Interseeding and Pitting on a Sandy Range Site in Eastern Montana

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Highlight: *A study of the effects of interseeding and pitting on herbage yield, species composition, soil water content, and nitrogen uptake was conducted on a sandy range site in eastern Montana from 1967 to 1972. Over these 6 years, interseeding with a lister and rotary tiller increased perennial grass yields 30 and 24%, respectively. Pitting increased the yield of sedges (*Carex *spp.) over most of the 6 years, but increased total grass yield only in 1969. The yield increase from interseeding was due to increased growth of native western wheatgrass (*Agropyron smithii*) and interseeded species. An interseeded mixture of western wheatgrass, bluebunch wheatgrass (*A. spicatum*), green needlegrass (*Stipa viridula*), and little bluestem (*Andropogon scoparius*) produced two to three times more than any individual species. Interseeding by lister and rotary tiller increased perennial grass yields in the sixth year after treatment by 58 and 41%, respectively, indicating potential long-term benefits from interseeding. Of the treatments, only lister interseeding showed evidence of increasing soil water recharge on this sandy range site. Tillage associated with the interseeding and pitting treatments increased the uptake of nitrogen by plants for at least 2 years after treatment.*

Overgrazing and drought have deteriorated a significant acreage of rangeland in the northern Great Plains. Approximately 22 million acres in eastern Montana need improvement (Montana State Soil Conservation Committee, 1970). The climax species on much of this range is now so sparse that proper livestock management alone would take a prohibitively long time to restore the range to its potential productivity. Under these circumstances, it is often profitable to mechanically or chemically renovate the range to create a favorable environment for the reestablishment of native grasses or to seed the desired species. Interseeding and pitting are two commonly used methods of range renovation and improvement.

Interseeding and pitting have been used in the northern Great Plains with various degrees of success. Nichols (1969) found that interseeding yellow sweetclover (*Melilotus officinalis*) increased production on dense clay range sites. Houston and Adams (1971) reported that interseeding on clayey and panspot range sites in southeastern Montana increased herbage production. Vallentine (1971) concluded from a literature review that interseeding has been more successful on coarse-textured than on medium- or fine-textured soils. Ryerson et al. (1970) found that interseeding and pitting increased herbage production on range sites infested with clubmoss (*Selaginella densa*), and that interseeding usually was more effective than pitting. Rauzi (1968) reported that lamb gain over a 24-year period averaged 7.2 lb/acre more on pitted shortgrass rangeland than on moderately grazed nonpitted rangeland in eastern Wyoming. Houston (1971) found that pitting moderately increased herbage production on overflow and clayey range sites but not on a silty range site. Nichols (1969) concluded that furrowing and pitting on dense clay range sites were of questionable value, because the furrows and pits rapidly eroded or refilled with sediment and thus lost their ability to retard runoff. Taylor (1967), after reviewing the literature on range pitting in the northern Great Plains, concluded that, "This practice seems most practical on ranges whose composition of cool-season mid-grasses is less than its potential, and when moisture runoff is likely to occur." He also concluded that pitting did not produce a suitable environment for artificial revegetation.

Many problems are associated with renovation practices; and good answers to the "when, where, and how" questions are not available. Results from range renovation are varied. More information

