

# Supplemental Water for the Establishment of Perennial Vegetation on Strip-Mined Lands

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The practice of supplying additional water by irrigation to supplement natural precipitation for the establishment of perennial vegetation on mined-land is discussed. Results show added water can provide fast and successful establishment of seeded species and can be extremely important at times when natural precipitation is limited. Poor quality water (EC of 3.0 to 4.0 mmhos/cm<sup>2</sup>) was successfully used for plant establishment with moderate increases of salts, soluble sodium and SAR in the soil/spoil profile on an area where there was good water movement through the soil/spoil system. While not an absolute necessity in North Dakota, supplementation of natural precipitation can provide protection against plant establishment failures and warrants consideration as a reclamation technique when water is available and the risk of failure is costly.

## INTRODUCTION

The new decade of the 80's has arrived and with it the challenge of meeting our nation's energy needs while becoming less dependent upon costly foreign supplies. Coal often is mentioned as a source of energy upon which the United States must depend in order to meet its energy needs in the near future. Much of the coal is best removed by strip-mining methods which require revegetation after mining.

In the West, over half of the area that will be mined is currently used as pasture and rangeland. Vegetative cover must be promptly reestablished after mining to protect the soil resource from excessive wind and water erosion. Re-established vegetation must also provide forage and cover for livestock and wildlife. Perennial species best meet these objectives.

In the semiarid and arid West, water is the most important single factor influencing successful revegetation (Study Committee on Potential for Rehabilitating Lands Surface Mined for Coal in the Western United States, 1974). In the semiarid and arid West, which includes western North Dakota, periods of drought are common and precipitation is often limited and very irregular (Ries and Day, 1976). For this reason, precipitation to insure initial establishment of vegetation is often lacking when needed. It is the purpose of this paper to review the practice of supplementing natural precipitation with additional water by irrigation during the establishment of perennial vegetation on mined-land in North Dakota.

*Contribution from U. S. Department of Agriculture, Science and Education Administration, Agricultural Research. Partial funding for this work was provided by the U. S. Forest Service SEAM Program and by the U. S. Environmental Protection Agency.*

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## STUDY METHODS

Research relative to the use of supplemental water for the establishment of perennial vegetation was started in 1975, at the Northern Great Plains Research Center, Mandan, ND. The experiment was conducted on a loam soil which was deep plowed to a depth of about 75 cm (29 inches) to simulate a disturbed soil condition similar to that occurring where 60 cm (24 inches) of good topsoil is replaced over spoil material after mining. Treatments studied consisted of two water levels, two planting dates and two species mixtures. Water treatments consisted of natural precipitation (Precipitation 1 - 18.94 cm (7.5 inches) for June-September) and natural precipitation plus sufficient added water applied twice a week to simulate precipitation received in a wet year such as occurs naturally one out of very 10 years (Precipitation 2 - 44.71 cm (17.6 inches) for June-September). The long term average precipitation for this period is 22.28 cm (8.8 inches). Mixtures were planted on May 29, 1975 (Early) and July 31, 1975 (Late).

An introduced forage species mixture composed of smooth brome grass (*Bromus inermis*), Russian wildrye (*Elymus junceus*), alfalfa (*Medicago sativa*), and intermediate wheatgrass (*Agropyron trichophorum*) was seeded at 18.5 kg/ha (16.5 lbs/a) PLS. A native forage species mixture composed of slender wheatgrass (*Agropyron trachycaulum*), western wheatgrass (*Agropyron smithii*), sideoats grama (*Bouteloua curtipendula*), and blue grama (*Bouteloua gracilis*) was seeded at 18.0 kg/ha (16.0 lbs/a) PLS. Plant density and dry matter production data were collected 7 weeks after seeding and analyzed to determine initial water and planting date effects.

