J. Range Manage.
50:175–177

Technical Note: Field measurement of etiolated growth of rhizomatous grasses

PATRICK E. REECE, JAMES T. NICHOLS, JOE E. BRUMMER, AND RUSSELL K. ENGEL

Authors are associate professor, Panhandle Research and Extension Center, University of Nebraska, 4502 Avenue I, Scottsbluff, Nebr. 69361; professor emeritus, West Central Research and Extension Center, University of Nebraska, Route 4, Box 46A, North Platte, Nebr. 69101; superintendent and research scientist, Mountain Meadow Research Center, Colorado State University, P.O. Box 598, Gunnison, Colo. 81230; research associate, West Central Research and Extension Center, University of Nebraska, Route 4, Box 46A, North Platte, Nebr. 69101.

Abstract

Defoliation effects on grasses have been quantified with measurements of etiolated growth since the 1960's, however, field techniques for measuring etiolated growth of rhizomatous grasses with dispersed tillers have not been reported. Tents constructed with landscape fabric were used in a field study of 2 species of rhizomatous grass. When manufactured, the woven polypropylene fabric is needle punched for air and water permeability. Light that may pass through perforations has no measurable effect on etiolated growth as indicated by a test of single and double layers of fabric. Tents can be sized to shade borders around interior sample areas to prevent translocation from outside tillers to harvested tillers. Landscape fabric tents are light weight and reusable and eliminate breakage, water vapor, and storage problems associated with other covers.

Key Words: initial-spring growth, total-organic-reserve index, *Calamovilfa longifolia*, *Andropogon hallii*

Resumen

Los efectos de defoliación sobre las gramineas han sido cuantificados con medidas de crecimiento etiolado desde la década de los 60's, sin embargo, no se han reportado técnicas de campo para la medición del crecimiento etiolado de gramineas rizomatosas. Se utilizaron carpas construidas con tela de invernadero en un estudio de campo de 2 especies de gramineas rizomatosas. Al ser fabricadas, la tela de polipropileno tejido fue agujereada con agujas para permitir la entrada del aire y la permeabilidad al aqua. La luz que puede pasar a través de dichas perforaciones no tiene un efecto medible sobre el crecimiento etiolado tal y como lo indica una prueba de una y 2 capas de tela. Las carpas pueden ser ajustadas para sombrear los bordos que circundan las áreas interiores de muestreo para evitar la translocación de los tallos externos a los tallos cosechados. Las carpas de tela de invernadero son ligeras de peso, reutilizables y eliminan el peligro de rompimiento, vapor de agua y problems de almacenamiento asociados con otro tipo de telas utilizadas como cubiertas.

Etiolated growth of grasses has been used to quantify the effects of grazing history, grazing date and frequency, fertilizer application, clipping date, stubble height, competitive stress from weeds, and to determine tolerance to herbicides (Peterson 1962, Raese and Decker 1966, Bryan and McMurphy 1968, Matches 1969, Young and Evans 1978, Reece et al. 1988, Reece et al. 1996). Mean tiller weight of etiolated initial-spring growth is a valid index of total organic reserves when environmental and physiological limitations do not occur (Busso et al. 1990). However, translocation of assimilates among distant tillers of rhizomatous species may confound measurements (Rogan and Smith 1974). Movement of assimilates from uncovered to covered tillers can be stopped by severing rhizomes around the perimeter of covers or by shading additional area around sample quadrats. Severing rhizomes is labor intensive and also cuts shallow roots. Material and/or labor costs for framed or rigid types of covers increase measurably when the shaded area increases. Our objective was to evaluate the utility and cost of tents constructed of landscape fabric.

Appreciation is expressed to Gordon D. Moeller, Brian K. Northup and Sharon Holman for their assistance.

Research was partially funded by a CSRS grant, Project No. NEB-43-053. Published as Paper 11247, Journal Series, Nebraska Agricultural Research Division.

Manuscript accepted 30 Mar. 1996.

Materials and Methods

Studies of etiolated initial-spring growth of prairie sandreed [*Calamovilfa longifolia* (Hook.) Scribn.] and sand bluestem (*Andropogon hallii* Hack.) were conducted in the field at the University of Nebraska, Gundmundsen Sandhills Laboratory, near Whitman, Nebraska. Soils were Valentine fine sands (mixed, mesic, Typic Ustipsamments). About 75% of the vegetation consisted of prairie sandreed, sand bluestem, little bluestem (*Andropogon scoparius* Michx.), and switchgrass (*Panicum virgatum* L.). The vegetation is described in more detail by Reece et al. (1996).

