Grazing Corn Produced Under Living Mulch Systems in Tennessee

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Keywords: Integrated crop-livestock systems; living mulch; sustainable corn production.

Abstract

The use of living mulch (LM) in the Southeastern U.S. has yet to be assessed for its potential for grazing operations to increase land use efficiency. Therefore, the need to determine the viability of the system is warranted. The objective of this study was to evaluate the benefits of white clover LM and crimson-clover cereal rye annual mulch in corn silage and grain production, and to evaluate the potential of LM grazing before and after the corn growing season in spring and fall. The study was conducted at the Middle Tennessee AgResearch and Education Center (MTREC), University of Tennessee, in Spring Hill, TN (35.68º N, 86.91º W, 810 ft altitude), from October 2018 to April 2021. The experimental design was comprised of 12 large paddocks (0.7 ha^{-1}). Paddocks were arranged in a complete randomized design (CRD) in triplicate, totaling 12 plots (2 corn treatments x 2 cover crop treatments x 3 replicates). The paddocks contained either corn silage or grain, grown with either perennial “Durana” white clover (Trifolium repens L.) [WC] or with a mixture of crimson clover (“AU Sunrise” Trifolium incarnatum L.) and cereal rye (“Wintergrazer” Secale cereale L.) [CCCR]). Grazing was performed in spring and fall of 2020 and 2021 before and after corn planting and harvest, respectively. In spring of both years, the LM proportion was greater in CCCR than WC, and a greater proportion of broadleaf weeds (BLW) were observed in WC. In the fall of 2020, LM proportion was greater in WC than CCCR, but no differences were observed in the fall of 2021. Meanwhile, the greatest MM was observed in WC at the beginning of the grazing period. White clover can reduce weed pressure under grazing systems. White clover as a LM also showed positive applications in grazing systems with greater MM.

Introduction

The LM is a system in which the forage species are established before or simultaneously with the row crop and maintained as a living cover throughout the growing season (Hartwig & Ammon, 2002). The use of LM in the Southeastern U.S. has yet to be assessed for its potential for grazing operations to increase land use efficiency. Therefore, the need to determine the viability of the system is warranted. To ensure the benefits of LM in the field, LM must be well suppressed to avoid competition with the main crop. Studies examining the use of herbicides (Sanders et al., 2017) or mechanical suppression of LM (Grubinger & Minotti, 1990) have been conducted. Yet, LM grazing has the potential to suppress the LM before planting a cash crop like corn, while providing sufficient feed for body weight maintenance of dry cows or weight gain of calves in integrated systems (Guy et al., 2020). The grazing of WC can also lead to greater milk production when compared to red clover and grasses (Johansen et al., 2017). Therefore, there is a need to determine the benefits of grazing and corn production in LM production systems. The objective of this study was to evaluate the benefits of white clover LM and crimson-clover cereal rye annual mulch in corn silage and grain production, and to evaluate the potential of LM grazing before and after the corn growing season in spring and fall.

Methods and Study Site

The study was conducted at the Middle Tennessee AgResearch and Education Center (MTREC), University of Tennessee, in Spring Hill, TN (35.68º N, 86.91º W, 810 ft altitude), from October 2018 to April 2021. The experimental design was comprised of 12 large paddocks (0.7 ha^{-1}). Paddocks were arranged in a complete randomized design (CRD) in triplicate, totaling 12 plots (2 corn treatments x 2 cover crop treatments x 3 replicates). The paddocks contained either corn silage or grain, grown with either perennial “Durana” white clover (Trifolium repens L.) [WC] or with a mixture of crimson clover

