent States.

Idaho
ID Plant Materials Technical Note 24. Conservation Plant Species for the Intermountain West

ID Plant Materials Technical Note 2a. Plants for Pollinators in the Intermountain West

Montana
MT Plant Materials Technical Note 46. Seeding Rates for Conservation Species for Montana

MT Plant Materials Technical Note 20. Creating Habitat for Pollinator Insects

New Mexico
NM Plant Materials Technical Note 69. Selecting the Appropriate Native Plants for Revegetation and Restoration Purposes in the Southwest

Oregon
OR Plant Materials Technical Note 13. Plants for Pollinators in Oregon

Utah
ID Plant Materials Technical Note 2c. Plant Materials for Pollinators and Other Beneficial Insects in Eastern Utah and Western Colorado

Washington
WA Biology Technical Note 24. Plants for Pollinators in the Inland Pacific Northwest

The Colorado Plateau and Mojave Basin and Range regions of Utah are vastly different from the Intermountain Basin and Range regions of southern Idaho, eastern Oregona and Washington and western Utah. Precipitation primarily occurs in the form of summer thunderstorms which supports warm season grassland communities as opposed to the cool season grasses found in the Intermountain areas. Grass species such as purple three-awn, blue grama, Indian ricegrass, sand dropseed and alkali sacaton are common natives on arid sites. Non-irrigated plantings are often installed in the summer in these areas in anticipation of summer rains.

In the Intermountain Region where winter snows provide much of the yearly precipitation cool season species such as bluebunch wheatgrass, basin wildrye and Sandberg bluegrass should be selected. In these areas, dormant fall planting is recommended on light sandy to loamy soils. On heavy to medium textured soils that tend to form soil crusts over winter, early spring planting should be considered. In general, spring dryland plantings should be completed early in the spring as soon as equipment can get on the field to take advantage of spring moisture. Hopefully, seedings will have at least 30-45 days of adequate soil moisture to reach a 3-5 leaf stage. Dormant seedings may be completed any time after measured soil temperatures are below 40-45º F.

Some general rules of thumb should be applied for developing seed mixtures. For non-irrigated situations, choose 4 to 6 species (6 to 10 for wildlife habitat) of diverse type and structure. Adding additional species generally increases cost but does little to increase overall diversity. Be mindful of compatibility issues. For example, will one species crowd out other species. You should also be aware of recommended seeding depths for each species. When using a seeding drill, deep seeded species and shallow seeded species should be planted separately, if possible. If separate seeding is not feasible, then the shallower depth should be used.

Extra consideration should be used when combining native and introduced species together. This practice is generally not recommended, as introduced species are very competitive and may out-compete native plants. However, introduced forbs such as alfalfa, blue flax and small burnet can be successfully established with native grasses.

When not addressed thoughtfully, pivot corners can represent lost benefits from unused space, and can become an eyesore and increased workload. However, several options are available to utilize this space to the benefit of the land owner and local ecosystems.

American Vetch

Vicia americana
Muhl. ex Willd.
Symbol =VIAM

American vetch. Photo ©Al Schneider, www.swcoloradowildflowers.com, used with permission.

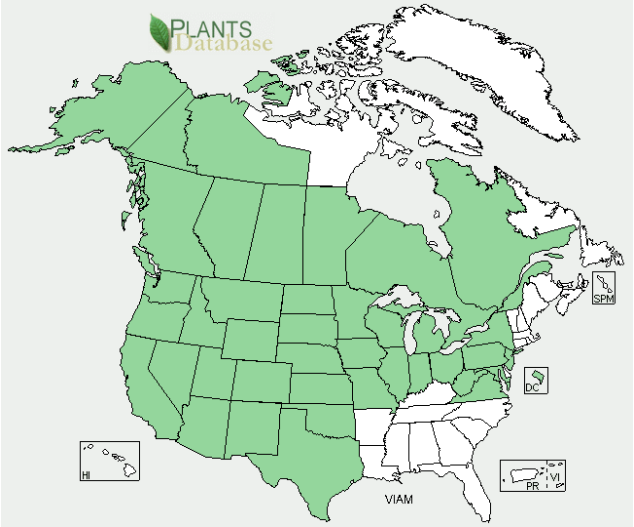
Alternate Names:
Purple vetch
American deer vetch
Stiff-leaf vetch

Scientific Names:
Vicia americana var. *americana*
Vicia americana var. *minor* Hook

Description
American vetch is a native rhizomatous, single-stemmed, climbing perennial forb that measurers up to 16 inches tall. The 8 to 16 leaflets are broadly elliptical to linear measuring 0.4 to 1.5 inches in length. The lower stipules are deeply lacerated, often appearing star-like (Isley 1998). The inflorescence is a raceme with up to 10 purple flowers approximately 0.5 to 1.5 inches long. Flowering occurs from May to August with the seeds maturing around one month after pollination (Voss, 1985; Wasser, 1982). The fruit is a 1 to 1.5 inch long pod bearing two to several pea-like seeds. There are approximately 33,000 seeds/lb (USDA-NRCS, 2015). American vetch has a moderate to deeply-branched taproot which reaches a maximum depth of 40 inches. The deep tap root allows for the plant to exhibit characteristics of severe drought tolerance.

PLANTS currently recognizes three subspecies of American vetch: ssp. *americana*, ssp. *minor*, and ssp. *mexicana* (USDA-NRCS, 2015). *V. a.* ssp. *americana* bears more flowers, (5-9) per inflorescence, and is more sprawling with prehensile, often branched, tendrils. *V. a. minor* has 3 to 4 flowers per inflorescence, erect stems and non-prehensile tendrils (Isley, 1998). Subspecies mexicana has calyx teeth all equal, differing from *V. a.* ssp. *americana* which has the upper two calyx teeth much shorter than the lower three (Gunn, 1979).

Distribution: American vetch is widely distributed west of the Mississippi River, in the northeastern United States, Alaska, and parts of Canada (Stubbendiek and Conard, 1989). Mexican American vetch (*V. a.* ssp. *mexicana*) is restricted to the Sierra Leon Mountains in Mexico and is geographically separated from *V. a.* ssp. *americana* (Gunn, 1979). *V. a.* ssp. *minor* is found primarily in the short grass prairie but extends into the Intermountain region. *V. a.* ssp. *americana* covers the range of the species (Isley, 1998).



American vetch distribution from USDA-NRCS PLANTS Database.

Habitat:
American vetch grows in a wide variety of habitats. It is typically found in moist areas, including swampy woods, mixed forests, sheltered canyons, and clearings, but can also be found in arid locations on hilltops or valley badlands (Cronquist et al, 1989).

Adaptation
American vetch is drought tolerant and has the ability to fix nitrogen into the soil (Stubbendiek and Conard, 1989). American vetch occurs frequently on slightly saline to moderately acidic soils of medium to coarse texture, but can also be found on clays. In western mountains, American vetch is usually more abundant in deep porous

loams that are rich in organic matter. American vetch is adapted to a wide range of plant communities from arid to mesic. It can be found growing in sites receiving as little as 10 inches mean annual precipitation to as much as 50 or more inches (Tilley et al, 2013).

Uses

Restoration: Relatives of American vetch are often used as cover crops. Planting American vetch in disturbed sites can help remediate the habitat and restore disturbed rangelands by providing a natural source of nitrogen (Kirk, and Belt, 2010). American vetch has been successfully seeded in disturbed alpine rangelands (Brown et al, 1979). American vetch is one of the few non-toxic native legumes adapted to sites receiving less than 12 inches mean annual precipitation, making it a valuable option for native restoration seedings on arid rangeland (Tilley et al, 2013).

Wildlife: American vetch provides high quality, although limited, grazing and fodder for game birds, small mammals, black bear, grizzly bear, and mule deer (Coladonato, 1993). Domesticated animals such as horses, sheep, and cattle will browse on the aerial portions of American vetch. It is considered preferred forage in spring and summer and desired in fall and winter for elk, deer, and antelope (Ogle and Brazee 2009).

Pollinator: American vetch is an important species for native pollinators. It is a known larval host plant for the western blue tailed butterfly (*Everes amyntula*) (Stout, 2015). American vetch has showy flowers and can be included in wildflower plantings and pollinator gardens.

Ethnobotany: Indigenous peoples used the seed leaves and seeds of American vetch as a source of food (Castetter, 1935). A poultice of the leaves has been used to treat aliments such as spider bites, and an infusion of the plant was used as an eyewash (Vestal, 1952). American vetch has also been used as a panacea, an aphrodisiac, and a good luck charm. Native Americans would get horses to smoke the plant to increase the horses' endurance (Wyman, 1951).

Status

Threatened or Endangered: American vetch is listed as endangered or extirpated in Maryland (USDA-NRCS, 2015).

Planting Guidelines

The full stand seeding rate for approximately 25 seeds/ft^2 is 33 PLS lbs/ac (Tilley et al, 2013). American vetch should be seeded in the fall to a depth of 1 to 2 inches. Unscarified seed will germinate in approximately 14 days. Scarification decreases the overall seed germination time between 3 to 7 days; however the scarification process does not improve the overall germination rate (Rose, 1998). The climbing nature of this plant should be considered when planting. Sowing the plant in combination with more upright growing species will ensure a climbing matrix to support the vetch. Vetch cover crops, including hairy vetch (*V. villosa*) and common vetch (*V. sativa*) are seeded at 20 to 40 pounds per acre.