Another study, started in 1977, used poor quality water for the establishment of vegetation on mined land in south-western North Dakota. The soil/spoil materials were loam textured and provided good water infiltration and movement. A mixture of western wheatgrass, slender wheatgrass, intermediate wheatgrass, tall wheatgrass (*Agropyron elongatum*), alfalfa, annual rye (*Lolium spp.*), green needle-

grass (*Stipa viridula*), and yellow sweetclover (*Melilotus officinalis*) was broadcast seeded and drag covered at a rate of 13.4 kg/ha (12.0 lbs/a). The primary species that established included the wheatgrasses, green needlegrass, annual rye, and yellow sweetclover. Four water levels were applied during July through September: natural precipitation (19.3, 57.6 and 91.4 cm (7.6, 22.7 and 36.0 inches) of natural precipitation plus good quality (Electric conductivity (EC) approximately 1.0 mmhos/cm<sup>2</sup>) or poor quality (EC of 3.0 to 4.0 mmhos/cm<sup>2</sup>) water. Poor quality water was applied for one and two seasons and good quality water was applied for one season. After the months of July-September, all plots received natural precipitation. The response of the vegetation, soil/spoil water content, and changes in soil/spoil salinity was monitored.

## RESULTS

Results from the initial (1975) study of the use of supplemental water for the establishment of perennial vegetation on disturbed soil showed that the number of plants established per unit area for the introduced mixture was not significantly affected by additional water or date of planting. Average dry matter production by the introduced mixture at 7 weeks after seeding increased significantly from 7.5 to 35.5 g/m<sup>2</sup> (67 to 317 lbs/a) where additional water was applied. Dry matter production was not affected by planting date.

Mean plant density of the native mixture was significantly increased from 207 to 499 plants/m<sup>2</sup> (173 to 417 plants/yard<sup>2</sup>) where plots received added water. Planting date had no effect on native plant density. Dry matter production of the native mixture 7 weeks after seeding was significantly increased from 8.6 g/m<sup>2</sup> (77 lbs/a) for Precipitation 1 to 19.4 g/m<sup>2</sup> (173 lbs/a) for Precipitation 2. The July planting of the native mixture produced 10.8 g/m<sup>2</sup> (96 lbs/a) less dry matter 7 weeks after seeding than the May planting.

A significant interaction for precipitation x planting date was observed for plant density of both the introduced and native mixtures. This interaction is graphically illustrated in Figure 1. When planted early, the mean density of the introduced species was 176 plants/m<sup>2</sup> (147 plants/yard<sup>2</sup>) and was the same for Precipitation 1 and 2. When planted late, mean density was greater for Precipitation 2 than Precipitation 1, 340 to 26 plants/m<sup>2</sup> (284 to 22 plants/yard<sup>2</sup>), respectively. Trends were similar for the native mixture. When planted early, the mean density of native species was statistically the same for Precipitation 1 and 2, 344 to 426 plants/m<sup>2</sup> (288 to 356 plants/yard<sup>2</sup>), respectively. When planted late, mean density of native species was statistically greater where water was added, 73 to 568 plants/m<sup>2</sup> (61 to 475 plants/yard<sup>2</sup>), respectively.

Ultimately, the species composition of perennial forage community greatly affects its potential productivity and use. Therefore, besides the response of total plant numbers within a mixture, the response of individual species is also important. The mean density of alfalfa increased significantly from 9 to 43 plants/m<sup>2</sup> (8 to 36 plants/yard<sup>2</sup>) where water was added. Alfalfa comprised 4.3% of the total population density when established under Precipitation 1 and 11.0% when established under Precipitation 2. Blue

grama density increased significantly from 47 to 250 plants/m<sup>2</sup> (39 to 209 plants/yard<sup>2</sup>) with added water. Blue grama comprised 14.7% of the native plant numbers when established under Precipitation 1 and 42.7% under Precipitation 2. Other seeded species did not respond significantly to added water. The density of weedy species in the native stand decreased significantly from 112 to 86 plants/m<sup>2</sup> (94 to 72 plants/yard<sup>2</sup>) when water was added.

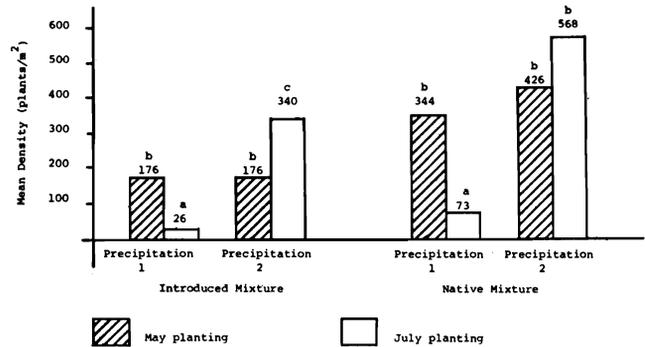


Fig. 1. Effects of precipitation and planting date on mean plant density for the introduced and native mixtures (means with different letters differ significantly at the 5% level of probability).

