Mountain Meadow Improvement Studies

Clee S. Cooper, Research Agronomist

Research to devise methods of increasing the quantity and improving the quality of hays produced on wild flood meadows has been in progress on this Station for 4 years. Much has been learned concerning fertility and management practices which may now be used to improve forage production and new findings are constantly pointing to higher and higher production. The following summary presents the results being obtained from research projects in progress.

Nitrogen

Studies concerning nitrogen fertilization have been conducted both on the Station and in cooperation with County Agents at some 35 locations in eastern Oregon. These trials have given useful information on nitrogen fertilization requirements of native meadows.

How much?

The average yield increase received from applications of 60 and 120 pounds of actual nitrogen per acre has been .8 and 1.2 tons per acre. Considerable variation in response occurs from meadow to meadow. Yield increases ranged from .33 to 1.10 tons per acre for the 60-pound rate of N application, and from .48 to 1.96 tons per acre for the 120-pound rate of N application. The 60-pound rate of application is recommended because the highest return per dollar expended is obtained at this rate. An operator owning several sections of meadowland may desire to fertilize a part of it. Having the choice of fertilizing 200 acres at 120 pounds of N per acre or 400 acres at 60 pounds of N per acre, he will get more return in relation to the fertilizer cost by using the larger acreage at the lower rate.

Where?

Trials have been conducted on the three major meadow types. These types are described as follows:

1. Nevada bluegrass---Areas containing almost pure stands of Nevada bluegrass, characterized by short periods of early spring flooding.

2. Rush-sedge-grass---Areas containing a mixture of rushes, sedges, and grasses with some native clovers, characterized by 6 to 12 weeks of flooding to a depth of 1 to 6 inches.

3. Rush---Areas which are almost pure baltic rush (wire grass), characterized by long periods of flooding to a depth of 6 inches or more.

We recommend the use of nitrogen only on the Nevada bluegrass and rush-sedge-grass types. Yields have not increased with nitrogen on meadows of the rush type.

When and what?

As these two questions are closely related they shall be discussed together. Nitrogen was applied in the form of ammonium nitrogen (Ammonium sulfate) and nitrate nitrogen (Calcium nitrate) in both fall and spring at five rates of application (0, 50, 100, 150, and 200 pounds of N per acre).

Preliminary data indicate that considerable nitrogen is lost when applied as nitrate nitrogen in the spring. There was no difference in yields between either calcium nitrate or ammonium sulfate fall applied or ammonium sulfate spring applied.

How?

Because the tough sod of native meadows prohibits the use of equipment that places fertilizer into the soil, application is limited to surface broadcasting.

Summary and conclusions

Our past recommendations have been to apply 60 to 80 pounds of nitrogen either in late fall or in early spring to meadows of the Nevada bluegrass or rush-sedge-grass type. Pending verification of results our present recommendations for applying nitrogen fertilizer on these two meadow types are: "Apply 60 to 80 pounds of N annually. If fall applied, either nitrate or ammonium nitrogen may be used; however, if spring applied, only ammonium nitrogen should be used. For applications of more than 100 pounds of N per acre, in either fall or spring, use only the ammonium form of nitrogen."

Phosphorus and Clover

Normally an application of phosphorus to a native meadow produces little response; however, when used in combination with certain harvest practices, phosphorus can triple the yield of hay and quadruple the yield of crude protein per acre. These returns are brought about by increasing the growth and density of white-tip clover (T. variegatum). Phosphorus stimulates this clover and delayed harvesting is used to allow the clover, which is an annual, to reseed and increase. Using this procedure the clover composition has been increased from less than one to more than 50 per cent by weight both on small plots and on large areas. A number of projects are in progress to study various aspects of white-tip clover culture. The following presents a brief summary of results from some of these projects, and a description of others of which no results are available.

Establishment

Although white-tip clover can be established by fertilization and harvest management, the rate of change is dependent upon the initial stand and may, on some areas, be very slow. A pilot type experiment conducted in 1954 in which clover was seeded with and without phosphorus application, demonstrated that the clover component can be increased by seeding on areas to which it is native. The resulting influence on yield and crude protein production are presented in Figures 1 and 2.

Figure 1. Yield in Tons Per Acre of Plots Seeded to Clover with and Without Phosphorus.

