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Productivity of a Triticale and Crimson Clover Winter Cover Crop for Dairies

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Abstract

The potential for a winter cover crop to align with agronomic objectives and to support milk production was evaluated at the Kansas State University Dairy Teaching and Research Center, Manhattan, KS. August planting of a triticale and crimson clover blend following corn silage harvest resulted in production of more than 3.5 tons of dry matter prior to subsequent corn planting. After ensiling, the impact of triticale/crimson clover silage (TCS) on milk production was evaluated in 48 mid- to late-lactation Holstein cows. Cows were blocked by parity (1 and 2+) and milk production, then randomly assigned within block to treatment sequence and pen. The crossover design consisted of two 21-day periods, with 17 days of diet adaptation and 4 days of sampling. Treatments were a diet which included TCS at 15% of diet dry matter (DM) and a control ration in which TCS was primarily replaced by alfalfa and grass hays. The TCS diet included additional bypass soybean meal in an attempt to balance metabolizable protein supply across diets. Samples of rations, feed refusals, and milk were obtained daily, and milk yield was recorded. The TCS diet decreased dry matter intake (48.4 vs. 55.9 ± 3.4 lb/d; $P = 0.02$), but did not alter milk yield ($P = 0.97$); therefore, feed efficiency was greater for the TCS diet ($P = 0.04$). Milk fat concentration tended to increase on the TCS diet ($P < 0.10$) whereas milk lactose yield tended to be lesser for TCS ($P = 0.09$), but other milk components analyzed (milk protein, MUN, SCC) did not differ between diets ($P > 0.15$). Utilization of TCS also impacted the dairy's nutrient management plan, as the winter forage harvest removed 40 and 340 lb/a of phosphorus and potassium, respectively. Overall, the blend of triticale and crimson clover as a winter cover crop produced good quality silage that maintained high milk production while also removing key nutrients from the soil to benefit nutrient management planning.

Keywords

triticale, crimson clover, silage, phosphorus

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Productivity of a Triticale and Crimson Clover Winter Cover Crop for Dairies

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Summary

The potential for a winter cover crop to align with agronomic objectives and to support milk production was evaluated at the Kansas State University Dairy Teaching and Research Center, Manhattan, KS. August planting of a triticale and crimson clover blend following corn silage harvest resulted in production of more than 3.5 tons of dry matter prior to subsequent corn planting. After ensiling, the impact of triticale/crimson clover silage (TCS) on milk production was evaluated in 48 mid- to late-lactation Holstein cows. Cows were blocked by parity (1 and 2+) and milk production, then randomly assigned within block to treatment sequence and pen. The crossover design consisted of two 21-day periods, with 17 days of diet adaptation and 4 days of sampling. Treatments were a diet which included TCS at 15% of diet dry matter (DM) and a control ration in which TCS was primarily replaced by alfalfa and grass hays. The TCS diet included additional bypass soybean meal in an attempt to balance metabolizable protein supply across diets. Samples of rations, feed refusals, and milk were obtained daily, and milk yield was recorded. The TCS diet decreased dry matter intake (48.4 vs. 55.9 ± 3.4 lb/d; $P = 0.02$), but did not alter milk yield ($P = 0.97$); therefore, feed efficiency was greater for the TCS diet ($P = 0.04$). Milk fat concentration tended to increase on the TCS diet ($P < 0.10$) whereas milk lactose yield tended to be lesser for TCS ($P = 0.09$), but other milk components analyzed (milk protein, MUN, SCC) did not differ between diets ($P > 0.15$). Utilization of TCS also impacted the dairy's nutrient management plan, as the winter forage harvest removed 40 and 340 lb/a of phosphorus and potassium, respectively. Overall, the blend of triticale and crimson clover as a winter cover crop produced good quality silage that maintained high milk production while also removing key nutrients from the soil to benefit nutrient management planning.

Introduction

Double cropping with winter forages provides the opportunity to maximize forage production while also removing phosphorus from manured soils, a key element in the nutrient management plan of dairies. Compared to wheat and barley, triticale produces more dry forage and removes more phosphorus. Mixing in a legume like crimson clover introduces the nitrogen fixing capability of legumes while also increasing the protein

[1] Landus Cooperative, Ames, IA.

content of the forage. The combination of the high fiber and protein content in the forage makes it a good option to partially substitute for alfalfa hay. The objective of the study was to determine the effect of feeding TCS on milk production, while also examining impacts on soil nutrients.