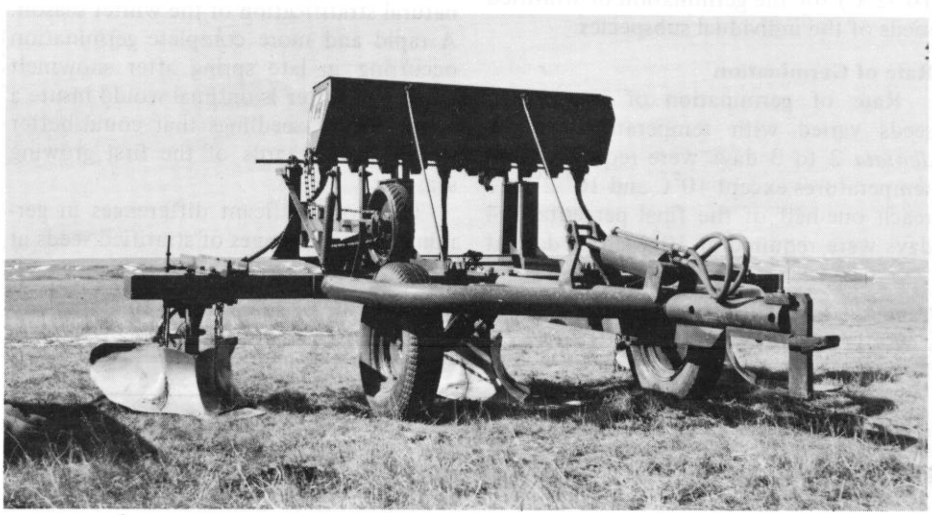

Fig. 1. *Lister interseeder.*

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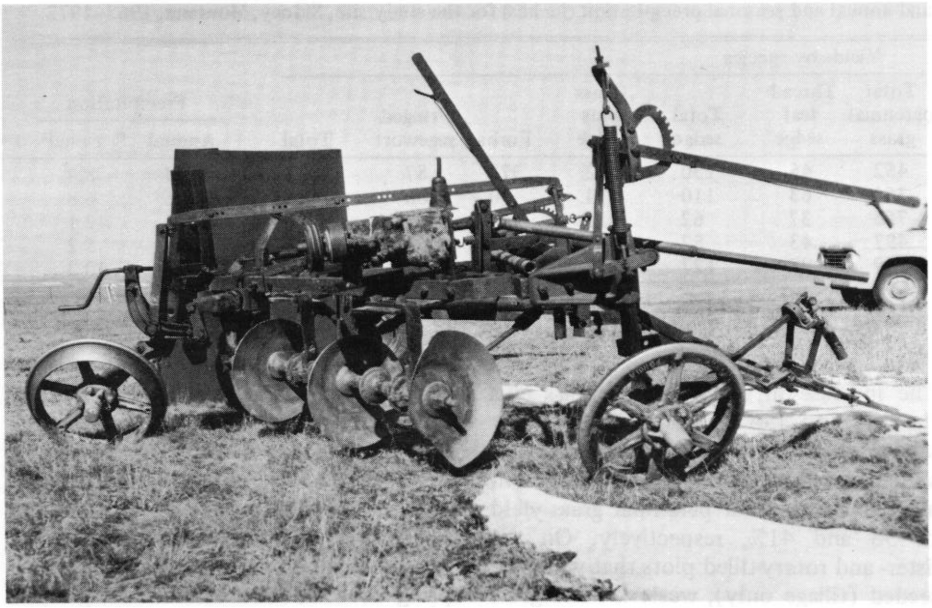

Fig. 2. *Pitter showing modified disks on the one-way plow.*

is needed on site-treatment interactions and how different range renovation treatments affect the microenvironment and the associated vegetational response. This paper reports and discusses the effect of interseeding and pitting on the vegetation, soil water, and soil nutrient availability of a sandy range site in eastern Montana.

Methods

This study was conducted from 1967 through 1972 near Sidney, Mont., on a sandy, glaciated plains range site (12- to 14-inch precipitation zone) with a 3 to 10% slope. Western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), needleandthread (*Stipa comata*), prairie Junegrass (*Koeleria cristata*), threadleaf sedge (*Carex filifolia*), and fringed sagewort (*Artemisia frigida*) were the dominant species. Clubmoss constituted a significant portion of the ground cover. Site vegetation and precipitation characteristics are shown in Table 1. Site condition class, according to the U.S. Soil Conservation Service range site classification system, was between fair and good.

