Fertilization of Native Range in the Northern Great Plains

ROBERT W. LODGE

Agricultural Research Officer, Experimental Farm, Swift Current, Saskatchewan, Canada

Research in the use of fertilizers on native range forage in the Northern Great Plains is being conducted to find if this may be a method of increasing the returns per acre. Clarke, Tisdale, and Skoglund (1947) reported the long term effect of manuring. An area of *Bouteloua-Stipa* vegetation, manured in 1928, sampled from 1933 to 1938, inclusive, yielded an average of 850 pounds per acre against an average of 420 pounds per acre from adjacent unmanured range. Work conducted at the Range Field Station at Cottonwood, South Dakota, by Westin, Buntley, and Brage (1955) from 1952 to 1954 showed increased yield on native range after fertilizer applications. Using rates of 20, 40, and 80 pounds of nitrogen per acre on pasture that had been grazed at heavy, moderate, and light intensities, they found the greatest response resulted from the application of 80 pounds of nitrogen per acre to the heavily grazed pasture. Increases in percent protein were obtained from the higher rates of nitrogen. Rogler and Lorenz (1957) conducted a fertilizer experiment on an upland blue grama (*Bouteloua gracilis*)-western wheatgrass (*Agropyron smithii*) site. Both heavily grazed and moderately grazed range showed an increase in yield after applications of 30 and 90 pounds of nitrogen per acre, with a greater return in pounds of hay produced per pound of nitrogen at the 30-pound rate. Crude protein level was higher in the forage from the plots which received 90 pounds of nitrogen per acre than from unfertilized plots.

These and other range fertilization experiments have shown that increased yields of forage may be obtained, and the fertilized forage will contain a greater percentage of crude protein. They do not show that the increased yields of forage and crude protein are sufficient to cover the costs of application. Further certain inconsistencies in the results suggest that the response of native range grasses to commercial fertilizers needs further investigation before clear-cut recommendations can be made as to their use as a range management device.

This article reports a fertilizer test on *Stipa-Bouteloua* range near Swift Current, Saskatchewan. The results of the experiments in themselves verify the findings of other work reported. However, observations made during and subsequent to the test indicate that the measurement of certain reactions of the vegetation complex and of individual species to fertilization might be desirable.

Procedure

In 1951 a test was laid down to determine the effect on yield and on protein content of a single application of fertilizers and manure to mixed-grass prairie. The test was located on the Alexander Coulee sheep range, Experimental Farm, Swift Current, Saskatchewan. The range was in excellent condition prior to the experiment, and the area used was not grazed during 1951 and 1952. Needle-and-thread (*Stipa comata*) and blue grama are the dominant grasses, other major species being western wheatgrass, Junegrass (*Koeleria cristata*) and threadleaf sedge (*Carex filifolia*). The soil of the site is classified as Haverhill Loam, rolling phase of the chestnut or brown soil zone, developed over undifferentiated glacial till (boulder clay). The climate is semi-arid, the long term precipitation at Swift Current being 14.94 inches, the average seasonal rainfall (May-June, inclusive) is 6.98, and the precipitation-evaporation index is 0.45. Annual precipitation was above average prior to and during the study, being in 1951, 19.06 inches and in 1952, 16.05 inches, and the seasonal rainfall was 5.17 and 8.58 inches in 1951 and in 1952.

The experimental layout was a randomized split plot with six replicates. Plots were 3 x 14 feet. Treatments consisted of four fertilizer treatments and one manure treatment each at two rates, and a check which was not fertilized or manured. Fertilizers used were ammonium phosphate 16-20-0, ammonium phosphate 11-48-0, ammonium nitrate 33.5 0-0, and barnyard manure. These were hand broadcast in April, 1951, at rates of 16 and 32 pounds per acre of nitrogen for the artificials, and 10 and 20 tons per acre of manure. The plots were mowed in late July, 1951, and early August, 1952, and the forage from a central 18-inch wide strip was collected from each plot, air dried and weighed. The samples from each treatment were later bulked, ground, and analysed for protein content.

Results

Forage yields obtained in the two years are given in Table 1. There was no increase in forage yield from the fertilizer applications in 1951. In 1952 there was a significant increase in yield as a result of the application of 32 pounds of nitrogen as ammonium nitrate and a highly significant increase in yield of forage on the

Table 1. Yield in pounds of forage per acre (dry matter) of mixed-grass prairie fertilized or manured at two rates.

Treatment	1951		1952	
	16 lbs.N. or 10 tons of manure	32 lbs. N. or 20 tons of manure	16 lbs. N. or 10 tons of manure	32 lbs. N. or 20 tons of manure
Ammonium Phosphate 16-20-0	341	290	620	468
Ammonium Phosphate 11-48-0	464	453	493	505
Ammonium Nitrate 33.5-0-0	302	412	600	666
Barnyard Manure	371	385	623	767
No fertilizer treatment	325	337	482	442

S.D. between treatments means: 1952 at 5% level 118 pounds.
at 1% level 234 pounds.

plots which received 20 tons of manure.

Results of analyses for crude protein content are given in Table 2. From these analyses and the forage yields the gross crude protein per acre for the various treatments was computed (Table 3).

In 1951 there were increases in crude protein content as a result of the treatments, and as a result a significant increase when 20 tons of manure was applied. Significant increases in gross protein also resulted from the application of 32 pounds per acre of nitrogen as 33.5-0-0 and 11-48-0. The application of 16 pounds per acre of nitrogen as 11-48-0 gave a very significant increase in gross protein.

