Light Interception, Reserve Status, and Persistence of Clipped Mott Elephantgrass Swards

C. J. Chaparro, L. E. Sollenberger,* and K. H. Quesenberry

ABSTRACT

Defoliation management is an important determinant of persistence of perennial forages. Persistence and related responses of 'Mott' elephantgrass (*Pennisetum purpureum* Schum.) have not been studied under a wide range of defoliation management practices. The objective of this study was to determine the effect of defoliation frequency and stubble height on Mott canopy light interception, rhizome mass and reserve status at season end, tiller number in spring, and persistence. Treatments imposed in 1989 through 1991 included all 16 treatment combinations of four defoliation heights (10-, 22-, 34-, and 46-cm stubble) and four defoliation frequencies (3, 6, 9, and 12 wk). Treatments were replicated three times in a randomized block design, and the soil was a hyperthermic, uncoated Aquic Quartzipsamment. Data were analyzed by fitting multiple regression equations starting with a second order polynomial model. Light interception after harvest ranged from 11 to 60% and was affected only by defoliation height. Light interception increased as defoliation height increased, but at a decreasing rate. Light interception before harvest ranged from 52 to 96% and was lowest for the 3-wk defoliation frequency, 10-cm stubble height treatment. In December following 2 yr of defoliation, rhizome total nonstructural carbohydrate concentration (TNC) ranged from 135 to 271 g kg^{-1} dry matter (DM), rhizome mass ranged from 24 to 733 g DM m^{-2}, rhizome TNC content was from nearly 0 to 197 g TNC m^{-2}, and rhizome N concentration was from 10.9 to 14.2 g kg^{-1} DM. Plants defoliated every 3 wk at a 10-cm stubble height had the lowest rhizome mass, TNC concentration and content, and N concentration, while values were greatest for those defoliated every 12 wk at a 46-cm defoliation height. Number of tillers per plant in May of 1990 and 1991 followed a similar trend. We conclude that Mott elephantgrass is persistent over a relatively wide range of clipping management practices, but close and frequent defoliation results in depletion of reserves and stand decline.

DEFOLIATION FREQUENCY and height affect forage persistence. The extent of their effect is determined by plant morphology and growth habit (Hodgkinson and Williams, 1983), environmental conditions (Harris, 1978), and the amount of time that a particular management practice has been imposed. In low-input systems of the subtropics and tropics, high establishment costs and low returns per unit land area have lead to an emphasis on species capable of long-term persistence. Understanding the effect of defoliation management on canopy characteristics related to persistence is an important component of forage evaluation programs.

Mott elephantgrass is a perennial forage that is well adapted to well-drained, fertile soils in the humid subtropics and tropics. Under rotational stocking, Mott has persisted well with 4- to 6-wk rest periods between grazings and 30- to 45-cm postgraze stubble heights (Sollenberger et al., 1988). Six harvests per year at a 5-cm height resulted in weakened plants of Mott and low yields in the third year of defoliation (Knettle et al., 1991). Chaparro et al. (1995) reported that in the third year of a clipping study with Mott, lowest total DM harvested was obtained with a 3-wk defoliation frequency, 10-cm stubble height treatment. Greatest total DM harvested in all years occurred with a 12-wk defoliation frequency, 10-cm defoliation height treatment. During a 1-yr grazing study with Mott, Rodrigues (1984) reported that close, frequent grazing reduced stem base TNC concentration and appeared to reduce the mass of the rhizome-root system. These studies suggest that Mott elephantgrass is productive over a relatively wide range of defoliation treatments, but close, frequent defoliation decreases total DM harvested, a result of reduced plant vigor.

Further characterization of Mott canopy characteristics and reserve status in response to clipping management should aid understanding of the productivity and plant vigor responses reported in the literature. Objectives of this experiment were to quantify the effect of defoliation frequency and stubble height on Mott elephantgrass (i) canopy light interception immediately before and after clipping, (ii) rhizome mass and TNC and N concentrations at season end, (iii) tiller number in spring, and (iv) plant persistence.

MATERIALS AND METHODS

This study was conducted from 1989 through 1991 at the University of Florida Forage Evaluation Field Laboratory, located 18 km northeast of Gainesville, FL (29°60′N lat). The soil at the experimental site was an Adamsville sand (hyperthermic, uncoated Aquic Quartzipsamment) that had a soil pH of 6.5 and Melich I extractable P and K of 94 and 38 mg kg^{-1} of dry soil, respectively. Phosphorus and K were broadcast applied at rates of 39 and 74 kg ha^{-1} in April each year. Eighteen kilograms per hectare of a micronutrient mixture (30 g kg^{-1} each of B and Cu, 180 of Fe, 75 of Mn, 2 of Mo, and 70 of Zn) were applied with the P and K. Nitrogen was broadcast applied at a rate of 160 kg ha^{-1} in four equal applications of 40 kg ha^{-1} at approximately 6-wk intervals throughout the growing season, starting in early to mid-April each year.

