Morphological Development Rates of Perennial Forage Grasses

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MORPHOLOGICAL DEVELOPMENT RATES OF PERENNIAL FORAGE GRASSES

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ABSTRACT
The objective of this study was to determine the rate of change in the morphological development of switchgrass (*Panicum virgatum* L.) and big bluestem (*Andropogon gerardii* Vitman). Pure stands of each species were sampled at weekly intervals in 1990 and 1991 at Mead, NE, and morphologically classified as mean stage count (MSC) and mean stage weight (MSW). Linear day of the year equations accounted for 94% of the variation in switchgrass MSC and MSW. Switchgrass MSC and MSW increased at an average rate of 0.0204 and 0.0234 units per day, respectively. Linear day of the year equations accounted for 73 and 84% of the variation in big bluestem MSC and MSW, respectively. Big bluestem MSC and MSW increased at an average rate of 0.0147 and 0.0215 units per day, respectively. The morphological development of switchgrass and big bluestem can be reliably predicted for adapted cultivars in the central Great Plains using day of the year due to the determinate growth habit of these grasses and their strong response to photoperiod.

KEYWORDS
<orphological development, growth rate, switchgrass, big bluestem

INTRODUCTION
Switchgrass and big bluestem are perennial, warm-season grasses native to the central Great Plains of the United States. Switchgrass and big bluestem have become increasingly important as pasture grasses in the central and eastern United States due to their ability to be productive during the hot summer months when cool-season grasses are relatively unproductive (Moser and Vogel, 1995). Cumulative effects of genetics, environment, and plant age are integrated and expressed in the developmental morphology of a species (Buxton and Marten, 1989). Morphological development influences the accessibility, palatability, and regrowth potential of forage species following defoliation (Briske, 1991). Understanding the rate of change in morphological development of perennial grasses can be used to predict and properly time the application of management practices. The objective of this study was to determine the rate of change in the morphological development of switchgrass and big bluestem tiller populations.

METHODS
Pure stands of 'Trailblazer' switchgrass and 'Pawnee' big bluestem were seeded in 1986 as a randomized complete block with six replications on a Sharpsburg silty clay loam soil (Typic Argiudoll) near Mead, NE. Switchgrass and big bluestem were harvested at approximately 7-d intervals beginning 6 June and concluding 6 September 1990, and beginning 22 May and concluding 3 September 1991. Tillers used for morphological classification were hand-clipped at ground level from 0.09-m^2 quadrats randomly located within each whole plot. Tillers were morphologically classified as mean stage count (MSC) and mean stage weight (MSW) at each harvest date using the system described by Moore et al. (1991) to quantify the developmental morphology of the tiller populations. The MSC and MSW for each species and harvest were regressed against day of the year, and morphological development rate determined by evaluating the slope of the regression for each species.

RESULTS AND DISCUSSION
Switchgrass and big bluestem developmental morphology progressed linearly with day of the year (Fig. 1 & 2). Day of the year accounted for 94% of the variation in switchgrass MSC and MSW. However, day of the year accounted for only 73 and 84% of the variation in big bluestem MSC and MSW, respectively. Switchgrass MSC and MSW were always higher than big bluestem MSC and MSW on common days of the year, which indicated that switchgrass matured more rapidly than big bluestem. Switchgrass had a larger proportion of tillers reach the seed production stage than big bluestem, causing the higher MSC for switchgrass. Few big bluestem tillers developed to the seed production stage prior to the completion of harvesting.

The morphological development rate was more rapid for switchgrass than for big bluestem (Fig. 1 & 2). Additionally, the rate of change in MSW was more rapid than the rate of change in MSC for both species. For switchgrass, the rate of change in MSC averaged 0.0204 units per day and was slower than the rate of change in MSW, which averaged 0.0234 units per day (Fig. 1). For big bluestem, the rate of change in MSC averaged 0.0147 units per day and was slower than the rate of change in MSW, which averaged 0.0215 units per day (Fig. 2).

