WHEATGRASS FERTILIZATION

Increases in forage yield occurred only in the better forage years. In the poorer years no forage increase resulted from fertilization. In no instance did the forage response justify the cost of the fertilizer.

LITERATURE CITED


plains reedgrass (Calamagrostis acutiflora), fringed sage (Artemisia frigida), and winterfat (Erythronium canadense). Studies in areas other than the Northern Great Plains show that changes in botanical composition were induced by fertilization. Klipple and Retzer (1959), working on blue grama range in northwestern Colorado, found that density and growth of palatable grasses and annual forbs varied with the fertilizer treatment. Patterson and Youngman (1960) found that increased rates of nitrogen aided cheatgrass (Bromus tectorum), at the expense of native species, on central Washington ranges. Rumberg and Cooper (1961) showed that the botanical composition of a native meadow in Oregon was radically changed by the application of nitrogen and phosphorus fertilizers.

Heady (1956) found that the amount and position of mulch influenced the botanical composition of a California annual-type grassland. Some species were favored by complete removal of mulch, others with nonremoval and still others responded with intermediate mulch treatments. The position and height of mulch had a direct influence on the growth, yield and density of plants.

The study reported herein was conducted at the Experimental Farm, Manyberries, Alberta. The objective was to determine the effects of single applications of manure, straw and inorganic fertilizers on the yield and chemical and botanical composition of Douteloua-Stipa range.

Procedure

The test was laid out in 1950 on a relic area protected from grazing for 20 years. The vegetation included the dominants, blue grama and needle-and-thread (Stipa comata), along with western wheatgrass, June grass (Koeleria cristata), Sandberg bluegrass (Poa secunda), Plains reedgrass (Calamagrostis montanensis) and some sedges (Carex spp.). Little clubmoss, fringed sage (Artemisia frigida) and winterfat (Erythronium canadense) were present. The soil is a light loam, with a solonized profile, within the chestnut or brown soil zone. The climate is characteristic of the semi-arid Northern Great Plains region, with great extremes in temperatures, low amounts of precipitation, high winds and high rates of evaporation. The long term annual and seasonal (May-June, inclusive) precipitation totals are 12.08 and 3.82 inches. During the study (1951-58) the annual and seasonal precipitation totals were 14.42 and 4.42 inches.

Five treatments were randomized in four replicates, with plots 10 by 50 feet in each treatment. The treatments were: control; 30 tons barnyard manure per acre; 30 tons wheat straw per acre; 30 tons straw per acre plus 300 pounds N, 150 pounds P2O5 and 300 pounds K2O per acre; and inorganic fertilizer alone. The inorganic fertilizer approximated the contents in 30 tons well-rotted barnyard manure, averaging 0.5 percent N, 0.25 percent P2O5 and 0.5 percent K2O. The inorganic fertilizers were sulfate of ammonia (21-0-0), ammonium phosphate (11-48-0) and potassium sulfate (0-0-48). The barnyard manure, straw and fertilizer were hand broadcast in September to a new stand and harvested in July each year from 1951 until 1958 within each plot for dry matter yield determinations. Chemical analyses were made on the mature forage samples obtained during the years 1951 to 1956, inclusive. The botanical composition of the vegetation on each plot was determined by the point quadrat method during August, 1958.

Results

The application of manure, fertilizer and straw plus-fertilizer significantly increased forage yields each year for eight successive years after treatment (Table 1). The straw treatment reduced yields slightly the first year after application but significantly increased yields from the fourth to the eighth year. The greatest first-year response to treatment was obtained from applications of inorganic fertilizer. The benefits from applications of organic constituents were not immediate but were extended over a long period.

