The Use of Woodchips and Nitrogen Fertilizer in Seeding Scab Ridges[1]

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Highlight

A depleted scab ridge in northeastern Oregon was treated with woodchips and nitrogen, and seeded with a mixture of hard fescue, timothy, and pubescent wheatgrass. On the deeper soils, plots receiving 1 inch woodchips disked in plus 300 lb N averaged 2,457 lb air-dry herbage/acre over a 7-year period. Control plots average 1,973 lb/acre and those receiving woodchips, but no N 1,434 lb/acre. On the shallow soils similar treatments yielded 1,193, 688, and 528 lb/acre, respectively. At 1 inch chips and 300 lb N/acre, whether the chips were disked into the soil was relatively unimportant. At 0.5 inch chips and 150 lb N/acre disking lowered yields from 1,288 lb/acre (not disked in) to 673. With time, pubescent wheatgrass increased on the deeper soils and remained constant on the shallower. Hard fescue increased and timothy decreased markedly on both soils.

Land managers concerned with forage production on wild lands in northeastern Oregon and southeastern Washington have long been troubled by unproductive sites known locally as "scab ridges." Seeding these almost barren areas occurring on nearly flat or gently rolling ridge tops has proved difficult. Rummell and Holscher (1955) discussed species adapted to the pine zone in which scab ridges occur. Variously estimated at from 50,000 to several hundred thousand acres, these sites range from 2,000 to about 7,000 ft in elevation. Annual precipitation varies from 17 to 26 inches, about one-third of which is snow. Summer air temperatures are cool. July and August are the driest months.

Usually the scab ridges are untimbered and the soil is shallow and stony. Some scab ridges are typified by a biscuit formation made up of the Albee and Rock Creek soils mapped as a complex. The Albee series is made up of mounds or biscuits, of various shapes, 1 to 5 ft in height, and from 10 to 50 ft wide and 25 to 200 ft long. There are three or four mounds per acre. Soil depth on the mounds, over a solid basalt bedrock, averages 28–36 inches. The Rock Creek series which occurs between the mounds has an average depth of 6 to 8 inches and is extremely stoney.

The shallow soils are quickly saturated by rains in the fall or by melting snow in the spring. Limited soil moisture storage results in extreme drying in summer, which, accompanied by moisture stresses, is often fatal to seedlings or young plants. All these conditions are less intense on the mounds (where the biscuit formation occurs) than on the shallower soils surrounding them.

Many scab ridges are devoid of desirable forage species. The mounds are dominated by cluster tarweed (*Media glomerata* Hook.). The low places produce Sandberg bluegrass (*Poa secunda* Presl.). It is believed that these sites once produced bearded bluebunch wheatgrass (*Agropyron spicatum* Pursh) (Scribn. & Smith) and Idaho fescue (*Festuca idahoensis* Elmer).

Numerous attempts have been made by various methods to seed the scab ridges with a number of species. Although not all the resultant failures are attributed to low organic matter content or low fertility of the soil, they are believed to have been important contributing factors. Glendenning (1939) observed that any material which partially shades the ground and retards drying of the surface soil will result in greatly increased germination. He states that on deteriorated soils, germination is practically prohibited by a lack of litter.

The shallow soils of the scab ridges are exposed to terrific frost-heaving. Seedling plants or young plants not yet established are heaved up and left to die on the soil surface. Bare soils freeze considerably faster than mulched soils. The most extensive frost heaving is associated with high levels of soil moisture, slow freezing, or alternate freezing and thawing. These factors, together with soil texture and organic content, rate of freezing and amount of water left unfrozen, were found by Domby and Kohnke (1955) to influence the amount of heaving. Earlier, Bouyoucos and McCool (1928) found that frost heaving of soils is due to the growth of an ice column or ice layers from unfrozen water drawn to the freezing surface, and not to mere expansion of water upon freezing. This growth of ice columns to 3 to 4 cm, exerts pressures up to 200 lb/in.^{2}, lifts seedlings, and either breaks their roots or pulls out entire plants, leaving them on the soil surface without anchorage or moisture supply.

The present study was undertaken because of the extent of scab ridges, the difficulty of revegetating them, and the need for forage and soil stabilization.

