Reprinted from the AGRONOMY JOURNAL
Vol. 48:543–545, 1956

The Effect of Source, Rate and Time of Nitrogen Application Upon the Yields, Vegetative Composition and Crude Protein Content of Native Flood-Meadow Hay in Eastern Oregon[1]

Clee S. Cooper[2]

SYNOPSIS

Nitrogen increased yields of native flood-meadow hay. A decrease in clover composition by weight with nitrogen fertilization was accompanied by a decrease in crude protein content of hay. Fall and spring applications of N were equally effective.

IN MUCH of the sagebrush-bunchgrass range country of the West, ranchers depend on hay produced from native flood meadows for their winter feed supply. These meadows, which occupy about 1 million acres in the northern great basin region, are quite important to the welfare of the livestock industry. Their average yield is about 1 ton per acre, and methods of increasing the yield and improving the quality of hay are needed badly.

Native flood meadows are unique as forage producing areas in that they are continuously flooded during the growing season, and little is known about the culture of the water-loving species of which the hay is composed. Because of this uniqueness, research results obtained from trials with other forage types are not necessarily applicable.

It has previously been shown that these meadows will respond to nitrogen fertilizer (1, 2). Increases in yield and crude protein production have also been reported from the use of nitrogen on high altitude meadows of Colorado (5, 6). Those meadows are somewhat similar to native flood meadows, but differ in that their elevation is several thousand feet higher, the vegetation is predominately grass species, and it is possible to obtain some control of irrigation and drainage.

The data presented are the result of an experiment initiated to study the influence of ammonium sulphate and calcium nitrate, applied in the fall and in the spring at various levels, upon the yield, vegetative composition, and crude protein content of native flood meadow hay.

[1] Contribution from the Squaw Butte–Harney Range and Livestock Exp. Sta., Burns, Oreg., which is jointly operated by the Agricultural Research Service, U.S.D.A., and Oregon Agr. Exp. Sta., Oregon State College, Corvallis, Oreg. Technical Paper No. 964, Oregon Agr. Exp. Sta. Received June 4, 1956.

[2] Research Agronomist, Squaw Butte–Harney Range and Livestock Exp. Sta., Burns, Oreg.

MATERIALS AND METHODS

The experiment was conducted on a typical native flood meadow of the rush-sedge-grass type (1). The meadow is continuously irrigated by uncontrolled flooding from about April 1 to July 1. Variation in the duration and depth of submergence is directly related to the amount and time of spring runoff from surrounding watersheds.

One cutting of hay is harvested from meadows during July of each year and regrowth is negligible. Cattle returning from range in the fall graze on the aftermath stubble until winter feeding begins.

The vegetation consists of water loving species mostly rushes (*Juncus* spp.) and sedges (*Carex* spp.) with minor amounts of grass, forbs, and native clovers. The principal rush species is baltic rush *(Juncus balticus)* and the principal sedge species is rusty sedge *(Carex subjunca)*. Principal grass species are Nevada bluegrass *(Poa nevadensis)*, meadow barley *(Hordeum brachyantherum)*, and beardless wild-rye *(Elymus triticoides)*. The most abundant clover species is annual white-tip clover *(Trifolium variegatum)*. The vegetative complex is composed of as many as 85 species which form a dense compact sod with root penetration seldom exceeding 14 inches. Growth is short and dense and the growing season is concurrent with the flooding period.

Two meadow sites were studied. Site I differed from site II in that it was flooded several weeks longer, and had less fluctuation in water level. Soils at both sites belong to the Klamath series (4). Surface soils of this series vary from 8 to 16 inches in depth and from a silt to clay loam in texture. The subsoils are a clay loam. Analyses of representative soil samples showed the soil reaction to be pH 7.8 at both sites. Total soluble salts were 1,288 ppm. at site I and 756 ppm. at site II.

Calcium nitrate and ammonium sulphate were applied at 5 levels each (0, 50, 100, 150, and 200 pounds of N per acre) in November and in March. The fertilizers were broadcast with a 3-foot Gandy spreader. Application was made in 1954 and 1955 at site I, but only in 1955 at site II. All plots received a uniform application of 80 pounds of P_2O_5 per acre.

The experiment was conducted as a complete factorial. Treatments were assigned at random to 9- by 30-foot plots within each of 4 replications.

Yield samples were obtained once each year by cutting a 38-inch strip throughout the length of each plot.

