The Performance of Several Improved Forage Species on Laughlin-like Soils in Western Oregon[1]

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Approximately 1,400,000 acres of foothill pastures surround the valleys of western Oregon (Beck, et al., 1952). Most of this acreage is unimproved. Many of these hill lands support a dense or open stand of white oak (*Quercus garryana*), while some are reported to be devoid of tree cover because of burning practice by Indians and early settlers (Sprague and Hansen, 1946). At present this type of agricultural land is considered to be marginal for crop production (Roberts, 1954).

Because of interest in the possibilities of improving this area for pasturage, the Oregon Agricultural Experiment Station in cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture undertook an experiment in 1943 to determine the establishment of sixteen forage species under four different methods of seedbed preparation. In 1952 it was decided that a more thorough evaluation of the species which had persisted in the original 1943 seeding should be obtained. Accordingly, data were collected on the performance of the six most persistent species in relation to moisture and soil.

Experimental Area

The Willamette Valley and the adjacent coast range foothills are dominated by a mixture of Douglas-fir and white oak. Cedar and hemlock, the typical climax dominants of the coastal areas, are not abundant here and the climax has been determined to be lowland white fir (*Abies grandis*) on the MacDonald Forest adjacent to the experimental area (Sprague and Hansen, 1946). Forest site classification work by Spilsbury and Smith (1947) in the northwest indicates that much of this area, with a pronounced deficiency of moisture during the summer months, is characterized by an invasion of Douglas-fir (*Pseudotsuga menziesii*) into original "prairies" and oak forests. The predominant shrubby species of this area are poison oak (*Rhus diversiloba*) and common wild rose (*Rosa rubiginosa*) which invade the open grassland in advance of the tree growth (Sprague and Hansen, 1946).

The climate of this area may be designated as a mild sub-coastal type with moist open winters, cool dry summers, and a dry harvest period. Violent storms, hail, strong velocity winds, high relative humidity, and high summer temperatures occur rarely (Powers, 1950). Precipitation and temperatures for the period of this study, as well as 60-year averages, are presented in Figure 1.

The soil of the experimental area was once designated as Cascade loam (Carpenter and Torgeson, 1924) but more recently reclassified as Laughlin-like (Roberts, 1954). These soils, both residual, differ in that the former was derived from igneous rocks, whereas the latter originated from shale and sandstone (Valassis, 1955). The Laughlin series was established in California in 1948 and differs from that on the study area chiefly in

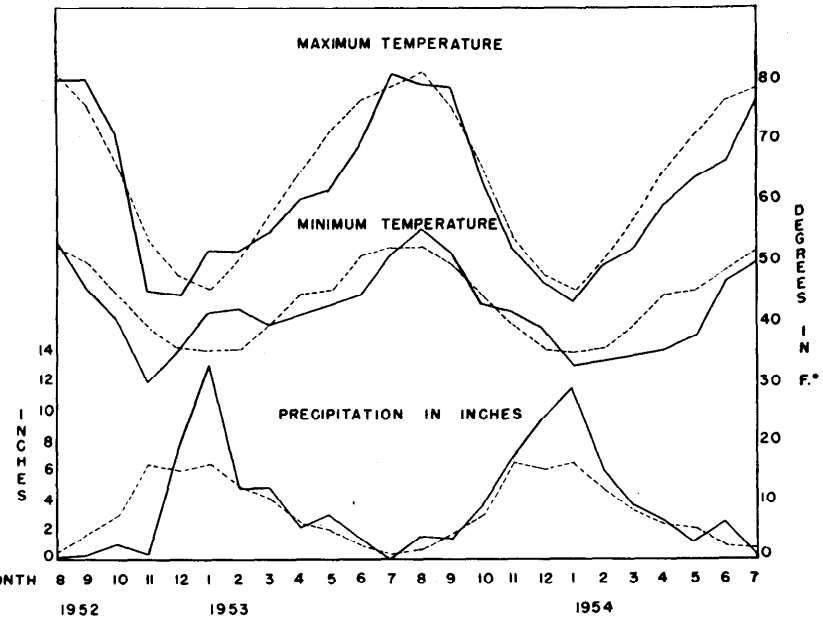

FIGURE 1. Monthly precipitation and mean temperatures. Solid line indicates monthly precipitation and mean temperatures for the years 1952-1954 on the experimental area. Broken line shows sixty-year average monthly precipitation and temperatures for Corvallis, Oregon.