Interseeding was done with a lister (L-interseeding) and a rotary tiller (R-interseeding). The interseeding and pitting treatments were applied in early April, 1967. Lister furrows 22 inches wide and 3 inches deep on 60-inch centers were formed with a machine (Fig. 1) similar to the one described by Ryerson et al. (1970). The R-interseeding treatment consisted of 24-inch strips tilled to about a 3-inch depth alternating with 24-inch nontilled strips. This spacing was achieved by removing the appropriate number of blades from a commercial rotary tiller. Pitting was done with modified discs on a one-way plow (Fig. 2), as described by Ryerson et al. (1970). Pits averaged about 48 inches long, 6 inches wide, and 4 inches deep. The L-interseeding, R-interseeding, and pitting treatments removed 37, 50, and 15% of the vegetation cover and disturbed an additional 37, 0, and 15% of the area, leaving 26, 50, and 70% undisturbed, respectively. A Plantet Junior[1] hand seeder with a double disc opener was used to seed a single row in the lister furrows and rototilled strips. The seeds were planted ¼ to ½ inch deep and covered with the small press wheel on the seeder. Species seeded and seeding rates are shown in Table 2. Treatments were applied on the contour on 30- by 50-ft plots arranged in a randomized complete block design with three replications.

Nitrogen (N) and phosphorus (P) fertilizer (40 lb N and 18 lb P/acre broadcast at seeding time) and herbicide (2 lb acid equivalent, low volatile ester of 2,4-D in 10 gallons of water per acre applied in mid-June 1968) were applied in factorial combinations with the check, pitting, and the L-interseeding and R-interseeding treatments that were interseeded with the grass mixture. This segment of the experiment was analyzed as a factorial with four mechanical treatments (L-interseeding, R-interseeding, pitting, and check), two herbicide treatments (0 and 2 lb 2,4-D per acre), and two fertilizer treatments (0 to 40 lb N plus 18 lb P/acre). Because the study site was inherently deficient in N and P, both were added as a fertilizer treatment to determine the potential benefit of fertilization of interseeding treatments.

Establishment of seeded species was determined in July, 1967, by counting seedlings per 4 lineal feet of row. Stand establishment was rated visually in 1972. Comparative production of seeded species was determined in 1972 by harvesting a 13.2-ft segment of seeded row.

Total production was measured in 1967, 1968, 1969, 1971, and 1972 by hand clipping herbage at ground level in a 10.8-ft^2 area within each plot. The forage was harvested about mid-July when the major grass species matured. Seeded species were not harvested in 1967. Harvested forage was separated by species, ovendried at 70°C, and weighed. Western wheatgrass and blue grama samples were ground to pass a 20-mesh screen and later analyzed for N. The study area was fenced, and grazing was deferred for 2 years. Beginning in 1969, cows were allowed to graze the study plots during fall months.

Yield data for individual species and species groups were analyzed by the appropriate analysis of variance technique, and significant differences were established at the 90% probability level. Yields shown in Table 3 are expressed as percent of the check and were calculated from the mechanical and fertilizer treatment means of the factorial analysis. The mechanical treatments (L-interseeding, R-interseeding, pitting, and check) all responded similarly to the fertilizer and herbicide treatments, thus permitting the comparisons in Table 3 to be made on the basis of the mechanical treatment means from the factorial analyses.

Soil water content was measured periodically throughout the 1967, 1968, and 1969 growing seasons in an L-interseeded, R-interseeded, pitted, and check plot in each replication. These plots received neither fertilizer nor herbicide and included plots interseeded with the grass mixture. Soil water was measured by the neutron method in two access tubes in each plot. In the pitted and interseeded plots, one access tube was located in the tilled area and the other tube in the adjacent undisturbed area. Measurements were made at 1-ft intervals to the 4-ft depth.

Results

Adequate soil water during the spring of 1967, the year of seeding, resulted in an excellent stand of most seeded species. Growing conditions were generally favorable throughout the 6-year study. Herbage yields were lowest in 1968 and 1971 and generally corresponded to variations in precipitation (Table 1).

Establishment and survival of seeded species are shown in Table 2. Seedling establishment of all species was successful. However, seedling establishment of the grass mixture was better in the lister

[1] Trade names and company names are included for the benefit of the reader and do not infer any endorsement or preference of the product by the U.S. Department of Agriculture.

Table 1. Herbage yields (lb/acre) of the check plot and annual and seasonal precipitation (inches) for the study site, Sidney, Montana, 1967–1972.

