EFFECT OF NITROGEN FERTILIZER ON YIELD AND QUALITY OF MEADOW FOXTAIL HAY

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SUMMARY

A 3-year study was conducted on a wild-flooded meadow in eastern Oregon to determine the response of the introduced grass, meadow foxtail (*Alopecurus pratensis* L.), to fertilizer nitrogen. Nitrogen was applied as urea in March each year at 0, 36, 72, or 108 lb N/acre rates. Forage was harvested at three weekly intervals in July each year. Nitrogen significantly increased forage yield each year although the increases were greatest in the second and third years, with up to 1.5 tons/acre of additional forage produced. Based on the dollar cost of the urea used in this study, the highest return in pounds of forage per dollar spent on nitrogen occurred in 1997 at the 72 lb N/acre rate with a forage yield increase of 120 lb/dollar spent on nitrogen. Compared to non-fertilized plots, nitrogen costs were between \$22 and \$26/ton of additional forage in years two and three. By contrast in year one, costs ranged from \$32 to \$45/ton. Based on this study, nitrogen fertilization appears to provide increased benefits during wet climatic cycles when forage production is high, but less benefit in the year immediately after a drought cycle when available soil nitrogen may be higher.

INTRODUCTION

Native meadows in eastern Oregon are of central importance to livestock producers. These lands are privately owned and are used both as a grazed forage and for grass hay production. Hay produced on native meadow is used primarily as winter feed, but some is also sold on the open market. The composition of the hay produced on these meadows has changed over time, and, as a result, traditional management options need to be revised. This paper discusses the use of nitrogen fertilizer to increase yield on native meadows dominated by meadow foxtail.

The meadows of eastern Oregon are classified as seasonally wet, and are flooded by diverting water from spring snowmelt and spreading it across the meadow. The period of flooding usually begins in April and continues through June, although some areas flood as early as February, and as late as July. The native plants that developed on these meadows were well adapted to a short flooding period having excess water, followed by drought. Historically, the forage included grasses such as Nevada bluegrass (*Poa nevadensis* Vasey ex Scribn.) and beardless wildrye (*Elymus triticoides* Buckl.), along with native rushes(*Juncus* spp.), sedges (*Carex* spp. and *Eleocharis* spp.). Forbs were common but production varied with flooding. Higher elevation sites were often dominated by saltgrass (*Distichlis stricta* (Torr.) Rydb.), while native grasses and sedges occurred at mid-elevations; and water-loving rushes predominated in the lower, wetter locations.

These native meadows produced about 1.6 ton/acre on the average (Rumburg 1961). Almost all of the production occurred during the short flooding period in spring. Regrowth production after haying or grazing was very low. Rumburg (1961) reviewed previous research at this location. Workers at this station have investigated the potential of both fertilization and introduced plant species to increase forage production and improve hay quality. They found that sedges and rushes responded very little to added nitrogen (N), and that with N fertilization, grass composition of the forage increased while sedges and rushes decreased. Based on this research, the recommendation was to apply 60 lb N/acre in the spring only to meadows containing Nevada bluegrass and sedges. Areas which flooded deeper than 4-6 inches were not recommended for fertilization. Fertilization at the recommended rate yielded about 0.75 tons/acre of additional forage. Source of nitrogen was not critical, and the general recommendation was to use the N source, which gave the lowest cost per pound of nitrogen.

Currently many native flood meadows throughout the area are shifting, or already have shifted, to a stand dominated by the introduced grass, meadow foxtail. This species is well adapted to growth in saturated soil, and tolerates cold temperatures and night-time frosts, which are common in eastern Oregon. It has displaced the native plants in the mid-elevation sites, and grows even in areas that are flooded as deep as 6-8 inches. Experiments in other areas have shown that meadow foxtail responds well to fertilizer. We conducted a 3-year experiment to determine the response of this plant to nitrogen fertilization, and to evaluate the costs and benefits associated with fertilization.

