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Casey and Julie Voigt v. Coyote Creek Mining Company, LLC

Case No. RC-23-348

Re-establishment of Grasses on Land Disturbed by Mining

Voigt Exhibit 52

71 RC-23-348 Filed 12/27/2023 Pages: 5
Exhibit 52 – Re-establishment of Grasses on Land Disturbed by Mining
Casey and Julie Voigt
Derrick Braaten, Braaten Law Firm

Re-establishment of Grasses on Land Disturbed by Mining in the Northern Great Plains

R. E. RIES, F. M SANDOVAL, AND J. F. POWER

Highlight

In this study topsoil replacement was essential to stand establishment and productivity on mine spoil. Fertilizer application increased stand production but did not influence stand density. Selection of grass species that are readily established is essential to establishing fully stocked initial stands.

The need for coal to meet the energy needs of the United States has greatly increased surface mining in the western states. A study of the Northern Great Plains (NGP) area comprising of parts of Wyoming, Montana, North Dakota, and South Dakota indicated approximately 36.8 million ha of potentially strippable coal reserves of which 9.7 million ha (26%) are classified as cropland and 25.5 million ha (70%) are in pasture or rangeland (Northern Great Plains Resources Program Staff [NGPRPS], 1975). The ha of rangeland that would be affected by coal development in the NGP area were estimated under three levels of development: 1) CDP-I — the minimum reasonable rate of coal development, 2) CDP-III — the maximum reasonable rate of coal development, and 3) CDP-II — an intermediate rate of coal development (NGPRPS, 1975). Current levels of coal development in the NGP area are between CDP-II and CDP-III. At this rate, the Northern Great Plains Resources Program Staff estimates that the amount of rangeland affected in the NGP area will be between 2632 and 5791 ha by 1980, 8343 and 18,711 ha by 1985, and 23,004 and 90,679 ha by year 2000. The impact on rangeland will be greatest in five counties: Rosebud and Bighorn in Montana, Campbell in Wyoming, and Oliver and Mercer in North Dakota. These five counties have approximately one-half of the rangeland area that will be affected by coal development in the NGP area.

Recent reclamation legislation calls for restoration of productivity on all land strip-mined for coal. This has stimulated the need for research on how to re-establish grasses on land disturbed by coal development, the first step in restoring forage productivity.

Spoil from surface coal mining in the NGP area is often fine textured, with a high exchangeable sodium content. Such spoil disperses readily, has low water intake and storage, and is erosive and unstable. Poor soil water movement and availability are aggravated by the limited and irregular precipitation received in the semiarid and arid sections of the NGP. Together, these factors make water the most important single factor influencing successful revegetation. Spoils are also often low in plant nutrients, especially plant-available phosphorus, and can have moderate salinity levels (Sandoval et al. 1973; Power et al. 1975).

Early exploratory research was conducted on use of such amendments as mulches, topsoil replacement, and fertilization. Topsoiling sodic spoil with as little as 5 cm of surface soil proved the best single treatment for enhancing grass establishment. Fertility problems were best handled by applying commercial fertilizers as needed (Agricultural Research Service and North Dakota Agricultural Experiment Station Staffs 1975 and 1977).

This study was designed to provide information on grass establishment on mined land as affected by surface soil replacement depth, species mixture, and fertilizer application.

Methods

Field plots 9 m x 9 m were established in a split split plot, randomized complete block design. Main plots were surface soil replacement depths of 0, 5, 15, and 30 cm. Each main plot was split and seeded with 16.8 kg/ha of good quality crested wheatgrass *(Agropyron cristatum* L. Gaertn.) or with 16.8 kg/ha of good quality native grass, using a double disk drill with depth bands. The native grass mixture was 35% western wheatgrass *(Agropyron smithii* Rydb.), 20% green needlegrass *(Stipa viridula* Trin.), 15% slender wheatgrass *(Agropyron trachycaulum* Link Malte), 10% little bluestem *(Andropogon scoparius* Michx.), and 20% sideoats grama *(Bouteloua curtipendula* Michx. Torr.). Each grass plot was split again with one half receiving no fertilizer and the other half receiving 56 kg/ha of nitrogen and 112 kg/ha of phosphorus as commercial fertilizers broadcast before seeding.

Field plots were prepared in late summer of 1972 and fertilized and seeded on March 20, 1973. Fertilized sub-subplots have received either 0 or 56 kg/ha of nitrogen each spring since initiation. Because of the poor establishment on the plots with no topsoil, they were disked and reseeded on October 24, 1974.