Treatments included all combinations of four levels of defoliation frequency (3, 6, 9, and 12 wk) with four levels of defoliation stubble height (10, 22, 34, and 46 cm). They were assigned at random to each of three complete blocks in the first year and imposed on the same experimental unit for all 3 yr. Plots were established vegetatively in July 1987. Each plot consisted of four, 5-m-long rows. Each row contained 10 plants and row spacing was 1 m. Plots were 2 m apart with 3-m alleyways between plot ends.

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Abbreviations: DM, dry matter; TNC, total nonstructural carbohydrate.

Before initiation of growth in mid-February each year, all plots were clipped at a 5-cm stubble height to remove the dead residue from the previous season. Defoliation frequency treatments of 3, 6, 9, and 12 wk corresponded to eight, four, three, and two harvests per year, respectively. Harvesting was initiated on 18 May 1989, 28 May 1990, and 21 May 1991, and ended on 20 Oct. 1989, 31 Oct. 1990, and 23 Oct. 1991.

Interception of photosynthetically active radiation was measured after the first harvest, and immediately before and after each subsequent harvest during the 1989 and 1990 growing seasons. Five measurements were taken per plot between 2 h before and 2 h after solar noon using a 1-m-long line-quantum sensor attached to a LI-COR 188B integrating quantum radiometer (LI-COR, Inc., Lincoln, NE). The line-quantum sensor was placed perpendicular to the rows above the canopy, and at soil surface beneath the canopy. Light interception data reported are averages across the year of before-harvest measurements and of after-harvest measurements.

Rhizome TNC and N concentration were assessed at the beginning (April–May) and end (December) of the 1989 and 1990 growing seasons. Two plants were split at each date. Half of each plant was removed from the soil and the other half left in place so as not to create large open areas in the plots. For the dug portion, rhizomes were separated from tops and roots, washed, and dried at 100°C for 1 h and 60°C to constant weight. The rhizomes were then ground and analyzed for TNC and N concentrations. Rhizome mass was quantified at the end of the second growing season (December 1990). Two entire plants were dug for this assessment. Rhizomes were processed as described earlier. Amount of TNC in rhizomes (TNC pool) at season end 1990 was calculated by multiplying rhizome mass per unit area by TNC concentration in rhizomes.

Total nonstructural carbohydrate concentration was determined by a modification of the procedure described by Christiansen et al. (1988). This procedure combines an enzymatic digestion phase (Smith, 1981) for conversion of starch and oligosaccharides into monosaccharides with a photometric copper reduction method for reducing sugars (Nelson, 1944). For each sample of 0.2 g, 1 mL of an enzyme mixture was used. The enzyme mixture was prepared using 40.5 mL of deionized water, 2.25 mL of acetate buffer (0.2 *M*), 2.25 mL of invertase concentrate (G. Schlesinger Industries, Inc., Karle Place, NY) and 0.6 g of amyloglucosidase (Boehringer Mannheim Corp., Indianapolis, IN). Nitrogen analysis was performed by a modification of the standard Kjeldahl procedure. Samples for N analysis were digested by a modification of the aluminum block technique of Gallaher et al. (1975), and analysis for ammonia in digestate was done by semi-automated colorimetry (Hambleton, 1977).

Plant counts were taken in the two center rows of each plot in April 1990 and 1991 to quantify plant persistence. From the same location, number of primary tillers was determined in May 1990 and 1991.

Data are reported by year because numerous interactions between defoliation treatments and year were detected with the General Linear Models procedure of SAS (SAS Institute, 1987). Within year, data were analyzed with the Response Surface Regression procedure of SAS (Freund and Littell, 1991; SAS Institute, 1987). The complete model used was a second-order polynomial of the form

$$y = \beta_0 + \beta_1 \mathrm{DF} + \beta_2 \mathrm{DF}^2 + \beta_3 \mathrm{DH} + \beta_4 \mathrm{DH}^2 + \beta_5(\mathrm{DF} \times \mathrm{DH}) + \varepsilon,$$

