UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
BRIDGER, MONTANA

and

MONTANA AGRICULTURAL EXPERIMENT STATIONS
MONTANA STATE UNIVERSITY
BOZEMAN, MONTANA

and

WYOMING AGRICULTURAL EXPERIMENT STATIONS
UNIVERSITY OF WYOMING
LARAMIE, WYOMING

in cooperation with the

DEER LODGE VALLEY CONSERVATION DISTRICT
MONTANA ASSOCIATION OF CONSERVATION DISTRICTS
DEER LODGE, MONTANA

NOTICE OF RELEASE OF STUCKY RIDGE GERMPLASM SILVERLEAF PHACELIA

The U.S. Department of Agriculture, Natural Resources Conservation Service, Bridger Plant Materials Center, Bridger, Montana; Montana Agricultural Experiment Stations, Montana State University; Wyoming Agricultural Experiment Stations, University of Wyoming in cooperation with the Deer Lodge Valley Conservation District, announce the release of a silverleaf phacelia (*Phacelia hastata* Douglas ex Lehm) for the intermountain foothills and mountains of central Montana and Wyoming for low pH and heavy metal contaminated soils.

This release will be referred to as Stucky Ridge Germplasm silverleaf phacelia. It is a selected class of certified seed (natural track) and tested under NRCS accession number 9081632. Staff from the Deer Lodge Valley Conservation District and Bridger Plant Materials Center jointly evaluated and selected Stucky Ridge Germplasm silverleaf phacelia.

Justification for Release: The alternative release is justified based on a critical need for well-adapted plant materials for non-amended, as well as lime-amended, acidic and heavy metal contaminated sites in low- to mid-mountain elevations in the foothills of central Montana and Wyoming. There is no other release of silverleaf phacelia for reclamation of acid and heavy metal soil conditions at this elevation. This release is expected to perform well on non-contaminated sites given similar environmental and climatic conditions. Stucky Ridge Germplasm silverleaf phacelia has superior seedling survival and vigor with a mean height growth relative to the other silverleaf phacelia accession tested, and superior performance compared to other forbs tested at the site. Stucky Ridge Germplasm silverleaf phacelia provides other conservation benefits such as pollinator habitat, wildlife habitat enhancement, and mine land reclamation.

Collection Site Information: The original seed collection of 9081632 was made on July 29, 1998, and August 6, 1998. The collection site is located in Deer Lodge County within the Anaconda Smelter Superfund Site, north of Montana Highway 569 junction with Montana Highway 1 near Anaconda, Montana, at an elevation of 5,081 feet (1.5 kilometers). The approximate latitude/longitude is North 46º07'23" West 112º52'28". The original donor plants were growing in association with slender wheatgrass [*Elymus trachycaulus,* (Link) Gould ex Shinners], redtop (*Agrostis gigantean* Roth), scarlet globemallow [*Sphaeralcea coccinea* (Nutt.) Rydb.], and western wheatgrass [*Pascopyrum smithii* (Rydb.) A. Love]. The mean annual precipitation at the site ranges from 10 to 13 inches (25.4 to 33.0 centimeters) with most of the precipitation occurring in late spring to early summer. The mean frost-free period is 90 to 105 days. The parent material is alluvium. The soil has a gravelly loam texture, well drained with an average slope of 5 to 10 percent. Aerial emissions from past copper smelting operations resulted in elevated levels of heavy metal and sulfur compounds in the soil at the collection site. Chemical properties of soil sampled from the seed collection site were within the phytotoxic level established by the Environmental Protection Agency (Table 1; CDM Federal, 1997).

Table 1. Laboratory analysis of soil sample from the seed collection site.

Sample	As	Cd	Cu	Pb	Zn	pH	Conductivity	Texture
	----------mg/kg----------					S.U.	mmhos/cm	
Collection site	246	9	724	175	477	5.7	0.23	Sandy loam
Phytotoxic Criteria†	136-315	5.1-20	236-750	94-250	196-240	<5.0	>4.0	

† Phytotoxic levels accepted by EPA (CDM Federal, 1997).

