Composition and Yields of Native Grassland Sites Fertilized at Different Rates of Nitrogen[1]

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Highlight

Four range sites were fertilized at three different rates of nitrogen (33, 67, and 100 pounds nitrogen per acre) in southwestern North Dakota. Increasing the production of a range site with nitrogen fertilization is closely associated with the inherent production potential of the site. In general, greatest increases in total dry-matter yields for a given increment of fertilizer were observed at the 67-pound nitrogen application. Total basal cover was reduced by fertilization on the Vebar and Havre sites but increased on the Rhodes and Manning sites. In general, reduction in total cover was due to a decrease in cover of the blue grama grass. An increase in cover and density of western wheatgrass and the sage species was generally observed on all sites.

Fertilization of native ranges has been carried out with varied success in the Northern Great Plains. Differences in climatic conditions, growing season, soil conditions, and management practices play an important role in determining the effectiveness of a given amount of nitrogen and increase in forage yield. Most of the work reported has been carried out on an individual site basis rather than on a variety of range sites covering various edaphic and vegetative conditions.

Heady (1952) applied barnyard manure annually from 1925 to 1935 to a relict native grassland near Havre, Montana. Stand and yield of grass increased after the first two years.

Lodge (1959) used heavy applications of manure and commercial fertilizers on native ranges at Swift Current, Saskatchewan. Heavy applications of manure were both immediate and lasting compared to commercial fertilizers, which may be of short duration and may not cause enough increase in growth to warrant their use.

The use of nitrogen fertilizer on native grassland has been reported by Rogler and Lorenz (1957) at the U.S.D.A. Northern Great Plains Research Center, Mandan, North Dakota. Pastures under moderate and heavy grazing intensities were fertilized annually for a 6-year period at rates of 30 and 90 pounds nitrogen per acre. Highest rates of return were realized from 30 pounds of nitrogen per acre, due mainly to the increase in western wheatgrass. Two years of fertilization of the heavily grazed pasture at the 90-pound rate did more to improve range condition and production than did six years of complete isolation from grazing. Changes in the botanical composition due to nitrogen fertilization were reported by Rogler and Lorenz (1965) and by Smoliak (1965).

Studies of yields from native range fertilization were initiated at the Dickinson Experiment Station, Dickinson, North Dakota by Whitman (1962) applying nitrogen at rates of 33, 67, and 100-pounds per acre. This study included two range sites and was expanded to include detailed studies of four different range sites, which is the basis of this paper.

Experimental Procedure

This study was conducted on four representative range sites within a 35-mile radius of the Dickinson Experiment Station in southwestern North Dakota during the years 1964–1966. The four range sites represented four soil types common in this region. The soil types are the Vebar fine sandy (sandy site), Havre silt loam (loamy site), Rhodes silt loam (panspots) and the Manning silt loam (shallow site). The range sites are designated by the soil type names throughout this discussion. The long-term average precipitation at the Dickinson Experiment Station is 15.42 inches, of which approximately 75 percent is received during the active growing season. A slightly greater amount of precipitation was received during the 1964–1966 study period.

The Vebar fine sandy loam is a soil developed from weathered, weakly-cemented, tertiary sandstone and is associated mainly with gently undulating to moderately steep topography. The site is situated on a gentle, southwest-facing slope and was heavily grazed in late fall of each year. The dominant vegetation consists primarily of the species given in Table 1.

The Havre silt loam soil series comprises a deep, light-colored, alluvial soil occupying creek bottom floodplains. This range site is found extensively only in the Badlands, where it is used for both summer and winter grazing, although it is considered of primary importance for winter use. Summer grazing was practiced on the site studied, with the range condition of the site in excellent condition. The plants regarded as the dominant vegetation are given in Table 2.

The Rhodes silty loam soil was classed as a Solonetz soil type, high in sodium, with a near-impervious layer of dispersed clay particles in the profile varying in depth from the soil surface to approximately 20 inches. This clay layer generally was found to be about 14 to 18 inches thick. The grazing capacity of this site is considerably reduced by claypan and barren panspots which support little or no vegetation. Heavy grazing in the past has further adversely affected the physical characteristics of the soil on this site. The dominant grass and forb species of this site are given in Table 3.