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FIGURE 2. A view of the southwest corner of the experimental area. White stakes mark the location of sampling units. Oregon oak is the prominent tree and common wild rose the dominant shrub in the foreground. The lighter portion to the right center is the highland bentgrass. The encroachment of tall meadow oatgrass is visible in this plot in the background. Notice the difference in height between the two species (May 21, 1954).

that Laughlin soils were formed on a more basic parent material.

A canopy of oak trees covers about the upper one-third of the experimental area. Scattered bushes of wild rose and poison oak occur in both openings and under the oak. Figure 2 illustrates the appearance of the vegetation in mid-spring. In addition to the seeded forage species, a number of native and introduced herbaceous species are abundant on the area.

The species studied in this experiment were originally seeded in 1943 as part of an adaptability and establishment trial. A total of twenty, 1-acre plots were seeded—sixteen to individual species and four to mixtures. The area was grazed by sheep rather lightly from 1944 until 1949. The area was grazed heavily during the spring and summer in 1949-50 and moderately throughout the year in 1950-51 and 1951-52. This continuous grazing, particularly in the spring and summer, has been shown to be detrimental to the vigor and maintenance of seeded forage perennials (Bogart and Hedrick, 1955).

In the spring of 1953 the experimental area was fenced to exclude grazing. The following species showed at least limited persistence and were selected for study: highland bentgrass (*Agrostis tenuis*), Alta fescue (*Festuca arundinacea*), tall oatgrass (*Arrhenatherum elatius*), Tualatin oatgrass (*Arrhenatherum elatius* var. *Tualatin*), burnet (*Sanguisorba minor*), and subterranean clover (*Trifolium subterraneum*). In addition, one plot seeded to chewings fescue (*Festuca rubra* var. *commutata*) was regarded as a failure and was selected to use as a check.

Methods

Seven soil pits, 5′ x 7′, and 3 to 10 feet deep, were opened in April of 1953 to study the soil profile. In addition to complete descriptions of the profile, quantitative data were obtained on the physical and chemical characteristics of this Laughlin-like soil. Other smaller pits were dug throughout the sample plots to determine concentration of roots in different horizons of the profile.

Twenty-four random sampling locations within each seeded plot were established for soil moisture and forage measurements. Forage yields were taken to determine total production, relative production of the improved seeded species by season, and the relative composition of the forage on the seven plots under study after one and two years protection from grazing.

Two square-foot sample plots were clipped at each sampling location to obtain data on forage production and composition. Whenever feasible, the clippings were hand separated to determine the relative amount of the seeded species. Seasonal clippings were obtained twice for 1953 and three times for 1954. Plots in 1953 were clipped on June 5 and September 5. In 1954 harvests were made on May 1, July 15, and September 15.

As the chemical composition of some forage species on the area was not available in the literature, samples were taken for analyses on July 20, 1954. These were made to determine the nutritive quality of the above mentioned forage species. The crude protein and other constituents were run in the Animal Nutrition Laboratory at Oregon State College. Methods used in these analyses were those recommended by the Association of Official Agricultural Chemists (1945).

Results and Discussion

The Laughlin-like soils described on the experimental area vary from a clay to clay loam in texture. They are rather shallow, ranging in depth from 17 to 32 inches to the parent material which consists of tuffaceous and micaceous marine shale and sandstones. A summary of some of their important physical characteristics is presented in Table 1.