In 1952 the percent crude protein of the forage from the treated plots was not apparently different from that of the plots which received no fertilizer, except in that from the plots which received 10 tons of manure. This is reflected in the 1952 data in Table 3 in which this treatment (10 tons of manure per acre) as well as the 32 pounds per acre of nitrogen application (as 33.5-0-0), gave a significant increase. Twenty tons of manure gave a highly significant increase in gross protein.

Discussion

Range fertilization in this study is concerned with relatively low rates of application broadcast in the spring. While drilling in of fertilizers is acknowledged superior to broadcasting, the latter is a more practicable method for rough, rolling, or stony ranges. Whether spring application is advantageous over fall application is not demonstrated. The differential effect of the several artificial fertilizers indicated that the increase in percent protein may be in part due to the provision of phosphorus, but all treatments gave an increase in the quality of the forage in the year of application. Yield increases cannot be expected from the use of fertilizer at rates of the order of 16 pounds of nitrogen. When 32 pounds of nitrogen were applied, the forage yield increased in the second year after application.

The use of manure in this experiment was intended to allow a comparison of it with those of Clarke *et al.* (1947). The first and second year advantages of the use of manure at rates of 10 and 20 tons per acre are apparent, both rates of application resulting in increased gross protein per acre in the first year and increased forage yields in the second year. On this somewhat more productive range type than that studied by Clarke the value of manure is as apparent in the short term as were the long-term advantages reported by Clarke. The use of supplies of manure from feedlots and wintering lots on selected areas of native range can have immediate as well as long continued beneficial results.

Continuing studies in the use of fertilizers on the native grass ranges of the Northern Great Plains are warranted.

Kilcher (1958) reported on the response to fertilization of three species of cultivated grasses. His work and the observations of Rogler and Lorenz (1957) on native prairie indicate the differential response of species to additions of nitrogen. Further studies should be concerned not only with the response in yield and in chemical composition of individual species, but more important they should examine the resultant changes in botanical composition of the sward.

Many workers in forage crop improvement programs have examined the effects on grass seed production resulting from applications of fertilizers. It is possible that in the complex of species that is a natural grassland, there might occur a differential response of the several dominant species. This certainly occurs in sexual reproduction, and possibly in vegetative reproduction. Rogler and Lorenz (1957) imply the latter. Moreover, the response to fertilization of individ-

Table 2. Percent crude protein of the forage harvested from mixed-grass prairie fertilized or manured at two rates.

Treatment	1951		1952	
	16 lbs. N. or 10 tons of manure	32 lbs. N. or 20 tons of manure	16 lbs. N. or 10 tons of manure	32 lbs. N. or 20 tons of manure
Ammonium Phosphate 16-20-0	10.05	10.36	8.45	8.08
Ammonium Phosphate 11-48-0	10.10	9.53	8.00	8.32
Ammonium Nitrate 33.5-0-0	10.00	10.38	8.24	8.13
Barnyard Manure	11.01	12.10	9.22	8.83
No fertilizer treatment	8.71	8.87	8.44	8.40

ual species in an overgrazed sward might well be expected to differ from the response of these same species in an undergrazed and therefore more stable stand. There appears the possibility that range fertilization might enable manipulation of the botanical composition of native ranges. But such manipulation to serve best the nutritional requirements of the grazing animal will first require additional attention to the effects of the change in nutrient status on the individual plant species and on the vegetation complex.

The warrant for any range management technique is increased animal production. A fertilization test to be realistic must be concerned with increased animal gains. The work of Smith and Lang (1958) who report on the use of nitrogenous fertilizers in achieving distribution is worthy of attention. The value of fertilization of a range may be reflected in other measures than increased forage quantity or chemical quality. The evaluation of fertilizer applications must include any benefits of better distribution, increased palatability, or increased feeding value. Further grazing trials in which the increased productivity is equated to the costs of fertilizer and its application are particularly necessary.

Table 3. Gross protein in pounds per acre of the forage harvested from mixed-grass prairie fertilized or manured at two rates.

Treatment	1951		1952	
	16 lbs. N. or 10 tons of manure	32 lbs. N. or 20 tons of manure	16 lbs. N. or 10 tons of manure	32 lbs. N. or 20 tons of manure
Ammonium Phosphate 16-20-0	34	30	52	36
Ammonium Phosphate 11-48-0	47	43	39	42
Ammonium Nitrate 33.5-0-0	30	43	50	54
Barnyard Manure	41	47	57	68
No fertilizer treatment	28	30	41	37

S.D. between treatment means: 1951 at 5% level 13 pounds.
at 1% level 17 pounds.
1952 at 5% level 15 pounds.
at 1% level 20 pounds.

Conclusions

The evidence presented indicates that the benefits of heavy applications of barnyard manure are both immediate and lasting, whereas the application of commercial fertilizers may or may not produce sufficient extra growth to warrant their use.

However, the observations made during the course of this experiment and the suggestions indicated by literature reviews are such that certain confusing issues are apparent. It is believed that further research should consider the following points:

1. That the study of the response of individual species to a specific mineral or combination of minerals should be a feature of fertilization studies.
2. The response of individual species and changes in botanical composition of the fertilized sward, should be interpreted only after consideration of the influence of different degrees of grazuse, past and future.
3. That the effects of range fertilization on the growth and development of the livestock using the range be considered. It is not the increased yield of forage or crude protein that is the ultimate concern, but that application of the knowledge will mean bigger calves and lambs and more wool and beef.

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