Density and dry matter production of vegetation on the plots were measured on July 18, 1974 and on July 13, 1976. Plant density expressed as plants/m^2 was obtained by counting the number of plants present on two 1-m^2 quadrats per sub-subplot. Dry matter production was determined by clipping in each sub-subplot. Weeds were controlled by spraying with 2,4-D each spring and were negligible at each sampling date.

The spoil material at the experimental site had the following characteristics: silty clay loam texture; pH (water-saturated paste) = 7.5; the saturation extract had an electrical conductivity of 3.0 mmhos/cm at 25 C, 30 meq/l sodium, 3.4 meq/l calcium, 2.0 meq/l of magnesium, and the sodium adsorption ratio was 25. The exchangeable sodium percentage correlated with the sodium adsorption ratio. Topsoil used was good quality non saline and non sodic A horizon material.

Temperature and precipitation for the periods discussed in this study are given in Table 1.

Analyses of variance were run on 1974 and 1976 data. Differences between crested wheatgrass and the native grass mix were statistically significant for both years. Therefore final analysis was conducted on each species group separately as a split, split plot analysis of variance with years being the main plot, replaced topsoil depth as the first split, and fertilizer treatment the final split.

Results

The statistical analysis for crested wheatgrass plant density and production is summarized in Table 2. Essentially all of the vegetation

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Table 1. Mean monthly air temperature (C) and precipitation (cm) at study area.

	1973		1974		1975		1976	
Month	C	cm	C	cm	C	cm	C	cm
Jan	− 7.9	.41	− 12.4	.25	− 9.8	.89	− 10.7	2.24
Feb	− 6.2	.18	− 7.4	.94	− 11.2	.96	− 3.8	.71
Mar	2.4	1.35	− 2.2	1.09	− 5.5	5.26	− 3.0	2.26
Apr	5.0	1.55*	6.0	10.24*	1.6	12.40	7.4	7.42*
May	13.3	4.14*	10.8	7.32*	12.0	2.21*	12.6	1.78*
Jun	17.5	4.83*	17.2	1.14*	17.2	10.97	18.4	9.47*
Jul	19.9	3.53*	22.6	1.09*	22.7	2.34*	20.6	1.32*
Aug	22.1	1.32*	16.7	2.16*	19.0	.25*	21.3	,13*
Sep	13.3	5.00*	11.7	.58*	12.4	2.46*	15.3	.89*
Oct	8.9	2.44*	8.2	1.62	7.9	1.70	4.8	.84
Nov	4.9	.30*	− 1.2	2.64	− .4	1.22	− 4.4	.81
Dec.	− 10.6	2.54	− 5.6	1.19	− 7.6	1.98	− 9.9	1.88
Annual	6.9**	27.59	5.4**	30.26	4.8**	42.64	5.7**	29.75
Growing Season (May-Sep)		18.82		12.29		18.23		13.59

*Precipitation as measured on site with continuously recording rain gauge — other entries are for US Weather Bureau recordings at Center, ND (24 km distant).

**Mean annual temperature

on these plots was crested wheatgrass — 97% in 1974 and 98% in 1976. Average density was essentially the same for 1974 and 1976, but dry matter production was greater in 1974. Depth of topsoil replacement significantly increased plant density and dry matter production. Average plant density increased from an average 23 plants/m² for 0 cm of topsoil to 70 plants/m² for 5 cm of topsoil, but did not increase further with greater depths of topsoil (15 and 30 cm) added. Average dry matter production of crested wheatgrass increased from 5 kg/ha for 0 cm of topsoil to 1802 and 1952 kg/ha for depths of 5 and 15 cm, respectively. Addition of 30 cm of topsoil increased production to 2596 kg/ha, which was significantly more than the production for 5- or 15-cm treatments. Fertilizer addition had no effect on the crested wheatgrass plant densities, but did increase average dry matter production.

Several significant interactions of the treatment variables were found for crested wheatgrass. Year x soil and soil x fertilizer interactions were significant for both density and production. Because the 0-cm topsoil plots were reseeded in the fall of 1974, and the precipitation pattern was very good in the spring of 1975, density and production of crested wheatgrass on these plots were greater in 1976 than in 1974, (Fig. 1). The significant soil x fertility interaction effect on density (Fig. 2) occurred because fertilization increased plant counts for 0 cm of topsoil replacement, but reduced counts for the 15-cm treatment. The significant production interaction for soil x fertilizer occurred because fertilization of the poor stand on the 0-cm topsoil plots failed to increase production, while fertilization of thicker stands for other topsoil depths did increase production.

