

Revegetation Treatments for Stand Establishment on Coal Spoil Banks¹

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Highlight

Coal spoil banks near Kemmerer, Wyoming were subjected to several treatments designed to facilitate revegetation. These included the use of snowfence, jute net, and straw mulch applied to banks of three different ages. Evaluation by seedling density suggested that the older the spoil the more suitable for planting. All treatments produced seedling stands but a combination of jute netting and mulch gave best results.

Much of Wyoming is underlain with coal, the mining of which has been a major industry since the foundation of the state. With changing times, operation has shifted from tunnelling to the more improved and economical open pit method.

Surface mining results in disturbed areas of land, not solely in the form of open pits but also as large amounts of waste material, commonly termed "spoil." The effects of erosion, stream pollution, and esthetic qualities of the deposits have motivated a restoration and stabilization movement, usually involving revegetation. This type of reclamation, while never ceasing to be a challenge, is simplified in regions of high rainfall; whereas, in the more arid regions revegetation is confounded by problems of heat, evaporation, drought, and many other factors. To confront this situation new techniques must be developed which will be not

only successful in a relatively short time but also economical.

Range management personnel fit well into the revegetation picture. They can furnish much needed information regarding the soils, climate, seeding methods, and choice of species based on parallel problems confronted in grazing land management and restoration.

The Kemmerer Coal Company with headquarters in Frontier, Wyoming, acknowledged the preceding statements by the selection of the Range Management Section, University of Wyoming, to conduct the first revegetation study on spoil banks in the state and probably one of the first in the arid regions of the west. The purpose of this investigation was to test species, treatments, and methods of seeding for use in restoring a plant cover to coal spoil banks which were practically barren of any plant life. This paper deals with some of the treatments used in this study.

Study Area and Procedure

The Kemmerer Coal Fields, where this study was conducted, lie in semi-arid southwestern Wyoming about four miles southwest of Kemmerer. Average annual precipitation for this area is 9.42 inches with periodic drought being the rule. Most of the precipitation occurs in the winter months as snow with average annual snowfall amounting to 56.5 inches of which, according to May (1967), 60 to 80% may be sublimated, leaving less than half of the moisture content to be transformed into water.

Description of Spoil Material.—Following mining operations, a heterogeneous mass is derived from the mined strata of earth which dictates the chemical and physical properties of the spoil. Within the same bank pH levels may range from highly acidic to extremely alkaline (Grandt and Lang, 1958).

Acidity is a major factor influencing the success of plant establishment and is usually caused by strata immediately above and below the coal seam.

¹Published with approval of the Director, Wyoming Agricultural Experiment Station, as Journal Article No. 354. Acknowledgment is made to Dr. Morton May, director of the study. Received March 1, 1968; accepted for publication September 16, 1968.



FIG. 1. Freshly deposited spoil (top), and the same bank one year later following weathering (bottom).

These layers often contain iron polysulfides which oxidize to sulfates when exposed to air. These in turn hydrolyze to sulfuric acid which causes the acidity (Rogers, 1951).

Spoil in the Kemmerer Coal Fields ranged from 2.2 to 9.2 in pH, being derived from sandstone and shale parent material. An extensive greenhouse experiment showed that the spoil was quite fertile regardless of the extremes in pH (Lujan, 1966).

Texture of the material has an influence upon the suitability for plant establishment. Freshly deposited spoil is extremely coarse, resembling boulders; however, it crumbles to a fine texture following weathering (Fig. 1). This process is completed in about one year, depending upon precipitation and temperature fluctuations.

Numerous problems presented in the character of the spoil and the arid climate have necessitated the use of certain treatments to enable and encourage plant growth.

Objectives of the Study.—The major objective of this study was the comparison of several treatments for plant establishment on spoil banks. The treatments included straw mulch, jute netting,

snowfence, and combinations of these. The snowfence was designed to accumulate snow for a water source, while jute and mulch were used to modify the microclimate of the seed.

The other objective was to determine if weathering affected seedling success. Three ages of banks were tested, representing the oldest and also the most recent depositions of 15, 9, and 3 years.

Each bank was seeded by hand broadcast method, after which the treatments were applied. The following grasses were used: intermediate wheatgrass (*Agropyron intermedium*), crested wheatgrass (*Agropyron cristatum*), Russian wildrye (*Elymus junceus*) and smooth brome (*Bromus inermis*). These were sown in a mixture at approximately 12 lb/acre because the sites were unprepared for seeding and essentially barren of plant life.

Snowfence.—Precipitation in the area occurs mainly in the form of snow, most of which is deprived from plants by wind action and sublimation. Snowfences have accumulated large snow drifts capable of supplying ample amounts of moisture to plants. For this particular study, standard four-ft fences of wood lathe supported by heavy gauge wire were located on or near the crests of the banks. The treatment areas, including jute and mulch, occupied approximately 200 ft².

Jute Netting.—Although the most common use of jute netting is for erosion control or stabilization of steep road banks, it was tested mainly for mulch value in this experiment. Strips of burlap net were placed on study sites at each location where seeding had been done. Straw was placed under portions of the netting to determine if this added mulch would influence seedling success.

Mulch.—Straw is often utilized as a mulch in conjunction with highway right-of-way seedings and was used as such in this study. Although the straw is usually crimped into the soil by a cutaway disk, a light wire net was used to hold the mulch in place due to the inaccessibility of the banks for machinery and seeding equipment.