Management

American vetch could be used as a minor component of restoration seed mixtures. Management strategies should be based on the key species in the established plant community. Grazing should be deferred on seeded lands for at least two growing seasons to allow for full stand establishment.

Pests and Potential Problems

Vicia spp. are susceptible to several species of *Botrytis* fungus. Vetch seeds are also susceptible to vetch bruchid, or vetch weevil (*Bruchus* sp.) injury (Bridwell, 1933).

Environmental Concerns

American vetch is a natural component of many native plant communities in North America. There are no known environmental concerns regarding American vetch.

Seeds and Plant Production

Hand harvesting of wildland populations with clippers or shears is the most common means of seed collection. Due to its low and twining growth habit, mechanical and vacuum harvesting are ineffective (Burton, 2015). Seed production fields may be harvested mechanically. It is suggested that a nurse crop such as alfalfa be used to elevate American vetch for easier harvesting. Species selected should have significantly dissimilar seed size and weight for easy separation (Burton, 2015).

Cultivars, Improved, and Selected Materials (and area of origin)

There are no recommended cultivars or selected materials for American vetch at this time. Seed source should be selected based on the local climate, resistance to local pests, and intended use. Consult with your local land grant university, local extension, or local USDA NRCS office for recommendations on adapted cultivars or germplasms for use in your area.

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UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
IDAHO PLANT MATERIALS CENTER
ABERDEEN, IDAHO

NOTICE OF RELEASE OF AMETHYST GERMPLASM HOARY TANSYASTER

The U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Idaho Plant Materials Center, Aberdeen, Idaho, announce the release of Amethyst Germplasm hoary tansyaster [*Machaeranthera canescens* (Pursh) A.Gray], a selected class natural track germplasm for conservation plantings in the Intermountain U.S. It will be identified by NRCS accession number 9076670. Amethyst Germplasm hoary tansyaster is a native forb collected near St. Anthony sand dunes in Fremont County, Idaho. This forb flowers and produces seed in the first growing season and provides late summer and early fall blossoms for native pollinators. It is recommended for pollinator plantings, wildlife areas and rangeland rehabilitation seedings in arid to semi-arid plant communities where native forb diversity is desirable.

Justification

At present conservationists and land managers have relatively few native forbs from which to choose for conservation seedings (Walker and Shaw, 2005). Native forbs improve ecosystem resiliency by increasing plant species diversity, improving wildlife habitat and providing food for numerous birds and mammals. Within the area of recommended use, sage-grouse (*Centrocercus urophasianus*), a potentially threatened upland bird, depend on native forbs and the insects they attract for ecological services (Connelly et al., 2000). Native forbs also provide pollen and nectar for native pollinator species (Mader et al., 2011)

In the Intermountain Western region of North America there is a need for native forbs adapted to arid and semi-arid habitats, particularly species that blossom during the first growing season and provide nectar and pollen quickly after planting (Ogle et al., 2011). Mass disturbances such as wildfire deplete food sources for native pollinators, many of which have limited range and are unable to travel long distances to find alternate food sources. Releases of native forbs that flower during the first growing season are necessary to sustain native pollinators until other perennial forbs reach flowering maturity (Cane 2008).

This germplasm selection addresses the need for a late blooming forb which blossoms during the establishment year. It is suitable for use in rangeland restoration on arid and semi-arid sites throughout much of the Intermountain West.

Description

Hoary tansyaster is a short-lived perennial forb with pale to dark purple flowers. Plants are 15 to 75 cm (6 to 30 in) tall with diffuse branching. The leaves are about 5 cm (2 in)

long and 6 mm (0.25 in) wide, oblong or lance shaped with entire to sharply toothed margins. Flower heads have many subtending bracts which are white and membranous at the bottom and green at the tip, that reflex away from the flower at the tip (Welsh et al., 2003). The flower heads and vegetation are very sticky and heavily scented. The fruit is an achene, 3 to 4 mm (0.12 to 0.16 in) in length (Cronquist et al., 1994). The pappus of the achene is dirty white and hair-like. There are approximately 1.3 million seeds/lb based on seed counts conducted by Aberdeen Plant Materials Center.

Hoary tansyaster occurs naturally in a variety of plant communities from shadscale saltbush [*Atriplex confertifolia* (Torr. & Frém.) S. Watson] and Wyoming big sagebrush [*Artemisia tridentata* ssp. *wyomingensis* (Beetle and Young)] shrub communities on the valley floors to mountain big sagebrush [*Artemisia tridentata* ssp. *vaseyana* Rydb. (Beetle)], aspen (*Populus tremuloides* Michx.) and lodgepole pine (*Pinus contorta* Douglas ex Loudon) communities at higher elevations (Welsh et al., 2003). It is recommended in pollinator and wildlife plantings in areas receiving 200 to 380 mm (8 to 15 in) mean annual precipitation (Ogle et al., 2011). Hoary tansyaster is very common in low seral degraded and disturbed sites and has been considered by some as a weedy species in meadows and rangelands (Whitson et al., 1996).

Method of Selection

Original seed collections were obtained from August through October 2008. A total of 9 accessions were collected at elevations ranging from 1,300 to 2,300 m (4,300 to 7,500 ft) in eastern Idaho and northern Utah (Table 1). Following collection, seed was stored in open collection sacks to dry prior to processing. Seed lots were cleaned using an air-screen cleaner and placed into storage at 10° C (50º F) until planting.

Table 1. Collection locations of hoary transyaster in Idaho and Utah in 2008.

Accession	Date	State	County	Coordinates
9076661	10/1/2008	ID	Lincoln	43 9' 1", -113 46' 49"
9076662	10/1/2008	ID	Lincoln	43 3' 25", -113 44' 26"
9076663	10/1/2008	ID	Lincoln	43 8' 3", -113 45' 56"
9076664	10/3/2008	ID	Bingham	43 3' 25", -112 57' 20"
9076666	8/26/2008	UT	Cache	41.95214, -111.49615
9076667	9/23/2008	ID	Bingham	43.13556, -112.90076
9076668	9/24/2008	ID	Lincoln	42.94173, -113.75234
9076669	9/24/2008	ID	Butte	43.57076, -113.06772
9076670	9/24/2008	ID	Fremont	44.02512, -111.79420

A common garden study was conducted at the USDA-NRCS Plant Materials Center Home Farm 3.2 km (2 mi) north of Aberdeen, ID. Weed-barrier fabric was laid over a well-prepared bed to reduce weed competition. Each plot consisted of 3 rows of 4, 7.6 cm (3 in) diameter planting holes (12 total) with 23 cm (9 in) plant spacing. The plots were arranged in a randomized complete block design within the fabric in four blocks with each block designated as a replication. The study was hand seeded on November 8, 2008. Each planting hole was seeded with a target of 12 to 25 seeds.

Weather during the first year of establishment was typical for southeastern Idaho with high temperatures averaging near 32° C (90º F) in the summer and dropping into the teens during winter months with occasional dips below -18° C (0° F) (Bureau of Reclamation, 2010). Precipitation for the year was above average. Total accumulated precipitation received was 290 mm (11.45 in) including an abnormal 97 mm (3.82 in) of rain in June. Mean annual precipitation for the site is 238 mm (9.39 in) (Bureau of Reclamation, 2010). Aberdeen received 153 mm (6.06 in) of precipitation during water year 2010. The plots did not receive supplemental irrigation or fertilization in either year of the study.

On June 3, 2009 the plots were evaluated for percent establishment. Establishment was recorded as the number of plant holes per plot containing plants divided by 12. On October 16, 2009, seed production estimates for each plot were assigned a visual rating of 1-9 with 1 being best and 9 being worst. Seed was collected October 16, 2009 from the three top seed producing plots in the trial and used to develop seed cleaning protocols.

Plots were evaluated for percent stand on May 10, 2010, and on August 16, 2010 the plots were evaluated for average plant height and plant vigor. Occasional wind storms caused the dispersal of seed from various plots at different times during the evaluation which complicated seed collection and prevented the comparison of seed yield among accessions. Data was subjected to an analysis of variance in Statistix® 8 (Analytical Software 2003) to determine differences among accessions and least significant difference (LSD) test was used to separate significant means at $P<0.05$.

Results

There were no significant differences in plant establishment or estimated seed yields in 2009 (Table 2). The best average establishment came from accession 9076670 with 87%. The lowest establishment percentage was recorded from accession 9076666 with 41%. The highest estimated seed yields were recorded for accessions 9076669 and 9076661, both with an average rating of 2.

Table 2. Percent stand and seed yield potential of hoary tansyaster accessions in 2009 USDA-NRCS Idaho Plant Materials Center, Aberdeen, Idaho.2009 evaluation of hoary tansyaster.