Chemical analyses showed that the forage on the control plots generally contained lower percentages of crude protein, crude fibre, and phosphorus and higher percentages of nitrogen-free extract, ether extract and calcium than forage on the treated plots (Figure 1), excepting those treated with straw alone. Crude protein and phosphorus contents were significantly higher on the

| Table 1. Yield of forage (oven-dry) in pounds per acre by treatments. 1951 to 1958. |
| Yrs. after No. of | Control | Manure1 | Straw1 | Fer- | Straw1- | L.S.D. |
| treating | ave. | | | tillator2 | plus-fertil.2 | P=0.05 | P=0.01 |
| treatment | years | | | | | | |
| 1 | 4 | 742 | 986 | 576 | 1606 | 1236 | 106 | 142 |
| 2 | 4 | 650 | 1476 | 934 | 1714 | 1877 | 202 | 260 |
| 3 | 4 | 912 | 1797 | 1138 | 1886 | 2031 | 220 | 294 |
| 4 | 4 | 972 | 1974 | 1370 | 1940 | 2021 | 171 | 228 |
| 5 | 4 | 978 | 1912 | 1499 | 1648 | 1978 | 214 | 286 |
| 6 | 3 | 974 | 1702 | 1348 | 1450 | 1670 | 207 | 278 |
| 7 | 2 | 750 | 1373 | 1283 | 1244 | 1608 | 221 | 301 |
| 8 | 1 | 690 | 1283 | 1234 | 1068 | 1271 | 376 | 529 |

130 tons per acre.
2300 lbs. N; 150 lbs. P2O5; 300 lbs. K2O per acre.
The percentages of the various constituents, with the exception of nitrogen free extract, in the forage on plots treated with straw alone did not differ significantly from those on the control plots.

Differences in the vegetative cover were found on the various plots five to eight years after being treated (Table 2). Percentage basal area of western wheatgrass was greater on the manure, straw, fertilizer and straw-plus-fertilizer treatments than on the control plots. Plains reedgrass increased in basal area on the straw-plus-fertilizer plots but decreased on the manure plots. Blue grama decreased in basal area on the manure and straw-plus-fertilizer plots while Junegrass and Sandberg bluegrass decreased on all treated plots. Total basal area of the grasses and sedges was lower on the manure and straw-plus-fertilizer plots than on the control plots. Fringed sage decreased on the manure, straw and straw-plus-fertilizer plots. Moss phlox increased on all treated plots. The total basal area of the forbs and shrubs was lower on the manure, straw and straw-plus-fertilizer plots than on the control plots. Little clubmoss decreased on the manure, straw, fertilizer and straw-plus-fertilizer plots.

Discussion

Range fertilization trials, generally, have been concerned with relatively low rates of application. Within the Northern Great Plains region rates of fertilization ranged from 0 to 90 pounds of elemental fertilizer per acre. In this study inorganic fertilizer and manure were applied at higher rates: 300 pounds of nitrogen, 150 pounds of phosphate and 300 pounds of potash per acre. The immediate response from applications of inorganic

Figure 1. Percentage of some chemical constituents in mature forage under various treatments 1 to 6 years after application.
fertilizer was demonstrated by increases in forage yield and in percent crude protein. Response from applications of barnyard manure was evident in the immediate increase in percent crude protein. The higher rates of fertilization had no deleterious effects upon the vegetative growth; therefore, it is conceivable that even higher rates may be applied in future trials.

The use of a mulch was an effective means of increasing forage production. The artificial mulch, contributed by the straw, suppressed forage growth the first year after application, but with subsequent decay and disintegration its effectiveness was pronounced. This humic mulch formed a layer 1 to 1.5 inches in depth. In studies on mixed grass prairie in South Dakota, Larson and Whitman (1942) showed that forage yields varied directly with the depth of a natural mulch. The importance of natural mulches in promoting infiltration of rainfall, in prevention of erosion and in general maintenance of normal plant-soil-water relations has been shown in the literature.

The benefits derived from applications of manure arc due to the nutrients and to the mulch contributed by this form of fertilizer. The slow release of nutrients from within the manure influences forage production during the first few years, while the mulch influence is of greater significance in later years.

Changes in the botanical composition of the vegetation were induced by the organic and inorganic treatments. Blue grama, a dominant species, was replaced by western wheatgrass when additional nutrients and mulch were added. The decrease in basal area of blue grama was due to a better plant-soil-water relation; it also may have been affected by the shade of the taller, more vigorous species (Weaver, 1954; Rogler and Lenzen, 1957). Weaver (1954) found that blue grama succumbed after two or three years of dense shading. The reduction in basal area of blue grama was more than the nutrients and to the mulch supplied by the organic and inorganic treatments. Blue grama decreased while western wheatgrass increased in basal area on plots treated with manure and straw-plus-fertilizer. Basal area of little clubmoss was reduced substantially on the manure, straw and straw-plus-fertilizer treatments.

