Survival of Alfalfa in Five Semiarid Range Seedings

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Abstract

Selected cultivars and strains of alfalfa were seeded at five locations in Northern Utah during 1953 and 1954. Average annual precipitation ranged from 20 to 36 cm. Observations and detailed plant counts showed a decline in alfalfa stand densities at four of the five sites. The reduction in plant density at two sites was attributed primarily to livestock grazing and to severe damage by rabbits. Moisture stress was an additional factor at two other sites. Plant density has remained high at the fifth location for 23 years.

The value of alfalfa (*Medicago sativa* L. and *M. falcata* L.) as a legume component of tame pastures in humid and subhumid environments is commonly recognized. Attempts have been made to introduce these species into more arid situations to supplement range vegetation for some usages. The legumes have been seeded or interseeded after varying degrees of site preparation. The plantings have been based on the premises that (1) the alfalfa will itself be a major contributor to forage yield and quality, (2) the alfalfa will fix additional atmospheric nitrogen unavailable to the plant community, (3) the fixed nitrogen will result in increased productivity and protein content of the associated grasses, and (4) the increased quality and quantity of forage will increase livestock production per hectare.

The opportunity for increasing the productivity of many grazing areas by seeding is substantial. Thomas and Ronningen (1965) believed that on sites where seeding was feasible it might offer the greatest potential of all possible vectors for bringing about increased productivity. They also recognized that because of technological and economic limitations, only a small part of the range area can be improved by seeding. Interseeding of legumes into existing sods has been a widespread practice in the Aldelaide Hills region of South Australia since about 1930 (Grimmett 1967). Rumbaugh and Thorn (1965) were successful in establishing alfalfa in 9 of 16 such seedings on dryland sites in South Dakota.

Increased short-term forage yields following the introduction of alfalfa on range sites in the subhumid Northern Great Plains have been reported by Lorenz and Rogler (1962), Gomm (1964), and Miles (1969). Hervey (1960) cited lamb gains that were 65% higher during the third year of grazing when alfalfa and crested wheatgrass (*Agropyron desertorum* [Fisch. ex. Link] Schult.) had been seeded into native sod in Wyoming.

Alfalfa is long-lived in some semiarid environments when lightly utilized. Kilcher and Heinrichs (1965) found that the creeping-rooted cultivar, 'Rambler,' survived better than three other strains for 5 years on sites that received 32 and 38 cm precipitation per year during the experiment. These plantings were not subjected to grazing, but were cut twice each year. Pearse (1965) showed a picture of a 2,430-hectare field of alfalfa in a 20-cm rainfall zone of the USSR that had remained productive after 6 years. The method of utilization of the alfalfa was not indicated.

During the early 1950's, the junior author initiated a number of experiements with alfalfa on rangeland sites in northern and central Utah. Five of these have been permitted to progress through successional events for more than 20 years. This paper reports the present condition of the alfalfas included in these five seedings.

Materials and Methods

Site Descriptions and Stand Establishment

Rosebud

A shadscale saltbush (*Atriplex confertifolia* [Torr. & Frem.] S. Wats.-big sagebrush (*Artemisia tridentata* Nutt.) range site located approximately 24 km southwest of Rosebud, Utah, was selected. Elevation is about 1,654 m and soils are of the Xerollic Haplargids–Xerollic Calciorthids Association. Precipitation averages approximately 20 cm per year and is uniformly distributed.

The test area was plowed in August and again in September, 1952, to destroy the existing vegetation and to prepare the seedbed. Crested wheatgrass (*Agropyron cristatum* [L.] Gaertn., *A. desertorum* [Fisch. ex. Link] Schult.) was seeded in October at a rate of 6.7 kg/ha. Alfalfa (*Medicago sativa* L. and *M. falcata* L.) was planted March 23, 1953, with a grass drill equipped with large single discs and drag chains. The legume seeding rate was 2.8 kg/ha in rows spaced 81 cm apart. Each plot was 14.6 m wide and 69.2 m long.

The experimental design was a randomized complete block with four replications and eight legume treatments. The alfalfa cultivars and strains were the following: (1) *M. falcata* L. from Coal Springs, South Dakota, (2) 'Grimm', (3) 'Ladak', (4) 'Nomad', (5) 'Ranger', (6) 'Rhizoma', and (7) 'Sevelra'. The eighth treatment was non-scarified seed of the *M. falcata* strain used as the first treatment.