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Methods

In 1952 the Forest Service initiated a study on the Umatilla National Forest on a typical scab ridge site at an elevation of 4,800 ft to observe the effects of applying woodchips, with and without nitrogen fertilizer, in a range seeding trial. Woodchips were made at the location with a portable chipper, using ponderosa pine (*Pinus ponderosa* Dougl. ex Lawson) logging slash, and pole-size lodgepole pine (*Pinus contorta* Dougl.), and fir (*Abies* spp.). The study site was plowed in the summer. In the fall, woodchips were applied to cover the plots at depths of either 0.5 or 1 inch. Nitrogen in the form of ammonium sulfate was subsequently added at the rate of 300 lb/A/N per inch of chips. Applications of 75 lb/A/N per inch of chips each were made in fall 1952, in spring, fall 1953, and spring 1954. This supplied the required amounts over a period of time to avoid damage from excessive applications. On some plots, woodchips were scattered and left on the soil surface (Fig. 1); in others, they were incorporated into the soil by cultivation with a disk harrow.

One set of treatments was located on the shallow Rock Creek series. Some of the treatments—those receiving woodchips at the 1-inch rate—were repeated on the deeper Albee series. The entire area was enclosed with a stock-proof fence, and there has been no grazing.

The plots were seeded at the rate of 12 lb/A with a mixture consisting of pubescent wheatgrass (*Agropyron trichophorum* (Link) Richt.) (six lb), hard fescue (*Festuca ovina* var. *duriuscula* (L.) Koch) (four lb), and timothy (*Phleum pratense* L.) (two lb). In some instances, the seed was broadcast before the chips were applied. Where chips were disked, seed was broadcast after disking.

In 1954, the study was transferred to the Agricultural Research Service. Beginning in 1957 herbage yields were collected annually.

In October 1955, a second study was established on the same scab ridge type, on the Rock Creek soil series, within the same enclosure and near the original plots. Woodchips were used in reduced amounts for a maximum of 0.25-inch with nitrogen at the original level of 300 lb/A per inch of chips, amounting to 75 lb/A of nitrogen. Another treatment consisted of 0.25-inch of chips and half the amount of nitrogen. A third treatment involved 0.25-inch of chips, with no nitrogen. Another series on the same site included nitrogen at three rates, 75, 37.5, and 0 lb/A, all without chips.

The second study was established without prior treatment or cultivation of any kind. The original 12 lb/A mixture was drilled on half the plots and broadcast on the other half. Where nitrogen was involved the entire amount was added at the time of seeding.

Yearly plant counts were made on the 1955 series of plots. Seeded grasses were recorded by species.

FIG. 1. These woodchips were applied four years previously on these plots at the 1-inch rate and not disked. Woodchips decomposed slowly. Even after several years there is little change in appearance from the time of application (Lucky Strike Area, 1956).

Table 1. Estimated success ratings of grass stands of mixtures seeded in 1952 on scab ridge plots with and without woodchip mulch, and with and without nitrogen. (Lucky Strike Area.)

Treatment		Years							
Chips (inches)	Nitrogen (lb/A)	1957	1958	1959	1960	1961	1963	1964	Avg.
ALBEE SERIES									
1 (disked)	300	10[1]	10	10	10	10	10	9	9.9
1	300	10	10	9	9	9	9	8	9.1
1	0	8	8	8	8	9	8	8	8.1
0 (check)	0	8	7	7	7	9	9	9	8.0
Mean (all treatments)		9.0	8.7	8.5	8.5	9.2	9.0	8.5	8.8
ROCK CREEK SERIES									
½	150	9	9	9	9	8	7	8	8.4
1 (disked)	300	9	7	8	7	8	7	8	7.7
1	300	8	8	8	8	7	7	8	7.7
1	0	6	6	6	7	7	6	7	6.4
½	0	5	5	5	6	8	7	7	6.1
½ (disked)	150	6	6	6	6	5	5	6	5.7
0 (check)	0	5	5	5	5	6	6	7	5.6
Mean (all treatments)		6.9	6.6	6.7	6.9	7.0	6.4	7.3	6.8

[1] Summation of ratings for plant numbers and distribution on plots: 5–6 medium; 7–8 good; 9–10 very good.

Table 2. Comparative herbage yields in pounds per acre, air dry, on a scab ridge site seeded by broadcasting in the fall of 1952 with a grass mixture at 12 lb/A on plots with woodchip mulch and nitrogen (Lucky Strike Area).

