Effects of Fertilization on A Little Bluestem Community

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Highlight

Phosphorus fertilization substantially increased little bluestem production. Potassium decreased its production because of an increase in weeds. It appears that little bluestem will respond to nitrogen only with sufficient moisture.

Little bluestem, *Andropogon scoparius* Michx., is well known for its ability to produce large quantities of forage. However, little is known about how it responds to fertilization. Such information is important; especially, if higher yields and more nutritious forage can be obtained.

The application of commercial fertilizers has been shown to affect native forage grasses in several ways. In an Arizona test Holt and Wilson (1961) applied ammonium phosphate and ammonium nitrate to a typical desert grassland site. They reported that both fertilizers almost doubled forage production over that produced on the unfertilized areas. Sulfur fertilization of an annual-plant range at the San Joaquin Experimental Range increased herbage production on two range sites by 59 and 57% during a five year period (Bentley, et al., (1959). Rogler and Lorenz (1957) found that forage production on heavily grazed ranges in the Northern Great Plains was significantly increased with nitrogen fertilization. The increase was due primarily to an increase in western wheatgrass. Rumburg and Cooper (1961) reported that high rates of nitrogen and phosphorus fertilization changed the botanical composition as well as increased forage yields on native meadows in Oregon.

Research has shown that fertilization will also improve the quality and palatability of range grasses. In a study of eleven important forage grasses grown on Lufkin fine sandy loam at College Station, Texas, Brittingham and Fudge (1944) found that the improvement of quality due to fertilization would increase at a greater rate than would the yields of forage. They reported that species of *Andropogon* showed enough improvement in quality of forage to justify the use of fertilizer.

Procedures

The experiment was conducted on a nearly pure stand of little bluestem on a gently sloping upland site near College Station, Texas. The soil is a typical Tabor sandy loam of low to moderate productivity. Soil tests revealed deficiencies of nitrogen, phosphorus, potassium, and calcium.

The experiment was a pilot study to determine if little bluestem plants would respond to fertilization both with and without weed control. The study was not intended to yield data for specific fertilization recommendations and was therefore designed to yield basic information through a minimum number of plots. Very high and low levels of fertilization, particularly with nitrogen, were stressed.

The basic design was a partial and unbalanced N, P, and K split-plot factorial. The factorial contained five levels of nitrogen, three levels of phosphorus and three levels of potassium. A uniform 1000-lb. calcium carbonate treatment was applied to all but the control and one treatment pertained to calcium only. Each treatment was replicated three times. The fertilization plots were 10 x 40 ft. and the fertilization treatments were completely randomized.

The fertilizer elements were applied March 22, 1963, at the following rates of active material per acre: 33% ammonium-nitrate at 0, 40, 80, 160, and 320 lb.; 20% superphosphate at 0, 40, and 80 lb.; and 60% muriate of potash at 0, 60, and 120 lb. Weed control was obtained by spraying one-half of each plot with 2,4-D amine at the rate of 0.5 lb. per 20 gal. of water per acre. Spraying was done during the early part of April and it was not necessary to respray.

Prior to fertilization the entire area was mowed to a uniform 6-inch stubble height. Initial variation between plots was determined by frequency analyses via the inclined point-contact technique. Subsequent, frequency analyses were also determined by the same technique.

The Student's t test revealed that some of the plots had a significantly different initial frequency of little bluestem than other plots. The treatment with the highest frequency of little bluestem was the control. These initial differences prompted a multiple regression analysis for forage yields including 14 variables: (1) time, (2) N, (3) P, (4) K, (5) $time^2$, (6) N^2, (7) P^2, (8) K^2, (9) time x N, (10) time x P, (11) time x K, (12) NP, (13) NK and (14) PK. The variable "time" was included to determine the effects brought about by natural environmental developments such as phenological development of the plant community. To test for curvilinearity, the original data were squared and included as the variables N^2, P^2, K^2 and $time^2$. The effect of calcium fertilization was determined by analysis of variance.

