Soil Fertility and Production Parameters of *Andropogon scoparius* Tillers

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Highlight: *Inherent soil fertility substantially influenced selected production parameters of little bluestem tillers. Net aerial production, heights of tallest flowering culm, and number of flowering culms of tillers grown in clay soil were significantly higher than those grown in sand. Second year survival and regrowth was also greater on the clay soil. Apparently, tillers grown on the sand are highly dependent on a rapid mineral cycle.*

Soil fertility is a major influence on plant production. Most fertility studies have been concerned with major agronomic crops where fertilizer applications have resulted in increased production. Rangeland fertilization has been investigated only on a limited scale. Few studies have been concerned with inherent soil fertility levels and plant production.

The effect of fertilizers on native forage grasses has received recent attention. Growth and development of grasses and forbs in the northern Great Plains was greater with 67 lb/acre of applied nitrogen as opposed to 33 or 100 lb/acre (Goetz, 1970). The maximum yield occurred with the highest rate of fertilizer application on Coastal Prairie rangeland (Drawe and Box, 1969). Holt and Wilson (1961) reported a doubling of forage production on a desert grassland in response to ammonium phosphate and ammonium nitrate. Fertilizer application resulted in a 50% increase in little bluestem (*Andropogon scoparius*) forage production on a Tabor fine sandy loam in the Post Oak Savannah of Texas (Reardon and Huss, 1965). Results from such studies often reflect treatment effects on a single soil type. This does not allow examination of variations among inherent fertilities of various soil types and plant production.

Studies comparing plant production with inherent soil fertility are uncommon. Caird (1945) reported that a fine sandy loam produced 1,101 lb/acre while a clay soil supporting a similar grassland community produced 2,116 lb/acre. Van Amburg and Dodd (1970) reported that little bluestem clones from a clay soil were generally larger in circumference and contained more tillers than those from a fine sandy loam. However, number of roots produced per tiller was greater from the fine sandy loam.

Little bluestem is one of the most important forage species of the United States (Gould, 1968). It is widespread in North America and occupies a wide variety of habitats (Hitchcock, 1950). This wide range of distribution results from adaptive characteristics. Weaver and Fitzpatrick (1934) have reported extensive grassland areas dominated by 55 to 90% little bluestem. It has a wide tolerance to variation in soil texture (Nixon and McMillan, 1964). Soil fertility may be the most important factor in species distribution on clay textured soils (White, 1961). However, Hubbard (1917) stated that little bluestem has a variable growth habit in response to both environmental and edaphic factors. The objective of this study was to quantitate differences in growth parameters of little bluestem resulting from differences in inherent soil fertility.

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Methods

The effects of inherent soil fertility on selected production parameters of little bluestem tillers were evaluated in a greenhouse utilizing surface soils of a Tabor fine sandy loam and a Heiden-Hunt clay. The soils vary considerably in inherent fertility, texture, and water retention (Mowery et al., 1958). The A horizon of both soils contains approximately 80% of the root system of little bluestem under field conditions (Van Amburg and Dodd, 1970).

The Tabor fine sandy loam soil (Alfisol) developed from a sandy clay. The surface soil texture is 6.5% clay, 27.5% silt, and 66.0% sand. X-ray diffraction indicated highly weathered clay minerals in the A horizon. The surface soil was characterized as having an exchangeable Ca content of 1.50 meq/100g, CEC 4.99 meq/100g, and base saturation 38.08% (Van Amburg and Dodd, 1970). Reardon and Huss (1965) reported this soil to be deficient in nitrogen, phosphorus, potassium, and calcium. Inherent fertility is low and the soil usually exhibits low to moderate productivity of native plants (Mowery et al., 1958).

The Heiden-Hunt clay soil (Vertisol) developed from a calcareous clay. The surface soil is 32% clay, 35% silt, and 33% sand. The clay soil is not as highly weathered and contains a larger quantity of montmorillonitic clay than the Tabor soil with a reported exchangeable Ca content of 8.81 meq/100g, CEC 28.59 meq/100g, and base saturation 45.23% (Van Amburg and Dodd, 1970). This soil has moderate productivity resulting from moderate to high inherent soil fertility (Mowery et al., 1958).