where y is the response variable, β_0 is the intercept, β_1 and β_3 are the linear coefficients for defoliation frequency (DF) and defoliation height (DH), β_2 and β_4 are the quadratic coefficients for defoliation frequency and defoliation height, β_5 is the interaction coefficient for defoliation frequency and defoliation height, and ε is the experimental error term. Lack of fit of the second order polynomial model was tested simultaneously. Only those coefficient estimates in the complete model that showed a significant effect ($P \leq 0.10$) on the response were considered in fitting the reduced model. The General Linear Models procedure (SAS Institute, 1987) was used to test the significance ($P \leq 0.10$) of coefficient estimates in reduced models. Terms that were not significant in the full model were retained in the reduced model only when higher order coefficients were significant. For example, when there was a defoliation frequency × defoliation height interaction, the linear effects of both terms were included in the model regardless of their level of probability. Similarly, when there was a quadratic effect, the linear effect was included. The $P(\mathrm{T} > \mathrm{T}) = \alpha$ values reported in Table 1 are for the coefficient estimates in the reduced model. Contour plots are presented to illustrate most responses. When contours are not presented, coefficient estimates are shown (Table 1) and the nature of the response is described in the text.

RESULTS AND DISCUSSION

Canopy Light Interception

Models describing light interception after harvest were similar in 1989 and 1990. Light interception was affected only by defoliation height and increased at a decreasing rate with taller cutting heights (Table 1). The range of this response was from 13 to 60% in 1989, and from 11 to 60% in 1990. These findings are similar to those reported for other forage species. Working with grazed rhizoma peanut (*Arachis glabrata* Benth.), Ortega-S. et al. (1992) found that postgraze light interception increased, also at a decreasing rate, as postgraze residual DM increased from 500 to 2500 kg ha^{-1}. In that study, length of rest period between grazings had no effect on light interception after grazing.

Models for light interception before harvest included all terms of the second-order polynomial in 1989, while in 1990, all but the quadratic term of defoliation height were included. In general, light interception increased with longer intervals between defoliations and taller defoliation heights (Table 1; Fig. 1 and 2). However, there was a defoliation frequency × defoliation height interaction in both years. Interaction occurred because the range of the light interception response to defoliation height was greater when intervals between harvests were short than when they were long (Fig. 1 and 2). When plants were defoliated at a 12-wk defoliation frequency, there was little effect of defoliation height on light interception before harvest, which was above 90% at any level of defoliation height. Values for light interception before harvest ranged from 63 to 96% in 1989, and from 52 to 95% in 1990.

Brougham (1956) found that light interception of a ryegrass (*Lolium multiflorum* Lam. × *L. perenne* L.)-white clover (*Trifolium repens* L.)-red clover (*T. pratense* L.) pasture ranged from 13 to 97% after plants were defoliated at 2.5-, 7.5-, and 12.5-cm stubble heights, but these differences disappeared by 24 d after defoliation. In

Table 1. Coefficient estimates for the fitted regression model: Estimated response = b_0 + b_1DF + b_2DF² + b_3DH + b_4DH² + b_5DF×DH or a reduced form of the model for responses reported.†

Response‡	b_0	b_1	b_2	b_3	b_4	b_5	R^2	Described in Fig.
LIA-89	−13.2	—	—	2.96	-3.00×10^{-2}	—	0.91	—
		—	—	0.001§	0.001	—		
LIA-90	−9.62	—	—	2.21	-1.67×10^{-2}	—	0.92	—
		—	—	0.001	0.004	—		
LIB-89	33.4	7.99	−0.261	1.02	-4.88×10^{-3}	-6.30×10^{-2}	0.92	1
		0.001	0.001	0.001	0.011	0.001		
LIB-90	18.0	10.2	−0.328	0.893	—	-7.20×10^{-2}	0.93	2
		0.001	0.001	0.001	—	0.001		
TNC-89	208	−1.04	—	−1.47	2.40×10^{-2}	0.112	0.53	—
		0.438		0.084	0.081	0.012		
TNC-90	52.8	13.6	—	5.12	-3.56×10^{-2}	−0.193	0.80	3
		0.001	—	0.001	0.080	0.004		
MASS	−197	48.6	—	7.54	—	—	0.92	4
		0.001	—	0.001	—	—		
POOL	−47.4	4.95	0.579	2.22		—	0.94	5
		0.181	0.020	0.001		—		
N	9.17	0.285	—	0.104		-5.74×10^{-3}	0.44	6
		0.014	—	0.001		0.098		
TILL-90	1.12	0.666	—	0.366	3.07×10^{-3}	-9.53×10^{-3}	0.76	7
		0.001	—	0.001	0.022	0.026		
TILL-91	−1.05	1.49	—	0.368		-1.37×10^{-2}	0.85	8
		0.001	—	0.001		0.064		