METHODS

The study was conducted at the Eastern Oregon Agricultural Research Center - Burns Location, located about 5 miles south of Burns. Spring flood water is supplied by runoff from snowmelt in the mountains north of the area. The meadow used in this study was typical mid-elevation meadow flooded to a depth of 2-6 inches between mid-April and late June, depending on the year. The vegetation on the meadow has shifted over the last two decades from a plant community of native species to a stand dominated by meadow foxtail. Native grasses, sedges and rushes occur, but are minor components of the total yield, as are broadleaf plants.

In March of each year (1995-1997), 48 plots were fertilized with 0, 36, 72, or 108 lb N/acre, applied as urea, using a tractor-drawn fertilizer spreader. Plots were 15 x 30 feet in size, with a 3-ft wide buffer on all 4 sides. Forage yield at each level of fertilizer was measured at three consecutive weekly intervals each year, beginning as soon as ground was dry enough for haying equipment. Initial harvest dates were 17 July 1995, 9 July 1996, and 10 July 1997, with two additional harvests following at weekly intervals. Each combination of fertilizer rate and harvest date was replicated four times.

On each harvest date, a swather was used to cut a 12-ft wide swath through the center of each plot. Immediately after swathing, a 20-ft long section from the center of the windrow was measured to obtain a fresh weight. A sample of the windrow was then placed in a bag, weighed, and taken to the lab for drying. All fresh weights were then converted to a dry matter basis, and reported as pounds or tons per acre. The dried sample was then ground and analyzed for crude protein, dry matter digestibility and fiber. Any claims of significant differences are made at $P=0.05$.

RESULTS and DISCUSSION

Nitrogen fertilization significantly increased dry matter yield each year of the study (Fig. 1). In 1995, incremental increases in yield at each level of fertilizer were about 700, 340, and 440 lbs/acre for 36, 72, and 108 lb N/acre fertilizer rates, respectively. In 1996, dry matter yield incremental increases were about 1000, 870, and 1175 lbs/acre for 36, 72, and 108 lbs/acre of N, respectively. In 1997, incremental increases at each level of fertilizer were similar to 1996. The first year of this study (1995), also marked the end of an extended drought in which 4 out of the last 5 years were drier than average. Nitrogen fertilization did increase forage yield in 1995, but the lower incremental increases at 72 and 108 lb N/acre indicate that nitrogen was probably not severely limited that year. One possible explanation for this is that during the previous drought years available soil nitrogen had increased through processes such as organic matter decomposition and atmospheric nitrogen deposition. These processes which increase available soil nitrogen were coupled with lower plant demand because of the drought years.