Grouse Creek

The experimental site was located approximately 2.5 km southwest of the village of Grouse Creek, Utah, in a big sagebrush rangeland area. Average annual precipitation was estimated to be 25 cm. The test site was plowed in August and again in September, 1952, and 6.7 kg/ha crested wheatgrass seed was planted in October. Legume treatments identical to those described for the Rosebud site were planted March 24, 1953, in rows spaced 46 cm apart. Plot size was 14.6 m by 56.4 m. A randomized complete block design with four replications was used. The soils are Xerollic Haplargids and Xerollic Calciorthids. Elevation is 1,600 m.

Snowville

The third experiment was situated about 2 km southeast of Snow-

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ville, Utah, on a site that previously had been used for dryland wheat (*Triticum aestivum* L.) production. Alfalfa was seeded at a rate of 2.8 kg/ha on May 20, 1954, in a one replicate planting with plots 12.2 m wide and 76.2 m long on the contour of a slightly sloping field. The legume strains and cultivars seeded were those previously described plus 'Utah Common' alfalfa. Precipitation in the vicinity of the test is 28 cm annually and the elevation is 1,420 m. The soils are similar to those at Rosebud.

Cottonwood Spring

A juniper (*Juniperus osteosperma* [Torr.] Little)-big sagebrush site located approximately 74 km south of Ouray, Utah, on the Hill Creek Extension of the Uintah and Ouray Indian Reservation was cleared, tilled, and seeded with crested wheatgrass in the fall of 1953. Alfalfa was planted April 22 of the following year. The experimental design was a split-plot with alfalfa strains as the whole plot treatments in two replications. A fenced exclosure bisecting the replications in the center of the test area provided the split-plot treatment contrast of grazing versus no grazing.

The whole-plots were 36.6 m by 112.7 m for the last six cultivars listed in the Rosebud site description. The seventh entry at Cottonwood Springs, *M. falcata* from Coal Spring, South Dakota, was seeded in whole plots 6.1 m wide and the same length as plots of the other cultivars. Precipitation was estimated to be about 33 cm and the elevation is 2,285 m. Soils in this area belong to the Typic Argiboralls-Lithic Argiboralls-Typic Haploboralls Association.

Mud Spring

This test was situated in a valley dominated by big sagebrush located approximately 8 km north of Altonah, Utah, at 2,240 m elevation. Precipitation was estimated to average 36 cm per year. Plantings were established in the same way as at Cottonwood Spring with alfalfa seeded on April 16, 1954. Whole-plot size was changed to 32.6 m by 124.9 m for the six cultivars of alfalfa and to 8.2 m by 124.9 m for the *M. falcata* plots. The exclosure constructed in the center of the test area bisected the whole-plots of the two replications.

Grazing Management

Detailed information on management of the test sites is not available. The Rosebud and Grouse Creek locations were used for wintering sheep, but stocking rates are not known. Both locations had high populations of rabbits (*Sylvilagus auduboni* and *Lepus* sp.) during the first 2 or 3 years of the experimental period.

The Snowville test site was used as early spring pasture for cattle. The animals were removed before June each year. The Cottonwood Spring and Mud Spring tests were grazed by sheep, cattle, and horses with some utilization by elk, deer, and rabbits. The exclosure fencing in both experiments has been down at intervals of varying durations since 1954. On May 17, 1956, the junior author noted that the exclosure fence at Cottonwood Springs was in disrepair and that the entire test had been closely grazed. On May 24, 1960, it was observed that herdsmen had been using the exclosure for horse pasture. Rabbits were more of a problem at Mud Spring than at Cottonwood Spring when the plantings were observed in 1956 and 1960.

Data Acquisition

Different procedures were followed to estimate alfalfa stand density and productivity. During the first part of the test period, numbers of alfalfa plants per hectare were estimated by counting all plants in each plot whenever stands were sufficiently thin for this to be accomplished easily. In other cases, plants were counted in 0.914-m square quadrats. The estimates in 1977 were made by counting all plants in each plot and marking them with paint as they were tallied. Productivity was measured by using 0.914-m square quadrats or by using a circular sampling frame with a 1.066-m diameter and an area of 0.892 m^2.

Results and Discussion

The initial stands of crested wheatgrass were excellent in all tests where seeded. Population densities of the alfalfas varied among sites but in each case the numbers were considered adequate for maximum utilization of the available moisture. However, at four of the five locations, alfalfa populations, and consequently alfalfa forage production, declined rapidly.

The Rosebud experiment was in the lowest precipitation zone of the five tests. Despite this, seed germination was sufficient to provide the equivalent of 39,506 alfalfa plants per hectare in the growing season of 1953. Seedling mortality was high and by the end of the 1954 season, there were fewer than 7,000 plants per hectare. The planting continued to deteriorate; and during the spring of 1956, the alfalfa stand density was estimated to be 25 plants per hectare. Differences among the treatments were inconsequential. All alfalfa plants observed were small and were believed to have resulted from hard seeds which had germinated after the year of sowing. At no time did the legumes materially contribute to forage yield as the plants were killed by rabbits and moisture stress before they developed much beyond the seedling stage.