† DF = defoliation frequency (wk); DH = defoliation height (cm).
‡ LIA = light intercepted by plant canopy after harvest (%); LIB = light intercepted by plant canopy before harvest (%); TNC = rhizome total nonstructural carbohydrate concentration in December (g kg^{-1} DM); MASS = rhizome mass in December 1990 (g DM m^{-2}); POOL = rhizome total nonstructural carbohydrate content in December 1990 (g TNC m^{-2}); N = rhizome nitrogen concentration in December 1990 (g kg^{-1} DM); TILL = number of tillers per plant in May.
§ Significance level $P(|t|>t\alpha) = \alpha$.

the current study, light interception before harvest was 85% or greater for canopies defoliated at 9- or 12-wk defoliation frequencies regardless of height of clipping. Light interception by canopies defoliated every 3 wk never reached 85% before the next harvest and was considerably less than 85% when plants were closely defoliated (e.g., 10- and 22-cm defoliation heights). When Mott elephantgrass is defoliated at a 10-cm stubble height, about 9 to 10 wk are required to restore a full canopy (i.e., capable of intercepting 90% of incident radiation). It has been suggested that under frequent and close defoliation, leaf area of forage plants may not be capable of supporting the plant's growth needs, and regrowth is dependent upon mobilization of stored reserves (Booysen and Nelson, 1975; Harris, 1978).

Rhizome Total Nonstructural Carbohydrate Concentration

At the end of the first year of defoliation, rhizome TNC concentration varied relatively little, from 192 to 240 g kg^{-1} DM, but was lower in plants that had been

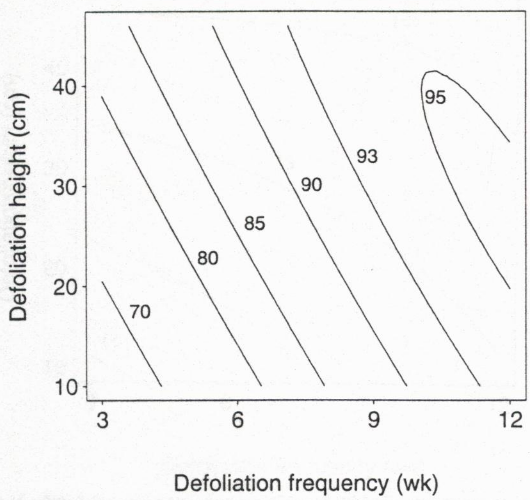

Fig. 1. Canopy light interception percentage before harvest as affected by defoliation frequency and defoliation height in 1989. Surface contours were generated by means of the model shown in Table 1.

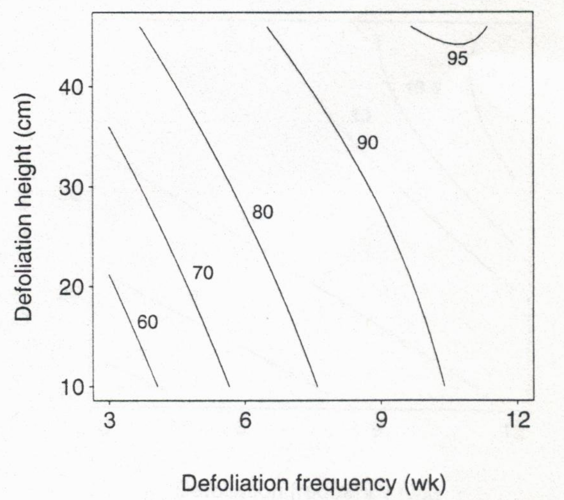

Fig. 2. Canopy light interception percentage before harvest as affected by defoliation frequency and defoliation height in 1990. Surface contours were generated by means of the model shown in Table 1.

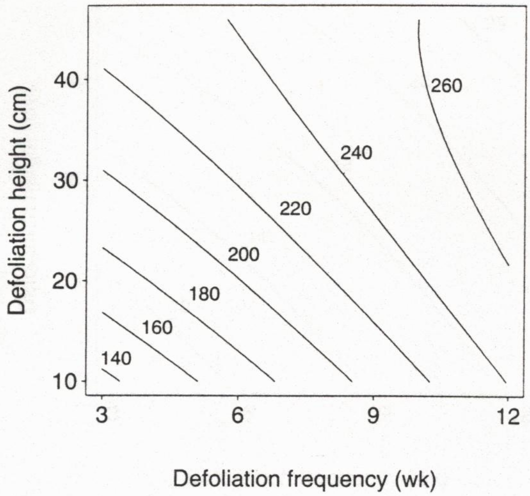

Fig. 3. Total nonstructural carbohydrate concentration (g kg^{-1} DM) in rhizomes at season end in 1990 as affected by defoliation frequency and defoliation height. Surface contours were generated by means of the model shown in Table 1.