Forage production was measured by clipping four circular quadrats containing 9.6 $ft.^2$ on each plot on May 30, July 30 and December 5, 1963. The latter date was determined by the first frost. The forage was clipped to a two-inch stubble height and clippings were not repeated on the same plot. Production at any clipping date represents growth in weight from the beginning of the growing season to that date and does not represent accumulated weight through repeated clipping. This was deemed necessary in order to avoid any influence that frequent clipping might have on forage production.

Results and Discussion

The study was largely influenced by drought during most of the growing season. Precipitation was less than three-fourths of the average for the area during six of the months of the year and was below average during eight months. Extremely low amounts of precipitation in May, June, and August were probably the most influential in respect to plant growth and certainly to the effects obtained from fertilization. Conversely, above average rainfall during April was beneficial to plant growth and response to fertilization.

The species composition of the community continually changed throughout the study, primarily due to weeds. The occurrence of annual weeds was significantly influenced by the variables K and time. These weeds were present on all plots at the beginning of the study and slightly increased with time to about May 16, then continually decreased (Figure 1). Nitrogen and phosphorus had no significant influence on the frequency of weeds, but potassium did. As shown in Figure 1, K at both the 60 and 120 lb. rates of fertilization caused a sharp increase in weeds from March 14 through May 16. The frequency of weeds was essentially the same at the beginning and the end of the growing season, whereas the frequencies on May 16 of the 60 and 120 lb. levels were twice as high as for the 0 level of K. The increase in weeds due to potassium fertilization had a significant influence on the production of little bluestem.

Fertilization definitely increased the oven-dry forage pro-

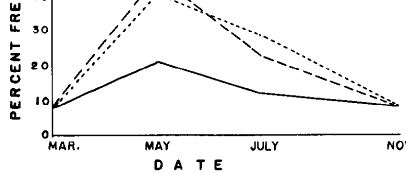

FIGURE 1. Effects of potassium fertilization (in pounds of active material per acre) on frequency of weeds.

duction of little bluestem as compared to no fertilization. The average increase with no weed control was 560 lb./acre—a 50% increase. This difference was not analyzed for statistical significance, but is considered important and significant, especially since the unfertilized plots had a higher initial frequency of little bluestem. The control of broadleaf herbaceous weeds resulted in an additional 21.7% increase in forage yield.

The variables related to a significant increase or decrease in the forage production of little bluestem are given in Table 1. The high regression coefficients for the phosphorus variable, both with and without weed control, indicate that the increase in forage production through fertilization was largely related to phosphorus. Also, the larger regression coefficient under weed control indicates that little bluestem plants will more efficiently respond to phosphorus fertilization in the absences of weeds than in their presences.

The effect of phosphorus on forage production was largely due to the 80 lb./acre rate. Fertilization at the 80 lb. level with no weed control brought about a 287 lb./acre increase in May, a 615 lb. increase in July and a 418 lb. increase in December. The 40 lb. level resulted in forage increases of only 77, 180, and 66 lb. during the same respective periods. The increases were greater in the presences of weed control.

With no weed control, potassium caused a decrease in forage yields of little bluestem (Table 1). This decrease in forage production was apparently caused by the increase in weed growth and subsequent competition brought about by potassium fertilization. This is partially substantiated by the fact that the negative and linear regression coefficient for the variable K was significant at the 5% level with no weed control, but was not a statistically significant variable with weed control (Table 1). Potassium also caused a sharp increase in herbage produced by weeds. The 60 and 120 lb. rates of potassium produced increases in weed yields of 612 and 572 lb./acre respectively.

