# Fertilization of Mountain Meadows in Eastern Oregon

**CLEE S. COOPER and W. A. SAWYER**

*Agronomist and Superintendent, Squaw Butte-Harney Range and Livestock Experiment Station*[1], *Burns, Oregon*

NATIVE flood meadows occupy nearly one half million acres of land in eastern Oregon and about three and one half million acres of land in the western United States. These lands serve as the wintering grounds for cattle in the sagebrush-bunchgrass country and provide the major portion of hay for feeding. Hay production from these lands is vital to the welfare of the livestock industry and has a profound influence on all phases of the livestock operation.

Hay production from mountain meadows has a direct influence on the management of rangeland. Many operators are forced to turn their cattle onto the range too early in the spring, due to a shortage of hay and due to the flooded condition of the meadows. Heavy spring use is thought to be a major contributing factor in the deterioration of our sagebrush-bunchgrass rangelands. Longer spring hay feeding could furnish one form of relief for this critical period.

Hay production also has a direct influence on livestock nutrition which may indirectly influence range management. As little regrowth is made after hay harvest, cattle grazing on meadow aftermath in the fall are on a low plane of nutrition and it is often necessary to provide bunched hay during this period. During the winter feeding period the low quality meadow hay does not provide an adequate wintering ration. These periods of low nutrition may cause low calf crops and result in unproductive dry cows being carried on the range. Higher calf crops resulting from better nutrition would allow more beef to be produced from the same number of cows and thus allow more efficient use of available range forage.

Ranchers have become increasingly concerned over an apparent decline in hay production. Yields have declined to an average of approximately one ton per acre and the quality of hay is low enough to make the winter feeding of a protein supplement advisable.

Because of the importance of native hay meadows to range cattle operations, trials were conducted to find the value of fertilizer applications to yield and quality of the crop and to the occurrence of regrowth forage.

## Description of the Area

The meadow on which the experiment was conducted lies in Harney Valley, seven miles south of Burns, Oregon, at an elevation of 4,100 feet. This meadow is typical of the major portion of native flood meadows in eastern Oregon.

Soils of the area are medium or fine textured. They are generally mildly calcareous and slightly to moderately alkaline.

The vegetation is composed of sedges (*Carex* spp.), rushes (*Juncus* spp.), water loving grasses and forbs. These species form a complex plant community. The distribution of the plant population is extremely variable with salt grass (*Distichlis stricta*) dominant on alkaline knolls and wire rush (*Juncus balticus*) dominant in the deeper swales. Areas between these extremes are composed of varying amounts of sedges, rushes, grasses and forbs. Most of the sedge and rush species are of a rhizomatous nature and form a compact sod with root penetration seldom exceeding twelve inches.

Meadows are irrigated by wild flooding in the spring for a period of from six to twelve weeks. The period of flooding is dependent upon rate, time and amount of spring runoff and usually begins in April and terminates in mid-June. Active growth ceases within two to three weeks after the recession of the flood.

Harvesting begins in the forepart of July and little regrowth is made after harvest. Cattle are grazed on the aftermath stubble in the fall and are fed on the meadowlands throughout the winter feeding period.

## Experimental Procedure

Four levels of nitrogen and of phosphorus fertilizer were applied alone and in combination to plots 45 feet long and 12 feet wide. Each of the sixteen resulting treatments was replicated four times. Nitrogen levels, applied as ammonium nitrate, were 0, 20, 40 and 60 pounds of actual nitrogen per acre. Phosphorus levels, applied as treble super phosphate, were 0, 40, 80 and 120 pounds of $P_2O_5$ per acre. The fertilizers were surface applied with a three foot Gandy fertilizer spreader in early November of 1951 and 1952.