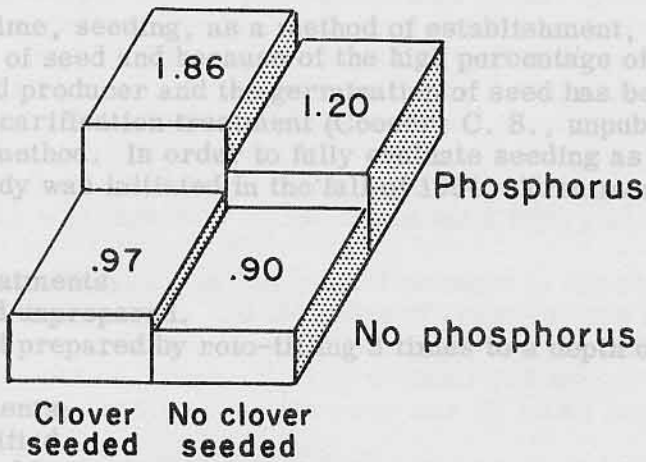
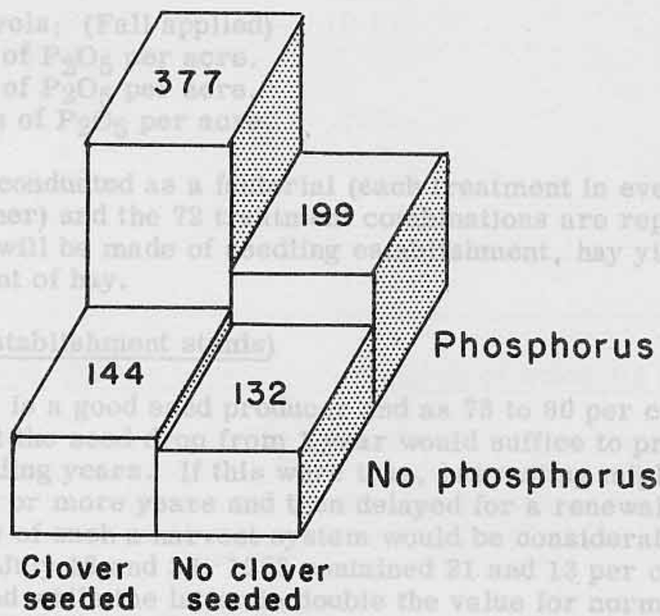


Figure 2. Yield of Crude Protein in Pounds Per Acre from Plots Seeded with and Without Phosphorus.



In considering these data, mention must be made that these are first-year yields. It is expected that yields of plots, both seeded and fertilized, will increase considerably more in the second year, as a stimulation of the rush-sedge-grass component, resulting from decomposition of clover roots and subsequent release of nitrogen, has been evidenced in other experiments.

At the present time, seeding, as a method of establishment, is curtailed because of the unavailability of seed and because of the high percentage of hard seed. Since clover is a good seed producer and the germination of seed has been increased from 8 to 35 per cent by scarification treatment (Cooper, C. S., unpublished data) it can soon be a practical method. In order to fully evaluate seeding as a method of establishment, a study was initiated in the fall of 1954. Treatments being tested are as follows:

1. Seedbed treatments:
   a. Seedbed unprepared.
   b. Seedbed prepared by roto-tilling 3 times to a depth of 5 inches.
2. Seed treatments:
   a. Unscarified.
   b. Scarified by immersing in 78 per cent sulfuric acid for 30 minutes.
3. Seeding rates: (Spring applied)
   a. 1 pound of germinable seed per acre.
   b. 3 pounds of germinable seed per acre.
   c. 5 pounds of germinable seed per acre.
   (Seeding rates are based on germinable seed. To apply 1 pound of germinable seed requires about 3 pounds of scarified or 6 pounds of unscarified seed per acre.)
4. Nitrogen levels: (Fall applied)
   a. No nitrogen.
   b. 60 pounds of nitrogen per acre.
5. Phosphorus levels: (Fall applied)
   a. 40 pounds of P_2O_5 per acre.
   b. 80 pounds of P_2O_5 per acre.
   c. 120 pounds of P_2O_5 per acre.

The experiment is conducted as a factorial (each treatment in every possible combination with the other) and the 72 treatment combinations are replicated three times. Measurements will be made of seedling establishment, hay yields, seed yields, and crude protein content of hay.