Accession	State	County	Coll. date	3Jun % Stand	16 Oct Seed yield
				----%----	
9076670	**ID**	**Fremont**	**9/24/08**	**87** [a]	**3** [b]
9076669	ID	Butte	9/24/08	81	2
9076663	ID	Lincoln	10/1/08	79	4
9076662	ID	Lincoln	10/1/08	73	5
9076664	ID	Bingham	10/3/08	70	5
9076668	ID	Lincoln	9/24/08	64	3
9076661	ID	Lincoln	10/1/08	62	2
9076667	ID	Bingham	9/23/08	56	5
9076666	UT	Cache	8/26/08	50	3
Mean				69	4
LSD $_{(0.05)}$				NS[a]	0.20

[a] Not significant [b] Seed yields were assigned a visual rating of 1-9 with 1 being best and 9 being worst.

In 2010, accession 9076670 continued to have the highest percent stand with 70%, significantly higher than any other accession in the trial (Table 3). Accession 9076670 also had the highest vigor rating (2.0) and tallest plants (60.5 cm); however there were no significant difference in vigor and height.

Table 3. Percent stand and seed yield potential of hoary tansyaster accessions in 2009 USDA-NRCS Idaho Plant Materials Center, Aberdeen, Idaho.2010 evaluation of hoary tansyaster.

Accession	10 May % Stand	16 Aug Vigor[a]/	31 Aug Height
	---%---		---cm---
9076670	**70 a**	**2 [a]**	**61**
9076669	42 b	4	59
9076663	38 b	5	57
9076662	38 b	5	49
9076664	29 b	6	45
9076668	38 b	5	48
9076661	33 b	5	50
9076667	33 b	6	60
9076666	46 b	6	46
Mean	41	5	
$LSD_{(0.05)}$	21	NS[a/]	NS

[a] (NS) - Not significant
[b] Plant vigor was assigned a visual rating of 1-9 with 1 being best and 9 being worst.

Discussion

Most accessions performed similarly for stand, vigor, and plant height. Accession 9076670 was chosen for release as a Selected Class Germplasm for having the superior establishment and stand in 2009-2010 and the greatest vigor rating in 2010. This accession also had the tallest plants in the study. Although we were not able to evaluate seed production in 2010 due to loss of seed caused by untimely wind storms, accession 9076670 plots were observed to have above average seed production.

The original source population of accession 9076670 is located near the St. Anthony Sand Dunes in Fremont County, Idaho at 1,524 m (5,000 ft) elevation. This population was brought to our attention by Scott Engle and Nate Matlack, NRCS Idaho. The soil at the collection location is Eginbench loamy fine sand supporting an antelope bitterbrush [(*Purshia tridentata* (Pursh) DC.], Indian ricegrass [*Achnatherum hymenoides* (Roem. & Schult.) Barkworth], rubber rabbitbrush [*Ericameria nauseosa* (Pall. ex Pursh) G.L. Nesom & Baird], lemon scurfpea [*Psoralidium lanceolatum* (Pursh) Rydb.] plant community. The location receives approximately 305 mm (12 in) mean annual precipitation (USDA NRCS 1993).

Anticipated Conservation Use

Hoary tansyaster should be considered for use in pollinator plantings and for adding biodiversity in rangelands. It is especially useful for post wildfire seedings where quick establishment of pollen and nectar sources is desired and to enhance sage grouse habitat. The primary intended users are land management agencies or landowners enrolled in USDA conservation programs.

Anticipated Area of Adaptation

It is anticipated that Amethyst Germplasm hoary tansyaster is suited for conservation plantings in MLRA B11, Snake River Plains and B13 Eastern Idaho Plateaus (USDA 2006). It is also likely adapted for use in arid locations throughout the Intermountain West, but has not been tested to that extent.

Availability of Plant Materials

G1 and G2 seed of Amethyst Germplasm hoary tansyaster will be maintained by the USDA Natural Resources Conservation Service, Aberdeen Plant Materials Center, Aberdeen, Idaho in cooperation with the Idaho Agricultural Experiment Station, University of Idaho. Seed through the G5 generation will be eligible for certification. G1 and G2 seed will be made available to commercial growers for distribution by the University of Idaho Foundation Seed Program and Utah Crop Improvement Association.

Small quantities of seed will be provided to researchers by request to the corresponding author.

Acknowledgements

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Signatures for the release of:

<Amethyst Germplasm Hoary Tansyaster (*Machaeranthera canescens*)

_____ _____

Jeff Burwell Date

State Conservationist

United States Department of Agriculture

Natural Resources Conservation Service

Boise, Idaho

_____ _____

for Terrell Erickson Date

Director, Ecological Sciences Division

United States Department of Agriculture

Natural Resources Conservation Service

Washington, D.C.

United States Department of Agriculture

A Conservation Plant Released by the Natural Resources Conservation Service
Aberdeen Plant Materials Center, Aberdeen, Idaho

Amethyst Germplasm Hoary Tansyaster

Machaeranthera canescens (Pursh) A. Gray

Amethyst Germplasm hoary tansyaster is a late season flowering forb that attracts a variety of pollinators.

Amethyst Germplasm hoary tansyaster (*Machaeranthera canescens*) was released in 2014 by the Aberdeen Plant Materials Center for use in wildlife habitat and pollinator plantings in the Intermountain West.

Description

Hoary tansyaster is a short-lived perennial forb with pale to dark purple flowers. Plants are 6 to 30 inches tall with diffuse branching. Leaves are about 2 inches long and oblong or lance shaped with entire to sharply toothed margin. The flower heads have many subtending bracts that reflex away from the flower at the tip. These bracts are white and membranous at the bottom and green at the tip. Leaves and flower heads are very sticky and heavily scented. The pappus of the achene is dirty white and hair-like. There are approximately 1.3 million seeds/lb based on seed counts conducted by Aberdeen Plant Materials Center.

Source

A total of 9 accessions were collected at elevations ranging from 4,300 to 7,500 ft in eastern Idaho and northern Utah. A common garden study was conducted at the Aberdeen Plant Materials Center Home Farm 2 miles north of Aberdeen, ID from 2009-2011. Plots were evaluated for percent stand, average plant height and plant vigor.

Most accessions performed similarly for stand, vigor, and plant height. Accession 9076670 was chosen for release as a Selected Class Germplasm for having superior establishment and stands in 2009 and 2010 with the greatest vigor rating in 2010.

Conservation Uses

Hoary tansyaster blossoms in late summer and early fall and is visited by bees, wasps and butterflies. The primary intended users are land management agencies or landowners enrolled in USDA conservation programs. Amethyst Germplasm hoary tansyaster should be considered for use in pollinator plantings and for adding biodiversity in rangelands and to enhance wildlife habitat. Due to its attractiveness to native insects, hoary tansyaster is an excellent species for sage-grouse habitat restoration. It is especially useful for post wildfire seedings where quick establishment of pollen and nectar sources is desired.

Area of Adaptation and Use

The original source population of Amethyst Germplasm hoary tansyaster is located near the St. Anthony Sand Dunes in Fremont County, Idaho at 1,524 m (5,000 ft) elevation. This population was discovered by Scott Engle and Nate Matlack, NRCS Idaho. The soil at the collection location is Eginbench loamy fine sand supporting an antelope bitterbrush, Indian ricegrass, rubber rabbitbrush, and lemon scurfpea plant community. The location receives approximately 12 inches mean annual precipitation.

It is anticipated that Amethyst Germplasm hoary tansyaster is suited for conservation plantings in MLRA B11, Snake River Plains and B13 Eastern Idaho Plateaus (USDA 2006). It is also likely adapted in arid locations throughout the Intermountain West, but has not been tested to that extent.

Establishment and Management for Conservation Plantings

Seed should be drilled or broadcast seeded in late fall into a firm, weed-free seed bed at a depth of 0 to 1/4 inches. For a pure stand, target delivery of 20 to 30 pure live seeds (PLS) per square foot, or 2 lbs PLS per acre. If seeding as part of a mix, adjust seeding rate to the desired percentage of the mixture. Broadcast seedings should be followed with a cultipacker to ensure good seed-to-soil contact.

Seed should be mixed with a dilutent such as rice hulls to assist seed flow through seeding equipment. When

calculating rice hull amounts based on seed bushel weights, it is important to determine the condition of the seed. Hoary tansyaster seed which has not had the pappus removed has a bushel weight of approximately 3 lb/bushel, while highly processed and cleaned seed bushel weights range from 20 to 24 lb/bushel.

When planted in a native reclamation seed mix, it will be a minor component of the establishing plant community; therefore management should be based on other key species in the mixture.

Ecological Considerations
This Selected Class Germplasm is from a species native to the Intermountain West and has no known negative impacts on wild or domestic animals. It can spread to adjoining vegetative communities under ideal environmental conditions.

Seed and Plant Production
Seed production fields of hoary tansyaster can be hand-planted into weed barrier fabric at 9 to 18 inch plant spacing or mechanically seeded into larger field plantings at 30 to 36 inch row spacing at 0.35 lb pure live seed (PLS)/ac. Seed can be planted in in spring or late-summer with irrigation, or late fall on non-irrigated fields. Late summer seedings are recommended to reduce annual weed competition. Plants grown in weed barrier fabric at Aberdeen, Idaho (an 8- 12 inch mean annual rainfall zone) required no supplemental irrigation. Flowering begins in late summer and continues for several weeks into the autumn.