Samples for yield determinations were taken by mowing one swath 38 inches wide through the length of each plot. The field weight of each plot was recorded and samples were taken from each plot for oven drying. Yields were calculated on

[1] *Squaw Butte-Harney Range and Livestock Experiment Station is jointly operated by the Bureau of Land Management, U. S. Department of the Interior, and Oregon Agricultural Experiment Station, Oregon State College, Corvallis, Oregon.*

*This report is published as Technical Paper No. 842 with approval of the Director, Oregon Agricultural Experiment Station.*

**Table 1. Relationship of nitrogen and phosphorus fertilization to yields of meadow hay**

| Year | Pounds of N applied per acre | | | | | Pounds of $P_2O_5$ applied per acre | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 20 | 40 | 60 | Avg. | 0 | 40 | 80 | 120 | Avg. |
| | *tons/acre* | | | | | | | | | |
| 1952 | 1.61 | 2.04 | 2.18 | 2.54 | 2.09 | 1.81 | 2.18 | 2.22 | 2.17 | 2.09 |
| 1953 | 1.89 | 2.17 | 2.70 | 2.95 | 2.43 | 2.21 | 2.49 | 2.60 | 2.42 | 2.43 |
| Avg. | 1.75 | 2.11 | 2.44 | 2.75 | | 2.01 | 2.33 | 2.41 | 2.30 | |

L.S.D. at 5% level of probability for comparison of:
Avg. rate yields, 0.27 tons
Avg. year yields, 0.19 tons

an oven dry basis plus 10% moisture. Samples taken for moisture determinations were analyzed for crude protein content.

## Results

### Yields

Nitrogen, phosphorus and years were all significant sources of variation in this experiment. Interactions between nitrogen and phosphorus, or between nitrogen or phosphorus and years were not significant.

Nitrogen fertilizer increased yields of hay one ton per acre at the 60 pound per acre rate of application (Table 1). There is no indication that rate of application was high enough in this study to result in reduced efficiency of nitrogen utilization by this forage. Residual yield effects from nitrogen fertilizer were not apparent one year after application.

Phosphorus increased hay yields one third of a ton per acre (Table 1) with no significant benefits occurring from applications above 40 pounds $P_2O_5$ per acre.

Yield increases from phosphorus fertilization are mainly due to stimulation of the annual white-tip clover (*Trifolium variegatum*). On phosphorus-fertilized plots this clover attained a maximum height of 30 inches as compared to 5 inches or less on unfertilized plots. Indications are that by proper management and fertilization this clover may be increased to occupy a position of dominance in the vegetative composition.

Residual yield increases from the 1951 application (Table 2) are of importance in considering phosphorus fertilization. As in the initial yields there was no significant increase from rates of application above 40 pounds $P_2O_5$ per acre.

FIGURE 1. Fertilizer boosts meadow hay yields. The area right of stake received 60 pounds of N and 120 pounds of $P_2O_5$ as compared to no fertilizer on the left. (Note stimulation of clover in lower right foreground.)

Yield increases were higher in the first year than in the second year following fertilization. As first year yields were taken prior to seed dissemination of white-tip clover, it is believed that the decrease in response is due to a reduced clover stand rather than to decreased availability of phosphorus. It is now believed that delaying harvest, until about one half of the seed heads of white-tip clover have turned brown, will allow for ample seed dissemination and will materially increase clover production and residual response to phosphorus.

Yields averaged .34 of a ton higher in 1953 than in 1952. This difference may be attributed partly to the selection of a more productive site for the 1953 trials. Two main factors influencing productivity were the absence of salt grass knolls on the 1953 site and a longer flood period. The 1953 site was submerged for a period of 105 days as compared to 75 days for the 1952 site. Apparently, for this water-loving type of vegetation, long flood seasons are advantageous.

Fertilizers did not stimulate regrowth on plots after harvesting. However, on an area on which white-tip clover has been increased through proper fertilization and harvest practices a stimulation of regrowth has been observed.

### Crude Protein Content

The crude protein content of meadow hay was not affected by

**Table 2. Initial and residual yield increase* from phosphorus applied in November 1951**

| Year | Pounds $P_2O_5$ applied per acre | | | |
|---|---|---|---|---|
| | 0 | 40 | 80 | 120 |
| | *lbs./A.* | | | |
| 1952 Initial | 0 | 750 | 821 | 724 |
| 1953 Residual | 0 | 402 | 332 | 476 |
| Total | 0 | 1152 | 1153 | 1200 |

L.S.D. at 5% level of probability for comparing total yield increase, 416 lbs.

