Outdoor Facts

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GUIDELINE TO SELECTING RATES OF NITROGEN FERTILIZER TO INCREASE HERBAGE PRODUCTION ON SAGEBRUSH WINTER RANGES[1]

Several researchers have reported on the possibilities of increasing production and improving the quality of forage on big game ranges with nitrogen fertilizer (Bayoumi and Smith 1976, Anderson 1972, Williams 1973, Carpenter 1971, and Wood and Lindzey 1967). Various levels of nitrogen have been evaluated in these studies in terms of yield increases and forage quality changes, but little attention has been given to evaluating the most beneficial rate in terms of pounds of herbage produced per pound of nitrogen applied. Increases in nitrogen fertilizer prices in recent years have focused greater attention on this question.

METHODS AND MATERIALS

Nitrogen fertilizer (ammonium nitrate, 33.4% N) was applied to three study areas located on native big sagebrush (*Artemisia tridentata tridentata*) rangeland in Grand County, Colorado in October 1969. These study sites represented three contrasting types of mule deer winter range in the Middle Park area. Fertilizer was applied at five different rates: 0, 30, 60, 90, and 120 lbs of nitrogen per acre.

Herbage production measurements were made in August the year before treatment (pretreatment) and for each of 3 yrs after treatment (1970, 1971, and 1972). These measurements were made with an electronic capacitance meter in a double sampling system where capacitance meter readings were read on certain plots, and then all vegetation on those plots was clipped, dried, and weighed. A regression was developed between meter readings and air-dry weights of forage; this regression equation was then used to predict vegetation yields on plots which were only meter-read (Carpenter 1970). Yields of both total herbage (forbs + grasses + shrubs) and shrub herbage alone were obtained for all treatments in all years of the study.

Inherent differences in yields among pretreatment yields on plots at each study area necessitated the use of covariance techniques to analyze the data. Covariance adjustments removed these natural site differences and made for more meaningful treatment comparisons.

These adjusted values for shrub herbage and total herbage for each treatment over the 3-yr evaluation period were used to calculate efficiency ratios. The adjusted increases in yields obtained at each nitrogen level compared to the control treatments (no nitrogen) for each year were added, and this total divided by the level of nitrogen applied to compute the efficiency ratios.

RESULTS

The highest level of nitrogen (120 lbs) was the most efficient in terms of pounds of herbage produced per pound of nitrogen applied when both shrub herbage and total herbage are considered (Tables 1 and 2). For total herbage yield, the second most efficient level was the lowest rate of nitrogen, followed by the 60- and 90-lb levels of N/acre, respectively. For shrub herbage, 60 lbs N/acre was second most efficient, followed by the 90- and 30-lb levels, respectively. Benefits from the lower two nitrogen rates were negligible in the third year, while increases in yields at the two higher levels were obvious all 3 yrs (Tables 1 and 2).

DISCUSSION

A hypothetical comparison of these efficiency values from the low and high rates of nitrogen will help illustrate what the values really mean. Assume there is $25,000 available for a range

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TABLE 1. Adjusted increases in shrub herbage yields (lb/acre) over control plots for 1970, 1971, and 1972, and the corresponding efficiency ratio for each level of nitrogen

Year	Rates of nitrogen fertilizer (lb/acre) 30	60	90	120
1970	89	257	169	507
1971	103	257	273	413
1972	-45	-14	97	292
Totals	147	500	539	1,212
Efficiency ratio	4.9	8.3	6.0	10.1

fertilization project. Further assume that ammonium nitrate fertilizer will cost $200 per ton, or $0.10 per pound (1975 prices), and that it will cost $35 a ton to apply from aircraft (Bayoumi and Smith 1976). By simple calculations, 105 tons of nitrogen fertilizer can be purchased at a cost of $21,000 and applied for $3,675 (105 x $35), for a grand total of $24,675.

Since ammonium nitrate fertilizer contains 33 percent elemental nitrogen, the total fertilizer weight (210,000 lbs) must be divided by 3 to determine the actual amount of nitrogen that will be applied (70,000 lbs). Next, this value is divided by 30 (30 lbs N/acre, the selected treatment level), yielding a value of 2,333, the acreage which can be treated with the $25,000 budget. At the level of 30 lbs N/acre, each acre can be stimulated to produce an average of 9.8 lbs of total herbage more than untreated areas for each pound of nitrogen applied (Table 2). By multiplying 70,000 (lbs of N applied) times 9.8, an average increase of 686,000 lbs of total forage on these 2,333 acres (an increase of 295 lbs of forage for each acre treated) will be realized.

For the high level of nitrogen the calculations are as follows: The amount of area that can be treated at the 120-lb-N/acre rate is found by dividing 70,000 by 120, or 583 acres. By applying nitrogen at a rate of 120 lbs/acre an increase of 11.7 lbs in total herbage yield over untreated areas can be obtained for each pound of nitrogen applied(Table 2). Next, multiplying 70,000 by 11.7 shows an increase of 819,000 lbs of total forage can be produced on these 583 acres (an increase of 1,405 lbs of forage for each acre treated). Similar calculations can be made for shrub herbage using the values in Table 1.

Obviously, the decision to be made is whether to apply the lower rate on a larger area and receive a smaller increase in total herbage yield per acre or to apply the higher rate and treat a smaller area but receive a larger increase in total herbage yield per acre. The answer to this question will require additional information on such factors as how inadequate is the untreated forage supply for the grazing animals in terms of pounds of forage per acre, and how much area is available to be treated.

Even though fertilizer costs are much greater at the high rate of application, the greater longevity of treatment effects demonstrated at this level may justify treating smaller areas.

TABLE 2. Adjusted increases in total herbage yields (lb/acre) over control plots for 1970, 1971, and 1972, and the corresponding efficiency ratio for each level of nitrogen

Year	Rates of nitrogen fertilizer (lb/acre) 30	60	90	120
1970	132	322	233	576
1971	156	233	302	486
1972	6	-7	135	346
Totals	294	548	670	1,408
Efficiency ratio	9.8	9.1	7.4	11.7

LITERATURE CITED

Anderson, B. L., R. D. Pieper, and V. W. Howard, Jr. 1974. Growth response and deer utilization of fertilized browse. J. Wildl. Manage. 38(3):525-530.

Bayoumi, M. A., and A. D. Smith. 1976. Response of big game winter range vegetation to fertilization. J. Range Manage. 29(1):44-47.

Carpenter, L. H. 1970. Middle Park deer study — range fertilization. Colo. Div. Game, Fish and Parks, Fed. Aid Proj. W-38-R-24, Work Plan 14, Job 5, Job Prog. Rep., Game Res. Rep. July. pp. 369-393.

_____. 1971. Middle Park deer study — range fertilization. Colo. Div. Game, Fish and Parks, Fed. Aid Proj. W-38-R-25, Work Plan 14, Job 5, Job Prog. Rep., Game Res. Rep. July. pp. 225-253.

Williams, G. L. 1972. Effects of nitrogen fertilization on the nutritional quality of mule deer winter forages. M.S. Thesis, Colorado State Univ., Ft. Collins. 85 p.

Wood, G. W., and J. S. Lindzey. 1967. The effects of forest fertilization on the crude protein, calcium, and phosphorus content of deer browse in a mixed oak forest. Naturaliste Can. 94(3):335-346.

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