The soil data of Table 1 indicate rather favorable physical characteristics for the establishment of improved forage species. Soil-moisture data from this study (Valassis, 1955), indicate that the moisture content of the deeper soil layers during the growing season seldom reached the wilting point for the year 1953 or in the deepest

Table 1. Apparent density, total porosity, and moisture content at one-third atmosphere and wilting point of Laughlin-like soils on the experimental area.

Depth	Apparent Density*	Total Porosity	One-third Atmosphere	Wilting Point**
(Inches)	(gms/cm³)	(Percent)	(Percent H_2O)	(Percent H_2O)
0- 6	1.23	52.7	30.9	12.0
6-12	1.40	46.2	28.6	12.0
12-18	1.37	47.3	27.0	13.1
18-24	1.38	47.2	27.9	15.2
24-36	1.32	49.2	33.1	16.1

* As determined by paraffin clod method.
** As determined phytometrically.
Particle density 2.60.

layers in 1954. Figure 3 illustrates the soil moisture trends in four horizons sampled throughout the summer and fall of 1953. It is apparent that species with abundant roots at a depth of two feet would not have been without moisture even in the driest part of the summer. Naturally when the horizons above 18 inches are dry the rate of growth will be greatly slowed, but the plants with roots at the greater depth will be better able to maintain themselves and more able to respond to favorable growing conditons than the shallower-rooted species.

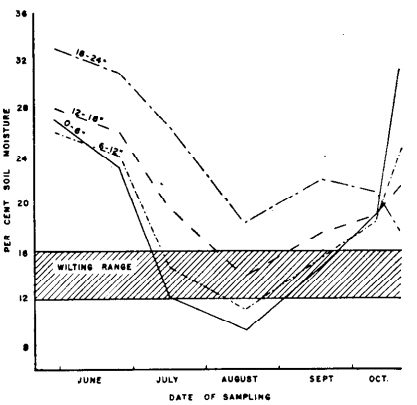

FIGURE 3. Percent of soil moisture at four sampling depths from June through October, 1953.

All of the persistent perennial species were found to be deep rooted, that is, roots from these plants all reached into the shale or parent material. This factor is extremely important since these studies have revealed that subsoil moisture is generally sufficient for growth during the summer dry period. Figure 4 shows the comparative rooting depth and concentration of roots on representatives of both successful fibrous and tap-rooted species on soils developed over shale.

Total and seasonal production of all species studied is presented in Figure 5.

Comparison of the early forage production for the two years has to be made carefully because of differences in the time of clippings. The first 1953 clipping was on June 5 and in 1954 on May 1. However, comparison of the total production based on September clippings for both years gives a clear picture of improvement after the exclusion of grazing for 18 months.

In comparing the production obtained in September for both years, the total yield differences among the plots of highland bentgrass, chewings fescue, burnet, and subterranean clover are not significant. On the other hand, the total yields of the remaining plots of Alta fescue and both oatgrasses were greater for 1954 than for 1953. Production from the first clippings for all plots in 1954 was lower than that obtained in 1953 because the yields were taken 35 days earlier in 1954.

Seasonal production of the improved species is given in columns numbered 3 and 4. The marked improvement in the production of Alta fescue and both oatgrasses is particularly evident after two seasons of protection from grazing. These columns also show the value of various species at different periods during the grazing season. For example, Alta fescue and tall meadow oatgrass produce the greatest amount of early spring feed whereas Tualatin oatgrass and highland bentgrass produce more in late spring or early summer.

The rate of growth, expressed in percent, of most species was greater after May 1, 1954, except for the two fescues. It is not surprising that both fescues yielded about 50 percent of their growth before May 1, 1954, since these species are typical cool season plants. Alta fescue makes a good summer regrowth, too, if properly managed in the spring (Bogart and Hedrick, 1955). The greatest yield for both fescues was obtained from the plots where grazing and burning were used for the original seedbed treatment under the oak canopy.

Unfortunately, the percent composition by weight of seeded species for the last clippings of September 1953 could not be obtained because the forage was so dry that separation into species was impossible. The percent composition for the production of the clippings for 1954 is presented in Table 2.

