Nature of Phytomer Growth in Blue Grama[1]

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Highlight

The pattern and relative growth rates of the individual phytomers of blue grama were determined. A mature blue grama shoot from the site had an average of 13 complete phytomers. The first six phytomers appeared to be initiated in the growing season prior to the one in which the plant reached maturity. Internodal elongation of over 100 mm in a period of two weeks was not uncommon. In most instances the internodes did not elongate before the sheath and blade reached maximum length. The leaf of the last phytomer was initiated just prior to the middle of June. Mature sheath length varied from 15 mm in phytomer 13 to nearly 80 mm in phytomers 11 and 12. Blade length varied from 4 mm in phytomer 2 to 134 mm in phytomer 10.

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Growth is quantitative while development is qualitative. The total growth of a plant, when plotted on a graph, will generally be represented by a sigmoid curve. The sigmoid curve can be separated into three parts: (1) early period of slow growth, (2) central period of rapid growth and (3) final period of slow growth (Curtis and Clark, 1950; Bonner and Galston, 1952).

A phytomer has been described as a segment of the shoot, or phyton unit. It is an internode together with the leaf at its upper end and a bud at its lower end. The bud may be represented only by a meristematic region. The leaf and bud are on opposite sides of the axis. A phytomer is a unit of structure of the shoot (Evans and Grover, 1940).

Each new grass leaf begins expansion inside the folded sheaths of the older leaves. When the leaf tip emerges from the enclosing sheath, the blade unrolls, the ligule is differentiated and the meristematic activity in the blades ceases. The leaf sheath ceases to grow when the ligule is exposed (Bonnett, 1936; Sharman, 1942).

Blades and sheaths of most successive grass leaves, formed prior to flower initiation, tend to become progressively longer, but continue

to appear at a constant rate that is characteristic of the environmental conditions. The difference in leaf size is due to differences in cell size rather than in the number of cells (Stucky, 1942; Cooper, 1951).

Internode elongation of wheat has been thoroughly studied. An internode does not begin to elongate until the leaf, attached to the node immediately above, has completed elongation, and the internode directly below, has stopped growth (Sande-Bakhuyzen, 1928). Internode elongation starts slowly, accelerates to a maximum and then gradually diminishes. This follows the sigmoid pattern of growth (Percival, 1921). Major internodal elongation begins soon after floral differentiation becomes evident (McKinney and Sando, 1935).

Methods

A 5 × 7-ft plot was established on a complete, undisturbed stand of blue grama (*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.) at the Scottsbluff Experimental Range. Starting on March 17, 1967, blue grama shoots were collected from this stand at weekly intervals until July 28, 1967. Collections were made at four locations within the plot at each collection date. The collected shoots were stored in a preserving solution until they were dissected.

Before a shoot could be dissected and measured, a decision had to be made as to what constituted a single shoot. In tillering grasses this is difficult to determine. The process of tiller formation and the development of nodal roots occur throughout the growing season. A clump of vegetative material appears to be one continuous plant.

In this study, an individual blue grama shoot was defined as plant material that was separated from other material by the presence of a prophyllum and had at least one nodal root. The prophyllum is the first leaf of the shoot. It is a two-keeled organ which encloses the axillary bud (Hitchcock, 1951).