The Manning silt loam soil is a soil type developed on high river terraces underlain by a gravel layer at about 18–24 inches below the surface. The site studied occupied one of the oldest and highest river terraces of this soil type in the area. The site is generally heavily grazed during

[1] Submitted as Journal Article number 177 with permission from the Director, Agricultural Experiment Station, Fargo, North Dakota. Received November 13, 1968; accepted for publication April 5, 1969.

Table 1. Average basal cover on the Vebar range site, and the average number of single-stalked species in each 1-ft² plot on the site, 1964 to 1966.

Species	0 N		33 lb N/acre		67 lb N/acre		100 lb N/acre	
	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²
Western wheatgrass	0.02	2.86	0.02	0.00	0.02	0.15	0.05	0.13
Needle-and-thread	2.13		2.02		2.92		2.20	
Plains reedgrass	0.27a[1]	2.28	0.37b	2.83	0.42b	5.01	0.78a	3.27
Prairie sandreed	0.17a	0.77	0.22b	0.84	0.37a	1.15	0.33b	1.45
Prairie Junegrass	0.10		0.05		0.10		0.07	
Blue grama	32.93		31.68		29.40		28.88	
Threadleaf sedge	1.43a		2.28a		1.02a		2.32a	
Needleleaf sedge	2.13a		1.77b		2.12b		1.70b	
Pennsylvania sedge	0.28		0.50		1.20		0.68	
Fringed sage	0.03	0.67	0.08	1.24	0.07	0.99	0.02	0.74
White sage	0.18	4.01	0.17	4.35	0.28	5.76	0.28	7.01
Skeleton weed	0.05	0.51	0.07	0.23	0.00	0.35	0.02	0.16
Scarlet globemallow	0.08	0.91	0.00	0.69	0.02	0.68	0.02	0.60
Butterfly weed	0.02	0.25	0.02	0.26	0.00	0.35	0.00	0.33
Birdsfoot trefoil	0.07	1.25	0.02	0.88	0.00	0.60	0.00	0.28
Rough pennyroyal	0.00	0.61	0.00	0.27	0.00	0.13	0.00	0.09
Total of site	40.15b	18.21a	39.33a	14.59b	38.22b	19.41b	37.47b	17.49a

[1]Means within a species and treatments are significantly different at the 0.05 level only when designated with the same letter superscript.

the early summer months and was in low good condition. Dominant grasses, sedges, and forbs are given in Table 4.

The experiment was designed as a random block of three different treatments and a check plot (no nitrogen), replicated four times. Individual plots measured 30 × 100 feet with 6-foot wide alleyways between replications. Treatments consisted of check plots, 33 pounds elemental nitrogen per acre, 67 lb N/acre, and 100 lb N/acre. The nitrogen was applied as ammonium nitrate between April 10–15 of each year.

Three 3 × 7 ft steel wire quonset-type cages were placed on each plot of each treatment and site. The cages were placed in a staggered line rather than a straight line to eliminate trailing by cattle. Yield samples were clipped to ground level at the end of the growing season from all treatments each year from the area protected by the wire cages, using a 2.5 × 5 ft steel frame. The forage was hand separated into tallgrasses, midgrasses, shortgrasses, perennial forbs and annual forbs. The plant material was oven-dried and weighed.

Basal cover was determined on each plot each year (1964, 1965, and 1966) by the point method, using an

Table 2. Average basal cover on the Havre range site, and the average number of single-stalked species in each 1-ft² plot on the site, 1964 to 1966.

Species	0 N		33 lb N/acre		67 lb N/acre		100 lb N/acre	
	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²
Western wheatgrass	26.48a[1]	84.84a	28.76b	90.40bc	38.82ab	103.41a	38.63a	114.19bc
Plains reedgrass	5.80	10.05	4.71	7.80	5.66	7.84	4.16	8.19
Green needlegrass	17.54		25.43		23.38		19.44	
Needle-and-thread	2.18		1.73		1.32		0.43	
Dwarf sagebrush	37.06a	1.58	31.32b	1.52	21.91a	1.61	31.55b	2.33
White sage	0.00	0.03	0.21	0.19	0.59	0.05	0.00	0.04
Wolfberry	7.51	0.31	2.43	0.73	3.90	0.34	0.26	0.41
Scarlet globemallow	0.34	0.49	0.00	0.58	0.15	0.11	0.12	0.31
White prairie aster	0.14	0.85	0.69	0.87	1.47	1.79	0.43	1.19
Yarrow	0.20	0.59	0.21	0.30	0.37	0.18	0.19	0.09
Total of site	40.15	99.63a	39.33	102.68ab	38.22	115.85a	37.47	127.00a

[1]Means within a species and treatments are significantly different at the 0.05 level only when designated with the same letter superscript.