* Each value is the average yield increase from that treatment at four levels of nitrogen fertilization, applied November 1951.

fertilization in this experiment; however, on an area where the clover composition has been increased to 80 percent through fertilization and delayed cutting the crude protein content was 12.99 percent on August 1, 1953, as compared to 6.50 percent for untreated rush-sedge meadow hay.

## Discussion

### Site Selection

Observations of fertilized plots indicate that care must be used in selecting sites for fertilization. On plots located on alkaline knolls and in the deeper swales in which water was standing at a depth of one foot or more during the growing season, response to fertilizers was poor. Maximum response was obtained on areas intermediate to these two extremes.

**Table 3. Yield increase and nitrogen efficiency of four levels of nitrogen fertilization applied in November 1951 and 1952**

| Application Rate, Pounds N per acre | Yield Increase, Pounds hay per acre | Nitrogen Efficiency, Pounds hay increase per pound of N applied |
|---|---|---|
| 0 | 0 | 0 |
| 20 | 710 | 35.5 |
| 40 | 1375 | 34.4 |
| 60 | 1988 | 33.1 |

L.S.D. at 5% level of probability, 538.

### Clover Production

The stimulation of clover production from phosphorus fertilization is of major interest and importance. The legume component of meadow hay at present is so small that is has little effect on the quality of hay. Ranchers state that in earlier years there was a larger proportion of clover in their meadow hay. Declining fertility and earlier cutting may be the main causes for the decline in clover production.

The phenomenal response of white-tip clover to phosphate fertilization suggests the need for special management and fertility practices to increase this component of meadow hay.

**Table 4. Initial and residual yield increases and P efficiency of four levels of phosphorus applied in November 1951**

| Application Rate, Pounds $P_2O_5$ per acre | Yield Increase in Lbs./Hay Per Acre | | | P Efficiency, Pounds of Hay Increase per Pound of $P_2O_5$ |
|---|---|---|---|---|
| | 1951 Application | Residuals of 1951 Application | Total | |
| 0 | 0 | 0 | 0 | 0.0 |
| 40 | 750 | 402 | 1150 | 28.8 |
| 80 | 821 | 332 | 1153 | 14.4 |
| 120 | 724 | 476 | 1200 | 10.0 |

### Economic Benefits of Fertilization

With nitrogen valued at 15 cents a pound and hay at $20.00 per ton, 15 cents expended for nitrogen produced 35 cents worth of hay (Table 3).

Residual yield increases should be considered when calculating returns from phosphorus application (Table 4). With phosphorus at 10 cents per pound and applied at 40 pounds per acre, and hay at $20.00 per ton, 10 cents expended for phosphorus produced 28 cents worth of hay.

## Summary

Nitrogen and phosphorus fertilizers were applied on native hay meadows in eastern Oregon in November 1951 and 1952. Nitrogen was applied as ammonium nitrate at 0, 20, 40 and 60 pounds of actual nitrogen per acre, and phosphorus as treble super phosphate at 0, 40, 80 and 120 pounds of $P_2O_5$ per acre.

Nitrogen increased hay yields at all rates of applications with an increase of one ton per acre occurring with the 60 pound per acre rate of application. There were no additional benefits from nitrogen fertilization one year after application.

Phosphorus increased hay yields one third of a ton per acre in the year of application, and one fifth of a ton per acre in the year following application. No additional benefits were obtained from phosphorus application rates higher than 40 pounds $P_2O_5$ per acre.

Phosphorus stimulated the growth of white-tip clover. Increased clover production, through the use of phosphorus and management practices, resulted in an increase in crude protein content of hay of 6.49 percent.

Site selection was important as response was poor on alkaline knolls and in the deep swales which were submerged to a depth of more than one foot.

Additions of both nitrogen and phosphorus were an economical means of increasing hay production.

## Acknowledgment

The authors wish to make acknowledgment to Dr. J. R. Haag, Head, Department of Agricultural Chemistry, Oregon State College, and his staff, for their splendid cooperation in conducting the crude protein analyses in this experiment