The only species density response to date of seeding was observed for the weedy species in both the introduced and native stands. Weedy species density in the established introduced species stand decreased significantly from 207 to 26 plants/m<sup>2</sup> (173 to 22 plants/yard<sup>2</sup>) for the early- and late-seeded areas, respectively. In the native stand, weedy species density decreased significantly from 181 to 17 plants/m<sup>2</sup> (151 to 14 plants/yard<sup>2</sup>) for early and late seeding dates, respectively.

Preliminary results from the study (1977) that used poor quality water for the establishment of vegetation have shown no detrimental effects to the vegetation. Natural precipitation plus good or poor quality water at 57.6 cm/season (22.7 inches/season), produced equal dry matter 128.1 and 123.7 g/m<sup>2</sup> (1,143 and 1,103 lbs/a), respectively, at the end of the establishment year. At the end of the third growing season, the stand of seeded species established with 57.6 cm (22.7 inches) of natural precipitation plus poor quality water for two seasons, produced 161.4 g/m<sup>2</sup> (1,440 lbs/a) dry matter compared to 50.6 g/m<sup>2</sup> (451 lbs/a) of dry matter produced by the seeded species in the stand established with only natural precipitation. Natural precipitation plus poor quality water at 57.6 and 91.4 cm/season (22.6 and 36.0 inches/season) for one or two years results in moderate increases in electrical conductivity, soluble sodium and SAR. Decreased levels of salts, brought about by leaching, followed these initial increases.

## DISCUSSION

Beneficial results were obtained from adding water by irrigation to supplement natural precipitation during the establishment of perennial forage stands. In the initial study (1975), dry matter production of both native and

introduced species was increased 7 weeks after seeding by supplementing natural precipitation with additional water by irrigation. The total density of native plants was significantly increased with supplemental water. All individual species did not respond to added water, but alfalfa and blue grama seedlings were significantly more abundant where natural precipitation was supplemented.

The significant interaction shown in Figure 1, demonstrated the importance of providing supplemental water when natural precipitation is lacking. Little benefit was found for plant establishment when the stands were seeded early because the early-season amounts of precipitation were high. The stands seeded late responded significantly to added water because late season precipitation was low. This further demonstrates the importance of supplemental water for plant establishment, even for early planting, if natural precipitation is lacking. In some cases, it can mean the difference between a successful seeding or a failure.

The late seeding date, made possible by the use of supplemental water, allowed tillage early in July prior to the late seeding. This tillage produced a dramatic reduction of weed species in both the late-seeded native and introduced stands.

Results can be summarized as follows: 1) The use of irrigation to supplement natural precipitation can help insure rapid and successful perennial plant establishment especially when natural precipitation is low. 2) The use of irrigation to supplement natural precipitation will permit planting later into the growing season which can help control weedy species. 3) The application of different levels of water after seeding can provide for some control of the final species composition in newly established stands.

Initial results from the study (1977) of poor quality water for perennial plant establishment have been encouraging. Stands established with good or poor quality water have been found equal. Even where natural precipitation plus poor quality water was used for two seasons, the

stands of seeded species established produced more dry matter than the stand of seeded species established with only natural precipitation. Increases in salt, soluble sodium and SAR were moderate where poor quality water was used. It appears the use of natural precipitation plus supplementation with poor quality water (EC of 3.0 to 4.0 mmhos/cm<sup>2</sup>) can enhance perennial plant establishment with only moderate increases in the salinity of permeable soil/spoils in North Dakota.

In conclusion, the use of added water applied by irrigation to supplement natural precipitation has been found beneficial for plant establishment. While not an absolute necessity in North Dakota, supplementation of natural precipitation can provide protection against plant establishment failures and warrants consideration as a reclamation technique when water is available and the risk of failure is costly.

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In conclusion, considering one year's data, coarse textured overburden required thicker topsoil or the addition of the second lift to achieve maximum spring wheat yields on strip mined reclaimed land. General yield levels were comparable with yields of grain on nondisturbed soils. Compaction made little difference in the amount of subsidence in these trenches. Final conclusions will be reserved until several more years of data are collected and evaluated.

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