harvested closely and frequently (Table 1). By the end of the second year of harvesting, TNC concentration occurred over a wider range (135 to 271 g kg^{-1} DM) and was affected by a defoliation frequency × defoliation height interaction (Table 1; Fig. 3). Interaction occurred because rhizome TNC concentration was not greatly affected by defoliation height when defoliation frequency was 9 to 12 wk. When defoliation frequency was 3 to 6 wk, however, TNC concentration increased with increasing defoliation height. Likewise, there was little effect of defoliation frequency on rhizome TNC when defoliation height was tall, but when defoliation height was 10 to 22 cm, TNC concentration increased with increasing interval between harvests. Minimum values were observed in plants defoliated every 3 wk at a 10-cm defoliation height, and the maximum occurred when

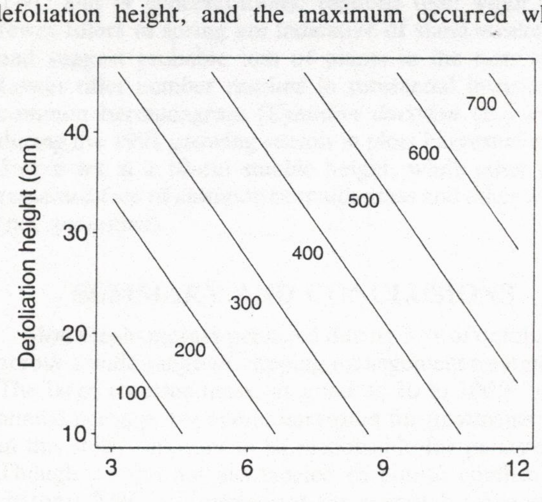

Fig. 4. Rhizome mass (g DM m^{-2}) at season end in 1990 as affected by defoliation frequency and defoliation height. Surface contours were generated by means of the model shown in Table 1.

defoliation frequency was 12 wk and stubble height was greater than 22 cm.

Our data demonstrate that close and frequent defoliation of Mott results in lower TNC concentration in rhizomes. Defoliation intervals of 9 wk or greater allowed TNC concentration to remain above 200 g kg^{-1} DM regardless of defoliation height (Fig. 3).

Rhizome Mass and Total Nonstructural Carbohydrate Pool

Rhizome mass at the end of the second year of defoliation ranged from 24 to 733 g DM m^{-2} and increased linearly as interval between harvests and defoliation height increased (Table 1; Fig. 4). Plants defoliated every 3 wk at a 10-cm height had the lowest rhizome mass per unit area, while those defoliated every 12 wk at a 46-cm defoliation height had approximately 30 times that amount (24 vs. 733 g DM m^{-2}). Rhizome mass of plants defoliated every 12 wk at a 46-cm stubble height was approximately equal to herbage DM harvested annually from that treatment (Chaparro et al., 1995). For the highest yielding treatment (12 wk, 10 cm) and for the treatment combination that resulted in greatest leaf DM harvested (9 wk, 22 cm; Chaparro et al., 1995), rhizome mass was only about 30% as great as the annual DM harvested.

The model for TNC pool at the end of the second year of defoliation included the linear and quadratic effects of defoliation frequency and the linear effect of defoliation height (Table 1; Fig. 5). Estimated values from regression ranged from 0 to 197 g TNC m^{-2}, although in no case was the actual value as low as zero. Because treatment differences in rhizome mass were much greater proportionally than for TNC concentration, the nature of the TNC pool response curve is similar to that described for rhizome mass.

Following close and frequent defoliation of a *Pennisetum* hybrid [*Pennisetum glaucum* (L.) Leeke × *Penni-*

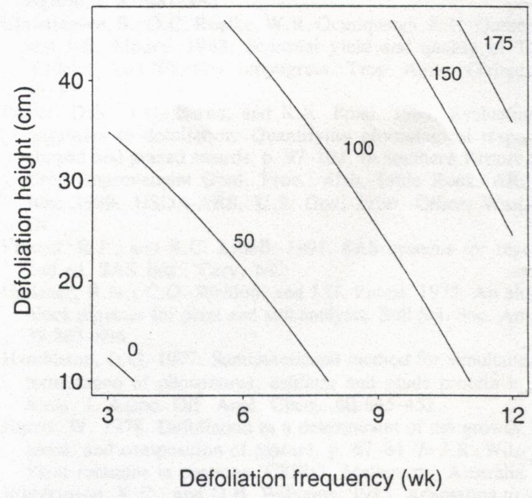

Fig. 5. Total nonstructural carbohydrate content (g TNC m^{-2}) in rhizomes (TNC pool) at season end in 1990 as affected by defoliation frequency and defoliation height. Surface contours were generated by means of the model shown in Table 1.

