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Production of Regrowth Forage on Native Flood Meadows[1]

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SYNOPSIS. Meadows of rush, sedge and grass were managed to produce two crops in the same growing season. Irrigation stimulated regrowth and produced 300 to 600 pounds of dry matter per acre. N with irrigation added 9 pounds dry matter per pound N. N also increased hay yields the following year. P had no effect on regrowth or on hay yields the following year. Advancing the date of hay harvest increased regrowth yields without decreasing hay yields.

NATIVE meadows in southeastern Oregon usually receive an abundance of water in the spring from snow which has accumulated at higher elevations. The water is directed across the meadows with a wild-flooding system of irrigation for a period of 8 to 12 weeks. With the termination of overflow and lowering of the water table, the soils gradually dry out until little or no available moisture remains in the soil by late July. These meadows would be classified as seasonally wet meadows (4).

Native meadows produce no regrowth after the cutting of a single crop of hay, usually in July; even though there may be some available moisture remaining in the soil. The cattle are transferred from the ranges to these meadows from August until October depending on the availability of feed and water on the semi-arid ranges. Because of the lack of regrowth, it is necessary for the ranchers to begin feeding soon after turning the cattle into the meadows or, as is commonly the case, to turn the cattle into fields where hay was bunched and left at the time of haying.

The absence of regrowth is a great economic problem. Characteristics of the environment are such that half of each growing season contributes virtually all that year's production. No growth occurs in late July, August, and September, even though mean temperatures in August (65° F.) and September (58°) are actually milder than those in May (48°) and June (55°) when most of the dry matter production occurs. Viewed another way, it requires about twice the area in production as would be necessary if the environment could be utilized to its full potential.

There is no information about the effect of fertilizers and irrigation on regrowth. For that matter, there is nothing to indicate that insufficient water is entirely responsible for the lack of regrowth; however, it has been shown that the water requirement of species growing in native meadows is very high (2). Certainly there could not be appreciable regrowth without supplemental water during late summer and early fall.

This paper presents the results of 4 experiments during a 2-year period to measure effects of fertilizers and harvest management on regrowth yields from native meadows under irrigation, and the contribution of regrowth yields to total forage production from these areas.

METHODS AND MATERIALS

These investigations were located on typical rush-sedge-grass meadows. Ammonium nitrate as a source of N and triple superphosphate as a source of P were surface-applied to 6- by 20-foot plots soon after the hay was removed in early July. The fertilizer was applied before irrigating.

Three to 6 inches of water, enough to bring the upper 12 to 24 inches of soil to field capacity, were added in the first irrigation; thereafter, water was added when 50% or less of the available moisture (measured by electrical resistance) had been removed at the 8 to 10 inch depth. The total amount of water used ranged from 9 to 14 inches in each experiment. Water was sprinkled on in overnight irrigations, approximately 3 inches in each.

Yield samples were obtained about mid-September by harvesting a strip of forage 38 inches wide through the length of each plot. These were subsampled for the determination of dry matter and N. N was determined by the Kjeldahl method.

One experiment in 1959 and 1 in 1960 were designed specifically to test levels of N and P. In 1959, 0, 40, 80, 120 and 160 lb. N/acre were applied in factorial combination with 0 and 17.5 lb. P/acre (40 lb. P_2O_5/acre) in a randomized block design. In 1960, 0, 60, 120, 180 and 240 lb. N/acre were applied in factorial combination with 0 and 26.2 lb. P/acre (60 lb. P_2O_5/acre).

Effect of date of hay harvest on regrowth yields was investigated by harvesting hay at weekly intervals beginning June 21 and ending July 12. Levels of 0, 40, 80 and 120 lb. N/acre were randomly applied to harvested plots the same day the hay was removed; however, water was not added until after the last hay harvest.

Levels of 0, 40, 80 and 120 lb. N/acre were applied to main plots of a strip-plot design in the fall of 1959 to determine if N applied in the fall to increase hay yields had a residual effect on regrowth yields. Zero, 30, 60, 90 and 120 lb. N/acre were applied to subplots after the hay was harvested to obtain additional information on the effect of N on regrowth yields and to test for a possible fall-applied N × spring-applied N interaction.

Hay yields in 1961 from 2 experiments in 1960 measured the residual N and P effect on the following year's hay yields. All experiments were replicated 4 times.

RESULTS AND DISCUSSION

With irrigation, N fertilizer significantly increased regrowth yields in 1959 and 1960 (Table 1). Each increment of N differed significantly (95% probability) from every other increment each year. The relation between yields and level of N was almost linear, indicating higher levels of N were just as effective in increasing yields as lower levels.

Phosphorus did not affect regrowth yields and the N × P interaction was not significant in either year. The primary response to P on native meadows has been from areas containing annual white-tip clover (*Trifolium variegatum* Nutt.) (1, 3). White-tip clover did not appear in the regrowth, although it was present in the area and contributed to hay yields.

Advancing the date of hay harvest significantly increased regrowth yields without decreasing hay yields. Hay yields of June 21, June 28, July 5, and July 12 were 2.05, 2.02, 2.10, and 2.06 tons/acre, respectively. During this period regrowth yields (averaged for levels of N) decreased about 200 lb./acre (Table 2). Delaying hay harvest by 3 weeks decreased available soil moisture from 84 to 50%, and this

Table 1—Dry matter yields of regrowth forage from native meadows receiving supplemental irrigation and nitrogen fertilizer.*

Year	Yield, lb./A., with levels of N (lb./A.):							
	0	40	60	80	120	160	180	240
1959	600	980	-	1260	1660	2030	-	-
1960	615	-	1238	-	1665	-	2208	2573

* In each year N and P were applied alone and in combinations, but P had no measureable effect on yields.