Description: Silverleaf phacelia (Figure 1) is a perennial taprooted forb with one to several prostrate to nearly erect stems 20 to 40 inches (50 to 100 centimeters) long. Stems and leaves are covered with fine, short, silvery hairs. Leaves are simple with prominent pinnate venation and margins are usually entire, although some leaves may have a pair of small lateral lobes at the base of the blade. Basal leaves are numerous and tufted and narrowly to broadly elliptic in shape tapering to long petioles. Stem leaves are reduced in size and become sessile on the upper stems. Flowers are in dense, tightly coiled clusters. The corolla is lavender, 5-lobed, 0.2 to 0.3 inches (4 to 7 millimeters) long and broad. The fruit is a capsule, 2-chambered, with several seeds per chamber. Stucky Ridge Germplasm silverleaf phacelia has approximately 153,000 seeds per pound (337,000 seeds per kilogram).

Figure 1. Silverleaf phacelia

Method of Breeding and Selection: Stucky Ridge Germplasm silverleaf phacelia is a direct increase of a single ecotype collected in Deer Lodge County Montana, and selected without purposeful manipulation.

I. Stucky Ridge Evaluation

Comparison to other silverleaf phacelia: Accession 9081632 was planted in 2003 in comparison with the only commercially available source at the time, a silverleaf phacelia (9082275) originating from California. These accessions were field planted in 2003 on Stucky Ridge north of Anaconda, Montana, then tested and evaluated annually for 6 years from 2003 through 2008 (Table 2). Accession 9081632 exhibited good seedling survival, vigor, and mean plant height on an amended acidic/heavy-metal impacted site at Anaconda, Montana. Accession 9082275 did not persist, presumably the result of a lack of winter hardiness or poor adaptation to site conditions.

Table 2. Mean percentage cover/stand, vigor rating, height, and biomass of *Phacelia hastata* accessions tested at Stucky Ridge, Anaconda, MT, from 2004 through 2008.

Year	Accession	Stand	Vigor[1]	Height	Biomass
		----%----	(1-9)	--cm--	--kg/ha--
2004	9081632	0.5	2.4	3.9	no data[2]
2005	9081632	6	2.8	16.7	no data[2]
2006	9081632	0	0	0	0
2007	9081632	0.5	5.0		22.2
2008	9081632	0	0	0	0
2004	9082275	0	0	0	0
2005	9082275	0.5	3.0	25.0	no data[2]
2006	9082275	0	0	0	0
2007	9082275	0	0	0	0
2008	9082275	0	0	0	0

1-Vigor rating: 1 = best vigor; 4 = average vigor; 9 = dead
2-Forb biomass data only collected in 2007.

Comparison to other forb species: Fourteen forb accessions representing five forb genera, and two subshrub accessions representing one subshrub species were tested at Stucky Ridge site near Anaconda, Montana (Table 3). Two accessions of silverleaf phacelia were among the 14 forbs tested.

Table 3. Forb and subshrub treatments included in the forb/subshrub trial near Anaconda, Montana, at the Stucky Ridge Comparative Evaluation Planting.

Genus & Species	Accession/Variety	Origin
Eriogonum ovalifolium	9082098	Deer Lodge County, MT
Eriogonum umbellatum	9082271	Utah
Eriogonum umbellatum	9082273	Idaho
Krascheninnikovia lantana	Northern Cold Desert	Composite from UT & ID
Krascheninnikovia lantana	Open Range	Composite from MT & WY
Penstemon eriantherus	Old Works Germplasm	Deer Lodge County, MT
Penstemon eatonii	Richfield Selected	Sevier County, UT
Penstemon strictus	Bandera 477980	Torrance County, NM
Penstemon venustus	Clearwater Selected	Clearwater River area, ID
Phacelia hastata	9081632	Deer Lodge County, MT
Phacelia hastata	9082275	California
Potentilla gracilis	9081679	California
Potentilla hippiana	9076274	Deer Lodge County, MT
Symphyotrichum chilense	9078675	Deer Lodge County, MT
Symphyotrichum chilense	9081678	Colorado
Symphyotrichum chilense	9082274	Unknown

On August 27, 2001, prior to tillage, four soil samples were collected at a depth of 0 to 6 inches (0- to 15.2-centimeter), bulked and subsamples taken from separate quadrants of the plot. Soil samples were analyzed for pH, total arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) concentrations.

Laboratory analysis of the soil samples indicated the average soil pH measured 5.7 (Table 4). Copper concentrations ranged from 485 to 706 milligrams per kilogram with an average of 560 milligrams per kilogram. Concentrations of As, Cd, Cu, and Pb in the soil exceeded the maximum tolerable levels for wildlife and domestic livestock, and As, Cu, Pb, and Zn concentrations measured 'Excessive or Toxic' for plants. Soil analysis results were used as a basis for determining soil amendment prior to planting.