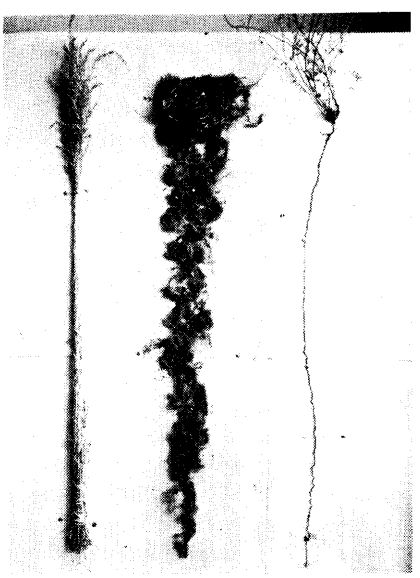

FIGURE 4. Root and top growth of two seeded forage species. From left to right: Top and root system of a Tualatin oatgrass plant and an individual plant of burnet.

The values of the chemical analyses are presented in Table 3.

The crude protein content from samples under the canopy was 7.3 percent for the tall meadow oatgrass and 5.0 percent for Tualatin oatgrass. No explanation is attempted for the differences in crude protein content of tall meadow and Tualatin oatgrasses growing under the canopy and in the open. More samples throughout the year would be needed to check the consistency of these results. Plantain leaves contain 7.1 percent crude protein, which is higher than that of plantain heads and stems, and that of burnet. On the other hand, burnet has 4.1 percent of ether extract, whereas plantain has a lower percentage. These chemical analyses of the three species indicate that all three of them are fairly high in nutritive value and should be encouraged as forage species.

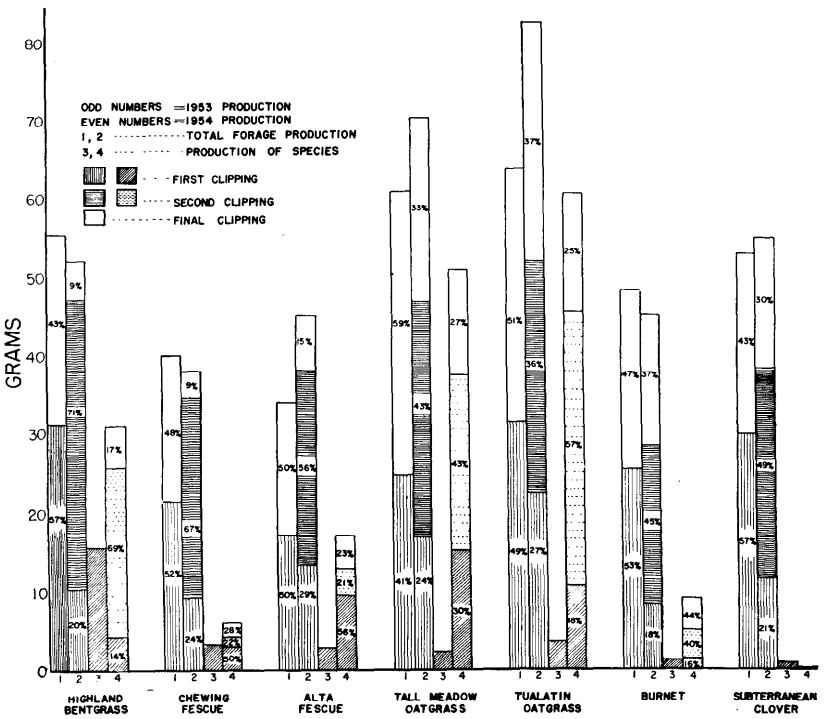

FIGURE 5. Forage production obtained by ground-level clippings for 1953 and 1954. Two clippings were made in 1953 and three clippings in 1954. Percent figures in columns 1 and 2 show the seasonal proportion of total production. Columns 3 and 4 show seasonal proportion of the improved seeded species.