The research was designed with the hypothesis that little bluestem production would respond primarily to nitrogen fertilization. The fact that this was not true is believed to be due to the below average precipitation during the study. If this is true, then little bluestem will respond to nitrogen fertilization only with sufficient moisture. This assumption is partially substantiated by the significant negative curvilinear relationship between nitrogen and little bluestem production (Table 1). The negative curvilinearity of little bluestem production was attributed to the rainfall pattern during the study. Production increased in the spring, decreased in the summer and again increased in the fall. However, it seems important to note that little bluestem production increased with phosphorous fertilization in spite of the drouth.

The interaction variable NK was also related to the increase in little bluestem production (Table 1). The positive effect of this variable is interesting in that the variables N and K by themselves caused a negative effect. Perhaps the effect of the variable NK is related to the curvilinear relationship between nitrogen and little bluestem production. The variable PK had no influence on little bluestem production in the absences of weed control, but was a significant variable with weed control. The negative regression coefficient indicates incompatability in the presences of weed control. Calcium fertilization caused no increase or decrease in little bluestem production.

It was observed during the growing season that the plants on the plots fertilized with nitro-

Table 1. Regression coefficient and Student's t of regression coefficient for little bluestem forage production[1]

Variable	No weed control Reg. Coef.	No weed control t of Coef.	Weed control Reg. Coef.	Weed control t of Coef.
N				
N^2	−.1535 (−2)	.2331 (1)	−.1133 (−2)	.2070 (1)
P	.7324 (0)	.3497 (1)	.1302 (1)	.4106 (1)
P^2				
K	−.4373 (−0)	.2018 (1)		
K^2				
NP				
NK	.5060 (−2)	.2660 (1)	.3963 (−2)	.2785 (1)
PK			−.8182 (−2)	.2956 (1)
time				
$time^2$				
time x N				
time x P				
time x K				

[1]Regression coefficients and Student's t are given only for the variables which were significant at the 5% level. The remaining variables were eliminated by the multiple regression procedure. Regression coefficients with a positive value denote the variables which cause a significant increase in the forage production of that species. The coefficients with a negative value denote a significant decrease in forage production. Figures such as .1535 (−2) mean .1535 x 10^{-2}.

gen and phosphorus began their vegetative growth from one to two weeks earlier than the ones on the unfertilized plots. This was also found to be true by Hoglund, et al. (1952) and Honnas, et al. (1959). It was noted also that the plots which received large amounts of nitrogen produced a much darker green coloration in the leaves and stems. The green color gradually faded as rainfall became a limiting factor. This coloration again appeared during the fall when there was sufficient precipitation to bring about growth.

Summary and Conclusions

The study was conducted on a Tabor fine sandy loam soil near College Station, Texas. The design was a partial and unbalanced split-plot NPK factorial. Weeds were controlled on one-half of each plot and all plots except the control received a base fertilization of calcium. One treatment pertained to calcium only.

The effects of fertilization were influenced by droughty conditions throughout most of the study. In spite of these conditions, little bluestem and the community responded in various ways to fertilization. Annual weeds increased considerably with potassium fertilization. This increase in weed frequency and consequent increase in weed herbage production decreased the forage production of little bluestem.

Fertilization resulted in an approximate 50% increase in little bluestem forage production. Weed control resulted in an additional 22% increase. This increase was largely due to phosphorus fertilization, particularly at the rate of 80 lb./acre of active material. The relationship between nitrogen fertilization and little bluestem production was curvilinear. The negative curvilinear regression coefficient for nitrogen was attributed to the rainfall pattern during the growing season. Rainfall was high in the spring, low during the summer and again high in the fall. Potassium fertilization in the absence of weed control reduced little bluestem production. In the presence of weed control, potassium had no significant effect. The variable NK was also related to the increase in little bluestem production, both with and without weed control. Calcium had no effect on the little bluestem community.

This study indicates that little bluestem in this area should not be fertilized with potassium. It appears that little bluestem will respond to nitrogen fertilization only with sufficient moisture. The species did, however, respond to phosphorus fertilization under droughty conditions. Only 40 and 80 lb. rates of phosphorus fertilization were employed in this study. Future studies should include higher rates of phosphorus.

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