Treatment		Years							
Chips (inches)	Nitrogen (lb/A)	1957	1958	1959	1960	1961	1963	1964	Avg.
ALBEE SERIES									
1 (disked)	300	5,134[1]	2,721	2,407	1,513	1,513	2,230	1,683	2,457
1	300	4,358	2,984	1,663	1,357	1,293	1,006	1,760	2,060
0 (check)	0	2,438	2,249	1,897	1,457	1,413	2,070	2,290	1,973
1	0	2,480	1,516	1,333	617	1,066	1,340	1,686	1,434
Mean (all treatments)		3,603	2,367	1,825	1,236	1,321	1,441	1,855	1,981
½	150	2,530	1,570	1,657	840	740	603	1,077	1,288
1 (disked)	300	2,605	1,528	1,070	947	550	780	870	1,193
1	300	2,527	1,300	950	750	680	496	1,260	1,138
0 (check)	0	1,165	555	820	497	473	596	710	688
½ (disked)	150	1,304	832	760	577	380	263	593	673
1	0	1,045	598	580	317	393	300	466	528
½	0	835	441	390	323	310	316	516	447
Mean, all treatments		1,716	975	889	607	503	479	785	851

[1] Each value is an average of three 9.6 square-foot samples per plot. Grass clipped as near ground level as possible.

Results

First Study

Early observations indicated good stands of grass with all species doing well on all plots. The treatments with the greatest amounts of woodchips with nitrogen produced the best initial stands. Success ratings based on plant numbers and distribution were made each year beginning in 1957 (Table 1).

Data indicate comparative stability in success ratings. Nitrogen tended to improve the stands, initially and throughout the data collecting period. There were no pronounced changes in the relative ratings of grass stands or in total density on the various treatments. Any change in vegetative composition was due primarily to replacement of one species by another, rather than to the mere disappearance of a species.

Herbage production from the different treatments varied from year to year (Table 2). One inch of chips, disked with a total of 300 lb/A/N (applied in 4 steps) had the highest yield, an average over 7 years of 2,457 lb/A air dry herbage. The next highest yield on Albee soils was from 1 inch chips (not disked) with 300 lb/A/N. The amount of chips and the amount of nitrogen here, are the same as in the previous treatment, but there is a sizeable decrease in herbage yield. The plot on Albee soil, which received 1 inch of chips with no nitrogen had the lowest herbage yield, indicating a depressing effect of chips without nitrogen. The "no chips and no nitrogen treatment" on the Albee soils was more productive.

On the Rock Creek soil series, the highest average herbage yield of 1,288 lb/A, came from the plot with 0.5 inch of chips with 150 lb/A/N (Fig. 2). In second and third places were 1 inch woodchips, disked, and 1 inch woodchips (not disked), both with 300 lb/A/N. Increasing chips from 0.5 to 1 inch, and N from 150 to 300 lb/A did not increase yield, while disking a 0.5 inch chip mulch cut yield in half.

The check treatment on the Rock Creek soils of "no chips and no nitrogen" is interesting. While the success rating was the lowest, a fairly respectable herbage yield was obtained with no soil additives. This yield was sustained fairly well throughout the

FIG. 2. Ten-year-old mixture of hard fescue, timothy, and pubescent wheatgrass on Rock Creek soil. The plot left of center averaged 1,193 lb/A from a treatment of 1-inch of chips disked into the soil plus 300 lb/A of nitrogen. The right plot, which yielded 1,288 lb/A, received ½-inch of chips, not disked, plus 150 lb/A of nitrogen (Lucky Strike Area, 1963).