Seed is harvested by hand, direct combining, flail-vac, or by a vacuum harvester. Harvested material should be air dried. Once dried, the seed can be processed using a brush machine followed by air-screen separators and indent cleaners

Purity and viability of 60 to 90% is achievable. Hand harvested and vacuum harvested seed is much easier to process, and higher purities (80 to 90%) are easily obtained due to the reduced amount of inert matter collected.

Mechanical harvest yields range between 2 and 7 lbs PLS/ac. Increasing the number of harvests beyond 2 in a single year may slightly increase the total yield. As more experience with harvest and seed processing occurs, clean seed yields may be increased incrementally.

Weed control efforts should begin prior to planting. Planting into a weed-free seed bed, or using weed barrier fabric greatly reduces management inputs. Weeds can be controlled using pre-emergent herbicides and by hand rouging. Weedy grasses can be controlled with selective herbicides.

Availability
For conservation use: Certified seed is available from commercial seed vendors.

For seed or plant increase: G1 and G2 seed of Amethyst Germplasm hoary tansyaster will be maintained by the USDA Natural Resources Conservation Service, Aberdeen Plant Materials Center, Aberdeen, Idaho in cooperation with the Idaho Agricultural Experiment Station, University of Idaho. Seed through the G5 generation will be eligible for certification. G1 and G2 seed will be made available to commercial growers for distribution by the University of Idaho Foundation Seed Program and Utah Crop Improvement Association.

Small quantities of seed will be provided to researchers by request to the Plant Materials Center.

For more information, contact:
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NOTICE OF RELEASE OF

AMETHYST GERMPLASM HOARY TANSYASTER

SELECTED CLASS OF NATURAL GERMPLASM

Derek J Tilley

ABSTRACT

The US Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Aberdeen Plant Materials Center, Aberdeen, Idaho, announces the release of Amethyst Germplasm hoary tansyaster (*Machaeranthera canescens* (Pursh) A. Gray [Asteraceae]), a selected class natural track germplasm identified by NRCS accession number 9076670 for conservation plantings in the Intermountain US. Amethyst Germplasm hoary tansyaster is a native forb collected near St Anthony Sand Dunes in Fremont County, Idaho. This forb flowers and produces seed during the first growing season and provides late summer and early fall blossoms for native pollinators. It is recommended for pollinator plantings, wildlife areas, and rangeland rehabilitation seedings in arid to semiarid plant communities where native forb diversity is desirable.

Tilley DJ. 2015. Notice of release of Amethyst Germplasm hoary tansyaster: selected class of natural germplasm. Native Plants Journal 16(1):54–59.

KEY WORDS
forb, rangeland, restoration, pollinators, Asteraceae

NOMENCLATURE
Plants: USDA NRCS (2015)
Animals: ITIS (2015)

Photos by Derek J Tilley

JUSTIFICATION

At present, conservationists and land managers have relatively few native forbs from which to choose for conservation seedings (Walker and Shaw 2005). Native forbs improve ecosystem resiliency by increasing plant species diversity, improving wildlife habitat, and providing food for numerous birds and mammals. Within the area of recommended use, sage grouse (*Centrocercus urophasianus* Bonaparte [Phasianidae]), a potentially threatened upland bird, depends on native forbs and the insects they attract (Connelly and others 2000). Native forbs also provide pollen and nectar for native pollinator species (Mader and others 2011).

In the Intermountain West region of North America, native forbs adapted to arid and semiarid habitats are needed, particularly species that blossom during the first growing season and provide nectar and pollen quickly after planting (Ogle and others 2011). Mass disturbances such as wildfire deplete food sources for native pollinators, many of which are unable to travel long distances to find alternate food sources. Releases of native forbs that flower during the first growing season following a restoration seeding are necessary to sustain native pollinators until other seeded perennial forbs reach flowering maturity (Cane 2008).

This germplasm selection addresses the need for a late-blooming forb that blossoms during the establishment year. It is suitable for use in rangeland restoration on arid and semiarid sites throughout much of the Intermountain West.

Species: *Machaeranthera canescens* (Pursh) A. Gray
Common name: Hoary tansyaster
Accession number: 9076670

A seed production field of Amethyst Germplasm hoary tansyaster.

DESCRIPTION

Hoary tansyaster (*Machaeranthera canescens* (Pursh) A. Gray [Asteraceae]) is a short-lived perennial forb with pale to dark purple flowers (Figure 1). Plants are 15 to 75 cm (6 to 30 in) tall with diffuse branching. The leaves are about 5 cm (2 in) long and 6 mm (0.25 in) wide, oblong or lance shaped with entire to sharply toothed margins. Flower heads have many subtending bracts that are white and membranous at the bottom and green at the tip, that reflex away from the flower at the tip (Welsh and others 2003). The flower heads and vegetation are very sticky and heavily scented. The fruit is an achene, 3 to 4 mm (0.12 to 0.16 in) in length (Cronquist and others 1994).

Figure 1. A western white butterfly (*Pontia occidentalis* Reakirt [Lepidoptera: Pieridae]) collects nectar from Amethyst Germplasm hoary tansyaster in a seed production field.

The pappus of the achene is dirty white and hairlike. Seed heads contain approximately 2.0 million seeds/kg (1.3 million/lb) based on seed counts conducted by Aberdeen Plant Materials Center.

Hoary tansyaster occurs naturally in a variety of plant communities from shadscale saltbush (*Atriplex confertifolia* (Torr. & Frém.) S. Watson [Chenopodiaceae]) and Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & Young [Asteraceae]) shrub communities on the valley floors to mountain big sagebrush (*A. tridentata* Nutt. ssp. *vaseyana* (Rydb.) Beetle), quaking aspen (*Populus tremuloides* Michx. [Salicaceae]), and lodgepole pine (*Pinus contorta* Douglas ex Loudon [Pinaceae]) communities at higher elevations (Welsh and others 2003). This species is recommended in pollinator and wildlife plantings in areas receiving 200 to 380 mm (8 to 15 in) mean annual precipitation (Ogle and others 2011). Hoary tansyaster is very common in low seral, degraded and disturbed sites and has been considered by some as a weedy species in meadows and rangelands (Whitson and others 1996).

METHOD OF SELECTION

Original seed collections were obtained from August through October 2008. A total of 9 accessions were collected at elevations ranging from 1300 to 2300 m (4300 to 7500 ft) in eastern Idaho and northern Utah (Table 1). Following collection, seed was stored in open collection sacks to dry prior to processing. Seedlots were cleaned using an air-screen cleaner and placed into storage at 10 °C (50 °F) until planting.

A common-garden study was conducted at the USDA NRCS Plant Materials Center Home Farm located 3.2 km (2 mi) north of Aberdeen, Idaho. Weed-barrier fabric was laid over a well-prepared bed to reduce weed competition. Each plot consisted of 3 rows of four 7.6 cm (3 in) diameter planting holes (12 total) with 23 cm (9 in) plant spacing. The plots were

TABLE 1

Collection locations of hoary tansyaster in Idaho and Utah in 2008.

Accession	Date	State	County	Coordinates
9076661	1 Oct 2008	ID	Lincoln	N43°9′1″, W113°46′49″
9076662	1 Oct 2008	ID	Lincoln	N43°3′25″, W113°44′26″
9076663	1 Oct 2008	ID	Lincoln	N43°8′3″, W113°45′56″
9076664	3 Oct 2008	ID	Bingham	N43°3′25″, W112°57′20″
9076666	26 Aug 2008	UT	Cache	N41°57′8″, W111°29′46″
9076667	23 Sep 2008	ID	Bingham	N43°8′8″, W112°54′3″
9076668	24 Sep 2008	ID	Lincoln	N42°56′30″, W113°45′8″
9076669	24 Sep 2008	ID	Butte	N43°34′15″, W113°4′4″
9076670	24 Sep 2008	ID	Fremont	N44°1′30″, W111°47′39″

arranged in a randomized complete block design within the fabric in 4 blocks with each block designated as a replication. The study was hand-seeded on 8 November 2008. Each planting hole was seeded with a target of 12 to 25 seeds.

Weather during the first year of establishment was typical for southeastern Idaho with high temperatures averaging near 32 °C (90 °F) in the summer and dropping into the teens during winter months with occasional dips below –18 °C (0 °F) (USDI BOR 2010). Precipitation for the year was above average. Total accumulated precipitation received was 290 mm (11.5 in) including an abnormal 97 mm (3.8 in) of rain in June. Mean annual precipitation for the site is 238 mm (9.4 in) (USDI BOR 2010). Aberdeen received 153 mm (6.1 in) of precipitation during water year 2010. The plots did not receive supplemental irrigation or fertilization in either year of the study.