Response from applications of straw was attributed to the mulch effect provided by this treatment. Response from applications of barnyard manure was due to the nutrients and to the mulch supplied by the manure.

Fertilization can be employed as a range management technique to increase livestock production through increased forage yields, through the increased nutritional qualities of the forage, and through the induced changes in the botanical composition of the sward.

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**Summary**

Manure, straw and straw-plus-fertilizer treatments increased forage production significantly up to eight years after fertilization. Forage on plots treated with manure, fertilizer and straw-plus-fertilizer generally contained higher amounts of crude protein, crude fibre and phosphorus and lower amounts of nitrogen-free extract, ether extract and calcium than forage on control plots. There was a differential species response to the additional nutrients and mulch supplied by the organic and inorganic treatments. Blue grama decreased while western wheatgrass increased in basal area on plots treated with manure and straw-plus-fertilizer. Basal area of little clubmoss was reduced substantially on the manure, straw and straw-plus-fertilizer treatments.
Silverberry, or wolf willow, is a shrub from about 2 to 12 feet tall which occurs from Quebec to Yukon, south to Minnesota, Nebraska, and Utah (Gleason 1952). It is common in the aspen parkland of western Canada, particularly on lighter soils if moisture is adequate. In overgrazed pastures it can multiply rapidly from its vigorous root system (Budd 1957), and is also increased from seeds borne in mealy drupes (U.S.D.A. 1948). Wind may be their main dispersing agency by detaching them and rolling them over the surface of crusted snow. Dormancy and germination behaviour of the seeds has been studied by Corns and Schraa (1962) and the role of the species in hastening succession from prairie to aspen forest has been noted by Bird (1961).

In the apparent absence of scientific literature dealing with methods of control of silverberry, the relevant research reported here was undertaken in 1960 and continued for three years.

### Materials and Methods

At the University Ranch near Kinella, Alberta, about 100 miles east of Edmonton, plot areas were chosen in a field from which livestock were excluded throughout the experiments. The sites were uniformly infested with silverberry averaging about 3 feet in height in a population of approximately 25 of these shrubs per 100 square feet (Figures 1 and 2). The dominant grass was rough fescue (Festuca scabrella Torr.), associated with small and unevenly distributed amounts of Hooker's oat grass (Helictotrichon hookeri (Scribn.) Henr., June grass (Koeleria cristata (L.) Pers., spear grass (Stipa comata, (Trin. and Rupr.)), blue grama grass (Bouteloua gracilis (HBK.) Lag.), bearded wheat grass (Agropyron smicrorhizum (Link) Hitch.), bluegrasses (Poa interior Rydb., P. secunda Presl.), and certain other species. The sedge (Carex helioihipha) was a common but inconspicuous component of the vegetation, Snowberry (Symphoricarpos occidentalis Hook.) was also present in part of the experimental area together with herbaceous broad-leaved plant species characteristic of aspen parkland. Poplar bluffs were not included in the plot sites. Soil of shallow black, light loam soil about 6 to 12 inches in depth, overlying gravelly subsoil. Average annual precipitation at Kinella is about 15 inches, three-fourths of which occurs during the growing season and the fall.

**Year 1960.—** (1) During the third week of August, amitrol T, dalapon, dicamba, silvex, 2,4-D, and 2,4,5-T were each applied at 3 lb/A active ingredient in 25 gal/A of water from a portable-tank compressed-air sprayer; to duplicate 200 sq. ft. plots for each of the herbicides. Some details concerning names and formulations of products used in various tests are summarized below.1

Periodic evaluation of results was visual, including records of numbers of incompletely killed and of new silverberry stems.

(2) In another experiment a truck-mounted sprayer was used with 2,4-D at 1.5 and 3 lb/A and 2,4,5-T at 4 lbs/A.