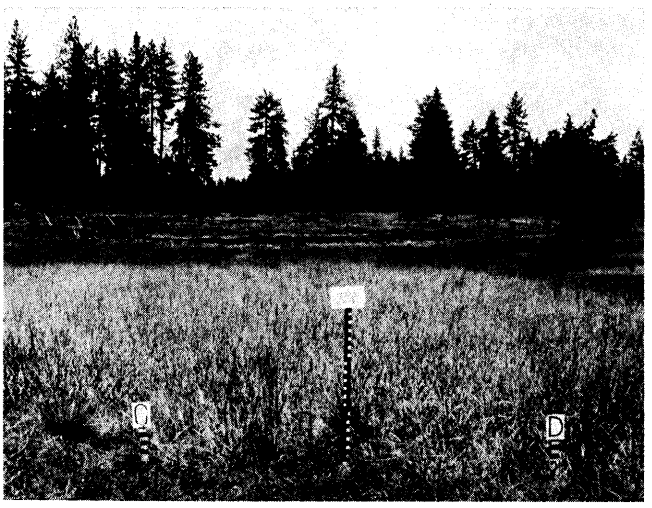


FIG. 3. Hard fescue, timothy, and pubescent wheatgrass 11 years old, on Albee soil. The check plot left of center stake averaged 1,973 lb/A, but yielded 2,290 lb the year photographed. The right plot, which received 1-inch of chips, disked, plus 300 lb/A of nitrogen averaged 2,457 lb, but yielded only 1,683 lb in 1964 (Lucky Strike Area, 1964).

study. The depressing effect of chips without nitrogen is again noted.

The check plot and the plot which received 1 inch of chips but no nitrogen on the Albee soil series yielded nearly three times as much as the corresponding plots on the Rock Creek soils for the 7-year average. On the two remaining plots in the Albee soil series, the yields were about twice the yields from the corresponding plots on the Rock Creek series. Apparently the shallow Rock Creek soil responded to 150 lb nitrogen and 0.5 inch woodchips to a greater degree than the Albee soil to 300 lb N and 1 inch woodchips (Fig. 3). It is also noteworthy that on both soils, where woodchips were added without nitrogen, yields were lower than checks. During the 7 years measured, average production on the Albee soils varied over the Rock Creek series from double in 1960 to nearly 3.5 times in 1963.

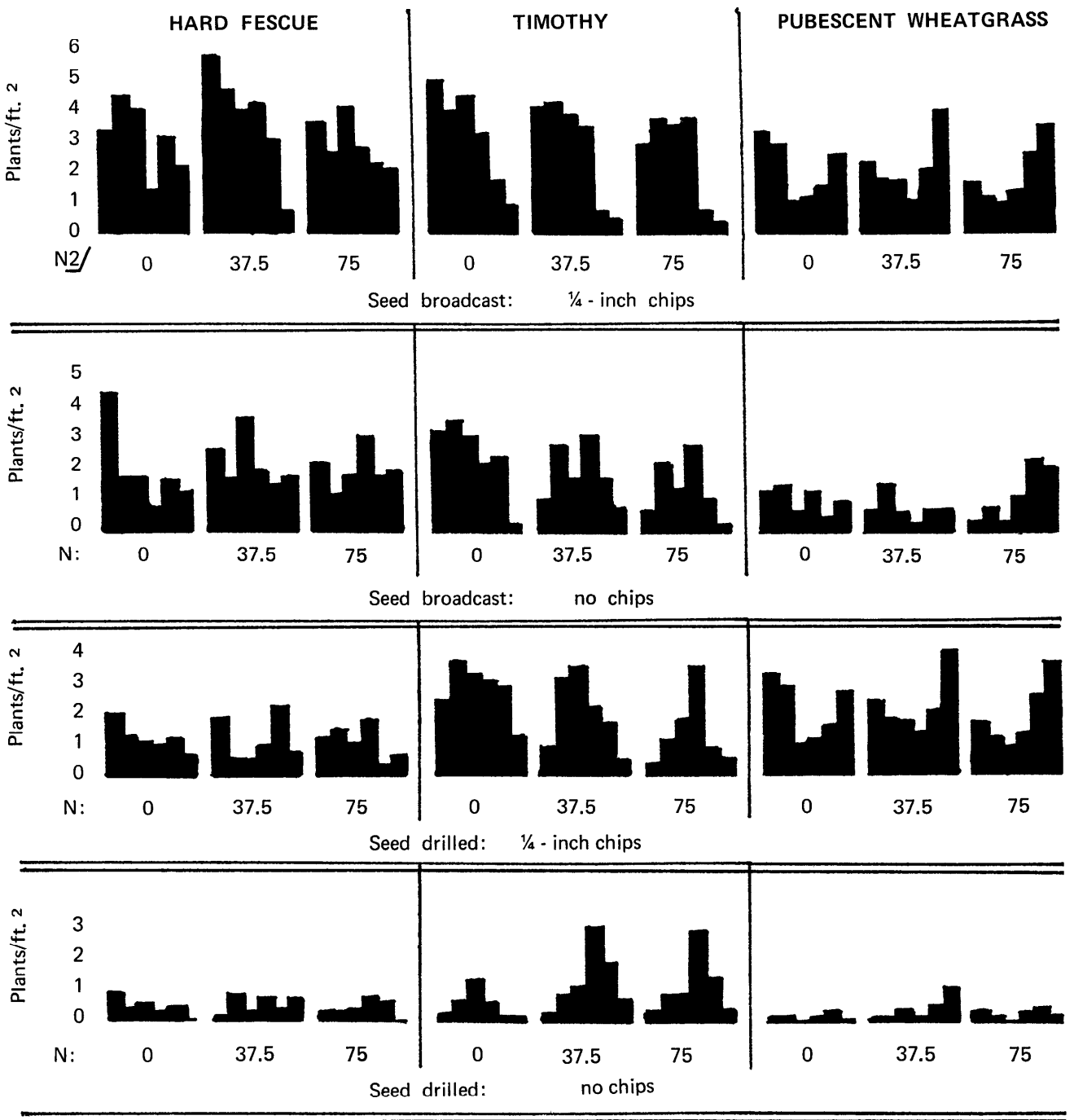
While herbage yields are related to treatment differences, as the residual effect of the initial applications of nitrogen was dissipated, there was a leveling-off, and all yields tended to become more nearly equal.