On 3 June 2009, the plots were evaluated for percent establishment. Establishment was recorded as the number of plant holes per plot containing plants divided by 12. On 16 October 2009, seed production estimates for each plot were assigned a visual rating of 1 to 9 with 1 being best and 9 being worst. Seed was collected 16 October 2009 from the 3 top seed-producing plots in the trial and was used to develop seed-cleaning protocols.

Plots were evaluated for percent stand on 10 May 2010, and on 16 August 2010 the plots were evaluated for average plant height and plant vigor. Occasional wind storms caused the dispersal of seed from various plots during the evaluation, which complicated seed collection and prevented the comparison of seed yield among accessions. Data were subjected to an analysis of variance in Statistix 8 (Analytical Software 2003) to determine differences among accessions, and least significant difference (LSD) test was used to separate significant means at $P < 0.05$.

Results

No significant differences in plant establishment or estimated seed yields were observed in 2009 (Table 2). The best average establishment came from accession 9076670 with 87%. The lowest establishment percentage was recorded from accession 9076666 with 41%. The highest estimated seed yields were recorded for accessions 9076669 and 9076661, both with an average rating of 2.

In 2010, accession 9076670 continued to have the highest percent stand with 70%, significantly greater than any other accession in the trial (Table 3). Accession 9076670 also had the highest vigor rating (2.0) and tallest plants (60.5 cm [24 in]); no significant difference was observed in either vigor or height.

Discussion

Most accessions performed similarly for stand, vigor, and plant height. Accession 9076670 was chosen for release as a selected class germplasm for having superior establishment and stand in 2009–2010 and greatest vigor rating in 2010. This accession also had the tallest plants in the study. Although we were not able to evaluate seed production in 2010 because of loss of seed caused by untimely wind storms, accession 9076670 plots were observed to have above average seed production.

The original source population of accession 9076670 is located near the St Anthony Sand Dunes in Fremont County, Idaho, at 1524 m (5000 ft) elevation. Soil at the collection location is Eginbench loamy fine sand supporting an antelope bitterbrush (*Purshia tridentata* (Pursh) DC. [Rosaceae]), Indian ricegrass (*Achnatherum hymenoides* (Roem. & Schult.) Barkworth [Poaceae], rubber rabbitbrush (*Ericameria nauseosa* (Pall. ex Pursh) G.L. Nesom & Baird [Asteraceae]), lemon scurfpea (*Psoralidium lanceolatum* (Pursh) Rydb. [Fabaceae])

TABLE 2

Percent stand and seed yield potential of hoary tansyaster accessions in 2009, USDA NRCS Idaho Plant Materials Center, Aberdeen, Idaho.

Accession	State	County	Collection date	3 Jun Stand (%)	16 Oct Seed yield
9076670	ID	Fremont	24 Sep 2008	87	3[y]
9076669	ID	Butte	24 Sep 2008	81	2
9076663	ID	Lincoln	1 Oct 2008	79	4
9076662	ID	Lincoln	1 Oct 2008	73	5
9076664	ID	Bingham	3 Oct 2008	70	5
9076668	ID	Lincoln	24 Sep 2008	64	3
9076661	ID	Lincoln	1 Oct 2008	62	2
9076667	ID	Bingham	23 Sep 2008	56	5
9076666	UT	Cache	26 Aug 2008	50	3
Mean				69	4
LSD				NS[z]	0.20

[z] Not significant.

[y] Seed yields were assigned a visual rating of 1 to 9 with 1 being best and 9 being worst.

Table 3

Percent stand and seed yield potential of hoary tansyaster accessions in 2009, USDA NRCS Idaho Plant Materials Center, Aberdeen, Idaho, 2010.

Accession	10 May Stand (%)	16 Aug Vigor[z]	31 Aug Height (cm)
9076670	70 a	2 a	61
9076669	42 b	4	59
9076663	38 b	5	57
9076662	38 b	5	49
9076664	29 b	6	45
9076668	38 b	5	48
9076661	33 b	5	50
9076667	33 b	6	60
9076666	46 b	6	46
Mean	41	5	
LSD (0.05)	21	NS[y]	NS

Note: Letters within a row denote significant differences at the $P < 0.05$ probability level.

[z] Plant vigor was assigned a visual rating of 1 to 9 with 1 being best and 9 being worst.

[y] NS, Not significant.

plant community. The location receives approximately 305 mm (12 in) mean annual precipitation (USDA NRCS 1993).

ANTICIPATED CONSERVATION USE

Hoary tansyaster should be considered for use in pollinator plantings and for adding biodiversity in rangelands. It is especially useful for post-wildfire seedings where quick establishment of pollen and nectar sources is desired and to enhance sage grouse habitat. The primary intended users are land management agencies or landowners enrolled in USDA conservation programs.

ANTICIPATED AREA OF ADAPTATION

Amethyst Germplasm hoary tansyaster is suited for conservation plantings in MLRA B11 Snake River Plains and B13 Eastern Idaho Plateaus (USDA NRCS 2006). It is also likely adapted for use in arid locations throughout the Intermountain West but has not been tested to that extent.

AVAILABILITY OF PLANT MATERIALS

G1 and G2 seed of Amethyst Germplasm hoary tansyaster will be maintained by the USDA Natural Resources Conservation Service, Aberdeen Plant Materials Center, Aberdeen, Idaho. Seed through the G5 generation will be eligible for certification. G1 and G2 seed will be made available to commercial growers

for distribution by the University of Idaho Foundation Seed Program and the Utah Crop Improvement Association. Small quantities of seed will be provided to researchers by request to the corresponding author.

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Seed production and field establishment of hoary tansyaster (*Machaeranthera canescens*)

Derek J Tilley

ABSTRACT

The USDA NRCS Aberdeen Plant Materials Center (PMC) produces certified early generation seed of hoary tansyaster (*Machaeranthera canescens* (Pursh) A. Gray [Asteraceae]), a late summer and fall blooming forb native to the Intermountain West region. Hoary tansyaster is an excellent forb candidate for restoration efforts in arid to semiarid sites. It is relatively easy to manage in a seed production system, establishes quickly in a rangeland situation, and provides blooms in late summer during the establishment year. Propagation methodologies including establishment, weed control, harvest, and seed processing are herein discussed. We have grown seed production fields of hoary tansyaster in 2 different field systems, one using weed barrier fabric and the other in open drill-seeded fields. Seed can be collected by hand, combine, Flail-Vac, or vacuum-type harvester and can be processed with brush machine and air-screen type cleaning equipment. Seed yields at Aberdeen, Idaho, range between 2 and 8 kg pure live seed (PLS)/ha (2–7 lb/ac).

Tilley DJ. 2015. Seed production and field establishment of hoary tansyaster (*Machaeranthera canescens*). Native Plants Journal 16(1):61–66.

KEY WORDS
forb, harvest, management, seed cleaning, rangeland, restoration, Asteraceae

NOMENCLATURE
Plants: USDA NRCS (2014)
Animals: ITIS (2015)

The past decade has seen a large increase in demand for native forbs for use in rangeland enhancement and restoration plantings (Shaw and others 2005; Walker and Shaw 2005). This change in demand has been driven, in large part, by increases in frequency and size of wildfires in the Intermountain West, a phenomenon driven by the spread of introduced annual grasses such as cheatgrass (*Bromus tectorum* L. [Poaceae]). Historically, post-fire restoration has been dominated by low-diversity grass seedings. Better understanding of range ecology suggests that native forbs and the insects they attract are an important component of wildlife habitat. Of critical importance, flowering forbs are desirable for the conservation and recovery of sage grouse (*Centrocercus urophasianus* Bonaparte [Phasianidae]) (Connelly and others 2000), and for providing pollen and nectar for native pollinator species (Mader and others 2011).

The greatest need in the Intermountain West is for native forbs that are adapted to arid and semiarid habitats, particularly species that blossom during the first growing season (Ogle and others 2011). Species that flower during the first growing season are necessary to sustain pollinators under post-disturbance conditions until other perennial forbs reach flowering maturity (Cane 2008). First-season blooming forbs provide a valuable supply of nectar and pollen to native pollinators that may be unable to travel the distance necessary to reach undisturbed food sources. Forbs that flower in late summer and early fall also provide nourishment that carries pollinators through the winter. Hoary tansyaster (*Machaeranthera canescens* (Pursh) A. Gray [Asteraceae]) is an excellent forb candidate for restoration efforts. It is relatively easy to manage in a seed production system, establishes quickly in a rangeland situation, and provides blooms in late summer during the establishment year. This article provides a detailed description of hoary tansyaster and details our seed production experience and success at the Aberdeen, Idaho, USDA NRCS Plant Materials Center.

PLANT DESCRIPTION

Hoary tansyaster is a short-lived perennial forb with pale to dark purple flowers. Plants are 15 to 75 cm (6 to 30 in) tall with indeterminate flowering habit. Each flower head supports 15 to 25 purple ray flowers and numerous yellow disk flowers, each sitting atop a seed-bearing achene (Welsh and others 2003). The achenes are 3 to 4 mm (0.12 to 0.16 in) in length (Cronquist and others 1994) with a pappus of dirty white and hairlike bristles. Seed heads contain approximately 2.0 million seeds/kg (1.3 million seeds/lb) based on seed counts conducted by Aberdeen PMC.