Harvest management (establishment stands)

As white-tip clover is a good seed producer and as 75 to 80 per cent of the seeds are hard, it may be that the seed drop from 1 year would suffice to provide a stand for two or more succeeding years. If this were true, harvesting might be conducted at the normal time for one or more years and then delayed for a renewal of the seed supply. The advantages of such a harvest system would be considerable. Samples of pure clover taken on July 16 and 30, 1953 contained 21 and 13 per cent crude protein respectively, and while the latter is double the value for normal rush-sedge hay at this date it would be advantageous to cut at an earlier date to obtain the higher crude protein content. To explore such a possibility a project was initiated in 1953 to determine the direct, 1-year residual, two-year residual, and cumulative effects of early and late cutting on the yield and crude protein content of clover hay.

The experiment is being conducted on an area which had a clover composition of over 50 per cent by weight in 1953 and receives an annual application of 80 pounds of P_2O_5 per acre. The experiment is factorial (each treatment in every possible combination with the other). The years 1954, 1955, and 1956 are factors at two levels of cutting (early and late) each. The early cutting date is before and the late cutting date after seed dissemination. Each treatment is replicated four times.

Table 1 presents the direct effects of early and late cutting on yields of clover hay. The subsequent effects will naturally not be known until 1955 yields are taken.

Several points are of interest in Table 1. Foremost is the astounding increase in yields of hay and crude protein. On the basis of crude protein alone, valued at 10¢ a pound, the returns per acre were \$65.90 and \$57.50 per acre for the early and late cutting treatments as compared to an original \$14.00 per acre before conversion. Total cost of fertilizer for the year was \$8.00 an acre.

Of considerable interest is the regrowth from early cut plots. Normally we get no regrowth after harvest nor did we this year on adjacent plots, on nonclover areas, cut at the same time. Apparently a release of nitrogen from decomposition of clover roots stimulates this regrowth. When considered in terms of pasture for livestock, returning from the summer range, this regrowth can be of major importance.

TABLE 1. Influence of Cutting Date on Yield of Hay and Crude Protein of a Meadow Converted to Clover

	Yield tons/acre	Per cent crude protein	Pounds protein/acre
Early cut	2.65	11.56	613
Regrowth	.22	10.37	46
Total	2.87		659
Late cut	3.08	9.33	575
Regrowth	0	0	0
Total	3.08		575
Before conversion	1	7	140

Phosphorus nutrition requirements of established stands of white-tip clover

Initially, when phosphorus is applied to native meadows, no response is obtained to applications higher than 40 pounds of P_2O_5 per acre, but as meadows are converted to a clover dominant aspect the demand for phosphorus increases. In order to more fully evaluate the nutritional needs of an established stand of white-tip clover a study was initiated to determine:

1. The level of available phosphorus which must be maintained in the soil for optimum growth of white-tip clover (T. variegatum).

2. The correlational relationships of applied phosphorus, plant phosphorus, and yield, and the extent to which one or more of these values may be used as criteria for fertilizer recommendations.

3. The effects of residual phosphorus on the growth of white-tip clover.

Measurements will be made of soil inorganic and organic phosphorus prior to fertilizer application, hay yields, crude protein, and phosphorus content of hay in the initial year of the experiment.

In successive years measurements will be made of yields, crude protein content, and phosphorus content of hays. In addition, using radioactive phosphorus, the amount of phosphorus in the plant derived from residual phosphorus will be determined.

Site selection

Areas have been successfully converted to a clover dominant aspect on the station through the application of research findings; however, information is needed to determine the extent to which these findings can be applied to meadow areas throughout the west. In cooperation with the county agents of Harney, Lake, Grant and Malheur counties, trials were initiated to obtain some of this information.

White-tip clover was seeded with and without phosphorus on 7 locations in Harney county, 4 in Lake county, 4 in Malheur county and 5 in Grant county. High rates of seeding (35 pounds per acre) and of fertilization (160 pounds of P_2O_5) per acre were used to insure an adequate supply of both seed and fertilizer. Two replications of the four treatments, check, clover, phosphorus, and phosphorus plus clover were applied at each location. Soil samples were taken to determine soil phosphorus prior to treatments.

If an area is deemed suited to clover conversion the basic information being obtained on the station relative to clover establishment and culture may be applied to it.

Minor Fertilizer Elements

In 1953 and 1954 trials were conducted to evaluate the effect of the minor elements copper, boron, zinc, and manganese on meadow hay production.

No response was obtained from these elements on the soils where this trial was conducted. They may have a place, however, on some of the meadow soils which approach the peat or muck type.

Harvest Management

A study was initiated in 1951 and is still being continued to determine the effect of date and height of cutting on native hay production and on crude protein content of hay.

