TRANSPLANTING AND ESTABLISHMENT OF WESTERN SNOWBERRY (*Symphoricarpos occidentalis* Hook.) ON RECLAIMED LAND[1]

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Abstract: Reestablishment of western snowberry (*Symphoricarpos occidentalis* Hook.) was attempted on surface mined land reclaimed to mixed grass prairie in western North Dakota. Undisturbed shrub patches were segregated and removed with tractor scrapers in 1989. These were directly replaced in two low drainage landscape sites, less than one hectare each, on reclaimed land. No seeding, herbicide spraying, or grazing was conducted on reclaimed sites. Stem counts and frequency were analyzed yearly. Regression correlations were calculated for average stems/0.25m^2 vs. April-July precipitation (r^2 = 0.90), vs. October-July precipitation (r^2 = 0.97), and vs. age of reclaimed stand (r^2 = 0.58). Regression correlations were also calculated for frequency vs. April-July precipitation (r^2 = 0.80), vs. October-July precipitation (r^2 = 0.88), and vs. age of reclaimed stand (r^2 = 0.58). October-July precipitation had the greatest impact on stand establishment and success. Special consideration should be given to site location and moisture conditions when transplanting western snowberry. Bond liability period length should be hased on moisture conditions, not age of the stand.

Additional Key Words: Revegetation, Shrub Establishment

Introduction

Reclaimed native grasslands are being successfully established on thousands of acres of surface mined lands in the Northern Great Plains. In western North Dakota these reclaimed lands are dominated far more by a grass component than they were prior to mining. Forbs and shrubs are generally not planted, as they contribute little to the planned post-mining land use of grazing and haying. Western snowberry (*Symphoricarpos occidentalis* Hook.) is a minor component of undisturbed mixed grass prairies in western North Dakota, but is the most common low shrub. It is found in patches, normally less than a hectare in size, on broad flats and shallow depressional areas, but not in areas so wet they contain standing water. This project encompassed reestablishment of two small snowberry patches, each about 0.5 hectare, on reclaimed lands at a large surface coal mine.

Although snowberry, commonly called "buckbrush" (Stevens 1963) is not a major component on prairies, it has an important function. Stephens (1973) notes that this species provides good cover and nesting sites for small birds, and that a few birds eat its berries during the winter. It is browsed by big game (Thornburg 1982). Other species of snowberry are important sheep forage in the Intermountain West (Ruyle et al 1983).

Shrub reestablishment during reclamation of surface mines has taken many forms. Van Epps and McKell (1978) describe criteria for shrub establishment on reclaimed lands, and note that many species can be direct seeded, although a seed source may not be readily available. Bjugstad (1984) says that moisture is the limiting factor in shrub establishment in the Northern Great Plains. Amendola et al (1984) found that containerized seedlings had better survival than bare-root seedlings for shrubs planted on reclaimed mined lands in Montana. They also found that land treatments which improved moisture retention enhanced seedling survival. A process called fluid drilling has been used in Wyoming to break seed dormancy and

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improve shrub seedling vigor. A liquid is mixed with seeds as they are planted (Booth 1984). Macyk and Widtman (1987) found shrub survival was greater when there was no grass competition. They used shrub cuttings in the foothills/mountain region of Alberta, Canada. They also found that rooted cuttings survived better than cuttings placed directly in the ground. Kiger et al (1987) compared seeding, transplanting shrub seedlings, and transplanting mature shrubs at a mine in Colorado. A different species of snowberry (*Symphoricarpos oreophilus*) was included in the study. Large shrub pads were transplanted with a front-end loader.

Experience at the Freedom Mine has shown that many forbs and shrubs volunteer on reclaimed lands, especially when using native prairie soil directly respread, rather than stockpiled. A large volunteer component of trees and shrubs has been found on other reclaimed lands using topsoil from forested lands (Larson and Vimmerstedt 1988, Wade and Thompson 1990). Van Epps and McKell (1978) state that root-sprouting shrub species often produce excellent stands, citing snowberry as a good example of a species with high root-sprout potential. Bailey et al (1990) found western snowberry to increase in stem density with heavy grazing in a Canadian study. Wasser (1982) recommends transplanting cuttings of snowberry, rather than seeding, and irrigating the revegetated site until shrubs are established.

Site Location

The Freedom Mine, located about 90 miles northwest of Bismarck, North Dakota, is owned and operated by The Coteau Properties Company, a subsidiary of the North American Coal Corporation. Lignite coal mining began in 1983, and current production is about 15.5 million short tons per year. From 150-300 hectares are mined and reclaimed annually. About 1,500 hectares have been reclaimed to date.