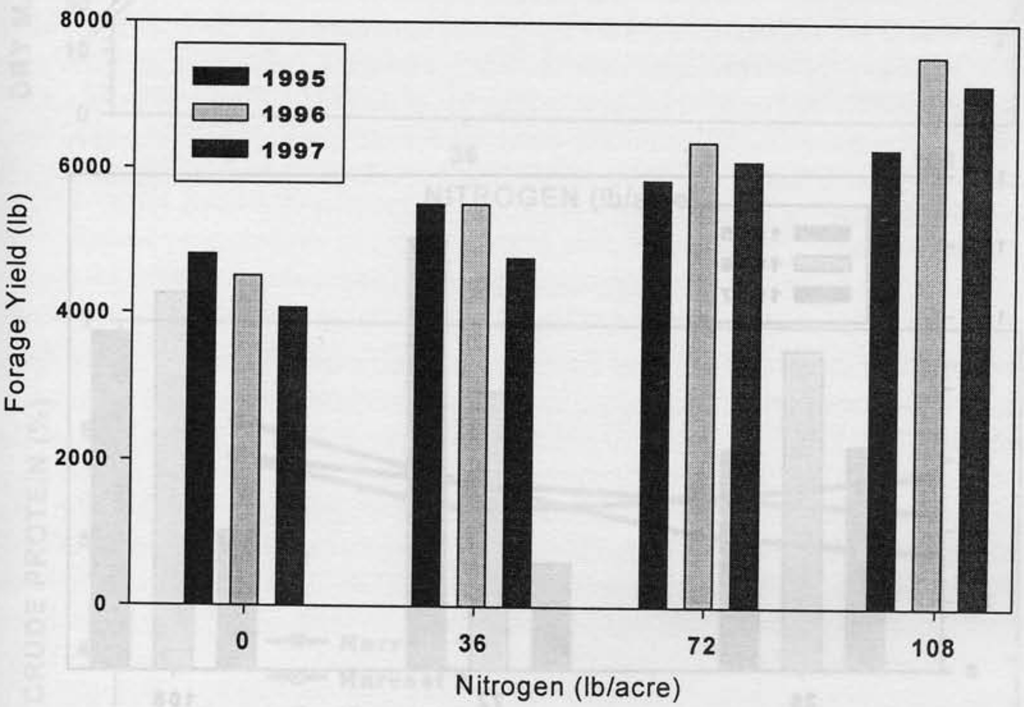

Figure 1. Dry matter yield on an eastern Oregon flood meadow fertilized at four levels with urea. Fertilizer was applied in March of each year. Dry matter yields are averages of three consecutive weekly harvests in each of the three years.

The next 2 years of the study (1996 and 1997) were also good water years, with excellent forage production. In these years the incremental increase in yield noted at each level of nitrogen remained fairly consistent, with the largest single increment observed for the 72-pound rate in 1997, with over 1300 pounds of added forage gained for the 36 additional pounds of N applied. The fairly linear increase for each level of N in the last 2 years indicates that nitrogen was probably more limiting than it was in 1995. Once again, this was probably a reflection of the effect of climate on soil nitrogen. During wet years, more of the available N is taken up by plants, both in aboveground forage, and in belowground roots and storage organs. The net result may be that enough soil nitrogen is tied up in organic matter to reduce its availability to plants.

Pounds of additional hay grown per dollar spent on nitrogen were calculated assuming a cost of $275.00/ton for urea (Fig. 2). The greatest incremental gain in yield per dollar of N spent occurred in the third year of fertilization between the 36 and 72 lb N/acre rates. Yield measurements showed that for each dollar spent on N in 1997, up to 120 lb of additional forage was produced. The lowest benefit occurred at the 72 lb/acre fertilizer rate in 1995, when only about 30 lb of added forage was produced for every additional dollar spent on nitrogen. Compared to unfertilized control plots, producing one additional ton of hay required between $22 and $26 worth of N in 1996 and 1997. Costs were almost twice as high per ton in 1995.