("AU Sunrise" Trifolium incarnatum L.) and cereal rye ("Wintergrazer" Secale cereale L.) [CCCR]). Grazing was performed in spring and fall of 2020 and 2021 before and after corn planting and harvest, respectively. The stocking rate was variable among paddocks according to the forage availability of each large paddock. Variable stocking rates were conducted to avoid over- or under-grazing and varied from 1 to 4 animals. Jersey cull cows were used, averaging 513 kg of body weight (BW) per paddock for each 28-d grazing period, and weighed immediately before and after entering the paddocks. Single-wire electric fences were used in each paddock and Bloat Guard® blocks (Sweetlix, Mankato, MN) were available to the animals to avoid bloating issues, while water was available ad libitum. To determine BC and MM of the paddocks, ten 0.1 m^2 quadrats were randomly clipped before and after the grazing period. The BC was determined by separating each LM sample into three categories: LM (WC or crimson clover + cereal rye), broadleaf weeds (BLW), and grass weeds (GW). Each sample was dried at 60ºC for 72-h, recombined, and weighed to determine the DM and MM. The statistical analyses were separated by year (2020 and 2021) and season (fall and spring), given the differences of each grazing period in production and composition. Sampling dates were considered the beginning and end of the grazing period. The dependent variables were BC and MM; and fixed effects were sampling date, LM species, and its two-way interaction with the random effect of replication. All results were evaluated for significance at $P < 0.05$.

Results and Discussion

Botanical Composition (BC)

In spring 2020, the LM proportion was greater in CCCR than WC, and a greater proportion of broadleaf weeds (BLW) were observed in WC (Figure 1). These results are expected, since WC was slowly starting to grow, allowing BLW competitiveness, while CCCR (a winter annual mixture) was at its peak productivity. Yet, the BC between the beginning and end of the grazing period did not differ (Figure 1). Similarly, during spring of 2021 greater LM proportion was observed in CCCR as compared to WC, although there were less LM in CCCR at the end of the grazing period. The CCCR were seeded in December 2020, and WC established in the fall of 2018, which could reflect the weakened stand to support animal pressure. In the fall of 2020, LM proportion was greater in WC than CCCR (Figure 1) due to the WC regrowth that occurred in the fall after corn harvest. In addition, BLW were greater in WC than CCCR, and the GW proportion was inversely related to the BLW composition in the field. Meanwhile, in the fall of 2021, no differences were observed for all variables.

Mulch mass (MM)

In spring 2020, there were no differences in MM between the beginning and end of the grazing period in corn grain or in silage paddocks, yet greater MM was observed in CCCR than WC in silage paddocks ($P = 0.0494$; Table 1), likely due to the greater LM proportion observed in the BC (Figure 1). In spring 2021, the grain paddocks had greater mass in the beginning of the season and greater MM was observed in WC. However, these findings were not seen in the silage paddocks, where no differences were found (Table 1). When harvesting the silage paddocks, the entire plant is removed of what would otherwise become organic matter which assists with plant regrowth.

In the fall of 2020, there was a main effect of LM species (Table 1) in grain paddocks, with greater MM in CCCR, and these results were attributed to the greater GW content (Figure 1). Meanwhile, there was a sampling date × LM species interaction (P = 0.0404) for silage paddocks, with less MM observed for WC at the end of the grazing period (Table 1). In the fall of 2021, there was a sampling date × LM species interaction (P = 0.0321) in grain paddocks, with the greatest MM observed in WC at the beginning of the grazing period. The CCCR paddocks did not differ in the same period and treatment, likely due to the amount of corn residue in the field, which remained constant throughout the grazing period.

Conclusions

The use of WC as LM leads to a reduction in weed pressure when compared with crimson clover-cereal rye mixtures under grazing systems. White clover as a LM also showed positive applications in grazing systems with greater MM. Since cull cows were utilized for grazing, further studies using steers are warranted to help advance the use of LM in the Southeastern U.S.