	Yields by species											Precipitation	
Year	Western wheatgrass	Blue grama	Prairie junegrass	Needle-and-thread	Total perennial grass	Thread leaf sedge	Total sedge	Grass plus sedge	Forbs	Fringed sagewort	Total	Annual	Seasonal[1]
1967	51	159	113	128	452	45	130	582	377	87	1047	15.1	8.4
1968	30	106	54	173	364	63	110	474	90	86	651	13.5	6.8
1969	42	288	128	290	756	37	62	817	348	83	1247	15.1	12.1
1971	73	95	116	203	497	43	52	549	274	53	876	15.4	5.2
1972	178	100	43	322	649	97	127	776	602	64	1442	18.0	10.3
Total	374	747	455	1117	2719	285	480	3199	1691	374	5264		

[1] April, May, June, and July precipitation.

furrows (69%) than in rotary-tilled strips (36%). After 6 years, only the grass species survived in sufficient number to be considered successfully established. The two saltbush species and winterfat did not grow beyond the seedling stage. Stands of sainfoin, which had become well established, were deteriorating at the end of the 6 years.

Six years after seeding, the grass mixture produced significantly more herbage (0.24 lb per 13.2 ft of row) than any other seeded species. Production of bluebunch wheatgrass was about double that of any other individually seeded species but was only half that of the grass mixture. Seeded species were still in well-defined rows and had not spread into surrounding tilled areas or adjacent native sod.

The effects of interseeding and pitting on herbage yields are shown in Table 3. Interseeding depressed yield of most species in 1967, the year of treatment. In 1968, yields of western wheatgrass, forbs, and shrubs increased. Western wheatgrass response was greater on L-interseeded plots than on R-interseeded plots and did not reach a maximum on the L-interseeded plots until 1971 as compared to 1969 on the R-interseeded plots. The yield response of forbs and shrubs on interseeded plots reached a maximum the second or third year following treatment, then gradually decreased.

Interseeding depressed yield of sedges and native grasses, other than western wheatgrass, throughout most of the study period. However, both interseeding treatments significantly increased total perennial grass yield except in 1967 on the L-interseeded plots and in 1967 and 1968 on the R-interseeded plots. Yield increases on interseeded plots resulted from production of seeded species and increased production of native western wheatgrass. In 1972, for example, western wheatgrass yielded 2.6 and 2.0 times more on L-interseeded and R-interseeded plots than on check plots, respectively. The increase in western wheatgrass plus the 185 and 156 lb/acre contributed by seeded species (grass mixture) on L-interseeded and R-interseeded plots resulted in an increase in total perennial grass yield of 58 and 41%, respectively. On the lister- and rotary-tilled plots that were not seeded (tillage only), western wheatgrass yields were 3.2 and 1.4 times more than on the check plots, respectively. On these plots, only L-interseeding increased total perennial grass yield (44% more than the check).

Pitting, which was not as severe a treatment as interseeding, had little measurable effect on the vegetation. Total perennial grass yield was increased only in 1969. In 1972, 6 years after treatment, the only measurable effects of pitting were an increase in sedge and a decrease in forb production. However, for the 6-year period, there was a 13% increase in the grass plus sedge production.

Soil water content was higher in interseeded and pitted plots than in check plots during the summer of 1967. At the end of the growing season (mid-July), water content of interseeded and pitted plots was 75 to 100% greater than that of check plots. Water content was highest in L-interseeded plots—plots in which approximately 74% of the vegetation had been removed or covered during treatment.

The only other measurable differences in soil water content occurred in early spring of 1968 and 1969. During April and May of 1968, soil water content in the surface 2 ft of L-interseeded plots was about twice that of check plots. Again in early April, 1969, soil water content in the upper 2 feet of L-interseeded plots was about 25% more than in check plots. Soil water content was higher in tilled and disturbed areas than in undisturbed areas during most of 1967 and 1968, but not in 1969.

Tillage associated with interseeding and pitting increased the growth and N content of plants. In 1967, N content of western wheatgrass was 1.84, 1.54, 1.50, and 1.43% on the L-interseeded, R-interseeded, pitted, and check plots, respectively. N content of blue grama followed the same pattern. This same year L-interseeding (26% cover), R-interseeding (50% cover), and pitting (70% cover) produced 63, 71, and 86% as much herbage as did

Table 2. Seeding treatments, seedling establishment, and stand ratings.