On February 28, 1972, little bluestem clones and surface soil were collected from each soil site located in the Post Oak Savannah near College Station, Tex. A transition zone with one exposed tiller was planted in a 4-liter can containing approximately 3,000 g of surface soil. The soil moisture was maintained without leaf wetting throughout the study to minimize the effect of moisture stress. Litter did not accumulate on the soil surface during the study. Volunteering plants were removed periodically by hand. These practices were employed to remove major return avenues for minerals in a nutrient cycle. Adequate growing temperatures were maintained in the greenhouse.

Total number of flowering culms and height of the tallest flowering culm per transition zone was recorded at 41 weeks after planting. Tillers were then harvested by clipping 2.5 cm above the soil surface. Plant material was dried at 82°C for 24 hours and weighed to the nearest tenth of a gram. Data are reported as net aerial production per transition zone. Fifty-nine tillers were measured from the Tabor fine sandy loam and 61 from the Heiden-Hunt clay. Unequal numbers resulted from failure of transition zones to establish. Eighty-four tillers were originally planted on each soil type.

Regrowth as number of tillers per transition zone and length of longest leaf was recorded 3 weeks post-harvest. Survival and net aerial production were determined 25 weeks after the initial harvest.

Data were analyzed using a two sample t test to determine significant differences among sample means. Confidence intervals about the sample means were computed and a correlation matrix for each soil type was generated using the various tiller attributes.

Results and Discussion

Initial transition zone establishment was similar between soil types. Sixty-one transition zones out of the 84 planted were established in the Heiden-Hunt clay and 59 in the Tabor sand. These surviving transition zones were the basis of this study.

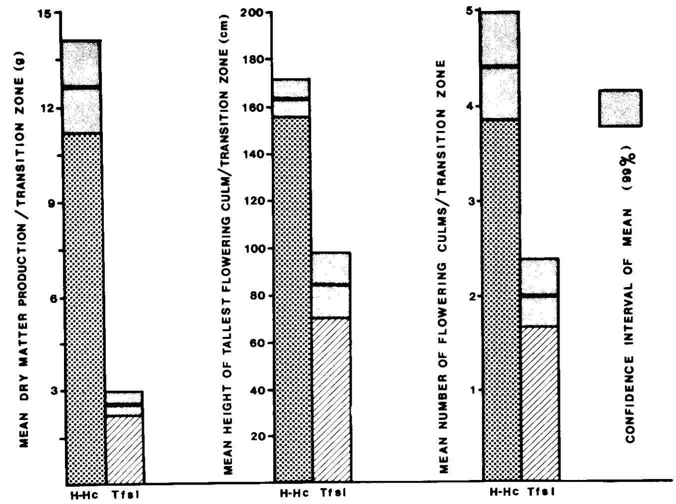

Fig. 1. *Mean dry matter production, height of tallest flowering culm, and number of flowering culms per transition zone for Tabor fine sandy loam (Tfsl) and Heiden-Hunt clay (H-Hc), 41 weeks after planting.*

Fig. 2. *Comparison of growth in Tabor fine sandy loam (left) and Heiden-Hunt clay (right) at maturation.*

Higher ($P < 0.01$) mean dry matter production (12.6 g/transition zone) on Heiden-Hunt clay than on the Tabor sand (2.6 g/transition zone) resulted at 41 weeks after planting (Fig. 1). Mean height of the tallest flowering culm (163.3 cm) from the Heiden-Hunt clay was taller ($P < 0.01$) than Tabor sand (84.3 cm) (Fig. 2). All transition zones had at least one flowering culm. Difference in the mean number per transition zone, 4.4 on Heiden-Hunt clay and 2.0 on Tabor sand, was significant ($P < 0.01$).

Three weeks after initial harvest, 77.1% of the transition zones in the Heiden-Hunt clay and 35.6% in the Tabor sand had initiated regrowth. At this time, length of the longest leaf per tiller and number of live tillers per transition zone were measured (Fig. 3). Of the plants developing regrowth, difference in mean length of the longest leaf, 6.5 cm on Heiden-Hunt clay and 7.2 cm on the Tabor sand, was not significantly different ($P > 0.05$). Difference in the mean number of tillers per live transition zone, 4.9 on Heiden-Hunt clay and 4.0 on Tabor sand, was significant ($P < 0.05$).