Table 3. Average basal cover on the Rhodes range site, and the average number of single-stalked species in each 1-ft² plot on the site, 1964 to 1966.

Species	0 N		33 lb N/acre		67 lb N/acre		100 lb N/acre	
	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²
Western wheatgrass	3.78[a1]	24.23	4.33[b]	20.67	6.31[a]	29.58	5.70[b]	33.25
Sandberg bluegrass	6.88[b]		7.22[a]		4.24[a]		7.14[b]	
Blue grama	84.71		83.58		85.03		81.69	
Needleleaf sedge	1.08		1.81		1.64		1.54	
Fringed sage	0.05	0.69	0.05	0.15	0.05	0.27	0.00	0.06
Brittle prickly pear	0.83	1.59	0.68	1.44	1.30	1.00	1.16	4.40
Prairie plantain	0.00	0.22	0.00	0.13	0.00	0.20	0.00	0.05
Bracted plantain	0.45	14.48	0.60	15.87	0.13	10.57	0.13	14.08
Plantago elongata	0.00	0.84	0.00	0.54	0.00	1.71	0.00	3.19
Rough pennyroyal	0.13	1.69	0.05	3.29	0.00	1.99	0.05	1.76
Salt sage	0.00	0.08	0.05	0.08	0.00	0.07	0.00	0.09
Yarrow	0.00	0.36	0.00	0.07	0.00	0.85	0.00	0.03
Kochia	0.00	0.16	0.00	0.60	0.00	0.69	0.05	0.39
Total of site	39.70	45.72[ab]	36.97	44.84[ab]	38.48	48.85[a]	38.93	60.77[ab]

[1]Means within a species and treatments are significantly different at the 0.05 level only when designated with the same letter superscript.

inclined frame with 10 points spaced at 2-inch intervals. The point-frame was placed at 10-foot intervals in 5 lines of 10 sets. The 5 lines were placed 5 feet apart. A total of 2000 points was taken in each treatment, on each site, every year of the study. An additional sampling procedure was carried out using a 1-ft² steel frame for counting all single-stalked plants within each frame in order to more adequately sample the single-stalked species of the sites. Counts were made of all single-stalked species in 10, 1-ft² areas for each plot, treatment, and site each year of the study.

Results and Discussion

Basal Cover and Density

Total basal cover of the plant species on the Vebar site showed a decrease at the end of the 3-year period at all rates of nitrogen applications (Table 1). Data were taken each year and are presented as averages over the 3-year period (1964, 1965, and 1966) in all sites. The lower total basal

Table 4. Average basal cover on the Manning range site, and the average number of single-stalked species in each 1-ft² plot on the site, 1964 to 1966.

Species	0 N		33 lb N/acre		67 lb N/acre		100 lb N/acre	
	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²	Basal cover (%)	Average plants/ft²
Western wheatgrass	0.74[a1]	3.68[a]	0.93[b]	3.93[a]	0.91[a]	5.44[a]	1.09[b]	5.39[a]
Plains reedgrass	0.33	1.60	0.11	0.96	0.00	1.45	0.10	0.46
Needle-and-thread	2.79[a]		1.98[ab]		2.10[a]		2.02[b]	
Blue grama	78.39		75.64		76.47		73.12	
Threadleaf sedge	13.19		16.43		14.68		17.38	
Needleleaf sedge	2.50		2.91		3.10		2.30	
Fringed sage	1.45[a]	12.12[ab]	1.57[b]	12.43[b]	1.90[a]	18.04[a]	3.33[b]	20.77[ab]
Skeleton weed	0.11	0.30	0.04	0.35	0.06	0.10	0.04	0.20
Green sage	0.00	0.23	0.00	0.07	0.04	0.12	0.06	0.08
Rough pennyroyal	0.00	0.83	0.00	1.68	0.06	1.19	0.00	1.65
Scarlet globemallow	0.07	2.33[ab]	0.15	1.49[ab]	0.26	1.41[abc]	0.06	1.64[ab]
Gaura		1.10		0.66		0.60		0.69
Total of site	44.88[a]	24.06[a]	46.38[ab]	23.96[b]	46.20[a]	30.31[b]	48.62[a]	32.44[a]

