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NATURAL RESOURCES CONSERVATION SERVICE
Plant Materials
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PLANT MATERIALS TECH NOTE

Plant Materials for Acidic/Heavy Metal Contaminated Soils

Introduction: In 1995, two comparative evaluation plots were constructed near Anaconda, Montana, on sites affected by heavy metals and acidic conditions. The purpose of the study was to identify plant materials that demonstrated superior tolerances to acidic/heavy metal contaminated soil. The plant materials evaluated in this study were assembled from seed collections made on lands impacted by mining in western and central Montana and from commercial seed sources. The study entries were evaluated for height, vigor, percent survival, rate of spread, and seedhead production. This paper summarizes the superior performing cultivars tested in the study after three growing seasons.

Study Background: The study plot sites (Site 1 and Site 2) were located on the Anaconda Smelter Superfund Site in southwestern Montana, approximately 25 miles northwest of Butte, primarily in Deer Lodge County. The area has a cool, semi-arid climate with approximately 14 inches of annual precipitation. The Anaconda Smelter Superfund Site contains large volumes of wastes, debris and contaminated soil from copper ore milling, smelting and refining operations that took place from 1884 to 1980. The aerial emissions from smelting operations resulted in deposition of arsenic, cadmium, copper, lead and zinc. Erosion from the tailing ponds and waste piles continue to distribute contaminates throughout the area.

Site 1, located near the junction of Highway 1 and Highway 48, has been affected by aerial deposition from smelter operations and ongoing contamination by fugitive emissions involving the redeposition of exposed hazardous substances. Much of the topsoil has been removed at Site 1 by wind and overland water erosion. Prior to plowing, Site 1 was sparsely vegetated and had an average pH of 5.5. The plot was deep plowed, cultivated with sweeps and roller packed. After plowing, the site had an average pH of 6.8–due to a calcareous layer within the top 12 inches of the soil profile. Composite samples from the top 10 inches of the soil indicate very high levels of cadmium, copper and zinc. Cadmium levels at the site exceed the upper limits established for phytotoxicity. Copper levels were three times higher and zinc 129 times higher than the specified upper limits. Surface samples had heavy metal concentrations several times greater in magnitude than the composite samples.

Site 2 is located on the Opportunity Ponds, approximately two miles northeast of the junction of Highway 1 and Highway 48. The Opportunity Ponds were used as a disposal site for tailings. During active disposal of smelter wastes, a portion of the ponds was covered with water, but have since been allowed to dewater. The Opportunity Ponds are characterized by very high levels of copper, lead and zinc. At Site 2, the area was void of vegetation except for sparse patches of redtop. The average pH at the plot site prior to plowing was 3.0. Quick lime (CaO) was incorporated at this site at three different rates: 0, 30, and 60 tons/acre. After the site was left to mellow for several months, the average pH of the 30 and 60 tons/acre treatments ranged from 7.5 to 8.0. The heavy metal levels at Site 2 were also very high in cadmium, copper and zinc. One surface sample contained cadmium concentrations 21 times greater, copper 53 times greater and zinc 266 times greater than the upper limits established for phytotoxity.

Materials Tested: The study tested a total of 220 entries. Of these, 80 were released cultivars and 140 were collections and commercial seed without release status. Within the released cultivars: 59 grasses, 18 forbs and 3 shrubs were tested. Of the 140 accessions: 69 grasses, 26 forbs, 35 shrubs and 8 trees were tested. The plots were all planted using a push type, single-row, belt seeder and seeded in

rows 30 feet long, with 1.5-foot row spacing, at approximately 0.5-inch deep. Both sites were constructed in a randomized complete block design and replicated three times.

Study Results: The tables below list the top five performing grass and forb cultivars at Sites 1 and 2. The five top performers at Site 2 listed below are cultivars with the highest average acres with the three treatments. Of the three shrub cultivars tested in the study, the best performing shrub was 'Rincon' fourwing saltbrush. From the 12 forb cultivars tested at Site 2 zero survived. All the entries were rated for vigor and percent survival after three growing seasons. Neither metal uptake analysis nor yield ratings were performed.

Site 1. Best performing cultivars in order of superiority

Life Form*	Cultivar	Species
G	'Schwendimar' thickspike wheatgrass	*Elymus lanceolatus* ssp. *lanceolatus*
G	'Magnar' Basin wildrye	*Leymus cinereus*
G	'Secar' Snake River wheatgrass	*Pseudoroegneria spicata* ssp. *spicata*
G	'Prairieland' Altai wildrye	*Leymus angustus*
G	'Goldar' bluebunch wheatgrass	*Pseudoroegneria spicata* ssp. *spicata*
F	'Tretana' birdfoot deervetch	*Lotus corniculatus*
F	'Timp' northern sweetvetch	*Hedysarum boreale*
F	'Bandera' Rocky Mountain penstemon	*Penstemon strictus*
F	'Kaneb' purple prairieclover	*Dalea purpurea*
F	'Kalo' birdsfoot deervetch	*Lotus corniculatus*

Site 2. Best performing cultivars in order of superiority

Life Form*	Cultivar	Species
G	'Volga' mammoth wildrye	*Leymus racemosus*
G	'Whitmar' beardless wheatgrass	*Pseudoroegneria spicata* ssp. *inermis*
G	'Prairieland' Altai wildrye	*Leymus angustus*
G	'Pennlawn' red fescue	*Festuca rubra*
G	'Newhy' hybrid wheatgrass	*Elytrigia repens* X *Pseudoroegneria spicata*

* Grass, Forb

Summary: The study results apply to acidic/heavy metal contaminated soils that have been ameliorated to raise the soil pH near neutral. In general, the results suggest that grasses outperform forb and shrub life forms. The forbs that did perform well at Site 1 were often legumes such as deervetch and sweetvetch. The best performing grasses were the wildryes and wheatgrasses. The preliminary results show that both native and introduced cultivars have the potential to perform well on ameliorated acidic/heavy metal contaminated soils. The native cultivars that show promise are: 'Goldar', 'Secar' and 'Whitmar' bluebunch wheatgrass; 'Critana' and 'Schwendimar' thickspike wheatgrass; 'Sodar' streambank wheatgrass; 'Pryor' slender wheatgrass; and 'Magnar' basin wildrye. The introduced cultivars that show promise are 'Reliant' and 'Manska' intermediate wheatgrass; 'Newhy' hybrid wheatgrass; 'Prairieland' Altai wildrye; 'Volga' mammoth wildrye; 'Bozoisky-Select' and 'Mankota' Russian wildrye.

For a complete listing of the plant materials tested contact Leslie Marty, Project Leader for the Development of Acid Tolerant Cultivar project. Coordinated by the Bridger Plant Materials Center and the Deer Lodge Valley Conservation District (406) 662-3579.