setum purpureum Schum.], Muldoon and Pearson (1979) reported assimilate reallocation from roots to regrowing leaves. Spitaleri et al. (1994) reported that rhizome mass of *Pennisetum* entries clipped every 6 wk at a 15-cm stubble was 38% lower than when the same entries were clipped every 12 wk to 15 cm. In the current experiment, closely and frequently defoliated plants were observed to have thin stems, few roots and rhizomes, and were easily uprooted. Similar responses were observed by Rodrigues (1984), who reported that Mott elephantgrass grazed frequently to a low residual leaf DM had shallow root systems.

Most studies relate TNC concentration in storage organs with plant persistence and regrowth after defoliation. Senescence of roots and redistribution of carbohydrates may allow the plant to maintain relatively high TNC concentrations in storage organs, thus making depletion of reserves seem less severe than it is. Because it encompasses both mass and TNC concentration of storage organs, more attention should be focused on the TNC pool. Ourry et al. (1988) concluded that the ability of perennial ryegrass to regrow after defoliation depended upon the total amount of available carbon and N. Likewise, Ortega-S. et al. (1992) found that depletion of rhizoma peanut rhizome mass under severe defoliation more nearly paralleled stand loss than did reduction in rhizome TNC concentration.

Rhizome Nitrogen Concentration

There was no effect of treatment on rhizome N concentration at the end of the first year of defoliation. The model for N concentration in rhizomes at the end of the second year included the linear effects of defoliation frequency and defoliation height and their interaction (Table 1; Fig. 6). Interaction occurred because as stubble height increased, N concentration increased more when plants were defoliated every 3 to 6 wk than when defoliated every 9 to 12 wk. Little variation in the response was observed across defoliation frequencies when plants were harvested at a 46-cm defoliation height. Estimated values for N concentration in rhizomes at season end in 1990 ranged from 10.9 to 14.2 g kg^{-1} DM.

In general, rhizome N decreased in closely and frequently defoliated plants, but the effects of frequency and height of defoliation were less pronounced than observed for TNC concentration. These data agree with those reported for rhizoma peanut by Ortega-S. et al. (1992). After imposing a wide range of grazing intensities and frequencies, they found that N concentration in rhizomes was not affected by defoliation management during the first year of the study. Thereafter, N concentration decreased linearly with decreasing residual DM remaining after grazing.

Tiller Number and Plant Persistence

Number of tillers per plant in May 1990 was affected by a defoliation frequency × defoliation height interaction (Table 1; Fig. 7). As defoliation height increased, number of tillers increased faster when defoliation frequency was 3 to 6 wk than when it was 9 to 12 wk. Range in estimated number of tillers per plant was 6 to 14, and lowest values were observed for the 3-wk defoliation frequency, 10-cm defoliation height treatment combination. In 1991, the response was similar. There was a defoliation frequency × defoliation height interaction because number of tillers increased faster with increasing defoliation height when interval between harvests was short than when it was long (Table 1; Fig. 8). Estimated values were from 7 to 26 tillers per plant, and the greatest number of tillers occurred with long intervals between harvests and tall defoliation heights.

Fisher et al. (1989) indicated that number of tillers in spring and early spring growth rates can be used to estimate root and rhizome mass. Within years, our data for tiller number support their observations. Tiller number for closely and frequently defoliated plants were 50 and 75% lower than for the treatment with the greatest

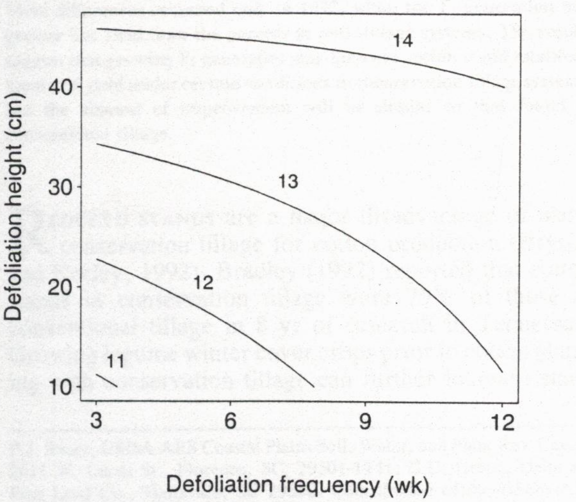

Fig. 6. Nitrogen concentration (g N kg^{-1} DM) in rhizomes at season end in 1990 as affected by defoliation frequency and defoliation height. Surface contours were generated by means of the model shown in Table 1.