Hoary tansyaster occurs throughout western North America from British Columbia to Saskatoon, south to California, Arizona, and Colorado. It is common in salt desert shrub, mixed desert shrub, pinyon-juniper, mountain brush, aspen-sagebrush, and mountain conifer plant communities (Welsh and others 2003). This species is highly valuable as a pollinator food source in late summer and early fall. Production fields at Aberdeen are visited by sweat bees (*Halictus* Latreille spp. [Halictidae]), green sweat bees (*Agapostemon* Guérin-Méneville spp. [Halictidae]), and European honey bees (*Apis mellifera* L. [Apidae]) (Figure 1). We have also observed visitation by bee flies (Diptera: Bombyliidae) and western white butterflies (*Pontia occidentalis* Reakirt [Lepidoptera: Pieridae]).

PRODUCTION SITE

Seed production has been limited to the Aberdeen USDA NRCS Plant Materials Center. The Aberdeen PMC farm is located in Major Land Resource Area (MLRA) B11, Snake River Plains, at 1310 m (4300 ft) elevation. Soil at the site is a Declo silt loam with a pH of 7.4 to 8.4, and average annual precipitation is 23.9 cm (9.4 in) (USDI BOR 2010). The average growing season is approximately 110 d, with spring last frost in early June and fall first frost in mid-September. Mean annual temperature is approximately 8 °C (46 °F), with an average high temperature of 37 °C (98 °F) and average low –26 °C (–15 °F) (USDA NRCS 1973).

Field Preparation

We have grown hoary tansyaster in 2 different field systems, one employing weed barrier fabric and the other in open drill-seeded fields. Prior to seeding, our fields are plowed, disked, and

Figure 1. Hoary tansyaster is highly attractive to pollinators. A green sweat bee forages on hoary tansyaster pollen. Photo by Derek J Tilley

finally packed with a roller cultipacker. For production on fabric, a 1.8 m (6 ft) wide strip of woven weed barrier fabric is laid down with a tractor-pulled fabric layer as described by Simonson and others (2006). At the time of planting, 7.6 cm (3 in) diameter holes are burned into the fabric using a steel spacing jig and an acetylene or propane torch. We have successfully planted in either single rows or double rows down the center of the weed barrier fabric at 23 to 46 cm (9–18 in) plant spacing.

Planting

Planting timing is important with hoary tansyaster. We have found that late summer (August) seeding is optimal because of reduced annual weed competition, tendency for plants to produce multiple bloom cycles, and better overall seed yield. Fields planted in the fall produced crops the following 2 y. In contrast, fields planted in spring or early summer did not produce a significant crop during the first year but did produce the following year and then died during the subsequent winter.

Seed of hoary tansyaster has no dormancy issues. Seed is sown into weed barrier fabric into slightly roughened soil and then lightly packed. Each hole is seeded at a target rate of 5 to 20 seeds using a drop tube seeder, a 7.6 cm (3 in) diameter tube with a spur at the bottom (Figure 2). The spur is used to roughen the soil, seed is dropped through the tube into the roughened area, and the soil is compacted by foot. We also seed strips of low-growing perennial grass cover on the edges of the weed barrier fabric. This step allows us to manage seasonal weeds with mowing, which reduces herbicide use and cultivation and prevents disturbance to ground-nesting pollinators.

Drill-seeded fields are seeded on 91.5 cm (36 in) row spacing at a rate of 0.39 kg PLS/ha (0.35 lb/ac) with Planet Jr seeders at a depth of 0 to 6 mm (0 to 0.25 in). This provides a target rate of 113 seeds/linear m (35 seeds/linear ft) of row. Drill-seeded fields received 10 cm (4 in) supplemental irrigation in late April and again in mid-May.

Figure 2. Seeding hoary tansyaster into weed barrier fabric rows with a drop tube seeder. The hole-spacing jig can be seen in the background. Photo by Loren St John

MANAGEMENT

Hoary tansyaster is very competitive against weeds and establishes well despite moderate weed pressure. Prostrate pigweed (*Amaranthus albus* L. [Amaranthaceae]) and redroot pigweed (*A. retroflexus* L.) are often our worst competitive weed species. These are controlled primarily with between-row cultivation using a Lilliston cultivator. Planting into a weed-free seed bed, or using weed barrier fabric, greatly reduces management inputs. Weed control efforts begin prior to planting. Weeds coming up in the holes of the fabric can be controlled by hand-roguing or with wick applications of glyphosate. Weeds along the fabric edges can be controlled by mowing.

Plants grown in the weed barrier fabric at Aberdeen, Idaho, require little if any supplemental irrigation because of the reduced evaporation caused by the fabric. Drill-seeded fields receive supplemental irrigation to approximate 30.5 cm (12 in) annual precipitation. Under good conditions, hoary tansyaster blooms indeterminately in late summer with plants still blooming and attracting pollinators into mid-November.

Moth caterpillars from the genus *Cucullia* Schrank spp. (Lepidoptera: Noctuidae) were observed on observational plots at the Aberdeen PMC (Figure 3). These insects were seen eating on flower heads, but did not appear to do extensive damage or significantly decrease seed production and no control strategies were required.

Figure 3. A *Cucullia* caterpillar feeding on hoary tansyaster flower heads. Photo by Derek J Tilley

HARVEST

Late summer and fall seedings can be harvested the following year. Spring plantings will flower the first season but seed production is low. Seed can be collected by hand, combine, Flail-Vac, or vacuum-type harvester. For harvesting on weed barrier fabric rows, we use a "Jet Harvester" as described by Tilley and Bair (2011) with the fan running at approximately 1900 rpm (Figure 4). This approach ensures that only ripe seed is harvested and allows for multiple harvests during the season. Seed readily disarticulates from flower heads when ripe. A significant advantage of the Jet Harvester is the limited amount of trash and other inert matter being collected, which makes post-harvest cleaning significantly easier. Harvesting by other methods adds to the inert matter that can be difficult to clean out. It takes the PMC crew approximately 90 min to vacuum harvest 150 m (500 ft) of row, up and down both sides. We typically conduct 3 to 5 harvests per season using the Jet Harvester.

In 2013, we harvested the drill-seeded field using a Flail-Vac seed stripper with a brush speed of 400 rpm and a tractor speed of 6 to 7 mph (Figure 5). The Flail-Vac was set to harvest approximately the top 20 to 30 cm (8–12 in) of the plants. We were able to complete 2 harvest cycles using the Flail-Vac, the first occurred on September 3 and the second took place on September 23. Flail-Vac harvesters gather significantly more material than hand harvesting or vacuum harvesting, and the material collected requires considerably more processing during cleaning. Flail-Vac harvesting also collected more weed seed than did more discriminatory methods.

Seed Cleaning

Harvested material is laid on a clean shop floor to air-dry for several days. The material is sifted and turned with hay forks twice each day to facilitate drying and to remove sticks. Once dried, seed is first processed through a Westrup laboratory brush machine with a number 7 mantle and a brush rotation speed of 3. The gate is closed to allow the brushed seed to fall through to the catch pan below. The brushed material is then cleaned using a multi-deck air-screen cleaner with 6 × 30 and 6 × 32 screens. The air is set at a low setting (1 to 2) to remove dust, pappus, and unfilled seed. Flail-Vac– and combine-harvested material contains a large amount of inert matter and needs to be run through the air-screen process 6 to 10 times for adequate cleaning. Following the air-screening, we use an indent cleaner with 1.8 mm indents to remove small weed seed, such as witchgrass (*Panicum capillare* L. [Poaceae]) and redroot pigweed.

The described cleaning method yields seed with approximately 60 to 90% purity and 60 to 90% viability (Figure 6). Hand-harvested and vacuum-harvested seed are much easier to process, and higher purity levels (80 to 90%) are obtained because of the reduced amount of inert matter collected. Sowthistle (*Sonchus* L. spp. [Asteraceae]) and prickly lettuce

Figure 4. PMC farm technicians Derek Jolley and Boyd Simonson harvest hoary tansyaster seeded into weed barrier fabric using the Jet Harvester. Photo by Derek J Tilley

Figure 5. Harvesting a drill-seeded field of hoary tansyaster using a Flail-Vac harvester. Photo by Derek J Tilley

Figure 6. Hoary tansyaster seed cleaned to high levels of purity using the proper equipment. Purities approaching 90% are attainable using a brush machine, air screen, and indent cleaner. Photo by Derek J Tilley

(*Lactuca serriola* L. [Asteraceae]) seed are similar in shape and weight to hoary tansyaster and are very difficult to remove during seed cleaning. These impurities are best handled by exclusion in the field through hand-roguing.

Yields range between 2 and 8 kg PLS/ha (2–7 lb PLS/ac). Hoary tansyaster is relatively short-lived (2–3 y) and volunteers readily from shattered seed. We remove our seed fields after 2 full growing seasons and harvests.