Table 4. Pre-amendment soil analyses of four soil samples from the Stucky Ridge test plot, and established tolerable levels for animals and plants.

	As	Cd	Cu	Pb	Zn
	----------mg/kg ----------				
Stucky Ridge Test Site (Average)	98	3	560	42	143
Maximum Tolerable Levels					
Domestic livestock[1]	50	0.5	100	30	500
Wildlife[2]	50	2	55	40	300
Metal Ranges in Plants [3]					
Deficient	--	--	2 to 5	--	--
Sufficient or Normal	1 to1.7	0.05 to 0.2	5 to 30	5 to 10	27 to 150
Excessive or Toxic	5 to 20	5 to 30	20 to 100	30 to 300	100 to 400

[1]NRC 1980. [2]Ford, 1996. [3]Kabata-Pendias and Pendias, 1992

Soil Treatment

Prior to spring planting, 22 tons per acre (49.3 metric tons per hectare) of lime kiln dust was surface applied and disked to a 6-inch (15.2-centimeter) depth in November 2002. In spring 2003, commercial fertilizer (12% N, 16% P_2O_5, 30% K_2O) was broadcast applied at a rate of 500 bulk pounds per acre (560.4 kilograms per hectare) and incorporated to a 6-inch depth (15.2 centimeters) with a chisel plow. The plot was seeded on May 13, 2003.

Data Collection

Seedling density assessed performance of the forb and woody species the first growing season (2003). Seedling counts were made on June 24 and August 25, 2003 by placing a 11.8-inch (30-centimeter) x 19.7-inch (50-centimeter) quadrat at five random locations within each 8-foot (2.4-meter) x 25-foot (7.6-meter) plot and counting the number of seedlings within the quadrat. The quadrat, aligned with its long axis perpendicular to the seeded rows, assessed two seeding rows (Table 5).

Only plants of Open Range Germplasm winterfat and accession 9081632 silverleaf phacelia emerged and showed survival resilience in 2004. No additional emergence of any accessions/species occurred in spring 2004. In 2005, plants of Open Range Germplasm winterfat; accession 9081632 silverleaf phacelia; Old Works Germplasm fuzzytongue penstemon; Richfield Select*;* and Northern Cold Desert Germplasm winterfat had survived. Accession 9081632 silverleaf phacelia was superior in performance to accession 9082275, which failed to emerge. In general, accession 9081632 rated good for seedling density, percentage stand, and plant density relative to the other forbs in the study.

Table 5. Mean seedling density (2003), percentage stand (2004), and total plant density (2005) of accessions.

Genus & Species	Variety or Accession	Seedling Density		Percentage Stand		Plant Density
		6/24/03	8/25/03	6/30/04	9/22/04	8/30/05
		-----plants/ft^2------		----------%----------		number/plot
Eriogonum ovalifolium	9082098	0	0	0	0	0
Eriogonum umbellatum	9082271	0.1	0	0	0	0
Eriogonum umbellatum	9082273	0	0	0	0	0
Krascheninnikovia lanata	Open Range	9.5	6.8	5.5	4.5	20.0
Krascheninnikovia lanata	Northern Cold Desert	0.2	0.2	0	0	0.3
Penstemon eatonii	Richfield Select	0	0	0	0	0.8
Penstemon eriantherus	Old Works	0	0	0	0	15.0
Penstemon strictus	Bandera	0.2	0	0	0	0
Penstemon venustus	Clearwater	0	0	0	0	0
Phacelia hastata	9081632	0.3	0.2	0.5	0.5	6.0
Phacelia hastata	9082275	0	0	0	0	0
Potentilla gracilis	9081679	0	0	0	0	0
Potentilla hippiana	9076274	0	0	0	0	0
Symphyotrichum chilense	9078675	0	0	0	0	0
Symphyotrichum chilense	9081678	0	0	0	0	0
Symphyotrichum chilense	9082274	0	0	0	0	0

II. **Forb Initial Evaluation Planting**

As part of a larger Forb Initial Evaluation Planting, ten accessions of wildland collected silverleaf phacelia from Montana and Wyoming, were evaluated at the Bridger Plant Materials Center from 2004 through 2008 (Tables 6 and 7). These were non-replicated plots of wildland collections planted in non-contaminated soil to assess plant performance. Depending on the year, plant height, percentage stand, vigor, and percent flowering were evaluated. Silverleaf phacelia 9081632 varied in mean height, percentage stand, and vigor rating over time, as did the other accessions tested. In three of four years tested, accession 9081632 had above average height and percentage stand compared to other accessions. In 2006, mean percentage stand measured 100% (highest in study) and mean vigor rating measured “1” (tied for highest in study). Mean percentage flowering (only assessed in 2007) of 9081632 measured 80%, one of the highest flowering percentages of the accessions tested, and well above the overall mean of 49%.