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Table 2—Dry matter yields of regrowth forage with irrigation and nitrogen, and hay yields from native meadows with delayed hay harvests.*

Date of hay harvest	Hay yields, T./A.	Regrowth yield, lb. dry matter per acre				
		Pounds of N per acre				Mean
		0	40	80	120	
June 21	2.05	568	884	1428	1548	1107
June 28	2.02	430	911	1479	1427	1062
July 5	2.10	396	842	980	1255	868
July 12	2.06	413	791	1032	1359	899
Mean		452	857	1230	1397	

* Means joined by the same line do not differ significantly from each other at 95% probability.

Table 3—Dry matter yields of regrowth forage from native meadows receiving nitrogen in the fall and nitrogen with irrigation in the summer after haying.*

Fall-applied, lb. N/acre	Regrowth yield, lb. dry matter per acre					
	Summer applied N (lb./acre)					Mean
	0	30	60	90	120	
0	232	444	430	896	862	572
40	311	420	420	726	954	566
80	318	500	604	1040	977	688
120	416	476	707	1073	975	729
Mean	319	460	540	934	942	

* Means joined by the same line do not differ significantly from each other at 95% probability.

moisture loss was not effectively utilized in dry matter production. Earlier hay harvest also produces higher quality hay (5). Forty, 80, and 120 lb. N/acre increased regrowth yields (Table 2), but there was no N × date of hay harvest interaction. Those plots harvested early turned dark green within a week after harvesting and fertilizing, which indicated that the plants absorbed the N, but since no water was added until after the last harvest date there was little growth during the intervening 3 weeks. Consequently, there was almost no opportunity for a significant N × date of hay harvest interaction, but this does not eliminate the possibility of such an interaction if other growth requirements were optimum. It may also be inferred from this observation that N would not increase regrowth yields appreciably without irrigation.

Zero, 40, 80, and 120 lb. N/acre applied in the fall produced hay yields of 2.42, 3.03, 3.31, and 3.80 tons/acre, respectively. There was some indication that this N had a residual effect on regrowth yields following haying, but the differences were not significant at the 95% level of probability (Table 3). Thirty, 60, 90, and 120 lb. N/acre applied after haying produced a significant increase in regrowth yields; however, the interaction of fall-applied N × summer-applied N was not significant at the 95% level even though the strip-plot design placed the precision on this interaction.

There was a significant and fairly large increase in yields of hay the harvest year following summer applications of N. Zero, 60, 120, 180, and 240 lb. N/acre produced 1.73, 2.00, 2.30, 2.64, and 2.92 tons hay/acre, respectively. Zero, 30, 60, 90, and 120 lb. N/acre in another experiment produced 1.93, 1.98, 2.02, 2.46, and 2.69 tons hay per acre, respectively. The reason for the extremely poor response to 30 and 60 lb. N/acre was not known, but this experiment continually exhibited more variability than the others.

The crude-protein content of regrowth forage was relatively high and increased with increasing levels of N. In 1959, levels of N of 0, 40, 80, 120, and 160 lb./acre resulted in crude-protein contents of 8.76, 9.51, 10.64, 10.84, and 12.83%, respectively. The crude-protein contents with 0, 60, 120, 180, and 240 lb. N/acre in 1960 were 11.3, 12.2, 12.6, 14.2, and 15.0%, respectively. These were considerably higher than crude-protein contents in 1959 with comparable levels of fertilization. Phosphorus did not affect crude-protein content.

Even in years of prolonged flooding when some available moisture remains in the soil after haying, native plants do not produce new shoots during the same growing season. This is likely the result of growth habits and specific requirements of rush (*Juncus* spp.) and sedge (*Carex* spp.), which comprise a large part of native meadow vegetation. Abundant water induced rush, sedge and associated grasses to produce new shoots. However, growth began slowly even when fertilized with N, and by the time photosynthetic tissue has accumulated in quantity, the photoperiod has decreased to approximately 13½ hours (mid-August) and continued to decrease rather rapidly along with continually decreasing temperatures. Consequently, native rush-sedge-grass meadows are not particularly well adapted to the production of two crops during the same growing season, on the basis of dry matter production. However, the forage appears to be of high quality (based on crude-protein content and age of maturity) so such a program may be economically sound. The cost of producing regrowth is approximately $43 per ton of dry matter (depending on the level of fertilization) with N at 12¢ per pound and water at $2 per inch, assuming 12 inches water/ton dry matter (2). This cost is partially offset through an increase in hay yields the following year. However, it is not known if the water requirements of the regrowth crop is as great as that of the initial crop as reported by Lewis. This is an important question because of the high costs of water.

SUMMARY AND CONCLUSIONS

Native meadows were managed to produce two crops during the same growing season. Irrigation alone produced regrowth yields of 300 to 600 pounds of dry matter per acre. Nitrogen, in combination with irrigation, added 9 pounds dry matter per pound of N over a wide range of N levels. N also increased hay yields the following year.

Phosphorus had no effect on regrowth yields or on hay yields the following year.

Harvesting hay earlier in the season increased yields of regrowth without decreasing hay yields. Earlier harvesting also conserved soil moisture which would tend to reduce the amount of irrigation water necessary.

The crude-protein content of unfertilized regrowth forage was 8.76% in 1959 and 11.3% in 1960. Increasing levels of N fertilizer increased the crude-protein content.

Native meadows can be managed, through irrigation and fertilization, to produce two crops during the same growing season. Employing the results of these experiments (irrigation, N fertilizer, and earlier harvesting of the initial crop) to produce maximum yields of both crops would increase the total forage resource, and should do so economically. It was concluded, however, that rush-sedge-grass meadows are not particularly well-adapted to a two-crop system of management because of the slow recovery after harvest and low production of the second crop.

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