Twenty-five weeks after initial harvest, dry matter production was measured on those transition zones with

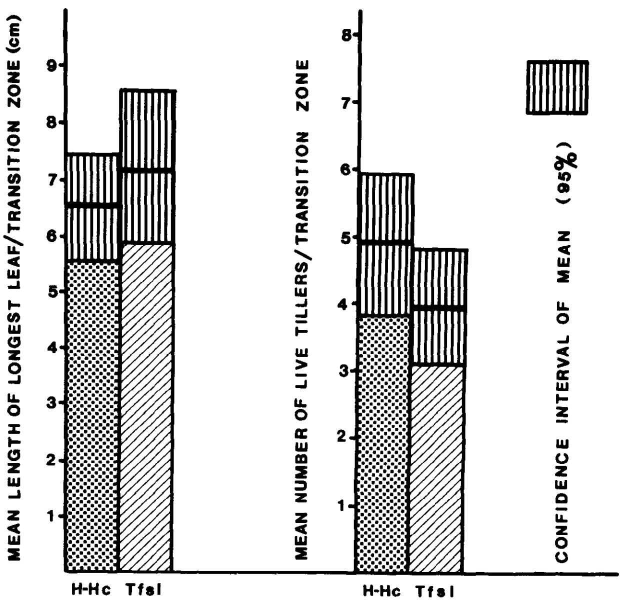

Fig. 3. *Mean length of longest leaf and number of live tillers per transition zone for Tabor fine sandy loam (Tfsl) and Heiden-Hunt clay (H-Hc), 3 weeks after initial harvest.*

regrowth (Fig. 4). Mean production from the Heiden-Hunt clay was 3.9 g per transition zone while only 0.3 g per transition zone was produced on the Tabor sand (significant at $P < 0.01$). At this time, 90.2% of the transition zones grown on Heiden-Hunt clay were alive while only 1.7% of those grown on Tabor sand were alive (Fig. 4).

Establishment of transition zones of little bluestem was similar in both soil types under greenhouse conditions. The greatest difference between the two soils was production of dry matter during the 41 weeks after planting. Production

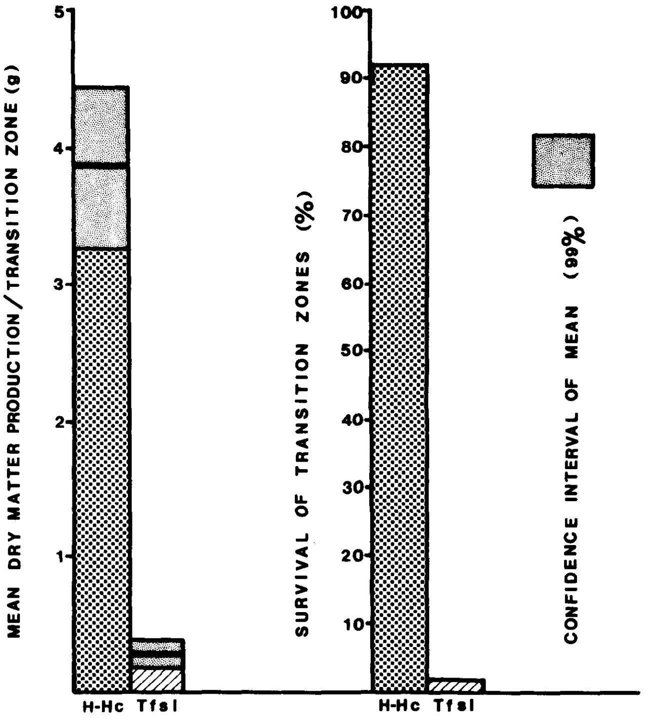

Fig. 4. *Mean dry matter production per transition zone and percent survival of transition zones for Tabor fine sandy loam (Tfsl) and Heiden-Hunt clay (H-Hc), 25 weeks after initial harvest.*

from Heiden-Hunt clay was five-fold greater than from Tabor sand. There is approximately a two-fold increase in production from Heiden-Hunt clay as compared to Tabor sand under field conditions (Waller, Unpublished data). Another contrast of tillers grown on these different soils was a doubling of average height of the tallest flowering culm and number of flowering culms per transition zone. Difference in development in field and greenhouse indicates that plants growing on Tabor sand are dependent on rapid mineral cycles.