[1]Means within a species and treatments are significantly different at the 0.05 level only when designated with the same letter superscript.

cover resulted mainly from a reduction in blue grama (*Bouteloua gracilis*). Slight decreases in cover were noted in needle-and-thread (*Stipa comata*). Plains reedgrass (*Calamagrostis montanensis*) and threadleaf sedge (*Carex filifolia*) showed slight increases in basal cover with increased rates of applied nitrogen. Prairie sandreed (*Calamovilfa longifolia*) showed an increase in basal cover with increased rates of nitrogen to the 67-pound rate but decreased at the 100-pound nitrogen rate. Differences in total basal cover were statistically significant at the end of the 3-year period between the check plots and the 67 and 100-pound-nitrogen treatments. The magnitude of the differences do not, however, appear to be of practical significance. Western wheatgrass (*Agropyron smithii*), needle-and-thread, prairie Junegrass (*Koeleria cristata*), needleleaf sedge (*Carex eleocharis*) and Pennsylvania sedge (*Carex pennsylvanica*) were well represented on the site although no significant differences in basal cover due to fertilization were observed.

At the conclusion of the 3-year study, analysis of the annual ft^2 count data indicated an increase in plant density of prairie sandreed on the Vebar site with increased rates of nitrogen to the 100-pound nitrogen rate (Table 1). A substantial increase in density also was observed in plains reedgrass, but only to the 67-pound nitrogen rate.

The forb species were well represented on the Vebar site. The dominant perennial forb of the site was white sage (*Artemisia ludoviciana*) which did not show a significant increase in plant density between treatments at the end of the 3-year period, although the individual plants increased appreciably in size in the presence of the nitrogen. Other important forbs of the site were skeleton weed (*Lygodesmia juncea*), birdsfoot trefoil (*Lotus americanus*), and rough pennyroyal (*Hedeoma hispida*).

The vegetation of the Havre site consisted mainly of single-stalked grasses and forb species The data indicated a slight decrease in basal cover at all rates of applied nitrogen at the end of the study period. Western wheatgrass and green needlegrass (*Stipa viridula*) both increased in cover while needle-and-thread and plains reedgrass showed decreases. Reductions in total basal cover also were found in the dominant shrub of the site, dwarf sagebrush (*Artemisia cana*) and wolfberry (*Symphoricarpos occidentalis*). Composition changes were not great at the end of the 3-year period, and the change in total basal cover was not statistically significant. Common forbs of the site were scarlet globemallow (*Sphaeralcea coccinea*), white prairie aster (*Aster ericoides*), and yarrow (*Achillea lanulosa*).

Data for the Havre site showed an increase in total plant density with increased rate of nitrogen at the end of the study period. Western wheatgrass, the dominant and single-stalked species of the site, showed a significant density increase at all rates of nitrogen fertilization as did the total species density of the site at the end of the 3-year study period (Table 2). Dwarf sagebrush indicated a moderate increase in density only at the higher rates of nitrogen. Forb species showed tremendously large variations with respect to the different rates of fertilization.

Total basal cover on the Rhodes site showed a slight annual increase under all treatments at the end of the 3-year study period. Western wheatgrass showed increases in basal cover with increased rates of fertilization each year of the study period. Responses by other species on the site were quite erratic and significant differences are shown in Table 3. Western wheatgrass showed a significant increase in basal cover only at the 67-pound nitrogen treatment, while Sandberg bluegrass (*Poa secunda*) showed significant increases at the 33 and the 67-pound nitrogen treatments.

Single-stalked species, chiefly western wheatgrass, increased with increased rates of fertilization over the 3-year period. Total species density was significant between the check plots and the 100-pound nitrogen treatment at the end of the 3-year study period (Table 3). Brittle prickly pear (*Opuntia fragilis*) was the only forb of the site which showed an apparent steady increase in density with higher rates of applied nitrogen. Other forb species of the site were fringed sage (*Artemisia frigida*), prairie plantain (*Plantago purshii*), bracted plantain (*Plantago spinulosa*), *Plantago elongata*, rough pennyroyal, salt sage (*Atriplex nuttallii*), yarrow, and fireweed (*Kochia scoparius*).