On May 6, 1960, only one alfalfa plant could be found and the vegetation had apparently stabilized with crested wheatgrass, shadscale saltbush, and halogeton (*Halogeton glomeratus* [M. Bieb.] C.A. Mey.) as dominant species. When searched in 1965 and again in 1977, no alfalfa plants were found at this location.

The experiment at Grouse Creek was observed on June 29, 1953, 3 months after tha alfalfa had been seeded. A fair stand was noted to be confined to the tractor tracks. It was possible that much of the seed was improperly covered at this site. The seedlings which were present were equivalent to 33,281 plants per hectare (Table 1). The plots of Ladak contained appreciably more seedlings than those of the other cultivars. Scarification of the *M. falcata* L. seeds almost doubled the stand of that strain. Rabbit damage was severe throughout the test.

Table 1. Numbers of alfalfa plants per hectare for several cultivars seeded at Grouse Creek, Utah, in 1953.

Cultivar or strain	Date				
	7-9-53	5-20-54	6-21-57	5-6-60	8-26-65 and 5-18-77
M. falcata (seed scarified)	33,580	9,111	1,494	12	0
M. falcata (seed not scarified)	19,185	8,395	2,580	37	0
Grimm	36,049	6,494	1,543	0	0
Ladak	60,000	10,074	2,731	12	0
Nomad	19,185	7,432	2,543	62	0
Ranger	12,000	8,395	1,877	0	0
Rhizoma	38,346	6,494	1,370	25	0
Sevelra	47,901	9,111	2,259	0	0
Mean	33,281	8,188	2,049	19	0

When examined on May 6, 1960, only 12 alfalfa plants could be found in the entire experiment. These were small, but were not seedlings. Sagebrush and crested wheatgrass provided most of the forage on the site with some halogeton present. When next viewed in August, 1965, and again in May, 1977, no alfalfa plants were seen.

Annual precipitation and available moisture at the Grouse Creek experimental site may approach the minimum level at which alfalfa can survive as a component of range vegetation. The decline in stand was quite rapid but mature plants did exist in appreciable numbers for 3 to 4 years (Table 1). The initial stand could probably have been improved by increasing the compaction of the soil above the seeds after sowing. Rabbit damage was severe throughout the early years of the test and undoubtedly contributed greatly to the stand loss observed in the

1953 to 1954 interval. Seeding of legumes on larger areas would reduce rodent damage and subsequent stand decline.

The experiment at Snowville was the most successful of the five described when judged by maintenance of the legume populations. Exact numbers of plants in the plots were not determined until 1977, but on May 12, 1959, the descriptions recorded varied from "poorest stand" and "stand thin but O.K." for the *M. falcata* entry to "good" for five of the eight alfalfas. Similar comments were noted in 1960, 1961, and 1966. Exact numbers of plants were obtained in July, 1977, and the equivalent density per hectare is shown in Table 2 for each treatment. These ranged from a low of 16,187 for Utah Common to 38,096 for Nomad. Phenotypically, the plants of Utah Common could not be distinguished from those of Ranger and the two populations had similar stands. The *M. falcata* entry which originally had the poorest stand rating contained more plants than any other entry except Nomad in 1977.

Alfalfa forage yields were estimated in 3 years (Table 2). Yields were high for this environment in 1956, averaging 3.90 metric tons of oven-dry forage per hectare. Precipitation at the nearest recording station 1.6 km from the plot area for the 12 months immediately prior to harvest totaled 32 cm and provided sufficient moisture to sustain an exceptional level of productivity. However, on June 3, 1960, there was insufficient growth to permit harvesting hay samples. Average yield was 0.74 and 0.46 metric tons/ha in 1961 and 1977, respectively. The most recent yield estimate was compared to that of an adjacent down-slope planting of crested wheatgrass seeded at the same time as the alfalfa. The grass produced 0.38 tons of forage per hectare or only 83% as much as the alfalfa.

Table 2. Oven-dry forage yields and numbers of alfalfa plants per hectare in a test seeded at Snowville, Utah, in 1954.

Treatment	Plants[1] per hectare (7-6-77)	Forage yield (ton/ha) 6-7-56	7-26-61	7-6-77
M. falcata	32,579	–	0.76	0.47
Grimm	17,155	3.90	0.49	0.45
Ladak	26,717	3.83	0.76	0.48
Nomad	38,096	3.41	0.78	0.40
Ranger	20,306	4.01	0.83	0.56
Rhizoma	30,019	3.59	0.56	0.34
Sevelra	26,254	4.06	0.92	0.53
Utah Common	16,187	3.99	–	0.43
Crested wheatgrass	–	–	–	0.38
Mean	25,914	3.90	0.74	0.46[2]
L.S.D. (0.05)	–	–	–	N.S.