Landscape fabric, Pro5 Weed Barrier[1] was used to construct tents. This material is an ultra-violet stabilized, woven and needle punched polypropylene fabric which allows air and water movement but is 99.8% opaque. Nixon (1993) reported an average distance of less than 15 cm between prairie sandreed tillers on the same rhizome. Consequently, 1.0 × 1.0 m tents were designed to cover an area about 90 × 90 cm. This provided a 20-cm wide shaded border around an interior 0.25 m^2 sample area to minimize translocation of assimilates. Tents were suspended with polyvinyl chloride (PVC) frames and anchored with 26-cm long, 4-mm diameter wire landscape staples.

Thirty, 0.25 m^2 sample areas with residual stubble of both study species were selected in each of 2 pastures with different grazing histories, rested versus heavy summer grazing during 1988–1989. In each pasture, 10 sample areas were randomly assigned to each cover treatment: (1) uncovered, (2) single layer tent or, (3) double layer tent. Tents were installed in early April before initial-spring growth had begun. Residual stubble of prairie sandreed and sand bluestem was cut to a height of 5 cm on the same day that sample areas were covered. Etiolated growth was examined at 1-week intervals under 6 randomly selected tents. Growth was initially rapid and declined through time. When visual evidence of growth did not occur for 2 weeks, tillers were counted and clipped at ground level from uncovered and covered 0.25 m^2 quadrats on 6 June 1990, oven dried at 60°C for 48 hours and weighed to estimate dry matter yield. Data were analyzed with the General Linear Models Procedure (SAS 1982). Means were separated with the least-squares means procedure within SAS (Searle et al. 1980).

Table 1. Effect of cover treatment on mean tiller weight, total herbage and tiller density of initial-spring etiolated growth for prairie sandreed and sand bluestem at the Gudmundsen Sandhills Laboratory near Whitman, Nebr.

Cover Treatments[1]	Weight/Tiller[2]	Total Herbage	Tiller Density
	(mg)	(g m^{-2})	(no m^{-2})
Prairie Sandreed			
Uncovered	131a	12a	89a
Single Layer	74b	5b	60b
Double Layer	83b	5b	64ab
Sand Bluestem			
Uncovered	137a	23a	173a
Single Layer	49b	6b	119b
Double Layer	54b	5b	106b

[1]Data for single and double layer treatments are for etiolated growth.
[2]Within columns and species, means with different lower case letters are significantly different, P≤0.05.

Results and Discussion

Etiolated initial-spring growth was not limited physiologically by availability of active meristematic tissue in either species. Uncovered areas produced about 45% more prairie sandreed tillers and about 55% more sand bluestem tillers compared to covered areas (Table 1). Similar differences between covered and uncovered plants occurred with blue grama [*Bouteloua gracilis* (H.B.K.) Lag.] and needleandthread (*Stipa comata* Trin. & Rupr.) initial-spring growth in western Nebraska (Reece et al. 1988). There were no measurable differences in the effect of single compared to double layers of landscape fabric on mean tiller weight, total herbage, or tiller density of etiolated growth for either species (Table 1).

Organic reserves from all plant parts, including roots, may be used for etiolated growth (Raese and Decker 1966, Ogden and Loomis 1972). Reserves include nonstructural carbohydrates, organic acids and nitrogenous compounds that may include proteins and amino acids (Davidson and Milthorpe 1965, McKendrick and Sharp 1970, Richards and Caldwell 1985). When plant growth is not limited mean dry matter yield of etiolated tillers increases as the concentration of reserves and/or the biomass of plant parts containing reserves increase (Adegbola 1966, Raese and Decker 1966, Matches 1969, Dovrat et al. 1972, Ogden and Loomis 1972, Busso 1988).

Based on the results of this study, tents used by Reece et al. (1996) consisted of a single layer of landscape fabric with a double folded 5 cm wide hem and grommets at each corner. Tents were stretched evenly over two 2.5 × 5.0 × 30.0 cm wood stakes, placed at the inside center of a 0.25 m^2 frame and driven to a remaining height of 15 cm, by securing the grommeted corners with wire landscape staples (Fig. 1). Additional staples were pushed through the hem to fit each side securely to the soil surface to exclude all light. Wood stakes were less expensive and required less labor compared to PVC frames used in 1990. The fabric was cut, hemmed and grommets installed for about $1.50 per tent at a tent and awning shop. Total labor and material cost per unit was about $5.00.