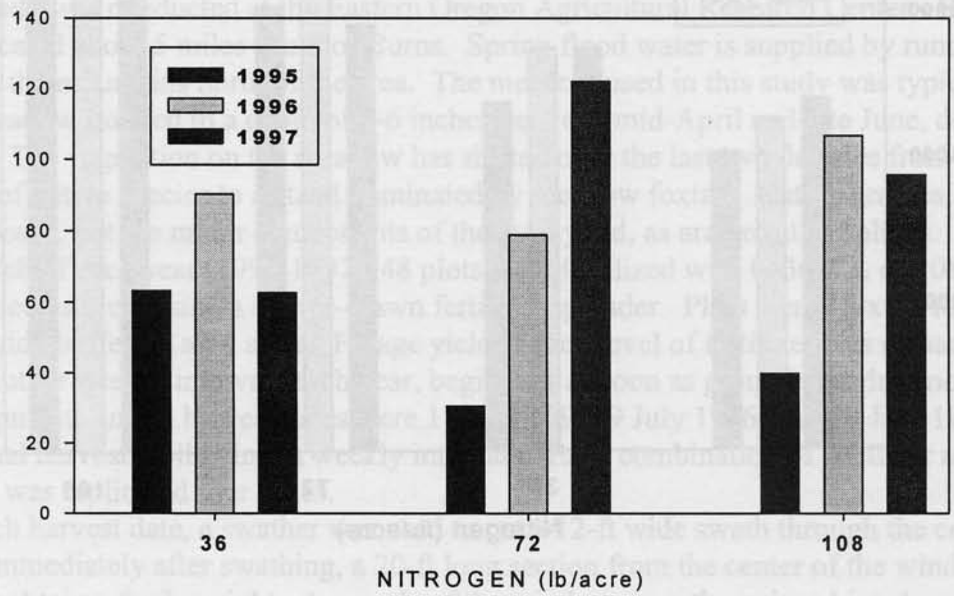

Figure 2. Additional pounds of forage harvested per dollar spent on nitrogen, at three rates of N over a three year trial. The first year, 1995, marked the end of an extended drought.