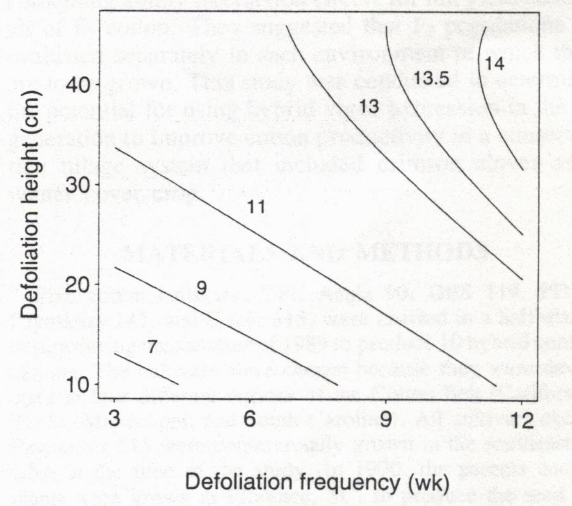

Fig. 7. Number of tillers per plant in May 1990 as affected by defoliation frequency and defoliation height. Surface contours were generated by means of the model shown in Table 1.

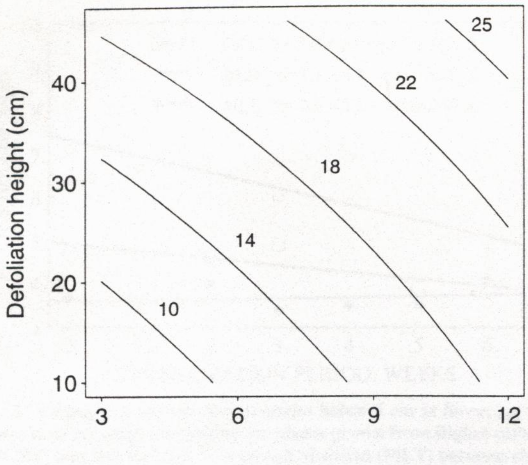

Fig. 8. Number of tillers per plant in May 1991 as affected by defoliation frequency and defoliation height. Surface contours were generated by means of the model shown in Table 1.

number in May 1990 and 1991, respectively. Associated with lower tiller number was low rhizome mass at the end of the 1990 season and progressive reductions in rhizome TNC and N concentrations over time (Chaparro, 1991). Rhizome TNC concentration in closely and frequently defoliated plants decreased from 231 g kg^{-1} on 18 May 1989 to 162 g kg^{-1} on 18 Sep. 1989, and from 166 g kg^{-1} on 18 Apr. 1990 to 116 g kg^{-1} on 5 Dec. 1990.

No plant loss occurred in any treatment through May 1991. However, by this time tillers were taller and more vigorous in plots that were defoliated infrequently or frequently at tall stubble heights, than in plots that were closely and frequently defoliated. Even though no plant loss was observed after 2 yr of frequent defoliation at a short stubble, lower rhizome mass, lower rhizome TNC and N concentrations, reduced tiller vigor, and fewer tillers in spring are indicative of stand weakening and suggest probable loss of plants in the near term. Lower tiller number resulted in substantial invasion by common bermudagrass [*Cynodon dactylon* (L.) Pers.] during the 1991 growing season in plots harvested every 3 or 6 wk at a 10-cm stubble height, while other plots remained free of common bermudagrass and other weeds (not quantified).

SUMMARY AND CONCLUSIONS

Mott elephantgrass persisted during 3 yr of defoliation across a wide range of clipping management treatments. The large rhizome mass, as great as 30 to 100% of the annual herbage dry matter harvested for treatments used in this study, appears to be responsible for persistence. Though we did not use labeled carbon to confirm that rhizome TNC was mobilized for regrowth when plants were defoliated frequently at a short stubble, our results are consistent with such a conclusion. During the experiment, Mott light interception before and after defoliation, rhizome mass, and rhizome TNC and N reserves were reduced by frequent, close defoliation. Short intervals between close defoliations during 3 yr lead to successively lower Mott DM harvested (Chaparro et al., 1995), while plants cut frequently to tall stubble heights or infrequently at a short stubble did not experience similar reductions in herbage harvested or reserve status. Based on these results, we conclude that Mott will not tolerate long-term, close, and frequent defoliation, at least in areas like North Florida where topgrowth is killed by freezing temperatures during winter.