Method and species	Live seeds planted per lineal foot	Percent seedling establishment, 1967	Stand rating, 1972
Lister interseeding			
Green needlegrass (*Stipa viridula*)	15	53	Successful
Western wheatgrass (*Agropyron smithii*)	15	50	Successful
Little bluestem (*Andropogon scoparius*)	15	9	Successful
Bluebunch wheatgrass (*Agropyron spicatum*)	15	53	Successful
Thickspike wheatgrass (*Agropyron dasystachyum*)	15	73	Successful
Mixture[1]	20	69	Successful
Nuttall saltbush (*Atriplex nuttalli*)	1	100	Unsuccessful
Fourwing saltbush (*Atriplex canescens*)	26	73	Unsuccessful
Winterfat (*Eurotia lanata*)	15	7	Unsuccessful
Sainfoin (*Onobrychis viciaefolia*)	20	69	Partially successful
Rototiller interseeding			
Mixture[1]	20	36	Successful
Winterfat	15	5	Unsuccessful
Sainfoin	20	60	Partially successful

[1] Mixture consisted of 2 parts western wheatgrass, 2 parts green needlegrass, 1 part little bluestem, and 1 part bluebunch wheatgrass all of which are either decreasers or increasers in the climax vegetation. Parts were determined on a pure live seed basis.

Table 3. Herbage production, expressed as percent of the check, of a sandy range site near Sidney, Montana, after interseeding and pitting treatments.

Method[1] and year	Species and groups: Western wheatgrass	Blue grama	Prairie junegrass	Needle-and-thread	Total perennial grass†	Thread-leaf sedge	Total sedge	Grass plus sedge	Forbs	Shrubs	Total
L–interseeding											
1967	75	50*	45*	57*	55*	45*	49*	53*	73*	70	63*
1968	384*	48*	118	108	154*	38*	57*	128*	431*	497*	168*
1969	470*	54*	91	79	132*	93	104	127*	206*	705*	158*
1971	521*	64	59	67*	166*	65	115	156*	114	495*	165*
1972	255*	36*	56	64	158*	61	91	146*	125*	193*	147*
Total	316*	51*	71	74*	130*	61*	78*	119*	129*	163*	128*
R–interseeding											
1967	100	75*	37*	88	75*	104	82	77*	55*	75	71*
1968	184	63*	160*	85	116	57*	65*	102	161	640*	132*
1969	266*	94	118*	97	141*	74	96	132*	115	390	137*
1971	246*	110	81	84	156*	65	103	146*	73	346*	141*
1972	197*	63*	67	58*	141*	66	73*	117	119	149	148*
Total	198*	82	88	83	124*	73*	83*	115	96	144	120*
Pitting											
1967	149	92	63*	104	97	100	88	88	79	79	86
1968	218	86	129	111	114	97	113	114*	157	351	128*
1969	191	116	173	119	135*	109	132*	134*	103	551	141*
1971	120	101	90	80	93	120	149	103	94	256	110
1972	146	97	144	80	107	145	141*	113	72*	167	111
Total	158	101	115	105	111	110	119*	113*	85	137	112*

[1] L–interseeding = lister interseeding and R–interseeding = rototiller interseeding.
*Significantly different from the check at the 90% probability level.
†Includes seeded grasses.

the check, respectively. Increased growth of individual species generally dilutes the mineral content of plant tissue. Thus, the small differences in N content as a result of treatment are more significant. Measurable fertility effects as a result of treatment disappeared during the second and third year after treatment.

Fertilization with 40 lb N and 81 lb P/acre in 1967 increased perennial grass production 50 and 18% the first and second year after application. Thereafter, no response was measured. The seeded grass mixture responded to fertilization in 1968 and 1969, producing 100 and 120% more than the unfertilized plots, respectively. There were no measurable fertilizer effects on forbs or shrubs.

The herbicide treatment reduced forb and shrub yields during most of the study. In 1968, the year of herbicide application, forb and shrub yields were reduced 65 and 90%, respectively. Residual effect of the herbicide treatment reduced forb production 25% in 1972. There was no measurable herbicide effect on shrubs in 1972. Only in 1969 was there a measurable increase in grass production on the sprayed plots.