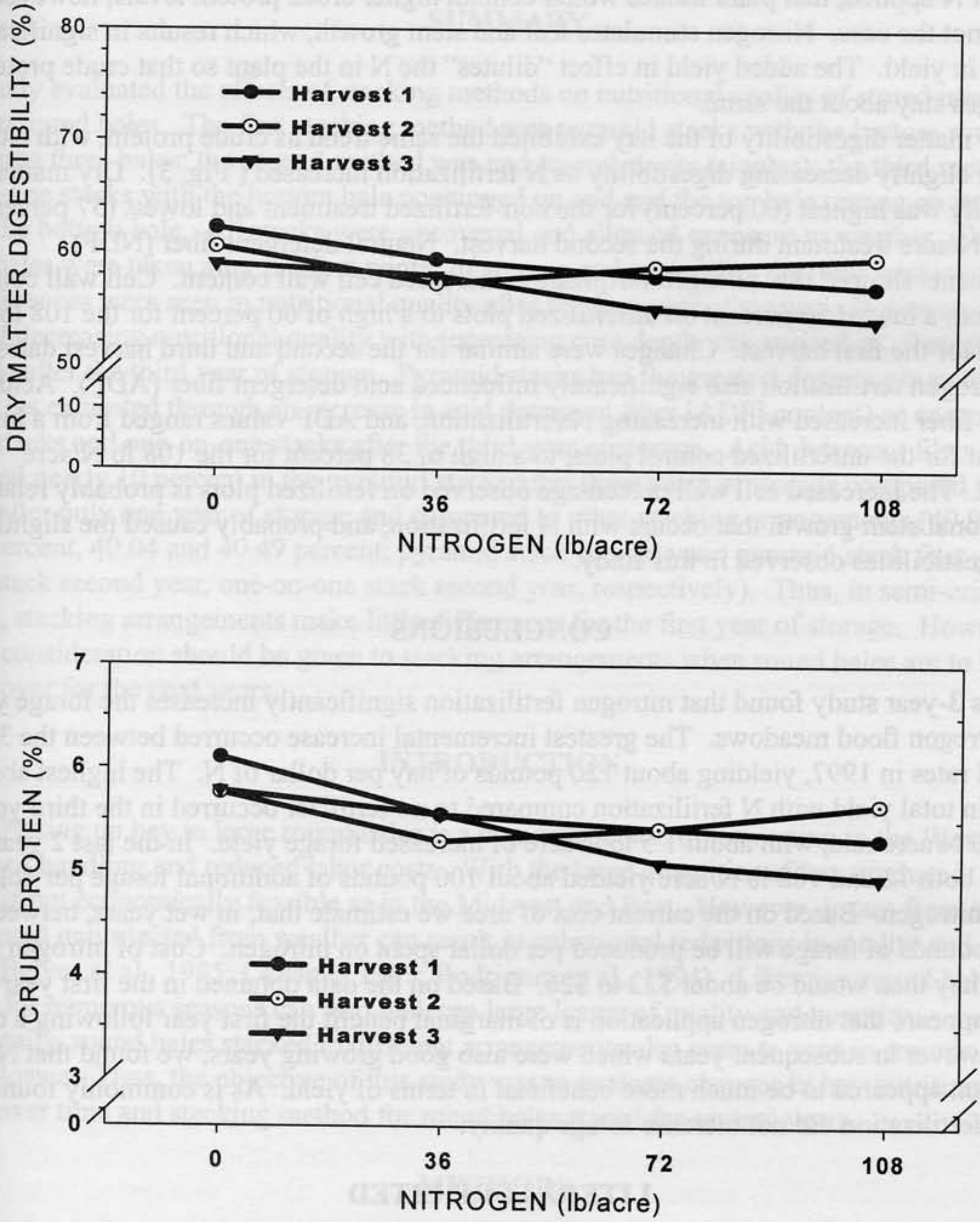

Figure 3. Percent crude protein and dry matter digestibility for meadow forage harvested at three weekly intervals in July over three consecutive years. Nitrogen was applied as urea in March of each year.

Forage quality was significantly influenced by harvest date and N fertilization, although not in the way one might expect. Averaged across years, as fertilizer N increased, crude protein remained the same, or decreased slightly (Fig. 3). One might expect that with the increased amount of N applied, that plant tissues would contain higher crude protein levels; however this is typically not the case. Nitrogen stimulates leaf and stem growth, which results in significant increases in yield. The added yield in effect "dilutes" the N in the plant so that crude protein percentages stay about the same.

Dry matter digestibility of the hay exhibited the same trend as crude protein, with either no change or slightly decreasing digestibility as N fertilization increased (Fig. 3). Dry matter digestibility was highest (60 percent) for the non-fertilized treatment and lowest (57 percent) for the 36 lb N/acre treatment during the second harvest. Neutral detergent fiber (NDF) measurements showed that nitrogen fertilization increased cell wall content. Cell wall content ranged from a low of 56 percent on unfertilized plots to a high of 60 percent for the 108 lbs/acre treatment for the first harvest. Changes were similar for the second and third harvest dates as well. Nitrogen fertilization also significantly influenced acid detergent fiber (ADF). Acid detergent fiber increased with increasing N fertilization, and ADF values ranged from a low of 36 percent for the unfertilized control plots, to a high of 38 percent for the 108 lb N/acre treatment. The increased cell wall percentage observed on fertilized plots is probably related to the additional stem growth that occurs with N fertilization, and probably caused the slightly lower digestibilities observed in this study.

CONCLUSIONS

This 3-year study found that nitrogen fertilization significantly increases the forage yield on eastern Oregon flood meadows. The greatest incremental increase occurred between the 36- and 72-pound rates in 1997, yielding about 120 pounds of hay per dollar of N. The highest absolute increase in total yield with N fertilization compared to no fertilizer occurred in the third year at the 108 lb N/acre rate, with about 1.5 tons/acre of increased forage yield. In the last 2 years of the study both 72 and 108 lb N/acre yielded about 100 pounds of additional forage per dollar spent on nitrogen. Based on the current cost of urea we estimate that, in wet years, between 80 and 120 pounds of forage will be produced per dollar spent on nitrogen. Cost of nitrogen per ton of added hay then would be about $22 to $26. Based on the data obtained in the first year of the study, it appears that nitrogen application is of marginal benefit the first year following a dry year. However in subsequent years which were also good growing years, we found that N fertilization appeared to be much more beneficial in terms of yield. As is commonly found, nitrogen fertilization did not increase forage quality.

LITERATURE CITED

Rumburg, C. B. 1961. Fertilization of Wet Meadows - A Progress Report. Miscellaneous Paper 116. Oregon State Univ., Agric. Exp. Sta. Corvallis, OR.