Grass Establishment on Uranium Exploration Sites in New Mexico[1]

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ABSTRACT

Many abandoned uranium exploration sites dot the landscape in west central New Mexico. These sites are commonly bare, and although small, are subject to considerable surface erosion. Such areas can be quite difficult to revegetate because the topsoil has been lost and annual precipitation is usually low (less than 30 cm). The study was conducted in the Grants uranium district on a site disturbed by linear prospecting. Eight prospects within a 2 km^2 area were regraded and grasses established using four treatments: combinations of straw incorporation, furrowing, straw mulching, and drill seeding. Treatments were evaluated after 5 years.

Galleta (Hilaria jamesii) and blue grama (Bouteloua gracilis) grasses responded well to the furrowing and straw incorporation treatments. Total cover and production were also improved by straw incorporation. Many of the less valuable pioneer plants did not respond to these treatments. Because galleta and blue grama are valuable for both forage and watershed protection, their improved establishment through incorporation of straw and furrowing is recommended.

ADDITIONAL KEY WORDS: Grants uranium district, arid land revegetation, contour furrowing, mulching, incorporation of organic material, drill seeding.

Abandoned uranium prospect sites are quite common in the Grants area in west central New Mexico. These small sites (<10 ha) are generally bare of vegetation and exposed to considerable erosion. Topography is quite broken, and consists of pits or trenches that must be graded prior to planting. The resulting surface material is usually a poorly mixed composite of the original soil profile and underlying material. The poor soil conditions in combination with low annual precipitation (<30 cm) make these sites difficult to revegetate.

Methods of reclaiming uranium prospects are not well established, but practices used to revegetate coal spoils may be adaptable. Practices such as incorporating straw into the soil, contour furrowing, and mulching have been useful in coal mine reclamation (Scholl and Pase, 1984; Gould et al., 1982; Packer and Aldon, 1978). Adding organic materials such as straw to uranium prospect spoils might be expected to (1) improve water infiltration, (2) improve water and nutrient holding capacities, (3) improve aeration and root penetration, and (4) stimulate microbial populations and nutrient mineralization (Fresquez and Lindemann, 1982). Contour furrowing can improve the probability of plant establishment by concentrating runoff in furrow bottoms (Scholl, 1985).

This study was conducted to determine the effect of straw incorporation, furrowing, mulching, and drill seeding on the establishment of several native grasses on uranium exploration sites.

METHODS

Study Site

The study, conducted 20 k north of Grants near the Zia Mine, includes a series of eight linear

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prospect trenches. The trenches were 3-6 m wide, 1-2 m deep and 0.2-1.0 k long. The soil and underlying material had been excavated and dumped on both sides of the trench, making the total width of disturbance about three times that of the trench. The prospects were laid parallel (east-west) and about 200 m apart.

Annual precipitation averaged 33.9 cm during the 5-year study, with 14.8 cm as winter and 19.1 as summer means. Seasonal precipitation varied by about 30% of the mean, especially in winter.

Vegetation outside the disturbed areas is pinyon-juniper woodland (Pinus edulis and Juniperus monosperma) with some large open areas (100ha) dominated by blue grama grass (Bouteloua gracilis) and broom snakeweed (Gutierrezia sarothrae). Several other grass species are present along with some prickly pear cactus (Opuntia spp.).

Soils on the area are developed from Morrison sandstone, and are generally calcareous in the subsoil. The major portion of the study area has fine sandy loam surface soils (35 cm thick) over a sandy clay subsoil (80 cm thick). Substratum materials are generally fine sand. These soils are tentatively classified as Ustollic Haplargid, fine, mixed, mesic. In the west-central portion of the area, however, the soil becomes more shallow to the sandy substrata and the resulting spoil is more sandy on the surface. The texture of the surface 15 cm of spoil can be rather variable over short distances, depending on the soil depth, depth of trenching, and degree of mixing of the various layers. Surface spoil textures were generally coarse, ranging from sand to sandy clay loam, with loamy sand and sandy loam being the most common.

Treatments and Measurements

All of the trenches were filled and the entire disturbed area graded with a crawler tractor with a front-mounted blade. Replicated (3) treatment and control plots were placed randomly on the graded spoil strips to effect a randomized block design. The plots varied in size (0.5-2 ha) from one strip to the next so that the whole disturbed surface would be included in the study.

The treatments included the following operations, in order of accomplishment: (1) straw incorporation ($2Mgha^{-1}$), furrowing (0.15 m deep, 0.3 m wide), drill seeding; (2) furrowing, drill seeding, mulching ($2Mgha^{-1}$); (3) drill seeding, mulching; (4) drill seeding. The straw incorporation and contour furrowing were done in one pass using a heavy, construction—type disk harrow. The disk was modified to make furrows by removing alternate disks from the back gang, which allowed each remaining disk (3) to leave an intact furrow (0.45 m apart). The modified disk could therefore be used for both incorporation (front gang) and furrow production (rear gang). A rotary tub mulcher was used to blow straw on the incorporation plots just ahead of the modified disk. Seeds were drilled with a rangeland drill.

The second treatement was similar to the first, except the straw was blown on after seeding (mulching) instead of before the disking. In the third treatment, seeds were drilled directly on the graded spoil, followed by mulching and crimping. The fourth treatment was drill seeding only on graded spoil.