The significant year x fertilizer interaction (Fig. 3) resulted because

Table 2. Statistical summary of plant density and dry matter production data for crested wheatgrass.

Source	DF	Parameter	Statistical significance[1]
Year		Density plts/m²	ns
		Production kg/ha	*
Soil thickness	3	Density plts/m²	*
		Production kg/ha	*
Fertilizer	1	Density plts/m²	ns
		Production kg/ha	*
Year x Soil	12	Density	*
		Production	*
Year X Fertilizer	8	Density	ns
		Production	*
Soil x Fertilizer	8	Density	*
		Production	*
Soil x Year x Fertilizer	8	Density	ns
		Production	ns

Mean values for:				
Years —		*1974*	*1976*	
		56 a[2]	61 a	
		2121 b	1057 a	
Soil thickness —	*0 cm*	*5 cm*	*15 cm*	*30 cm*
	23 a	70 b	72 b	68 b
	5 a	1802 b	1952 b	2596 c
Fertilizer —		*with*	*without*	
		58 a	58 a	
		2155 b	1022 a	

[1]ns = not significant, * = significant at P = 0.05.
[2]Mean values in the same row with different letters differ significantly at the 5% level of probability, according to Duncan's multiple range test.

Voigt-003

fertilization increased dry matter production in 1974, but not in 1976. Part of this difference in fertilizer response may have been due to less soil water available for plant growth in 1976.

Table 3 summarizes the statistical analysis for the native grass stand. Western wheatgrass and green needlegrass were the two species of the mix successfully established. These two species made up 92% of the total plants observed in the native stands in 1974, of which 63% was western wheatgrass and 37% was green needlegrass. In 1976, these two species made up 88% of all plants observed, with 86% of this total consisting of western wheatgrass and only 14% green needlegrass.

The increase in average plant density (plants/m²) in the native mix stands from 32 in 1974 to 71 in 1976 was accounted for primarily by western wheatgrass. Because of this increase in number of plants, average dry matter production on the native plots decreased only slightly (831 to 819 kg/ha) between 1974 and 1976 even though the precipitation pattern was less favorable in 1976 (Table 1). Topsoil replacement increased density an dry matter production similar to the response observed for crested wheatgrass. No further increase in plant density was obtained when more than 5 cm of topsoil was replaced. Average dry matter production was very similar on plots with 5 and 15 cm of topsoil thickness, but was less than that for plots with 30 cm of topsoil replacement.

Fertilizer increased dry matter production but did not significantly affect plant density. Average dry matter produced with fertilizer added was 1015 kg/ha, compared with 635 kg/ha without fertilizer.

The year x fertilizer interaction was significant for dry matter produced by the native mix. The interaction resulted from less response to fertilizer in 1976 than in 1974. With fertilizer, production was 1132 kg/ha in 1974, compared with 897 kg/ha in 1976. With no fertilizer, production was 530 kg/ha in 1974 and 740 kg/ha in 1976. We believe the lower response to fertilizer in 1976 was due to relatively high soil water use by fertilized plants in 1974 and 1975. April and May of 1976 were warmer and drier than those months in 1974, which along with the high water use in 1974 and 1975, resulted in less water available for plant growth in 1976.

Discussion

Topsoil thickness is a very important factor in establishing and producing vegetation on sodic mine spoil. In this study, density of both crested wheatgrass and native grass mix was increased when 5 cm of topsoil were replaced over sodic spoil, but density did not increase further with greater topsoil thicknesses. This indicates that small amounts of topsoil could be used to establish thicker stands of grass where the supply of topsoil is limited. Production of crested wheatgrass and the native grass mix was greatest on plots that had 30 cm of topsoil replaced. Even though plants can be readily established with minimum replacement of topsoil, restoration of productivity to sodic spoils requires greater topsoil thickness. In continuing studies, it has been shown that grass production from sodic spoils increased as replaced topsoil thickness increased to 75 cm (Agricultural Research Service and North Dakota Experiment Station Staffs 1977).