Earth moving for mining is accomplished with tractor-scrapers, bulldozers, a truck-shovel-fleet, and two 110 cubic yard class draglines. Spoils are regraded immediately behind active pits, and topsoil and subsoil are respread and seeded immediately after regrading. Reclaimed lands are currently being used for hay and grain production and livestock grazing.

The undisturbed landscape is characterized by mostly gently rolling and well-drained croplands used for dryland wheat production. About a third of the mine is composed of steeply sloping mixed grass native rangeland used for livestock grazing. Most grazed areas have soils too shallow and slopes too steep for farming.

Undisturbed native rangelands are dominated by blue grama (*Bouteloua gracilis*), western wheatgrass (*Agropyron smithii*), green needlegrass (*Stipa viridula*), needle-and-thread (*Stipa comata*), upland sedges (*Carex sp.*) and prairie junegrass (*Koeleria cristata*). Forbs are common in all areas, although trees and shrubs are normally restricted to more mesic sites, such as drainageways. At the Freedom Mine, western snowberry comprises less than 1% of pre-mine species composition. Many snowberry patches are trampled by livestock, and are not very dense.

Methods and Materials

Most topsoil is stripped using tractor-scrapers, and directly respread on reclaimed lands. About 5% is stockpiled for later respread. During topsoil stripping in late summer 1989, a special effort was made to segregate patches of snowberry, and respread them in low reclaimed prairie sites. The shrub patches would not "roll" into the scraper pan as originally planned, but chunks of snowberry sod, several square meters in sized, were saved and respread. These sod chunks made the two reclaimed patches very rough, and unsuitable for farm equipment. No seeding, spraying, rockpicking, or grazing was conducted at these sites.

Site monitoring began in 1990. Correlations of stem densities and frequencies were made with October-July precipitation, April-July precipitation, and age of the stand.

Sampling was conducted in August. A circular 0.25 m^2 plot was used for sampling. Stems were counted if they existed 2 cm above ground level. Rainfall records were maintained from rain gauges at the mine site.

Results

A large number of species invaded the patches, and by 1994 a diverse native species component had developed (Table 1). Kochia (*Kochia scoparia*), Russian thistle (*Salsola kali*), and blue wild lettuce (*Lactuca pulchella*) dominated the patches the first year, and decreased in frequency over time.

Table 1. Plant species found in snowberry plots on reclaimed land in 1994.

Achillea millefolium - western yarrow
Agropyron cristatum - crested wheatgrass
Artemisia absinthium - absinthe wormwood
Artemisia ludoviciana - cudweed sagewort
Bouteloua curtipendula - sideoats grama
Carex eleocharis - needleleaf sedge
Carex heliophila - sun sedge
Chrysopsis villosa - hairy goldenaster
Cirsium undulatum - wavyleaf thistle
Dalea enneandra - bigtop dalea
Echinochloa crusgalli - barnyard grass
Erigeron strigosus - daisy fleabane
Grindelia squarrosa - curlycup gumweed
Helianthus maximiliani - Maximilian sunflower
Hordeum jubatum - foxtail barley
Lactuca pulchella - blue lettuce
Panicum virgatum - switchgrass
Plantago patagonica - wooly plantain
Polygonum convolvulus - wild buckwheat
Psoralea argophylla - silverleaf scurfpea
Rumex crispus - curled dock
Salidago missouriensis - Missouri goldenrod
Stipa comata - needle-and-thread
Stipa viridula - green needlegrass
Vicia americana - American vetch
Agoseris glauca - false dandelion
Agropyron smithii - western wheatgrass
Artemisia frigida - fringed sagewort
Aster ericoides - heath aster
Bromus inermis - smooth brome
Carex filifolia - threadleaf sedge
Chenopodium album - lambsquarters
Cirsium arvense - Canada thistle
Convolvulus arvensis - field bindweed
Echinacea angustifolia - purple coneflower
Elymus canadensis - Canada wildrye
Galium boreale - northern bedstraw
Gutierrezia sarothrae - broom snakeweed
Helianthus rigidus - stiff sunflower
Kochia scoparia - kochia
Lactuca scariola - prickly lettuce
Petalostemon purpureum - purple prairieclover
Poa sp. - bluegrass
Rosa arkansana - prairie rose
Ratibida columnifera - prairie coneflower
Salsola kali - Russian thistle
Solidago rigida - stiff goldenrod
Stipa spartea - porcupine grass
Tragapogon dubius - salsify

The best correlation was between the per cent of plots with > 10 stems and October-July precipitation ($p < 0.05$) (Tables 2 and 3). October-July precipitation correlated best with other stand establishment indicators, such as average stems/0.25 m^2 plot ($p < 0.05$), per cent of plots with zero stems, and species frequency. April-July precipitation was not as important. This may be because snowfall in the October-July period provides subsoil moisture important to growing shrubs.