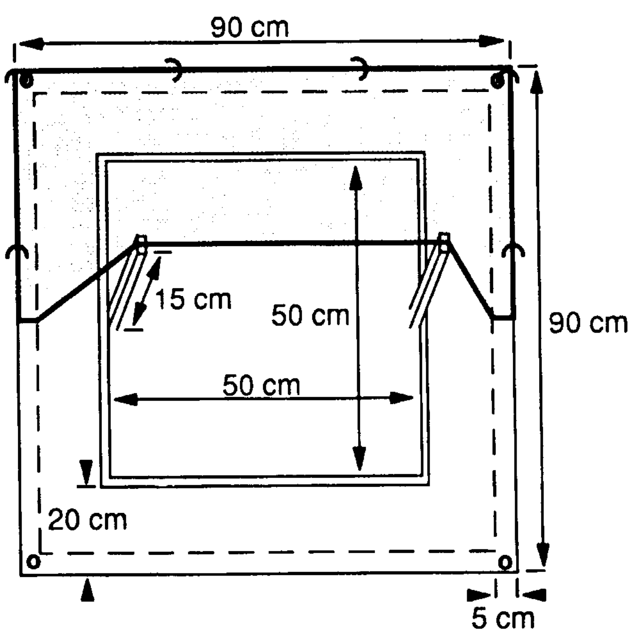

Fig. 1. Placement of 0.25 m^2 frame and wooden stakes for installation of shade tents constructed of a single layer of landscape fabric.

[1]DeWitt Company, Inc., Hwy 61 South, Sikeston, Mo. 63801.

Literature Cited

Adegbola, A. 1966. Preliminary observations on the reserve carbohydrate and regrowth potential of tropical grasses. Proc. 10th Int. Grassl. Congr. 10:933–936.

Bryan, G.G. and W.E. McMurphy. 1968. Competition and fertilization as influences on grass seedlings. J. Range Manage. 21:98–101.

Busso, C.A. 1988. Factors affecting recovery from defoliation during drought in two aridland tussock grasses. Ph.D. Diss. Utah State Univ., Logan, Utah.

Busso, C.A., J.H. Richards, and N.J. Chatterton. 1990. Nonstructural carbohydrates and spring regrowth of two cool-season grasses: Interaction of drought and clipping. J. Range Manage. 43:336–343.

Davidson, J.L. and F.L. Milthorpe. 1965. Carbohydrate reserves in the regrowth of cocksfoot (*Dactylis glomerata* L.). J. British Grassl. Soc. 20:15-18.

Dovrat, A., B. Deinum, and J.G.P. Dirven. 1972. The influence of defoliation and nitrogen on the regrowth of Rhodes grass (*Chloris gayana* Kunth). 2. Etiolated growth and non-structural carbohydrate, total-N and nitrate-N content. Neth. J. Agric. Sci. 20:97–103.

Matches, A.G. 1969. Influence of cutting height in darkness on measurement of energy reserves of tall fescue. Agron. J. 61:896–898.

McKendrick, J.D. and L.A. Sharp. 1970. Relationship of organic reserves to herbage production in crested wheatgrass. J. Range Manage. 23:434–438.

Nixon, J.L. 1993. Dynamics of prairie sandreed rhizome development. M.S. Thesis. Univ. of Nebraska. Lincoln, Nebr.

Ogden, P.R. and W.E. Loomis. 1972. Carbohydrate reserves of intermediate wheatgrass after clipping and etiolation treatments. J. Range Manage. 25:29–32.

Peterson, R.A. 1962. Factors affecting resistance to heavy grazing in needleandthread grass. J. Range Manage. 15:183–189.

Raese, J.T. and A.M. Decker. 1966. Yields, stand persistence, and carbohydrate reserves of perennial grasses as influenced by spring harvest stage, stubble height, and nitrogen fertilization. Agron. J. 58:322–326.

Reece, P.E., R.P. Bode, and S.S. Waller. 1988. Vigor of needleandthread and blue grama after short-duration grazing. J. Range Manage. 41:287–291.

Reece, P.E., J.E. Brummer, R.K. Engel, B.K. Northup, and J.T. Nichols. 1996. Total organic reserves in prairie sandreed and sand bluestem after four years of grazing treatments. J. Range Manage. 49:112–116.

Richards, J.H. and M.M. Caldwell. 1985. Soluble carbohydrates, concurrent photosynthesis and efficiency in regrowth following defoliation: A field study with *Agropyron* species. J. Appl. Ecol. 22:907–920.

Rogan, P.G. and D.L. Smith. 1974. Patterns of translocation of ^{14}C-labeled assimilates during vegetation growth of *Agropyron repens* (L.) Beauv. Z. Pflanzenphysiol. Bd. 73:405–414.

SAS. 1982. User's guide: Statistics. SAS Inst., Inc. Cary, N.C.

Searle, S.R., F.M. Speed, and G.A. Milliken. 1980. Populations marginal means in the linear model: an alternative to least squares means. Amer. Statistician. 34:216–221.

Young, J.A. and R.A. Evans. 1978. Etiolated growth of range grasses for an indication of tolerance to atrazine. Weed Sci. 26:480–483.