Over the 7-year period, those plots receiving N (1952–1954) yielded significantly more than the non-fertilized plots. The two fertilized plots on Albee soils averaged 2,258 lb/A as compared to 1,704 lb/A for the non-fertilized plots. On the Rock Creek soils, the two fertilized plots which received 1 inch chips and 300 lb/A/N averaged 1,165 lb/A as compared to 980 lb/A for the plots that received half as much. The non-fertilized plots yielded an average of only 554 lb/A of herbage. The fertilized and non-fertilized plots differed most the first year. By 1959 the differences were non-significant, because the effects of the fertilizer had largely been dissipated. Nevertheless, throughout the study the vegetation on the Rock Creek soil seemed to benefit from the fertilizer.

Each succeeding year production on the Rock Creek series has declined, except in 1964 when there was a noticeable increase, due to unusually favorable spring precipitation. On the Albee series, the decline was rather sharp through 1960 and since

Table 3. Estimated species composition by percentages on plots on a scab ridge site seeded with hard fescue (4 lb/A), timothy (2 lb/A), and pubescent wheatgrass (6 lb/A) on plots with and without woodchip mulch, and with and without nitrogen (Lucky Strike Area).

Treatment		Hard fescue						Timothy						Pubescent wheatgrass					
Chips (inches)	Nitrogen (lb/A)	'58	'59	'60	'61	'63	'64	'58	'59	'60	'61	'63	'64	'58	'59	'60	'61	'63	'64
ALBEE SERIES																			
1 (disked)	300	20	28	28	32	35	22	45	22	27	21	7	0	35	50	45	47	58	78
1	300	12	23	30	33	48	37	48	35	42	22	7	3	40	42	28	45	45	60
1	0	5	7	7	8	13	48	73	66	63	64	15	8	22	27	30	28	72	44
0 (check)	0	12	15	20	49	33	42	15	20	18	13	8	0	73	65	62	38	59	58
Mean (all treatments)		12	16	21	30	32	37	46	38	38	30	9	3	42	46	41	40	59	60
ROCK CREEK SERIES																			
1 (disked)	300	47	58	60	92	86	71	20	10	13	0	2	2	33	32	27	8	12	27
1	300	15	25	20	27	35	75	25	10	17	3	0	0	60	65	63	70	65	25
1	0	37	63	75	83	92	73	2	0	0	0	0	5	61	37	25	17	8	22
0 (check)	0	17	27	30	45	25	13	63	41	32	5	8	2	20	32	38	50	67	85
½ (disked)	150	30	57	50	58	65	38	20	10	15	15	0	5	50	33	35	27	35	57
½	150	8	38	38	50	57	53	25	13	17	3	0	5	67	49	45	47	43	42
½	0	8	25	30	25	45	28	40	23	20	7	0	5	52	52	50	68	55	67
Mean (all treatments)		20	42	44	54	58	50	28	13	16	5	1	3	52	45	40	41	41	47



1/ Each value is an average of ten samples per plot.
2/ Nitrogen supplement added: pounds of N per acre.