Basal cover increased on the Manning site with increased rates of fertilization each year of the 3-year study period. Western wheatgrass showed a moderate increase while threadleaf sedge showed an appreciable increase in total cover at all rates of nitrogen application. Needle-and-thread showed a decrease in basal cover while blue grama appeared not to be affected on this site. Wide differences in response to nitrogen by various forbs were observed at the different rates of fertilization (Table 4). In general, the largest increase in basal cover of the forbs due to fertilization occurred in fringed sage, which increased each year of the study. Western wheatgrass was the most important single-stalked grass species on this site. There was a significant increase in density of this species and in total plant density at all rates of fertilization during the 3-year study period.

The most important and consistent response by the forbs of the site was observed with fringed sage. Plant density of this species increased significantly each year with increased rates of nitrogen.

Table 5. Three-year average production (lb/acre, oven-dry) on four native grass range sites fertilized with nitrogen at three different rates, 1964 to 1966 seasons.

Site	Treatment	Mid grasses	Tall grasses	Short grasses	Total grasses	Perennial forbs	Annual forbs	Total yields
Havre	0 lbs N	2050	-	9	2059	350	0.7	2410
	33 lbs N	2329	-	4	2333	212	3	2548
	67 lbs N	2942	-	6	2948*	312	1	3261*
	100 lbs N	3046*	-	48	3094*	151	2	3247*
Vebar	0 lbs N	258	46	958	1262	242	99	1603
	33 lbs N	232	58	1324	1614	411	48	2073
	67 lbs N	402*	17	1758	2177*	645*	15	2837*
	100 lbs N	487*	113	1708	2308*	625*	20	2953*
Manning	0 lbs N	265	-	995	1260	321	5	1586
	33 lbs N	260	-	1130	1390	509	6	1905
	67 lbs N	343	-	1572*	1915*	880*	17	2812*
	100 lbs N	411*	-	1673*	2084*	1225*	16	3325*
Rhodes	0 lbs N	309	-	433	742	34	62	838
	33 lbs N	357	-	488	845	29	109	983
	67 lbs N	488	-	606*	1094*	143*	46	1283*
	100 lbs N	500	-	706*	1206*	42	154	1402*

*Means differ significantly from check plot means at the 0.05 level as determined by Duncan's Multiple Range Test.

Profuse branching of individual plants also was observed at the high rates of fertilization. No consistent increases in other forbs were noted at the different rates of fertilization.

Yields

Increases in total dry-matter yields were generally observed from all rates of nitrogen fertilization on all sites studied (Table 5). The 33 and 67-pound nitrogen treatments resulted in the greatest increases in yield per increment of added nitrogen. The 100-pound nitrogen rate did not greatly increase the yields beyond those obtained from the 67-pound nitrogen treatment. On the Manning site, however, the forb component did show an appreciable increase in yield over the check plots at the 100-pound nitrogen rate.

The Havre site was the highest yielding of the four sites studied. The largest increases in yield due to the applied nitrogen were observed at the 67-pound nitrogen treatment, being slightly higher at this level than at the 100-pound nitrogen treatment. Only a very small increase was observed above the yield from check plots at the 33-pound nitrogen treatment. Statistically significant increases in yields over check plots were noted only at the 67 and 100-pound nitrogen treatments. Forbs did not show an appreciable increase in production at any rate of fertilization during the 3-year study period. Data on the botanical composition of this site show that the yield consisted mainly of midgrasses with only nominal amounts of shortgrasses at any rate of fertilization (Table 6). It was apparent at the end of the 3-year study period that the percentage of midgrasses had increased appreciably, while the percent production of forbs had shown a general decrease.

Three-year average yield data for the Vebar range site are given in Table 5. Statistically significant increases in yield over check plots were generally observed at the 67 and 100-pound nitrogen treatments. The yield of the forb component of the vegetation increased substantially on the Vebar site at the 33 and 67-pound nitrogen treatments, but showed no further increase at the 100-pound nitrogen rate. Annual forbs did not contribute appreciably to the total production at any rate of fertilization on this range site. The percent composition of the yields, by midgrass, shortgrass, and forb components, did not show any definite trend at the different rates of nitrogen fertilization over the 3-year study period (Table 6).