RANGELAND SEEDING

We recommend that seed be drilled or broadcast-seeded during late fall into a firm, weed-free seedbed at a depth of 0 to 6 mm (0 to 0.25 in). The full seeding rate, with a target delivery of 480 to 540 PLS/m^2 (45–50 PLS/ft^2 is 1 kg (2 lb) PLS per acre. If seeding as part of a mix, adjust seeding rate to the desired percentage of the mixture. Broadcast plantings should be seeded at double the drill seed rate and be followed with a cultipacker to provide a shallow covering of soil with firm seed-to-soil contact.

SUMMARY

Hoary tansyaster is a competitive short-lived native forb that acts as an early colonizer of rangelands and disturbed sites. It flowers during the first growing season after dormant fall seedings, making it a valuable restoration species for post-fire applications where pollinator habitat requires a quick source of forage. The species is readily visited by a variety of native pollinators that have been shown to be important in the life cycle of sage grouse and other upland birds. Seed of hoary tansyaster is grown at the Aberdeen, Idaho, Plant Materials Center in fabric rows or in direct-seeded fields. Summer planting is recommended to decrease weed pressure and to increase field longevity. The Idaho PMC has used several methods and devices to harvest seed. Hand- and vacuum-harvesting methods are more precise and easier to process, while larger, less discriminate harvesting methods require additional processing.

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A low-cost modification to a Flail-Vac Harvester for collecting lightweight, wind-dispersed seed

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ABSTRACT

Indeterminate wildflowers with pappus-bearing seed are difficult to effectively harvest at yields approaching maximum potential using traditional equipment. We modified a Flail-Vac Seed Stripper by mounting heavy loops of chain to the front of the Flail-Vac to provide agitation of the floral canopy to disarticulate seed from the flowers of hoary tansyaster (*Machaeranthera canescens* (Pursh) A. Gray [Asteraceae]). The modification allowed for multiple, non-damaging harvests that collected only shatter-ready, fully ripe seed. Labor and time associated with post-harvest drying and seed cleaning were reduced because of the decrease in vegetative matter accumulated.

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Photos by Derek J Tilley

Two obstacles to native forb seed production are an indeterminate ripening habit and lightweight pappus-bearing seed evolved for wind dispersal. For optimum yields, indeterminate species require multiple harvests to capture seed as it ripens and before it disarticulates from the flower and falls to the ground. Lightweight-seeded species such as those in the Asteraceae are particularly difficult to harvest without losing significant amounts of seed to shatter and wind. Currently, available methods of mechanical harvesting that allow for multiple harvests are limited. Hand- or vacuum-assisted harvesting are options, but both can be labor intensive and increase end costs.

We examined several techniques for harvesting lightweight, wind-dispersed seed. Direct combining is time efficient; however, this method yields correspondingly less seed due to the single harvest restriction. Additionally, once-over harvest methods add considerably to the time required to clean the seed because of large amounts of accumulated inert matter. Kujawski and others (2001) developed modifications to a Trac Vac leaf vacuum for harvesting forb seed. They reported this system worked adequately, although creating uniform suction distribution was problematic. In 2011, Tilley and Bair presented the Jet Harvester as an alternative for forb seed harvest. This apparatus is highly effective but is labor intensive, as it requires 2 people to operate the tractor and vacuum head. Also, use of the Jet Harvester is limited to small-scale production because the small opening in the collection nozzle results in slow coverage of a crop.

The use of a Flail-Vac harvester (Woodward Flail-Vac Seed Stripper, Ag-Renewal Inc, Weatherford, Oklahoma) can be a viable alternative for harvesting forb seed in some cases, but it can be highly destructive and the number of harvests before plants lose productivity is limited. The nylon brushes in the header whip the plants at high speeds to remove the seed and to create suction to pull the seed into the hopper in the rear. This feature, unfortunately, causes significant damage to mature and unripe flowers, limiting activity to 2 harvests before the canopy is effectively destroyed. Flail-Vac harvesting also adds more inert matter that must be removed during seed conditioning. Keys (2006) presented a modification to the Flail-Vac brush in which the standard solid brush was replaced with a cartridge-wafer-configured brush to improve seed-harvesting efficiency. Though this modification reduced the cost of the brush unit itself and increased harvestable yields, it does not address the difficulties associated with indeterminate flowering and seed maturation.

Hoary tansyaster (*Machaeranthera canescens* (Pursh) A. Gray [Asteraceae]) exemplifies species that express the problems associated with harvesting fluffy, wind-dispersed seed over a long maturation period. Hoary tansyaster has a small seed (achene) with a pappus of capillary bristles (Welsh and others 2003) used for wind dispersal. Seed is very light with approximately 2.8 million seeds/kg (1.3 million seeds/lb) (Tilley 2015). Plants produce numerous indeterminately ripening flowers spread throughout the branch structure (not just on the canopy periphery).

Our stated objective is to explore modifications to a Flail-Vac harvester that will allow multiple harvests and will improve seed yield potential for hoary tansyaster. This article portrays our experience and successes with a series of harvester modifications and finally describes the features of the optimally modified harvester.

DEVELOPMENT OF A PROPOSED SOLUTION

Addition and testing of Flail-Vac modifications occurred during 3 production y. Yields, though not taken from the same year or field, had similar potential due to similar plant ages and management conditions. Note, however, that inherent differences are present among harvest years, and direct-yield comparison must be used with caution. Hoary tansyaster increase blocks were planted on 91-cm (36-in) row centers at a rate of 1.1 kg/ha (1 lb/ac).

In 2012, we direct-combined a 1-y-old hoary tansyaster field using a Wintersteiger Delta combine (Wintersteiger Inc, Salt Lake City, Utah). From a 0.24-ha (0.6-ac) field we harvested 25 kg (55 lb) of material, which cleaned to just 0.34 kg (0.75 lb) pure seed, equivalent to 1.4 kg/ha (1.3 lb/ac). In 2013, we harvested a different 1-y-old hoary tansyaster field using a Flail-Vac seed stripper with a brush speed of 400 rpm and a tractor speed of 6 to 7 mph (Figure 1). The Flail-Vac was set to contact approximately the top 20 to 30 cm (8 to12 in) of the flowering stems. We made 2 harvests using the Flail-Vac, the first on 3 September and the second on 23 September. The first harvest

Figure 1. A standard Flail-Vac set at a sufficiently low height to allow the nylon brushes to strip seed from the hoary tansyaster plant. This process damages the plant, limiting the number of possible harvests, and accumulates significant amounts of vegetative material along with the harvested seed.

Figure 2. Harvested material from a standard Flail-Vac, which contains significant amounts of vegetative material. The presence of living green leaves, stems, and flowers is evidence of the damage done to the plants and ultimate yield potential lost.

yielded 2.0 kg (4.5 lb) clean seed, and the second harvest yielded 1.3 kg (2.8 lb) for a combined total of 3.3 kg (7.3 lb), equivalent to 13.7 kg/ha (12.2 lb/ac). Only 2 harvests were possible because of the destructive aspect of the Flail-Vac brush on the plants (Figure 2).

In 2015, we experimented with 2 modifications to the standard Flail-Vac harvester in a 0.4-ha (1.0-ac) hoary tansyaster field in an attempt to increase seed yields. The first modification involved adding a rigid pipe rake by mounting 13 lengths (61 cm [24 in]) of galvanized tubing (1.9 cm [0.75 in]) to the front of the Flail-Vac hood (Figure 3). We attached the tubing by bolting a long piece (1.8 m [71 in]) of angle iron (5 × 5 × 0.64 cm [2 × 2 × 0.25 in]) to the front of the hood. To the angle iron we welded 13 long vertical segments (7.6 cm [3 in]) of square tubing (2.54 cm [1 in]) on 15.2-cm (6-in) centers with the exception of the outer most segments, which were mounted at 12.7-cm (5-in) centers. Set screws in the vertical square tubing permitted adjustment of the rake lengths, allowing us to control the aggressiveness of the winnowing action. We configured each section of pipe to penetrate 15.2 to 30.5 cm (6–12 in) into the plant canopy. The Flail-Vac head itself was elevated just above the plants so the brushes had minimal contact with the flowers.

Figure 3. A rigid pipe rake installed on the hood of the Flail-Vac effectively agitated the floral heads, knocking seed loose and allowing them to be collected by the suction created from the rotating brushes. The metal rake modification tended to break or uproot plants.

Seed yields with the metal rake modification were promising; however, we found this technique to be more damaging to the plants than was optimal. The first harvest occurred on 8 September followed by a pass in the opposite direction on 10 September. These 2 initial passes yielded 13.6 kg (30.0 lb) cleaned seed (Table 1). The tubes effectively agitated the plant canopy and shook loose, ripe seed from the flowers and left non-ripe flowers and vegetation intact, but plants became hung up on the pipes and were broken or uprooted. We had to stop the tractor regularly to lift the arms and remove broken stems and plants from the front of the Flail-Vac.

TABLE 1

Harvest data from a 0.4-ha (1.0-ac) field of hoary tansyaster with seed yields combined for the metal-rake and drop-chain modifications, 2015.