Permanent plots are cut at 5 dates and 3 heights of cutting. Dates of cutting are correlated with the vegetative development of two grass species, Nevada bluegrass (Poa nevadensis) and Meadow barley (Hordeum nodosum). The five stages of maturity are (1) Poa--full bloom, Hordeum--beginning bloom, (2) Poa--soft dough, Hordeum--soft dough, (3) Poa--hard dough, Hordeum--spikelets disarticulating, (4) Poa and Hordeum--green color one-half gone, and (5) Poa and Hordeum--green color all gone. Cutting heights at each stage of maturity are 2, 4, and 6 inches.

Influence of cutting at different dates on yield trends for 4 years is shown in Table 2.

Differences in yields among years appear to be directly related to the amount of runoff received during the growing season as 1952 was the wettest, 1954 the driest of the 4 years, with 1951 and 1953 quite comparable.

There are no significant differences among yield averages due to time of cutting for the 4-year period. Of interest, however, are yield trends by years. In 1951 yields showed a decline as the cutting season progressed, which is to be expected as all of the rush and sedge species have reached maturity by the first date of cutting. In subsequent years the trend is readily illustrated when yields of the last four dates of cutting are expressed in per cent of the first date of cutting in 1951 and 1954 (Table 3).

This increase in yield of continuously late-cut plots is believed to be mainly due to an observed increase in beardless wild rye (Elymus triticoides).

Crude protein percentages of hays cut at different dates and heights of cutting are presented in Table 4 for the years 1951, 1952, and 1953.

The differences in crude protein among hays cut at different heights may be attributed to the relative amount of leaves and stems in the samples analyzed. Hay cut at 2 inches has a greater proportion of stems than hay cut at the other two cutting heights, and consequently less protein. The loss of protein with advancing maturity is to be expected. Of interest, however, is the more rapid loss occurring in 1951 as compared to 1952 and 1953. This loss seems to be related to the time of flood recession. In 1951, water receded from plots on June 21 as compared to July 14 in 1952 and July 12 in 1953.

TABLE 2. Yields of Hay, Expressed in Tons Per Acre, of Plots Cut at Five Dates of Cutting in Four Consecutive Years

Years	Dates of cutting					Average
	1	2	3	4	5	
1951	1.38	1.47	1.36	1.33	1.20	1.35
1952	1.48	1.45	1.20	1.38	1.52	1.41
1953	1.32	1.32	1.24	1.33	1.44	1.33
1954	.87	.86	.88	.93	.98	.90
Average	1.26	1.28	1.17	1.24	1.29	

TABLE 3. Yields of Hay in 1951 and 1954 Expressed as Per Cent of the First Date of Cutting.

Year	Dates of cutting 1	2	3	4	5
	Per cent	Per cent	Per cent	Per cent	Per cent
1951	100	106	99	96	87
1954	100	99	101	107	113

TABLE 4. Crude Protein Percentages of Hays Cut at 5 Dates and 3 Heights of Cutting in 1951, 1952, and 1953.

Year	Height of cutting	Dates of cutting 1	2	3	4	5	Average
1951	1	7.12	6.53	5.67	4.44	3.53	5.45
	2	7.68	7.14	6.05	4.63	3.86	5.87
	3	7.78	7.26	6.38	4.64	3.66	5.94
	Average	7.52	6.97	6.03	4.57	3.68	5.75
1952	1	6.63	6.67	6.63	5.87	5.23	6.20
	2	7.15	6.99	7.06	6.24	5.38	6.56
	3	6.93	7.31	6.93	6.51	5.52	6.64
	Average	6.91	6.99	6.88	6.20	5.38	6.47
1953	1	6.70	6.72	6.38	6.50	5.05	6.27
	2	6.87	6.94	6.82	6.18	5.55	6.47
	3	7.32	7.37	6.80	6.39	6.17	6.81
	Average	6.96	7.01	6.66	6.36	5.59	6.52

Summary and Conclusions

At the present time, it would appear the cutting is not too important from an economical standpoint. Early cutting may be slightly detrimental to sustaining yields as compared to late cutting; however, early cut hays are higher in crude protein content and of better all-round quality.

Publications Available

Cooper, C. S. and W. A. Sawyer. 1955. Fertilization of Mountain Meadows in Eastern Oregon, Jour. Range Management, Vol. 8. No. 1. PP 20-22.

Cooper, C. S. More Mountain Meadow Hay with Fertilizers. Oregon Agricultural Experiment Station Bulletin No. 550. May 1955.