The Rhodes site was the lowest producing of the four range sites studied (Table 5). Increases in yield were observed with each increased rate of applied nitrogen although total yields from the treatments were extremely low when compared to similar nitrogen applications on other sites. Significant increases in the shortgrass component were observed at the end of the study period between

Table 6. Three-year average composition (%) of yields of native grass range sites fertilized with nitrogen at three different rates, 1964 to 1966 seasons.

Site	Treatment	Mid grasses	Tall grasses	Short grasses	Perennial forbs	Annual forbs
Havre	0 lbs N	85.0	-	0.4	14.5	T
	33 lbs N	91.4	-	0.2	8.3	0.1
	67 lbs N	90.2	-	0.2	9.6	T
	100 lbs N	93.8	-	1.4	4.7	0.1
Vebar	0 lbs N	16.1	2.9	59.7	15.1	6.2
	33 lbs N	11.2	2.8	63.9	19.8	2.3
	67 lbs N	14.2	0.6	62.0	22.7	0.5
	100 lbs N	16.5	3.8	57.8	21.2	0.7
Manning	0 lbs N	16.7	-	62.8	20.2	0.3
	33 lbs N	13.6	-	59.4	26.7	0.3
	67 lbs N	12.2	-	55.9	31.3	0.6
	100 lbs N	12.4	-	50.3	36.8	0.5
Rhodes	0 lbs N	36.8	-	51.7	4.1	7.4
	33 lbs N	36.3	-	49.7	2.9	11.1
	67 lbs N	38.0	-	47.3	11.1	3.6
	100 lbs N	35.7	-	50.3	3.0	11.0

check plots and 67 and 100-pound nitrogen treatments, mainly in the shortgrass component. A significant increase in the forb production was observed at the 67-pound nitrogen treatment. The greatest increase in yield per increment of nitrogen was at the 67-pound nitrogen treatment.

Conclusions

Variations in the degree of response by individual plant species with respect to level of treatment and site became apparent during this study. Certain species, such as western wheatgrass, showed continued increase in basal cover and density with increased rates of applied introgen on all range sites. Blue grama, in general, decreased in basal cover with increased rates of nitrogen on the sites where it was the dominant plant cover. Still other grass and sedge species increased or decreased in cover and density only at certain levels of fertilization, indicating that optimum amounts of applied nitrogen varied widely for any given species.

A change in botanical composition was becoming apparent on the Vebar and Manning sites at the end of the 3-year study. The grasses showing the greatest increases in basal cover and density on both of these sites were western wheatgrass and plains reedgrass. Although both species were present on both sites, plains reedgrass was increasing more rapidly on the Vebar site while western wheatgrass was increasing faster on the Manning site. Threadleaf sedge showed an increase in basal cover while needle-and-thread appeared to decrease on both sites with increased rates of fertilization. Forb species, mainly white sage on the Vebar and fringed sage on the Manning sites, showed definite responses to the presence of the applied nitrogen, generally increasing with each added increment of nitrogen. In addition to the increase in density of the species, the plants showed definite tendencies toward profuse branching, which greatly increased the area of a single plant. The Havre and Rhodes sites did show some changes in basal cover and plant densities, although the composition of the vegetation of the site had not changed appreciably during this period.

The probability of increasing the production of a given range site is closely associated with the natural productive capacity of the site. The Havre site was considered to be a high producing site and the highest added increase in production with nitrogen fertilizer was obtained at the 67-pound nitrogen treatment on this site. The Vebar and Manning sites were considered to be less productive, although substantial increases in yield to the 67-pound nitrogen treatment were realized. The increases in total production were, however, much greater than the increases in grass alone due to the increase in the forb component, mainly the sages. The increase in the sage species does not represent

an increase in actual forage production, as they are largely non-palatable to livestock.

The Rhodes site was the lowest producing of the sites, although increases in production were observed at all rates of nitrogen fertilization. The perennial forb component also increased on this site but only to the 67-pound nitrogen treatment. Annual forbs were present in large numbers during the 1965 season, especially at the high levels of nitrogen application.

It became apparent from the data that caution and good judgment must be exercised when fertilizing native rangelands in western North Dakota. Nitrogen fertilizer may be a valuable tool in range improvement when the factors of plant and soil response to the applied nitrogen are known and applied on a range site basis.

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