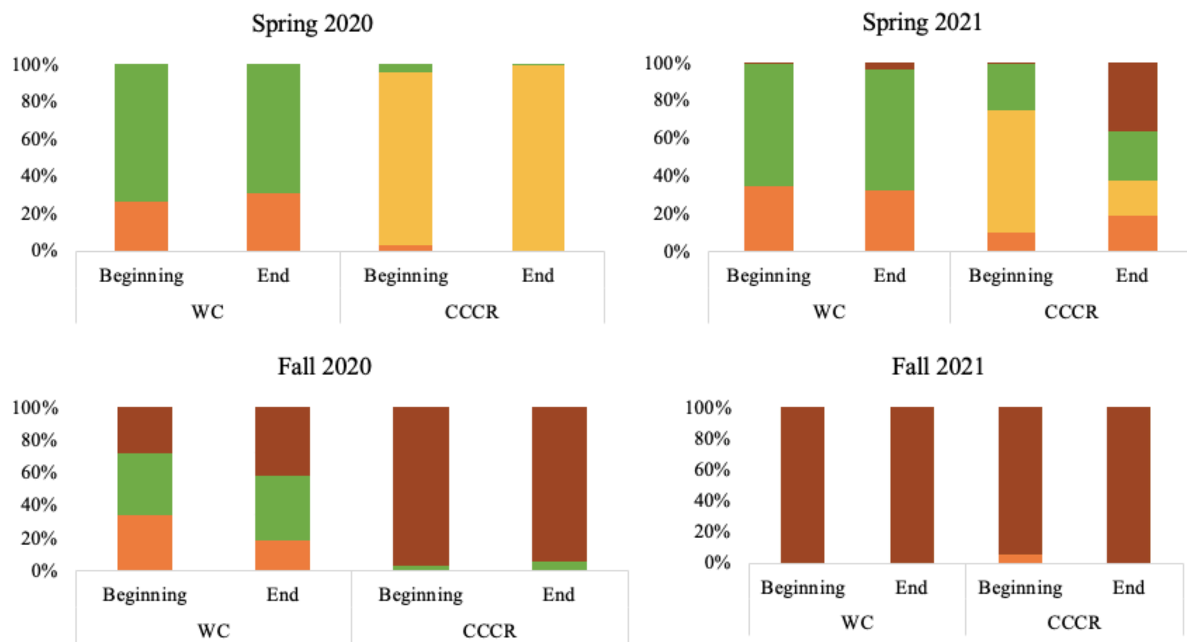

Figure 1: Botanical composition (BC) of living mulch (LM) (crimson clover/cereal rye, CCCR; and white clover, WC) paddocks during each 28-d grazing period on spring and fall of 2020 and 2021 in Spring Hill, TN (BLW, broadleaf weed; GW, grass weed).

Table 1: Mulch mass (MM, kg ha-1) at the beginning and end of each 28-d grazing period during two consecutive years in Spring Hill, TN.

	Grain			Silage		
Spring 2020	Beginning	End	Average	Beginning	End	Average
†CCCR	1608	1428	1518	2493	2364	2429^{a}
WC	983	1098	1040	1171	1605	1388^{b}
Average	1295	1263		1832	1985	
Sampling date (S)		0.9102			0.7311	
LM Species (LM)		0.1324			0.0494	
S × LM		0.6100			0.5306	
Spring 2021						
CCCR	388	111	249^{b}	724	505	615
WC	582	379	481^{a}	805	537	671
Average	485^{a}	245^{b}		764	521	
Sampling date (S)		0.0125			0.0825	
LM Species (LM)		0.0145			0.6474	
S × LM		0.6010			0.8410	
Fall 2020						
CCCR	1299	1764	1531^{a}	1181^{a}	1137^{a}	1159
WC	407	391	399^{b}	1155^{a}	549^{b}	852
Average	853	1078		1168	843	
Sampling date (S)		0.1232			0.0236	

LM Species (LM)		0.0001			0.0294	
S × LM		0.1040			0.0404	
Fall 2021						
CCCR	1964^{b}	1593^{b}	1778	1755	855.	1305
WC	2758^{a}	1394^{b}	2076	1759	1081	1419
Average	2361	1494		1757^{a}	968^{b}	
Sampling date (S)		0.0029			0.0171	
LM Species (LM)		0.1473			0.6517	
S × LM		0.0321			0.6629	

†WC, white clover; CCCR, crimson clover-cereal rye mixture. ‡ N.S. not significant
Means without a common superscript letter differ within each grazing season at $\alpha \leq 0.05$ using Fisher's LSD test.

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