Crested wheatgrass density remained constant between 1974 and 1976, but native grass stand density increased. In 1974, only western wheatgrass and green needlegrass, both cool-season grasses, were present for the native mix, even though the seed mixture included

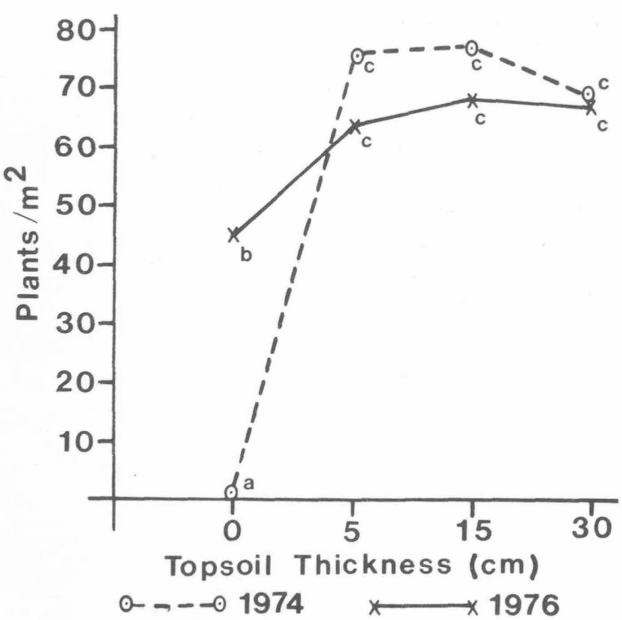

Fig. 1. Crested wheatgrass plant density as affected by year and soil thickness. (Means with different letters differ significantly at the 5% level of probability, according to Duncan's multiple range test.)

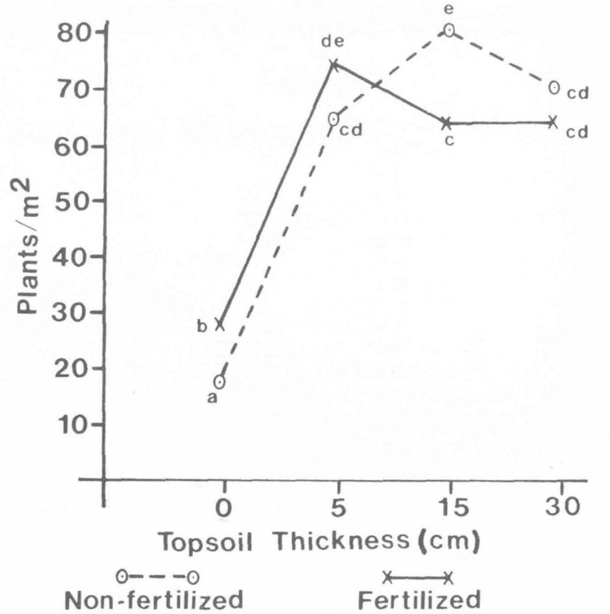

Fig. 2. Crested wheatgrass density as affected by soil thickness and fertilization. (Means with different letters differ significantly at the 5% level of probability, according to Duncan's multiple range test.)

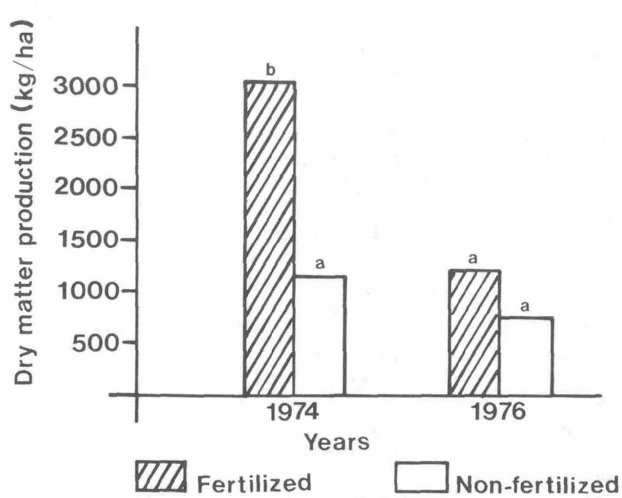

Fig. 3. Crested wheatgrass dry matter production as affected by year and fertilization. (Means with different letters differ significantly at the 5% level of probability, according to Duncan's Multiple range test.)

Table 3. Statistical summary of plant density and dry matter production data for native grass mixture.