The following grass species were seeded (0.5 $kgha^{-1}$ each) on all plots in June 1981: blue grama, Indian ricegrass (Oryzopsis hymenoides), galleta (Hilaria jamesii), and sand dropseed (Sporobolus cryptandrus). The blue grama and Indian ricegrass seeds were from selected cultivars obtained from the SCS Plant Materials Center at Los Lunas, New Mexico.

Cover (%), production ($kgha^{-1}$), and density (plants m^{-2}) were sampled in September, 5 years after seeding, along 3 transects in each of the treatment plots. Cover and density were determined by the CSA line transect method (Pase 1980). Plant cover was estimated inside a 5 x 10 cm frame, every 2 m (n=50), along a randomly located line. Density was determined by counting plants inside a 0.5 m^2 loop placed every 20 m along the same line (n=5). Production was measured using a double sampling technique along the same line at a random location inside a circular sample loop (.89 m^2). The plants in one of three loops were clipped (selected randomly) and weighed, and then reweighed after air drying. Field weight was estimated for all samples (3), and the unclipped samples (2) adjusted for deviation from the clipped sample (1) (Schumacker and Chapman 1948). All weights were then adjusted to air dry equivalent. The contribution of each species to total production was estimated as a percentage. An analysis of variance and Duncan's multiple range test were used to evaluate all results.

RESULTS AND DISCUSSION

The warm season native species used in this study established slowly, requiring several years to mature. Plant cover and production also developed slowly, while plant numbers increased more rapidly and were stable in two years. After 5 years, galleta and blue grama, along with the other species, achieved maximum production and ground cover (Table I). Among the individual seeded species, galleta and blue grama were the most important (cover and production) especially on furrowed plots. Both species are considered valuable for grazing and watershed protection.

Sand dropseed was somewhat more numerous (density) than the other grasses, especially on the no-mulch and control plots. Sand dropseed and other invader species, including (Russian thistle (Salsola kali)), were the dominant plants on these plots. Although the volunteer plants were numerous on the control and no mulch plots, their contribution to forage and watershed protection was minimal. Sand dropseed, although numerous and palatable to livestock, had relatively low production. Broom snakeweed, another important perennial invader, provided significant cover on most plots but has little forage value.

Furrowing and especially straw incorporation produced the best growth (cover and production) of the more desirable galleta and blue grama plants. Incorporation of straw, instead of mulching, was best for establishing blue grama. Sand dropseed and Indian ricegrass showed little response to most treatments, but were minor contributors on the furrowed plots. Sand dropseed, however, produced the highest cover of the grasses on the seed-only

Table 1. Response of four native grasses on uranium exploration sites to various land treatments.

	Drill Seed				No seed
	Furrow			No Furrow	
Measurement	Incorp.	Mulch	No Mulch	Mulch	No Mulch
Cover (%)					
Galleta	8.8[a][1]	9.9[a]	2.3[b]	2.9[b]	1.8[b]
Blue grama	8.2[a]	1.4[b]	3.7[b]	2.0[b]	2.8[b]
Sand dropseed	2.8[a]	1.3[a]	6.4[b]	2.0[a]	2.7[a]
Indian ricegrass	0.9[a]	1.3[a]	1.2[a]	0.3[a]	0.5[a]
Other[2]	17.0[a]	11.5[a]	11.7[a]	11.8[a]	16.5[a]
Total	37.7[a]	25.4[b]	25.3[b]	19.0[b]	24.3[b]
Production ($kgha^{-1}$)					
Galleta	725[a]	516[ab]	280[bc]	336[bc]	127[c]
Blue grama	493[a]	134[b]	134[b]	78[b]	179[b]
Indian ricegrass	145[a]	26[ab]	20[ac]	3.8[bc]	5[bc]
Sand Dropseed	98[a]	101[a]	261[a]	165[a]	235[a]
Total	1461[a]	777[ab]	695[b]	583[b]	546[b]
Density (plants m^{-2})					
Sand dropseed	11[ab]	6.4[ab]	18[b]	4.4[a]	15[ab]
Galleta	9.2[a]	5.6[a]	3.2[a]	5.6[a]	3.2[a]
Blue grama	7.2[a]	1.2[a]	8.6[a]	3.4[a]	8.6[a]
Indian ricegrass	1.8[a]	2.6[a]	2.4[a]	0.6[a]	1.0[a]
Total	29[a]	16[a]	32[a]	14[a]	28[a]

[1]Values with same letter in rows are not significantly different (P=0.05), n=3.

[2]Broom snakeweed, Russian thistle, and other grasses and forbs.

plots. Its ability to grow on bare, unprepared soil is clearly shown. Sand dropseed played a lesser role on furrowed plots, where competition was greater from blue grama and galleta. We assumed, although data is lacking, that blue grama and galleta responded to improved soil conditions resulting from the furrow and straw treatments.

For all species, (total) the straw incorporation treatment on furrowed plots had the highest cover and production, with galleta and blue grama being the major contributors. No significant treatment effects were found in the density totals, but the relatively high levels on bare plots (no mulch and control) were mainly the influence of thick but low producing stands of sand dropseed.

SUMMARY

Galleta and blue grama grasses responded well to the furrowing and straw incorporation treatments. Total cover and production from all species were also improved by straw incorporation. Galleta responded to furrowing with straw mulching, but blue grama did not. Less productive species such as sand dropseed and Indian ricegrass showed little response to the treatments. Sand dropseed, an initial pioneer, actually became dominant on the bare soil plots. Because galleta and blue grama are valuable for both forage and watershed protection, their improved establishment through use of straw incorporation and furrowing is recommended.

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