Application of Results to Pasture Improvement and Management

These data clearly show the relative seasonal production of the species studied. Alta fescue and tall meadow oatgrass were outstanding producers of early spring forage. Tualatin oatgrass was the greatest producer of late spring and early summer feed. Burnet, which only made up 20 percent of the stand, yielded the greatest proportion in late summer. The poor performance of subterranean clover can probably be attributed to the protection of the area from grazing during the fall months. This plant is a winter annual that needs a fairly open seedbed in the fall and early spring for establishment.

On similar hill grazing lands with shallow soils derived from shale and sandstone, limited seedbed treatments can probably be used effectively. Mixtures composed of Alta fescue, Tualatin oatgrass, burnet, and a suitable legume are suggested under these conditions for a maximum all-season production of forage. In areas where well-prepared seedbeds are feasible, more simple mixtures of one or two grasses with a suitable legume might be more easily managed for top seasonal production. Under the latter conditions, Alta fescue is suggested for winter and early spring pasture whereas Tualatin oatgrass and burnet would be more suitable for late spring and summer grazing.

During and after the period of establishment, good grazing management is particularly important in order to maintain a vigorous stand of forage plants. The relatively low production from Alta fescue in this study was probably brought about by a combination of heavy early and late spring grazing. Other studies (Bogart and Hedrick, 1955), have shown this type of use to be detrimental to stands of fescue. On the other hand, heavy early spring grazing is recommended for this species provided the grazing pressure is

Table 2. Percent composition by weight of air-dried forage production of seeded species and other grazable species obtained for the entire growing season of 1954 from the seven plots clipped at ground level.

		Date					
		May 1		July 15		September 1	
Plot. No.	Seeded Species	Seeded sp.	Other spp.	Seeded sp.	Other spp.	Seeded sp.	Other spp.
5	Highland bentgrass	41	59	55	45	60	40
6	Chewings fescue	33	67	12	88	16	84
9	Alta fescue	71	19	34	66	38	62
11	Tall meadow oatgrass	90	10	80	20	72	28
12	Tualatin oatgrass	47	53	87	13	73	27
16	Burnet	17	83	18	82	20	80
17	Subterranean clover	0	100	0	100	0	100

Table 3. Chemical composition of several forage species.

Species	Percent				
	Dry matter	Crude protein	Ether extract	Ash	Crude fiber
Tall meadow oatgrass					
Open field	56.3	6.0	—	—	—
Under oak canopy	59.7	7.3	—	—	—
Tualatin oatgrass					
Open field	55.1	6.5	—	—	—
Under oak canopy	56.8	5.0	—	—	—
Burnet					
Open field	60.1	6.2	4.1	5.8	20.1
Plantain					
Open field					
Heads and stems	57.4	6.2	3.7	4.1	26.3
Leaves	73.0	7.1	2.8	8.2	13.3

relieved early enough to allow reasonable summer regrowth and food storage to take place. This is accomplished by deferring a heavily grazed winter and early spring pasture while there is still ample soil moisture left for regrowth of perennials. Proper timing of this deferment results in the reduction of annual species and an accompanying increase in the perennials.

Summary

Studies were undertaken in 1953 to evaluate seedings made in 1943 on marginal, oak-covered hill lands in the Willamette Valley near Corvallis. The soil was found to be Laughlin-like having developed *in situ* from marine shale and sandstone. Although it has good physical properties, it is low in pH and deficient in essential nutrients, notably phosphorus.

Out of sixteen species originally planted in 1943 under four different methods of seedbed preparation, only six persisted as recognizable stands. Of these stands, only highland bentgrass could be considered as relatively good and uniform at the start of the study. However, stands of Alta fescue, both tall meadow and Tualatin oatgrasses, chewings fescue, and burnet made remarkable recovery following two seasons protection from grazing.

Chewings and Alta fescue in 1954 produced 50 percent of their seasonal production by May 1. Tall meadow oatgrass was also a heavy producer of early spring forage, whereas highland bentgrass, Tualatin oatgrass, and burnet all produced a greater proportion of feed in late spring and summer. The importance of this relative seasonal production to a pasture improvement and management program was pointed out.

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