The treatments were initiated during the summer of 1966 and evaluated one year later. Measurements of seedling density were made on each site by counting seedling numbers per square foot in five samples and averaging these.

Results

In each of the respective age categories all treatments exceeded the control and seedling density increased with age of weathering (Table 1).

Snowfence.—All of the snowfences did not accumulate snow, but those which did produced densities exceeding nontreated broadcast areas by twice the number of seedlings. Despite this in-

Table 1. Average seedling number per ft² for each treatment and age group, and relative density of seedlings expressed as a percentage of highest value in any age group.

Treatment	Age group (Years)					
	15		9		3	
	No.	%	No.	%	No.	%
Jute-mulch	255	100.00	142	55.68	14	5.49
Mulch	240	94.11	105	41.17	—	—
Jute	221	86.67	93	36.47	13	5.09
Snowfence-jute-mulch	138	54.11	85	32.33	33	12.94
Snowfence-jute	110	43.13	83	32.54	18	7.05
Snowfence	64	25.09	55	21.56	11	4.31
Control	35	13.72	15	5.88	1	0.39

crease the snowfences failed to equal results of other treatments except on the least weathered bank.

Jute Netting.—Jute netting produced densities which exceeded the control areas by at least six times on every bank. The combination of jute netting and straw mulch gave even greater seedling densities, out-producing any other treatment except the combination of snowfence and jute with mulch on the least weathered spoil.

Mulch.—Straw mulch held in place by a wire netting boosted density six times and more that of the control sites. Although mulch was omitted from the three year old site, the 9 and 15-year old banks gave densities which were second only to jute with mulch.

Age of Spoil.—A partial analysis on six soil samples representing the three age groups is presented in Table 2. Although there seemed to be a general trend toward a more neutral pH with increased age of weathering, there were not enough soil samples to really substantiate this trend. Based on seedling density, however, older banks were more productive than the more recent depositions. Older banks were also observed to be more stable due to settling and the movement of voluntary vegetation onto the spoils from surrounding areas.

Table 2. Partial analysis of spoil material from three age groups.

Age (Years)	Texture	pH	Organic matter %
3	Clay	4.1	5.55
3	Clay	4.5	3.57
9	Sandy loam	4.8	5.11
9	Clay	7.7	2.27
15	Silt loam	7.0	3.57
15	Clay	7.4	4.01

Table 3. Comparative individual treatment costs per acre for material and labor, excluding seed costs.

Treatment	Material (\$)	Labor ¹ (\$)	Total per acre (\$)
Jute-mulch	1,488.30	91.25	1,579.55
Mulch	181.50	91.25	272.75
Jute	1,306.80	68.43	1,375.23
Snowfence-jute-mulch	1,628.30	199.68	1,827.98
Snowfence-jute	1,446.80	108.43	1,555.23
Snowfence	140.00	40.00	180.00
Control	0.00	2.50	2.50

¹ At \$1.25 per man hour.

Economic Consideration of Treatments.—Cost considerations are extremely important in decisions which might include selection of revegetation methods. Comparisons may detect economic feasibility between treatments producing similar results at different levels of expense. Studies such as this one might show broadcast seeding alone to be the most economical practice; however, the time necessary for a method to be effective in revegetating an area may offset a decision based entirely on cost.

Expense varies with the amount of area treated. For instance, while Table 3 gives the approximate expenses of the test plots, these are based on the actual retail prices of supplies purchased in small lots for experimental use. Larger quantities of material would have resulted in lower costs per unit.

The most expensive treatment was the combination snowfence-jute-mulch while snowfence alone was the least expensive.

Summary and Conclusions

The study indicated that older banks would give better seedling establishment than more recent depositions. Greater stabilization of the material was thought to be a factor responsible for this.

Evaluated according to their ability to influence seedling density all treatments gave considerable advantage over the untreated areas. A combination of jute and straw mulch gave the highest seedling density.

Economic comparisons were made from retail costs of the material. The snowfence-jute-mulch combination was the most expensive; however, a combination of jute and mulch gave the best results on the fifteen and nine year old banks.

Questions arose as to whether seedling density had any real meaning in terms of potential stand establishment due to the chance of uneven seed distribution. This was a possibility due to hand-broadcast seeding on an unprepared site; however, the sites were unsuitable for conventional seeding

equipment and the plot sizes were felt to be of adequate size to offset the variability of distribution.

The fact that the plants did not mature beyond the seedling stage was not felt to be critical (based on earlier unpublished work conducted at the study area). These trials gave the indication that stand establishment was accomplished over a period of several years and that the precipitation received immediately before and during the growing season would tend to influence whether or not the plants matured from seed during the first year.

A very probable source of variability was inherent within the spoil itself. The extremes of pH and textures over short distances on the banks

could cause great differences in suitability for plantings and would likely invalidate replication of treatments.

LITERATURE CITED

- GRANDT, A. F., AND A. L. LANG. 1958. Reclaiming Illinois strip coal land with legumes and grasses. University of Illinois Agr. Exp. Sta. Bull. 628. 64 p.
- LUJAN, LEANDRO E. 1966. Revegetation of strip-mined areas in Southwestern Wyoming. M.S. thesis, University of Wyoming.
- MAY, MORTON. 1967. Mine reclamation in the Western States. Mining Congress J. Aug., 1967.
- ROGERS, NELSON F. 1951. Strip-mined lands of the Western Interior Coal Province. Missouri Agr. Exp. Sta. Res. Bull. 475. 55 p.