Switchgrass and big bluestem MSC was linearly related to MSW. However, MSC slightly underestimated MSW in both species, particularly at later stages of development, which is consistent with the results of the morphological development rates, and previous research on warm-season grasses (Hendrickson, 1992). The MSC is a weighted average of all tillers present, so the contribution of juvenile and mature tillers is equally weighted (Kalu and Fick, 1981). However, the MSW is based on the weight of individual tillers. Since mature switchgrass and big bluestem tillers weigh much more than juvenile tillers, the mature tillers affect MSW proportionately more (Kalu and Fick, 1981), and may make MSW more applicable for growth rate predictions.
The morphological development rates of switchgrass and big bluestem occurred in a linear, highly predictable manner. Consequently, the morphological development of switchgrass and big bluestem can be reliably predicted for adapted cultivars in the central Great Plains of the United States using day of the year due to the determinate growth habit of these grasses and their strong response to photoperiod. Understanding the rate of development in perennial grasses will provide additional information for quantifying the growth and development of range and pasture species, and for making management recommendations to producers. It should be recognized that for quantifying the developmental morphology of perennial grasses, MSW may be the best estimator in research studies, whereas MSC may be the most applicable for producer recommendations.

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REFERENCES

Briske, D.D. 1991. Developmental morphology and physiology of grasses. Pages 85-108 *in* R.K. Heitschmidt and J.W. Stuth (ed.) Grazing management: an ecological perspective. Timber Press, Portland, OR.

Buxton, D.R. and G.C. Marten. 1989. Forage quality of plant parts of perennial grasses and relationship to phenology. Crop Sci. **29**: 429-435.

Hendrickson, J.R. 1992. Developmental morphology of two Nebraska grasses and its relationship to forage quality. M.S. thesis, Univ. of Nebraska, Lincoln.

Kalu, B.A. and G.W. Fick. 1981. Quantifying morphological development for studies of herbage quality. Crop Sci. **21**: 267-271.

Moore, K.J., L.E. Moser, K.P. Vogel, S.S. Waller, B.E. Johnson and J.F. Pedersen. 1991. Describing and quantifying growth stages of perennial forage grasses. Agron J. **83**: 1073-1077.

Moser, L.E. and K.P. Vogel. 1995. Switchgrass, big bluestem, and indiangrass. Pages 409-420 *in* R.F. Barnes, et al., ed. Forages: an introduction to grassland agriculture (5th ed.) Iowa State Univ. Press, Ames.

Figure 1
Mean stage count (a) and mean stage weight (b) as a function of day of the year for switchgrass grown near Mead, NE, USA during 1990 and 1991 (n = 27).

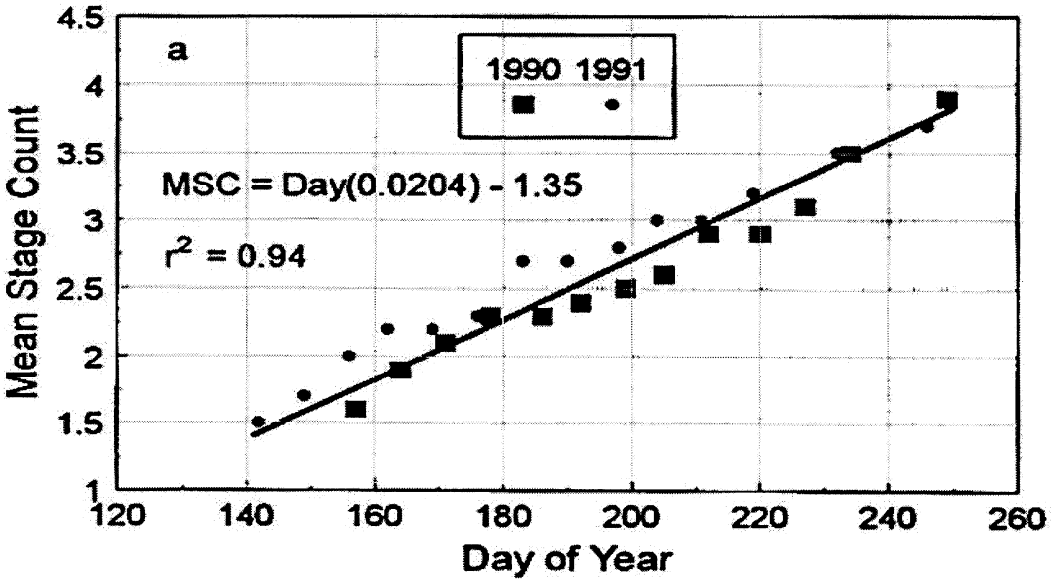

Figure 2
Mean stage count (a) and mean stage weight (b) as a function of day of the year for big bluestem grown near Mead, NE, USA during 1990 and 1991 (n = 27).