Lister furrows and pits showed only moderate weathering over the 6-year period and their effective life was estimated to be at least another 10 and 20 years, respectively. Western wheatgrass, prairie Junegrass, and annual forbs were the primary reinvading species of both the lister furrows and pits. Lister furrows that had not been seeded were 50 to 80% revegetated, with considerable variation among plots. Where a good stand of seeded species was present, reinvasion by native species was slight. However, on L-interseeded plots, native western wheatgrass increased significantly between furrows. Rotary-tilled strips revegetated more rapidly than lister furrows or pits, and the main species found on these disturbed areas included prairie Junegrass and needleandthread.

Discussion

Wight and Siddoway (1972) suggested that mechanical treatments can improve production on semiarid rangelands in at least three ways: (1) improved species composition, (2) improved soil water regime, and (3) improved soil fertility. In this study, yield increases on treated plots were mainly due to change in species composition. Improved soil fertility and soil water regimes were both evident, but were not of major significance.

Mechanical treatments, primarily interseeding, altered the species composition considerably. Western wheatgrass, seeded grass, forbs, and shrubs initially replaced clubmoss, blue grama, and sedges in tilled areas. At the end of 6 years, western wheatgrass and the seeded grass species were still present, but forbs and shrubs were being replaced by reinvading prairie Junegrass and needleandthread. This species composition was more productive than the original and should have long-term benefits.

Ryerson et al. (1970) and Nichols (1969) indicated that seeding in conjunction with a mechanical treatment such as lister furrowing may not be necessary on sites where an adequate amount of rhizomatous species such as western wheatgrass is present. This native grass quickly reinvades disturbed areas and, in this study, significantly increased total grass yield on lister-tilled plots not seeded with the grass mixture. Western wheatgrass response on these plots in 1972 increased total grass yield 44% as compared to a 58% increase where seeded species were present. However, if other species are desired to balance species composition and extend the grazing season, interseeding appears to be an effective way of obtaining a stand of the desired species.

R-interseeding and pitting are generally not effective water conservation practices on sandy range sites where runoff is infrequent. The higher soil-water content in 1967 was related to the decrease in vegetational cover. Lister furrowing showed some advantage over the check, as indicated by higher soil water content in the early spring. Furrows, applied on the contour, not only trapped snow but also retarded snowmelt runoff.

However, on this sandy site, runoff is infrequent and the furrows would not be as effective as on finer textured sites. Houston (1965) found that pitting increased the soil water on a fine-textured range site but not on a coarse-textured range site. Ryerson et al. (1970) working on a medium-textured range site found that the effectiveness of interseeding and pitting as water conservation practices varied with the amount of annual precipitation. Interseeding (lister type) and pitting only improved the soil water regime during years of normal or above-normal precipitation.

Mechanical disturbance of native sod causes the release of plant nutrients through soil weathering and decomposition of organic matter. The initial response to interseeding and pitting in this study was due to nutrient enrichment of the soil plus reduced competition for available nutrients.

Both interseeding methods were about equally effective in increasing grass yields. The firm seedbed of lister furrows was better suited for establishment of the seeded grasses than was the loose seedbed of rotary-tilled strips. Where a rough surface such as is caused by lister furrows is undesirable, R-interseeding would be preferable. However, some method of firming the seedbed probably would be needed.

Results of this study do not provide adequate information to make an accurate economic evaluation of the interseeding and pitting treatments. Good estimates of the permanency of the changes in species composition are not available. However, assuming an effective life of 25 and 15 years for L-interseeding and pitting, respectively, and based on the production of grass plus sedge for 1968-1972, L-interseeding and pitting would increase carrying capacity of the study site a total of 2.7 and 0.8 animal unit months per acre over a 25- and 15-year period, respectively. With an estimated treatment cost of $8.00 and $3.50 per acre for L-interseeding and pitting, respectively, (Ryerson et al., 1970) plus other costs such as equipment depreciation and interest, pitting would be uneconomical. The draft requirement of the rotary tiller is somewhat greater than for the L-interseeder and pitter and no attempt has been made to estimate the cost of this treatment. However, we estimate potential benefits of R-interseeding to be somewhere between those of the L-interseeding and pitting.

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