Chaparro et al. (1995) reported that Mott elephantgrass harvested every 9 wk at a 10-cm stubble had the greatest annual leaf lamina DM harvested among treatments. Leaf lamina percentage in the herbage DM harvested was 72 to 76 for this harvest management, and in vitro digestible organic matter concentration exceeded 650 g kg^{-1} organic matter. Based on the current study, the 9-wk defoliation frequency, 10-cm defoliation height treatment also results in maintenance of a large rhizome mass and high rhizome TNC and N concentrations. Thus, infrequent but close clipping management can result in persistent stands that produce moderate to high yields of forage of good nutritive value.

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Evaluation of F_2 Genotypes of Cotton for Conservation Tillage

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ABSTRACT

Reduced plant populations often occur when cotton (*Gossypium hirsutum* L.) is grown in conservation tillage systems. Our objectives were to determine the potential of exploiting hybrid vigor in F_2 cotton to improve stand establishment and yield in conservation tillage systems and to compare the expression of heterosis in this system with that in a conventional tillage system. This field study was conducted in 1991, 1992, and 1994 on a Norfolk loamy sand soil (fine-loamy, silicious, thermic, Typic Kandiudult) near Florence, SC. Five cotton cultivars were crossed in a half-diallel design to generate 10 F_2 generation genotypes. The parent and F_2 generations were planted into conservation tillage plots that had desiccated crimson clover (*Trifolium incarnatum* L.) as a surface mulch and into conventional tillage plots. Cotton stands were similar for both generations in both tillage systems in 1991. At 2 wk after planting in 1992, a tillage × (Parent vs. F_2) interaction ($P \leq 0.05$) occurred for plant population as stands in conventional tillage were 7.5 and 8.4 plants m^{-1} for the parent and F_2 generations, respectively, while stands in conservation tillage were 4.1 plants m^{-1} for the parents and 4.2 plants m^{-1} for the F_2 generation. At 2 wk after planting in 1994, stands of the F_2 generation were 1.3 plants m^{-1} greater than the parents averaged over both tillage systems. Yield differences occurred only in 1992, when the F_2 generation had greater lint yield than the parents in both tillage systems. The results suggest that growing F_2 genotypes may improve cotton stand establishment and yield under certain conditions in conservation tillage systems, but the amount of improvement will be similar to that found in conventional tillage.

REDUCED STANDS are a major disadvantage of using conservation tillage for cotton production (Bryson and Keeley, 1992). Bradley (1992) reported that cotton stands in conservation tillage were 75% of those in conventional tillage in 8 yr of research in Tennessee. Growing legume winter cover crops prior to cotton planting with conservation tillage can further increase stand establishment problems (Grisso et al., 1985; Brown et al., 1985; Hutchinson and Sharpe, 1989; Rickerl et al., 1989).

Improvements in seedling vigor and early plant growth can be achieved through the use of heterosis or hybrid vigor. As early as 1927, Brown (1927) observed that the F_1 generation from intraspecific hybrids was frequently larger, more vigorous, and more productive than the parents. In a study on growth and leaf area partitioning in cotton hybrids, Wells and Meredith (1986) attributed increased vegetative productivity of F_1 cotton to more rapid early growth. Hybrids in that study had a higher percentage of yield at first harvest than parents.

Commercial production of F_1 hybrid cotton seed is currently not economically feasible; however, heterosis has been reported in F_2 generation cotton (Meredith, 1990; Meredith and Bridge, 1972) and commercial F_2 seed is currently being marketed with reported vigor advantages. Tang et al. (1993) found environment × general combining ability and environment × specific combining ability interaction effects for lint yield heterosis of F_2 cotton. They suggested that F_2 populations be evaluated separately in each environment in which they are to be grown. This study was conducted to determine the potential for using hybrid vigor expression in the F_2 generation to improve cotton productivity in a conservation tillage system that included crimson clover as a winter cover crop.

MATERIALS AND METHODS

Five cotton cultivars, DPL Acala 90, DES 119, PD 3, Paymaster 145, and Coker 315, were crossed in a half-diallel design during the summer of 1989 to produce 10 hybrid combinations. The cultivars were chosen because they were developed in four different regions of the Cotton Belt (California, Texas, Mississippi, and South Carolina). All cultivars except Paymaster 145 were commercially grown in the southeastern USA at the time of the study. In 1990, the parents and F_1 plants were grown at Florence, SC, to produce the seed for this study.

The study was conducted at the Clemson University Pee

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