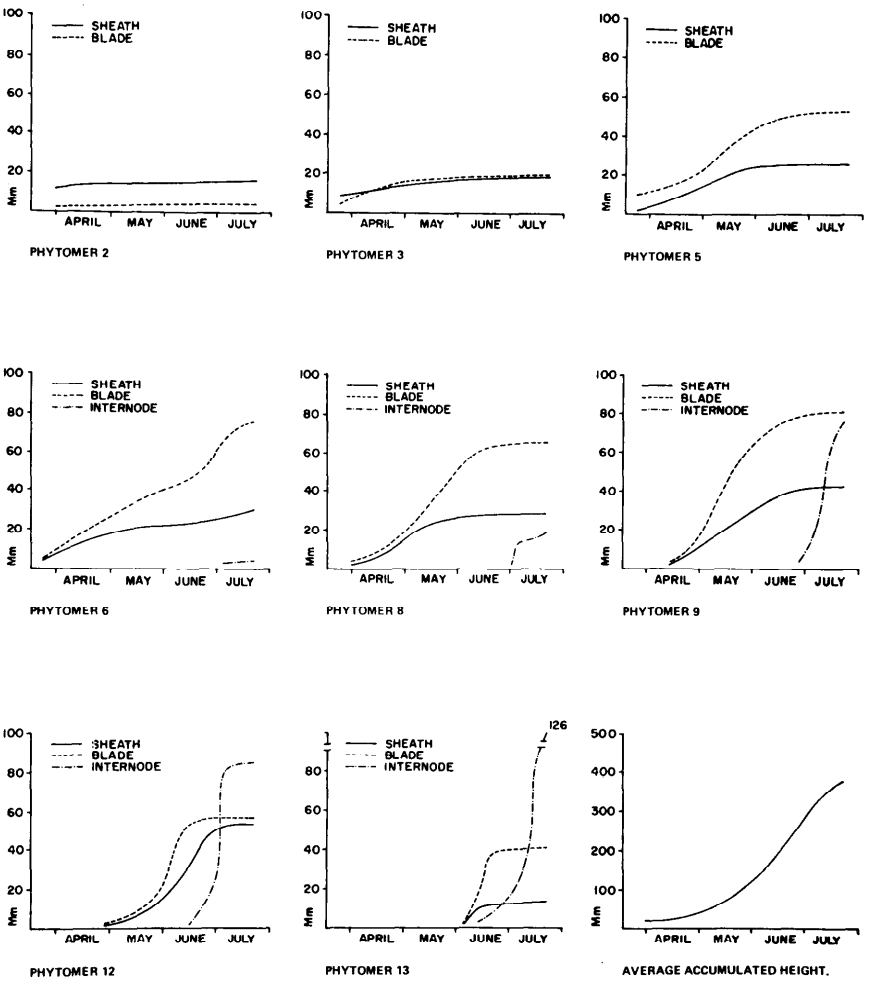

FIG. 1. The average accumulated length and rate of growth of the components of selected phytomers and the average accumulated height of the blue grama plant—April through July, 1967.

Individual shoots were dissected in reverse order of their collection dates. This allowed their development to be more easily traced. Measurements were made to the nearest millimeter on each of 4 shoots for each collection period.

Results and Discussion

The mature shoots that were dissected had an average of 15 internodes. The first five internodes were basal and are termed the proaxis. The next eight internodes were elongated and made up the reproductive culm. The last two internodes were located directly below and between the nodes to which the rachises of the spikes were attached.

The leaves of the first six phytomers were initiated during the growing season previous to the one in which the plant reached maturity. The first phytomer grew little, if any, in the growing season that the plant reached maturity. The leaves associated with the first phytomer were scales. A scale is a reduced leaf composed mainly of sheath tissue.

The internodes of phytomer 1 through 5 were less than 2 mm in length. No structures measuring less than 2 mm were shown in Figure 1. The internode of the first 5 phytomers remained at, or below the soils surface all season. The sheath and blade of phytomer 2 grew little from the first of April

to the end of July. The leaf blade for the phytomer was shorter than the leaf sheath. The leaf blade of phytomer 3 surpassed the sheath length during the last week in April. The extension in length of these two phytomer elements was parallel for the rest of the growing season.

The last basal internode was associated with phytomer 5. The internode of phytomer 6 elongated to more than 2 mm in the middle of July. Additional growth of the sheath and blade occurred at the time of internode elongation.

Internode elongation of blue grama differs from that which has been reported for wheat (Sande-Bakhuyzen, 1928). The internodes of both wheat and blue grama do not elongate until the leaf attached to the node immediately above has completed elongation, but the internodes of blue grama do start to elongate before the internode directly below stopped growth.

Phytomer 7 and phytomer 8 were the first to be initiated after spring growth started during the first week in April. The majority of the internode elongation of phytomer 8 occurred with a period of one week (Fig. 1).

The first measurable growth of phytomer 9 occurred in the middle of April. This is approximately one week later than that of phytomers 7 and 8. The first major internodal elongation occurred in phytomer 9. It grew approximately 75 mm within a period of two weeks.

The growth of phytomers 10, 11 and 12 was quite similar. In all cases, the internode did not show any major elongation until the sheath and blade reached their maximum length. The major internodal elongation for all phytomers occurred over a one or two week period in late June and early July.

The first measurable growth of phytomer 13 (Fig. 1) was recorded for the second week in June. This is almost a month later than that of phytomer 12. The lengths of the blade and sheath of this phytomer were smaller than those of phytomer 12. An average internode length of 126 mm was recorded. This length represents a major contrast with the average internodal length of less than 2 mm in the first five phytomers.

In an earlier paper Stubbendieck and Burzlaff (1970) indicated the tiller development in blue grama was dependent upon the elongation of the reproductive culm. A supporting report is available from Green (1969) who showed tillers with maximum length occurred on the reproductive culm. The nature of the morphological development of blue grama would indicate that a 2–3 week deferment from grazing is desirable while the reproductive culm is undergoing rapid elongation. This will assure active tiller initiation and development for the subsequent years production.

The mature blue grama shoots that were dissected had an average of two spikes per reproductive culm. Length of the mature internode separating the two spikes was 60 mm. Elongation of the internode occurred over a 3-week period. The average accumulated height of the mature shoot of blue grama measured in this study was 375 mm. The rate of growth of the whole plant followed a sigmoid pattern similar to that of the individual phytomer.

This data represents a response to a particular set of environmental circumstances. The length of blades, sheath, internodes and number of phytomers per shoot and accumulated shoot height could be quite different under another set of environmental conditions.

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