Source	DF	Parameter	Statistical significance[1]	Mean value for:				
				Years —	*1974*	*1976*		
Year	1	Density plts/m²	*		32 a[2]	71 b		
		Production kg/ha	ns		831 a	819 a		
				Topsoil —	*0 cm*	*5 cm*	*15 cm*	*30 cm*
Soil	3	Density plts/m²	*		8 a	70 b	66 b	64 b
		Production kg/ha	*		2 a	1065 b	920 b	1313 c
				Fertilizer —	*with*	*without*		
Fertilizer	1	Density plts/m²	ns		54 a	50 a		
		Production kg/ha	*		1015 b	635 a		
Year x Soil	12	Density	ns					
		Production	ns					
Year x Fertilizer	8	Density	ns					
		Production	*					
Soil x Fertilizer	8	Density	ns					
		Production	ns					
Soil x Year x Fertilizer	8	Density	ns					
		Production	ns					

[1]ns = not significant, * = significant at P = 0.05.

[2]Means in the same row with different letters differ significantly at the 5% level of probability, according to Duncan's multiple range test.

slender wheatgrass, little bluestem and sideoats grama. This resulted in a suboptimum grass stand in 1974, which increased in density by 1976. By 1976 the stands of both crested wheatgrass and the native mix were nearly euqal. This emphasizes the importance of having species that are easily established in the total seed mixture. If the seeding mixture contains plants that will not establish readily, the initial stand may be sparse and will require more time to become fully stocked. Frequently, the presence of slender wheatgrass in a mixture assures good stands during the first few years after seeding. Why it failed to establish well in this study is not known.

Crested wheatgrass production was less in 1976 than in 1974, because of the less favorable moisture year accompanied by the reduction in fertilizer effect. However, the native grass mixture became more fully stocked between 1974 and 1976, was not as greatly affected by fertilizer, and had used less stored soil water; and thus, it produced only slightly less dry matter in 1976 than in 1974. Even with this decrease in production, crested wheatgrass produced more dry matter in 1976 than the native mix.

Both stands of grass responded to fertilizer, but the crested wheatgrass stands were more responsive. Fertilization had no statistical effect on stand density for either crested wheatgrass or the native grass mix. This indicates that fertility levels are less important in stand establishment than in restoring productivity.

The significant interaction that occurred for year x soil, which resulted from better establishment for the 0-cm topsoil treatment when reseeded in 1974 as compared with the 1973 planting, demonstrates the problem of repeatability in stand establishment in different years. This difference was probably due to a better precipitation pattern after the fall seeding in 1974. Problems of stand establishment resulting from limited and irregular precipitation patterns can potentially be lessened by using supplemental water during the establishment period. Research indicates that supplemental irrigation can almost insure successful establishment, give more flexibility in seeding dates, and can provide some control of species composition in the stands established.

It can be concluded from this study that topsoil replacement is needed to establish grass on sodic mine spoil. Depth of topsoil replacement is even more important in returning sodic mine land to productivity levels equal to or better than before mining. Fertilizer improves productivity of stands, but had no effect on stand establishment. Density was not closely related to stand production because the same density produced significantly different amounts of dry matter. Initial stand densities may be reduced by the inclusion of species that are hard to establish, resulting in understocking. Topsoil replacement, fertilizer, and selection of grass species that are readily established must be considered in order to restore forage productivity after mining.

Literature Cited

Agricultural Research Service and North Dakota Agricultural Experiment Station Staffs. 1975. Progress Report on research on reclamation of strip-mined lands in the Northern Great Plains. Northern Great Plains Research Center and North Dakota Agricultural Experiment Station Progress Report. 20 p.

Agricultural Research Service and North Dakota Agricultural Experiment Station Staffs. 1977. North Dakota Progress Report on Research on Reclamation of Strip-mined Lands — Update 1977. Northern Great Plains Research Center and North Dakota Agricultural Experiment Station Progress Report. 26 p.

Northern Great Plains Resources Program Staff. 1975. Effects of Coal Development in the Northern Great Plains. Northern Great Plains Resources Program. Denver, Colorado. 165 p.

Power, J. F., R. E. Ries, F. M. Sandoval, and W. O. Willis. 1975. Factors restricting revegetation of strip-mine spoil. Proceedings Fort Union Coal Field Symposium, W. F. Clark (Editor), Montana Academy of Science, Billings, Montana. p. 336-346.

Sandoval, F. M., J. J. Bond, J. F. Power, and W. O. Willis. 1973. Lignite mine spoils in the Northern Great Plains — Characteristics and potential for reclamation. Symposium on Research and Applied Technology of Mine-land Reclamation, Pittsburgh, Pennsylvania. p. 117-133.

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