Litter decomposition and throughfall are two major avenues for nutrient return to the soil. By eliminating these avenues of return, the tillers are dependent on the available nutrient reservoir in the soil. The difference in production between sand and clay grown tillers expresses the inherent nutrient status of the soil when the mineral cycle is eliminated. Tiller growth on sand is dependent on a rapid mineral cycle to maintain adequate nutrient concentrations in the tiller root zone. This was verified by ^{134}Cs research on mineral cycling of little bluestem on both of these soil types (Dodd and Van Amburg, 1970). Sixty percent of the cesium was maintained in the upper 10 cm of soil on the Tabor fine sandy loam. Tillers grown on the Tabor sand maintained a high, constant level of the isotope over time while those in the Heiden-Hunt clay exhibited a general loss over time. This was correlated with a more rapid movement through the soil of ^{134}Cs indicating a lack of dependence by the clay grown tillers on a rapid mineral cycle. The Heiden-Hunt clay has adequate nutrient concentrations to support growth of little bluestem tillers. However, the nutrient status of the Tabor sand is marginal requiring some type of nutrient return to maintain growth over time.

A correlation matrix (Table 1) of measured plant attributes provides further information. Variation in growth habit is illustrated by the relationship of height of tallest flowering culm, initial harvest (HGTA) and dry matter production, initial harvest (WGTA) for the different soils. The correlation for Heiden-Hunt clay was only 0.2847 while for Tabor sand it was 0.6145, indicating that most changes in dry matter production from Tabor sand were contributed by the inflorescences. However, on Heiden-Hunt clay the major contribution was from leaves and sheaths.

Table 1. Correlation matrix of measured production attributes of little bluestem tillers grown in Heiden-Hunt clay and Tabor fine sandy loam in the greenhouse.

	HGTA[2]	NFLC[3]	LTIL[4]	NTIL[5]	WGTB[6]
Correlation coefficients– Heiden-Hunt clay					
WGTA[1]	0.2847	0.2252	0.1707	0.2005	0.2197
HGTA		−0.4826	0.1518	−0.1432	−0.0158
NFLC			−0.0224	0.1938	0.3201
LTIL				0.5713	0.3159
NTIL					0.3632
Correlation coefficients– Tabor fine sandy loam					
WGTA[1]	0.6145	0.5268	−0.1868	−0.2694	0.0401
HGTA		0.2541	−0.0258	−0.1640	0.0843
NFLC			−0.0752	−0.0544	0.0978
LTIL				0.6877	0.4870
NTIL					0.6958

[1] WGTA = Dry matter production, initial harvest.
[2] HGTA = Height of tallest flowering culm, initial harvest.
[3] NFLC = Number of flowering culms, initial harvest.
[4] LTIL = Length of longest leaf, 3 weeks after initial harvest.
[5] NTIL = Number of surviving tillers, 3 weeks after initial harvest.
[6] WGTB = Dry matter production, 25 weeks after initial harvest.

Three weeks after the initial harvest, tillers from Tabor sand had slightly longer leaves than did those from Heiden-Hunt clay. However, tillers from the Heiden-Hunt clay had more leaves and about twice as many shoots as the Tabor sand. Also, from the correlation matrix, it can be noted that for Heiden-Hunt clay a positive correlation existed between WGTA and number of surviving tillers, 3 weeks after initial harvest (NTIL) while for Tabor sand there is a negative correlation. This suggests that tillers grown on Tabor sand depleted the available nutrients for dry matter production before the initial harvest. This resulted in reduced tiller regrowth following harvest.

Dry matter production measured 25 weeks after the initial harvest illustrated a large decrease in production from both soils. There was a substantial 10-fold increase in the ratio of dry matter production on Heiden-Hunt clay with that on Tabor sand. There was virtually no correlation between the amount of dry matter produced prior to the initial harvest (WGTA) and that produced 25 weeks after the initial harvest (WGTB), regardless of soil type. However, Tabor sand exhibited a high correlation between WGTB and NTIL while Heiden-Hunt clay showed a low correlation. This illustrated that on the less fertile Tabor sand, dry matter production was more dependent on the number of surviving tillers than on the fertile Heiden-Hunt clay.

Data indicate that production, regrowth, and survival of little bluestem were greater on the more fertile Heiden-Hunt clay soil than on the Tabor fine sandy loam. This implies that range forage grasses, such as little bluestem, could be utilized more frequently or in different grazing systems on the more fertile range sites than on sites of low soil fertility. Vegetation on range sites of low soil fertility would require more intensive management to insure sustained production, regrowth, and survival of the desirable species.

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