Harvest date, 2015	Uncleaned kg (lb)	Cleaned kg (lb)
9/8, 9/10[z]	89 (197)	13.6 (30.0)
9/14	68 (149)	12.1 (26.6)
9/21, 9/23, 9/24	23 (50)	3.0 (6.5)
9/28, 9/29	12 (26)	0.8 (1.7)
Total yield	192 (422)	29.5 (64.8)

[z] Harvests on 9/8 and 9/10 were completed with the metal-rake modification. All other harvests were made with the chain-modified Flail-Vac.

In the second iteration, the lengths of pipe were removed and replaced with loops of heavy chain (Figure 4). Six chains were hung using plastic cable ties from the mounting points remaining on the Flail-Vac from the initial metal rake modification. Chains hung approximately 66 cm (26 in) from the mounting points, allowing them to drag freely through the plants while the brushes remained largely above the canopy. We used 1.3-cm (0.5-in) log chain, weighing approximately 3 kg/m (2 lb/ft) (Figure 5). The chain had enough weight to press into the canopy and scour the plants but was less rigid than the solid rake. As the chains dragged through the plant, the outer chain loops pushed the outer portion of the plants to the center of the rows away from the tires and into the path of the Flail-Vac. Ripe seed was stripped from the flowers, and the loose seed was caught by the air current created by the rotating brush. This method caused very little, if any, damage to the plants. We experienced no broken large stems or uprooted plants using the chain method (Figure 6).

We made 7 additional passes (above and beyond those completed with the rake-modified harvester) with the chain-modified Flail-Vac over a 15-d period. Seed from harvest passes conducted the same or consecutive days were combined, resulting in 4 yield points. Each harvest run along a row was completed in the opposite direction as the previous pass. Immediately after each harvest pass, the plants were leaning over from the weight of the heavy chain, but after a day or two they had regained their upright attitude.

On 14 September, we harvested in both directions for a total of 12.1 kg (26.6 lb). Three more passes were conducted on 21, 23, and 24 September, yielding a total of 3.0 kg (6.5 lb). The final harvest passes were completed on 28 and 29 September, which yielded an additional 0.8 kg (1.7 lb). Final yield of clean seed using the modified Flail-Vac (metal rake and chain modifications combined) was 29.5 kg (64.8 lb) from a 0.4-ha

Figure 4. Loops of heavy log chain illustrating the most effective modification to the Flail-Vac machine for harvesting wind-dispersed seed of hoary tansyaster.

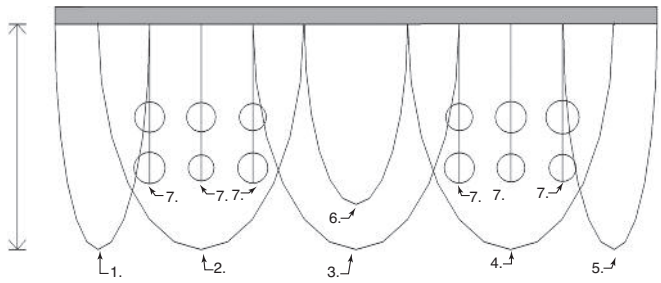

Figure 5. Schematic illustration of chain configuration for the chain-modified Flail-Vac. Dimensions: Outside drop chains (1 and 5), 168 cm (66 in). Over-row loop (2 and 4), 168 cm (66 in). Middle loop (3), 157 cm (62 in). Center loop (6), 137 cm (54 in). Over-row drill drag chains (7), 36 cm (14 in). Diagram by Nathaniel Tilley.

Figure 6. Illustration of the stripping action generated by the chain-modified Flail-Vac. Chains are heavy enough to push the stems over and cause significant agitation, yet are pliable enough to limit plant injury.

(1.0-ac) field, equivalent to 72.6 kg/ha (64.8 lb/ac). Although direct comparisons of yield among the harvest methods (once-over Wintersteiger, non-modified Flail-Vac, and the modified Flail-Vac) should be used cautiously, it was obvious to us that much higher yields were obtained by adding a non-destructive agitation feature to the Flail-Vac harvester.

In evaluating run parameters for the chain-modified Flail-Vac, we found the best results for hoary tansyaster occurred with a slow ground speed, between 0.9 and 1.1 km/h (1.4 and 1.8 mph), with the Flail-Vac set at 400 rpm. Lower brush speeds resulted in insufficient air flow, while higher speeds caused increasing amounts of seed to be sucked completely through the Flail-Vac and blown out the exhaust opening. Run parameters will likely be unique to the species being harvested, given different seed weights and wind-resistance characteristics.

Minimal stem or extraneous materials were accumulated using the chain-modified Flail-Vac. The harvested materials consisted primarily of seed, pappus fluff, and involucral bracts (Figure 7); the negligible amount of stem material collected could easily be separated with a hay fork as the seed dried prior to initial bagging. The time required to dry harvested material, which can be an issue with hoary tansyaster (Winter 2014), was greatly reduced because only ripe seed was harvested with little green vegetative matter.

Because the relatively clean material harvested using the chain-modified Flail-Vac is so light, it requires a slightly altered process for cleaning than is used for a typical seedlot. We ran the seed through a Westrup Laboratory Brush Machine 2 times to remove the pappus; brush machine settings were #7 mantle,

Figure 7. Hoary tansyaster seed harvested with a chain-modified Flail-Vac showing minimal vegetative matter accumulation, thus making it easier to dry and clean.

brushes 3 to 4 mm (0.12 to 0.16 in) from the mantle surface, speed 2.0, and gate opened to approximately 1 cm (0.4 in) to allow small portions of stem to be removed, while the seed falls through the mantle into a catch bin below. A mantle with a smaller screen size might work better and could possibly eliminate the need to run the material through twice; however, even with the added time of a second pass through the brush machine, processing was significantly faster than for seed collected with harvesting methods that tended to accumulate more vegetative material.

Many species possess seed characteristics similar to hoary tansyaster—namely indeterminate ripening and a lightweight, wind-dispersed nature—and may be effectively harvested with a chain-modified Flail-Vac. These species belong primarily to genera within the Asteraceae family including aster (*Symphyotrichum* spp.), hawksbeard (*Crepis* spp.), goldenrod (*Solidago* spp.), groundsel (*Packera* sp.), and agoseris (*Agoseris* spp.). Species in other families that may potentially be harvested with the chain-modified Flail-Vac include willowherb (*Epilobium* spp. [Onagraceae]) and milkweed (*Asclepias* spp. [Asclepiadaceae]).

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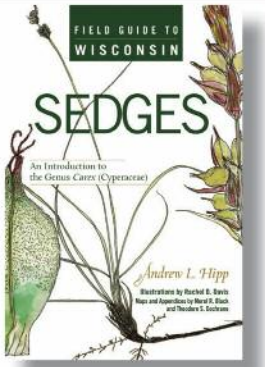

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2015

Title: Soil Health
Presenter: D. Tilley
Location: American Falls, Idaho
Description: Presentation to 5th graders for Power County SCD.
Date presented: 2/14/2014

Title: Habitat restoration in Intermountain rangelands
Presenter: D. Tilley
Location: Moscow, Idaho
Description: Site evaluation and restoration plan development presented to UI restoration class.
Date presented: 1/21/15

Title: Source Identified role in NRCS Plant Materials Program
Presenter: D. Tilley
Location: Sacramento, CA
Description: Presented to Society for Range Management
Date presented: 4/8/2015

Title: Plants and pollinators
Presenter: D. Tilley
Location: Aberdeen, Idaho
Description: South Bingham SCD 5th grade field day
Date presented: 5/12/2015

Title: Curlew NG off-center species adaptation trial
Presenter: D. Tilley
Location: Holbrook, Idaho
Description: Tour of Curlew off-center trial for National Grassland Association
Date presented: 5/13/2015

Title: IDPMC PM Committee Meeting and Field Day
Presenter: D. Tilley
Location: Aberdeen, Idaho
Description: Update on PM developments.
Date presented: 7/21/2015

Title: IDPMC review for NW Plant Materials Advisory Board
Presenter: D. Tilley
Description: Update on PMC activities.
Date presented: 11/18/2015

2016

Title: Plant establishment with feral rye removal
Presenter: D. Tilley
Location: Blackfoot, Idaho
Description: Discussed strategies for rye removal and plant materials for site reclamation.
Date presented: 1/26/2016

Title: Plant Materials needs for the Intermountain West
Presenter: D. Tilley
Location: Reno, NV
Description: Presented to NV NRCS and BLM.
Date presented: 5/24/2016

Title: Soil Health
Presenter: D. Tilley
Location: American Falls, Idaho
Description: Presentation to 5th graders for Power County SCD.
Date presented: 5/10/2016

Title: PMC Tour for Aberdeen Elementary
Presenter: D. Tilley
Location: Aberdeen, Idaho
Description: Demonstrations on soil health, seed cleaning, riparian establishment.
Date presented: 5/16/2016

Title: IDPMC 3-day training for NRCS field office staff
Presenter: PMC staff
Location: Aberdeen, Idaho
Description: Multi-day training for field offices.
Date presented: 6/14/2016

Title: Wetland Plant Identification
Presenter: D. Tilley
Location: Aberdeen, Idaho
Description: Wetland plant ID for NRCS delineators
Date presented: 9/8/2016