FIG. 4. Numbers of plants of hard fescue, timothy, and pubescent wheatgrass per square foot broadcast and drilled on plots with and without woodchip mulch, and with three levels of nitrogen fertilizer. Six annual samplings (Lucky Strike Area).

then production has gradually increased. Although there have been some minor changes in the stand, we do not know whether these were sufficient to have affected production (Table 1).

With increasing age of stands there has been a change in the vegetative composition. Observations were begun in 1958 to determine the trend and extent of the change. The estimated composition by percentages of the species on the stands which received the various treatments was recorded (Table 3). Overall estimates indicated that pubescent wheatgrass remained relatively stable on the shallow soils, but increased on the deeper soils during the 7-year period (1958–1964). In contrast, on the shallow soils hard fescue had increased while on the deeper soils it had remained constant during the same period. There was a marked decline in timothy, with time, on both soils.

All data lead to the conclusion that nitrogen was much more important than chips, both in forage production and in full stand establishment. But since chips are known to reduce the severity of frost heaving, they could assume greater importance in some seasons.

Second Study

In 1955, we drilled and broadcast the three species, using lower rates of nitrogen and reduced amounts of woodchips. Beginning in 1957, we made annual plant counts. Numbers were recorded by species from sample areas on each treatment (Fig. 4). Generally, the number of plants was greater on plots that received 0.25 inch of woodchips. Nitrogen did not significantly affect plant numbers. Although initial plant numbers were greater with no nitrogen, final numbers were greater with high nitrogen. The greatest difference in number of plants was between broadcasting and drilling. Both with and without woodchips, broadcasting resulted in more plants per square foot than drilling. It is possible that drilling may have covered the seed too deeply. Since the woodchips were added after the seed was broadcast, this may have provided sufficient seed cover for a good stand.

Timothy showed the highest initial plant number where broadcast. Later timothy numbers declined sharply under all treatments.

Pubescent wheatgrass numbers, while usually not high initially, tended to increase with time. Broadcasting with chips was best, followed by drilling with chips; both surpassed broadcasting and drilling without chips.

The number of plants has been decreasing from the original counts. The numerous early seedlings are now developing into fewer but larger mature plants. However, on the basis of one plant per square foot being considered a complete stand on this soil type, under existing climatic conditions, by 1964 nearly all treatments had acceptable stands (Table 4).

Table 4. Counts of established plants. 1955 scab ridge seeding on shallow Rock Creek soil. 1964 data. Plants per square foot average of N and no N treatment.

Species	Broadcast Chips		Drilled Chips	
	¼ in.	None	¼ in.	None
Timothy	.5	.3	.8	.4
Hard fescue	1.7	1.7	.6	.3
Pubescent wheatgrass	3.5	1.3	2.0	.5
Totals	5.7	3.3	3.4	1.2

Five conclusions can be drawn from the second study in terms of numbers of plants:

1. Broadcast seeding was twice as good as drilling.
2. Chips were twice as good as no chips.
3. Nitrogen was of no value initially; in fact, on the whole, it was slightly harmful.
4. Hard fescue and timothy each averaged about twice as many initial plants as pubescent wheatgrass, except in the presence of chips, where difference was not so great.
5. Pubescent wheatgrass had the highest final numbers of plants and seemed to be increasing.

Summary

Woodchips and nitrogen were used in a study in northeastern Oregon begun in 1952 to revegetate scab ridges. The soil was an intermixture of shallow Rock Creek soil series and deeper mounds of the Albee soil series. A mixture of timothy, hard fescue, and pubescent wheatgrass was sown. Good initial stands were obtained from all treatments.

Highest forage production resulted from a combination of woodchips and N, and lowest from woodchips without N. On the deeper soils pubescent wheatgrass and hard fescue increased with time and timothy declined. On the shallow soils pubescent wheatgrass numbers remained constant, hard fescue increased, and timothy declined. Establishment was enhanced by broadcasting.

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