Table 6. Origin of *Phacelia hastata* accessions in Initial Evaluation Planting, BPMC, 2005-2008.

Accession Number	Species	County	State
9078432	*Phacelia hastata*	Deer Lodge	MT
9078436	*P. hastata*	Park	MT
9081632	*P. hastata*	Deer Lodge	MT
9081669	*P. hastata*	Rosebud	MT
9081670	*P. hastata*	Big Horn	MT
9081671	*P. hastata*	Powder River	MT
9081675	*P. hastata*	Sublette	WY
9081829	*P. hastata*	Wheatland	MT
9081830	*P. hastata*	Powder River	MT
9082290	*P. hastata*	Mineral	MT

Table 7. Mean *Phacelia hastata* evaluation data by year, Initial Evaluation Planting, BPMC, 2005-2008.

Accession	2005		2006			2007				2008		
	Height (cm)	Stand (%)	Height (cm)	Stand (%)	Vigor (1-9)*	Height (cm)	Stand (%)	Vigor (1-9)*	Flower (%)	Height (cm)	Stand (%)	Vigor (1-9)*
9078432	10	75	20	90	4	30	75	3	90	23	50	3
9078436	15	50	55	80	1	25	20	5	70	37	25	6
9081632	10	75	35	100	1	26	40	5	80	32	70	4
9081669	15	75	25	40	5	20	70	2	10	30	100	2
9081670	12	60	25	70	5	23	80	2	90	40	100	1
9081671	10	85	20	40	4	30	80	1	60	25	85	2
9081675	10	50	25	90	2	12	40	5	40	20	50	4
9081829	10	50	20	15	7	20	45	4	35	35	90	2
9081830	NA	0	NA	0	NA	15	60	4	5	32	90	2
9082290	9	30	45	55	5	20	40	5	5	31	5	6
Mean	11	55	30	58	3.8	22	55	3.6	49	31	67	3.2

*The lower number indicates the higher rating; 1 = best

Ecological Considerations and Evaluation: An Environmental Evaluation of Plant Materials Releases was completed using guidelines established by the NRCS (USDA-NRCS, 2010), and the best available information for this germplasm. Stucky Ridge Germplasm silverleaf phacelia has been assessed for its impact on habitats and ecosystems, ease of management, conservation need, and reproductive characteristics as they may impact invasiveness. In all regards, Stucky Ridge Germplasm is likely to have low adverse impacts on the environment where planted and when managed under natural conditions, and is easy to control. Stucky Ridge Germplasm is a direct increase of a single ecotype and had no genetic modification. It is believed that any negative impact to other native species or plant communities would be minimal to non-existent.

Conservation Use: Stucky Ridge Germplasm silverleaf phacelia is recommended for use on severely impacted sites with low pH and high concentrations of heavy metals, although it performs well and can be used on non-impacted sites as well. It can be used in the following conservation practices:

Wildlife:

Provides pollen and nectar for native bees and other beneficial insects during an extended blooming period (May through September).

- Conservation Cover (327)
- Early Successional habitat Development / Management (647)
- Restoration and management of Rare or Declining Habitats (643)
- Upland Wildlife Habitat Management (645)
- Pollinator Plantings (CP42) and Honey Bee Pollinators Initiative
- Field Border (386)

Reclamation:

Stucky Ridge Germplasm silverleaf phacelia is valuable in the revegetation of disturbed sites. Stucky Ridge Germplasm silverleaf phacelia was originally collected from plants growing near Anaconda, Montana on soils impacted by mining activities and is therefore well suited for reclamation purpose on amended sites. Stucky Ridge Germplasm silverleaf phacelia has exhibited tolerance and adaptation to acid soils (pH range 4 to 5) and the presence of heavy metals. The species provides excellent soil erosion control.

- Critical Area Plantings (342)

Landscaping:

The attractive lavender flowers, long blooming period, and drought tolerance make this an excellent species to use in xeriscaping plans.