[1] Plants one year old or older
[2] Alfalfa alone

The differences in productivity among the legume strains listed in Table 2 were not statistically significant ($P>.05$). Sevelra and Ranger were slightly superior to the other five entries. Nomad, the cultivar with the most plants per hectare, yielded next to least of the eight legumes. Three scientists who examined the plots 1 week before harvest had also visually ranked Nomad as the poorest of the eight. Plants of Nomad were markedly smaller and shorter than those of Sevelra in the adjoining up-slope plot and of Ranger on the adjoining down-slope plot.

The Snowville site was infested with Russian Thistle (*Salsola kali* L. var. *tenuifolia* Tausch). Forage yield of this species was determined from two samples per plot obtained the same day the alfalfa was cut in 1977. Average dry weight per hectare was computed to be 422 kg with no significant differences among the alfalfa populations.

The Cottonwood Spring and Mud Spring sites and plantings in eastern Utah were quite similar. The earliest notes now available were recorded on May 17, 1956, 2 years after planting. At that time, both sites had been closely grazed both inside and outside the exclosures by livestock and rabbits. Stands of alfalfa and crested wheatgrass at Cottonwood Spring were described as "satisfactory." Exact stand evaluations were not attempted at that time, but Grimm and Ranger were judged to be slightly inferior to the other cultivars. At Mud Spring, there was a "fairly good stand of all varieties" and Nomad and Rhizoma were showing a tendency to spread vegetatively. The ground cover was estimated to be 85% grass and 15% alfalfa.

In the spring of 1960, stands of Grimm and Ranger were still rated as inferior at Cottonwood Spring and stand density as well as forage composition at Mud Spring was about the same as in 1956. At the latter site, Grimm and Ranger plants were also throught to be less plentiful than those of the other entries.

All alfalfa plants surviving in the Cottonwood Spring and Mud Spring experiments were counted in mid-July, 1977. Averages of 176 plants per hectare within and 31 plants per hectare outside the exclosure were found at Cottonwood Spring. Numbers ranged from 230 plants per hectare for Nomad and Sevelra within the exclosure to 16 for Sevelra outside the exclosure. Although some of the experimental contrasts were statistically significant, the low population densities of the legumes indicate that they contributed very little to forage production on this range site in 1977. Those plants that were observed were small and only 10 were found to be sufficiently developed to permit flowering. Many of the alfalfa plants were intimately associated with sagebrush plants which provided protection from grazing. Only 30 alfalfa plants survived to 1977 in the Mud Spring experiment. Eighteen were within and twelve outside the exclosure. Several cottontail and jack rabbits were started from the test area both within and outside the exclosure. The comparative quantities of grass indicated that the exclosure had effectively excluded livestock during the 1977 growing season.

The only successful experiment, when evaluated in terms of alfalfa population density, was the one at Snowville. Although the Grouse Creek and Rosebud locations did not receive sufficient precipitation to sustain high forage yield levels, some alfalfa plants should have survived. We believe that the elimination of plants was due to close grazing by rabbits. Certainly the Cottonwood Spring and Mud Spring sites receive sufficient moisture to support more plants than were counted in 1977. The higher elevations of these two tests should have caused more efficient utilization of the precipitation than in other experiments. When compared to the Snowville planting, the major factors noted throughout the years which could have caused the differences in population density were livestock grazing and intensity of rabbit damage. A slight amount of foraging which appeared to have been done by rabbits was observed at Snowville during the summer of 1977, although no animals were seen. Several rabbits and some damage by them were noted the same year at Cottonwood Spring and Mud Spring. These latter two experiments were surrounded by thousands of hectares of brush rangeland which provided habitat for rodent populations. The Snowville test, however, had wheat and tame hay and pasture lands around it. The neartest native rangeland was approximately 1.6 km distant. This minimized the impact

of rabbits on that planting.

Conclusions

The plant counts and forage yields in the Snowville experiment demonstrated that alfalfa can survive and remain productive when grazed for 23 years in a semiarid environment. At the end of that time period, the alfalfa yielded 121% as much oven-dry forage as crested wheatgrass in a adjacent planting.

Rabbits can cause rapid reductions in alfalfa stands even when the plantings receive 30 cm precipitation per year. This may not be as much of a problem in larger scale seedings as it was in the small tests considered in this report. Moisture stress may prohibit utilization of either *Medicago falcata* L. or *M. sativa* L. as range or permanent pasture species in localities with less than 28 cm annual precipitation.

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