The percentage composition by weight of white-tip clover and of associated species (hereafter referred to as "rush-sedge") in the hay was estimated for all treatments in 1954 on site I by hand separating 2 random 3.2 square-foot samples per plot. In 1955 species composition was estimated only on unfertilized plots of site I as clover was negligible on fertilized plots. Species composition was estimated by the constituent differential method (3) using calcium as the differing constituent. This method determines legume composition by weight in a mixed hay when the grass and legume species contain different levels of oven dry matter, protein, or calcium. Calcium was determined with a flame photometer. Clover plants were infrequent at site II and composition was not determined.

Crude protein content of hay from each treatment was determined at site I in both years and at site II in 1955 by the Kjeldahl method.

RESULTS

Hay Yields

Yields of hay were significantly influenced by nitrogen at site I in 1954 and at both sites in 1955 (table 1).

In 1954 mean yield increases due to nitrogen were approximately equal between sources; however, a significant source × rate interaction indicates that the two sources of nitrogen gave unequal response at some rates. It will be shown in the following section that sources differed primarily with respect to botanical composition.

Nitrogen inreased hay yields at both sites in 1955, but this response was unequal between sources. Ammonium sulphate was more effective than calcium nitrate at site I and less effective at site II.

The efficiency of nitrogen (pounds of hay produced per pound of N applied) decreased with increasing rates of application (table 2).

Fall and spring applications were equally effective in increasing the yields of hay.

Botanical Composition

Rate and source of nitrogen application significantly influenced botanical composition at site I in 1954 (figure 1).

Yields of "rush-sedge" increased and yields of clover decreased with increasing amounts of nitrogen. Yield responses of "rush-sedge" to the two sources of nitrogen were equal at the lower rates of application; however, at applications of 150 and 200 pounds of N per acre ammonium sulphate increased yields more than did calcium nitrate. The decline in clover yields was affected by source of nitrogen because at 50 pounds of N per acre calcium nitrate increased yields while ammonium sulphate depressed yields. These effects of source of nitrogen upon the botanical components were responsible for the significant source by rate interaction in the analyses of hay yields.

As a result of the decrease in clover yields and the increase in "rush-sedge" yields with increasing rates of nitrogen, clover composition declined from 31 % on unfertilized plots to 21, 16, 10 and 8 % on plots fertilized with 50, 100, 150, and 200 pounds of nitrogen per acre respectively.

Clover composition increased on unfertilized plots at site I from 31% in 1954 to 40% in 1955; however, on fertilized plots the clover had nearly disappeared in 1955.

Clover plants were infrequent at site II and vegetative composition was not measured.

Table 1.—Yields of hay at site I in 1954 and 1955, and at site II in 1955, as influenced by rate and source of nitrogen.

Source of nitrogen	Pounds N applied per acre					
	0	50	100	150	200	Avg.
	T/A	T/A	T/A	T/A	T/A	T/A
	Site I 1954					
Ammonium sulphate	1.76	2.35	2.92	3.44	3.60	2.81
Calcium nitrate	1.80	2.74	3.06	3.02	3.34	2.79
Average	1.78	2.54	2.99	3.23	3.47	——
	Site I 1955					
Ammonium sulphate	2.20	2.92	3.71	4.08	4.34	3.45
Calcium nitrate	2.10	3.16	3.44	3.64	3.87	3.24
Average	2.15	3.04	3.57	3.86	4.10	——
	Site II 1955					
Ammonium sulphate	1.58	1.94	2.43	2.79	3.18	2.38
Calcium nitrate	1.54	2.63	2.75	3.08	3.62	2.72
Average	1.56	2.28	2.59	2.93	3.40	——

5% LSD

	Site I 1954	Site I 1955	Site II 1955
Rate average	0.25	0.30	0.33
Source average	NS	.19	.21

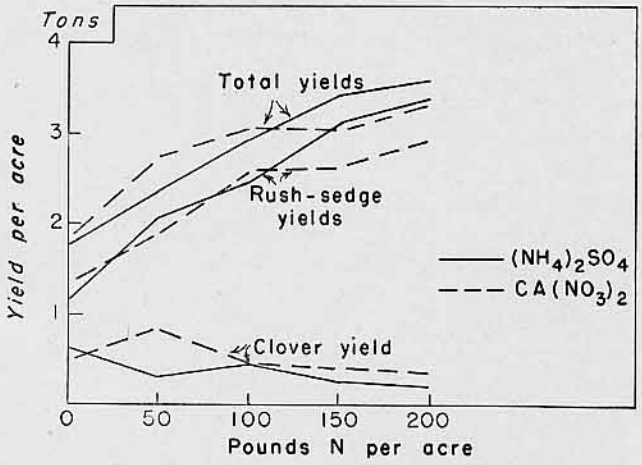

FIG. 1.—Yields of clover, rush-sedge and total hay at site I in 1954 as influenced by rate and source of nitrogen (mean values from fall and spring applications).