Table 2. Snowberry on reclaimed land at the Freedom Mine.

	1990	1991	1992	1993
Average Stems/0.25 m^2	3.05	2.08	2.98	10.1
Frequency %	50	34	52.5	95
% Plots with Stems:				
0	50	57.5	47.5	5
1-5	15	30	32.5	35
6-10	25	5	10	20
11+	10	7.5	10	40
Precipitation (cm):				
Oct.-April	3.50	6.50	9.01	5.43
April-July	25.83	20.25	15.84	45.53
Oct.-July	29.33	26.65	24.85	50.96

Table 3. Correlation between snowberry establishment and precipitation/age of stand.

R^2	Correlation
0.974	Percent of plots with >10 stems vs. Oct.-July precipitation
0.970	Average stems/0.25 m^2 vs. Oct.-July precipitation
0.939	Percent of plots with 0 stems vs. Oct.-July precipitation
0.900	Percent of plots with >10 stems vs. April-July precipitation
0.899	Average stems/0.25 m^2 vs. April-July precipitation
0.879	Frequency vs. Oct.-July precipitation
0.856	Percent of plots with 0 stems vs. April-July precipitation
0.803	Frequency vs. April-July precipitation
0.584	Average stems/0.25 m^2 vs. age of stand
0.578	Frequency vs. age of stand

The age of the stand was not a strong factor in stand establishment. This is important, as the 10 year liability period imposed by surface mining laws assumes that stand establishment and permanence is related closely to the length of time the stand has existed. This study shows that, for western snowberry at least, precipitation should be considered a much more important factor than simply the age of the stand. This has implications in determining how long a surface mining bond should be tied up before bond release.

Reclaimed snowberry stands are establishing quite well. This is in large part due to record rainfalls received in the summer of 1994. Low areas collect more moisture, thus enhancing the effect of increased precipitation. Irrigation would be an important supplement to help stand establishment.

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EVALUATION OF CULTURAL METHODS FOR ESTABLISHING WYOMING BIG SAGEBRUSH ON MINED LANDS[1]

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Abstract: Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) is one of the most widely distributed and adapted shrub species in Wyoming and the region. However, its reestablishment on mined lands has proven difficult because of low seedling vigor, its inability to compete with herbaceous species, poor seed quality, and altered edaphic conditions. Field research evaluating the effect of topsoil management, mulching practice, and plant competition have shown that all of these factors significantly influence early initial sagebrush establishment. Greater sagebrush establishment occurred on fresh topsoil compared to 5 year old stockpiled topsoil. Stubble and surface applied mulch and elimination of herbaceous species competition also significantly increased big sagebrush establishment in the first growing season. However, a cool, wet second year growing season (April-September) resulted in large increases in sagebrush seedling density across all treatments. These large increases resulted in some changes in response to imposed treatments; however, greater sagebrush seedling densities were still evident on fresh compared to stockpiled topsoil and competition still significantly reduced seedling density on the fresh topsoil treatment. Mulch type showed limited effects on sagebrush seedling density in the later phases of the study. This research indicates that big sagebrush seed viability may be longer than previously thought and that seed dormancy, safe site development, and climatic conditions play an important role in germination and establishment of this species.

Additional Keywords: Topsoil, Mulching, Plant Competition, *Artemsia tridentata*

Introduction

Wyoming big sagebrush (*Artemesia tridentata* ssp. *wyomingensis*) occurs across the West and east to the Black Hills (Beetle and Johnson 1982). Although controversy exists over its value (Colbert and Colbert 1983, Tessman and Kleinman 1989), the mining industry is encouraged or required to restore Wyoming big sagebrush on mined lands if it existed in the pre-mined ecosystem. Establishment of big sagebrush on reclaimed mined lands can be accomplished by direct seeding or transplantation. Luke and Monsen (1983) found that direct seeding was the most cost effective method; however, the reliability of direct seeding for shrub reestablishment is not good. Many theories exist as to the reasons for poor establishment of big sagebrush from direct seeding, including poor seed viability (Harniss and McDonough 1976, Young and Evans 1989), seed dormancy, seed harvest methods, and seedbed microclimate (McDonough and Harniss 1974, Meyer and Monsen 1992).

Herbaceous species competition may be another reason for the variable success of direct seeded sagebrush. Blaisdell (1949) reported that grasses outcompeted sagebrush when seeded from two years before to one year after seeding sagebrush and Jones (1991) was able to show increased survival of big sagebrush by removing other vegetation competition. Cook and Lewis (1963) and Sturges (1977) noted that competition effects are probably related to sagebrush seedlings inability to compete for water. Another issue identified as a factor that might reduce sagebrush seedling establishment is the lack, of or reduced level of vesicular-arbuscular mycorrhizae (VAM)

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