Area of Adaptation: Stucky Ridge Germplasm silverleaf phacelia has been tested and proven adapted to two locations in Montana (red areas in Figure 2). The test location near Anaconda, Montana was a limed and fertilized site impacted by acid and heavy metal fallout from historic mining operations. The Bridger, Montana location was a valley bottom site characterized by deep alluvial soils. Stucky Ridge Germplasm did not survive testing in Idaho and Utah when planted in annual precipitation zones of less than 10 inches, which is lower than most areas within the native range of the species. Based on these findings, Stucky Ridge Germplasm should perform well under environmental conditions comparable to the test sites within the boundary delineated in Figure 2. These include areas of dry open terrain, loamy to sandy soils, elevations ranging from 2,000 to 8,000 feet, average annual precipitation of 10 to 14 inches, and an average frost-free period of 90 or more days. Additional plantings are needed to verify the area of potential adaptation to eastern Oregon and Washington, northern Idaho, Montana, Wyoming, and northern Colorado.

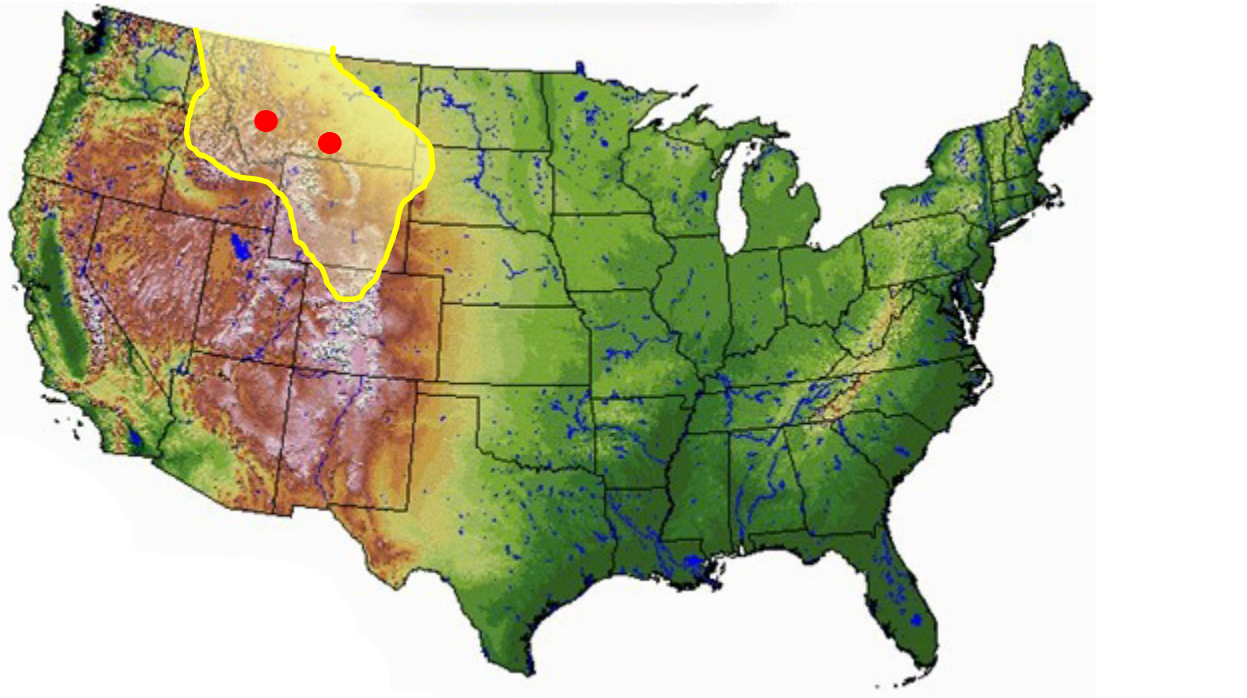

Figure 2. Range of known adaptation (red) and potential area of adaptation of Stucky Ridge Germplasm. silverleaf phacelia.

Availability of Plant Materials: Generation G1 (equivalent to Foundation) seed of Stucky Ridge Germplasm silverleaf phacelia is available to commercial growers from the USDA-Natural Resources Conservation Service (NRCS), Bridger Plant Materials Center, Bridger, Montana, through the Foundation Seed Stocks Program at Montana State University-Bozeman or the University of Wyoming Foundation Seed Service at Powell, Wyoming. Commercial production of two generations (G2 and G3) beyond G1 is allowed.

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