Crude Protein

Crude protein values of hay from nitrogen fertilizer plots were significantly lower than those from non-fertilized plots at site I in both years (table 3). The decreased protein content is a direct reflection of the decrease in white-tip clover composition on fertilized as compared with non-fertilized plots. Among plots receiving nitrogen, crude protein increased slightly with rates of application.

DISCUSSION

The results of the experiment show that nitrogen can effectively increase hay production of native flood meadows. Applications of 50 pounds of nitrogen per acre were most efficient. Consequently, a rancher should restrict fertilization to a rate of 50 or 60 pounds of N per acre until all of his acres have been fertilized.

Ammonium sulphate was more effective than calcium nitrate at site I and less effective at site II. No definite explanation can be given for this interaction of site × source; however, it was observed that sites differed in botanical composition and in depth and duration of flooding.

Fall and spring applications of nitrogen were equally effective. Generally speaking, late fall applications are most convenient.

The influence of nitrogen upon vegetative composition and subsequently protein content is of importance. It has been shown that the yield and quality of hay may be greatly enhanced when white-tip clover is increased through proper fertilization and management (1). On areas where this can be done nitrogen should not be used as the clover component and subsequently crude protein content is decreased.

Table 2.—Nitrogen efficiency values for site I in 1954 and both sites in 1955.

N level	Pounds of hay produced per pound of N applied			
	Site I		Site II	
	1954	1955	1955	Avg.
50	35	36	29	33
100	24	28	21	24
150	19	23	18	20
200	17	20	18	18

Table 3.—Influence of rate of nitrogen application upon the crude protein content of hay at site I in 1954 and 1955.

Year	Pounds of N applied per acre					Avg.
	0	50	100	150	200	
	%	%	%	%	%	%
1954	9.7	8.4	8.4	8.6	8.8	8.8
1955	10.6	7.4	7.7	8.0	8.3	8.4
Avg.	10.2	7.9	8.0	8.3	8.6	

5% LSD for rates = 0.5%.

SUMMARY

The influence of source, rate, and date of nitrogen application upon yields, vegetative composition and crude protein content of native flood meadow hay was studied in a factorial experiment.

Ammonium sulphate and calcium nitrate were each applied broadcast at rates of 0, 50, 100, 150, and 200 pounds of nitrogen per acre in the fall and in the spring at 2 sites.

Nitrogen increased the yields of total hay and of the "rush-sedge" component, but decreased yields of the clover component with increasing rates of application.

Calcium nitrate increased yields more effectively than ammonium sulphate at one site and less effectively at the other. The reasons for the differential response to source of nitrogen could not be determined.

Fall and spring applications of nitrogen were equally effective in increasing yields of hay.

Hay from unfertilized plots was higher in crude protein content than hay from fertilized plots due to a larger amount of clover. Among fertilized plots crude protein values increased slightly with increasing rates of nitrogen application.

LITERATURE CITED

1. COOPER, C. S. More mountain meadow hay with fertilizer. Oregon Agr. Exp. Sta. Bul. 550. 1955.

2. ————, and SAWYER, W. A. Fertilization of mountain meadows in eastern Oregon. Jour. Range Mgmt. 8:20–22. 1955.

3. ————, HYDER, D. N., PETERSEN, R. G., and SNEVA, F. A. The constituent differential method in estimating species composition of mixed hay. Agron. Jour. (in press) 1957.

4. LEIGHTY, W., POWERS, W. L., and JORDAN, J. V. Reconnaissance soil survey of Silvies valley. Mimeo. U. S. Corps of Engineers. 1946.

5. MILLER, D. E., and AMEMIYA, M. Better quality mountain meadow hay through early harvesting and fertilization. Colorado Agr. Exp. Sta. Bul. 434–A. 1954.

6. WILLHITE, F. M., ROUSE, H. K., and MILLER, D. E. High altitude meadows in Colorado: III. The effect of nitrogen fertilization on crude protein production. Agron. Jour. 47:117. 1955.