Experimental Procedures

Crop Production

The K-State Dairy Teaching and Research Center planted 110 acres of triticale/crimson clover in 2 separate fields on September 1, 2016. Beardless triticale (*Triticosecale*) and crimson clover (*Trifolium incarnatum*) were drilled into untilled ground at 100 and 5 lb/a, respectively, following corn silage harvest. No fertilizer was applied to the fields prior to planting. Lagoon water was applied on one field over the course of the growing season. The second field did not receive lagoon water but solid manure was spread on this field.

Animals and Treatments

The potential of TCS to maintain milk production was evaluated in 48 mid- to late-lactation Holstein cows (223 ± 67 DIM) in a study conducted from June to August 2017. Cows were blocked by parity and milk production, randomly assigned to treatment sequence within block, then randomly assigned to 1 of the 2 freestall pens assigned to that particular treatment sequence. Treatments were applied to pen (n = 4). The crossover design consisted of 2 periods of 21 days, with the first 17 days for diet adaptation and the final 4 days used for sample collection. Cows were fed once daily and milked three times a day. Treatments were control or TCS diets; nutrient analysis of the TCS is shown in Table 1 and it was incorporated in the TCS diet at 15% of DM. Therefore, the TCS diet was adjusted by reducing proportions of the alfalfa and grass hays and adding bypass protein. Metabolizable protein, estimated using the Cornell model (version 6.55) as implemented in NDS software (RUM&N Sas, Reggio Emilia, Italy), was balanced across diets.

During the sampling period, TMR samples were taken daily and composited by period for nutrient analysis by Dairy One Forage Laboratory (Ithaca, NY). Samples of feed refusals from each pen were taken daily to determine pen dry matter intake; this value was divided by the number of cows in the pen on that day to determine dry matter intake per cow. In addition, milk yield was recorded and milk samples were taken at each milking for composition analysis (MQT Labs Services, Kansas City, MO). Fat-corrected milk (FCM) was calculated as (0.432 × milk yield) + (16.216 × fat yield), and energy-corrected milk (ECM) was calculated as (0.327 × milk yield) + (12.95 × fat yield) + (7.65 × protein yield). Two cows were removed from the study due to mastitis in period 2.

Results and Discussion

Forage Production

On November 5, 2017, hay was harvested from the 110 acres, producing 120 round bales of hay, averaging 1,100 lb each at approximately 64% DM. Forage dry-down was a challenge at this time of year, resulting in excessive moisture and generating some Maillard products in the baled forage. Hay quality was further impacted by substantial weed carryover from the summer crop. However, harvesting hay in the fall resulted in a very clean forage crop in the spring. On April 22, 2017, the cover crop was swathed and allowed to partially dry, chopped at a 0.75-inch cut, and stored in silage bags with an inoculant. Fermentation analysis by Dairy One Forage Laboratory (Ithaca, NY) is shown in Figure 1. This crop produced 1,001 tons of silage (33% DM). Overall costs for the production of the TCS crop totaled between \$30,000–\$35,000, equating to \$90–\$106 per dry matter ton invested in the production of the feed.

In addition to forage production, this cover crop played a role in the dairy's nutrient management plan through its ability to extract phosphorus. Table 2 summarizes the amount of phosphorus and potassium removed from the soil. Across both harvests, the cover crop removed almost 40 lb of phosphorus per acre and over 320 lb of potassium per acre. The ability of this crop to remove those nutrients creates the opportunity to spread more manure or lagoon water on these fields. Additional potential benefits of the cover crop include prevention of soil erosion, better weed control, and improvements in subsequent summer crop yield.

Lactating Cow Responses

A treatment diet was formulated to evaluate responses to TCS, primarily replacing alfalfa hay, with some other adjustments designed to balance diets for similar fiber, protein fractions, and energy (Table 3). The DMI and milk production variables are summarized in Table 4. Dry matter intake was lesser for the triticale diet than control diet (48.36 vs. 55.90 ± 3.44 lb/d; $P = 0.02$; Figure 2A). Despite lesser intake, milk yield did not differ between triticale and control (80.86 vs. 80.75 ± 2.07 lb/d; $P = 0.97$). Milk fat concentration tended to be greater on triticale than control (3.84 vs. 3.76 ± 0.08; $P < 0.10$), and milk lactose yield tended to be lesser on the triticale diet (3.92 vs. 3.79 ± 0.11 lb/d; $P = 0.09$). The other milk components analyzed including milk protein and lactose concentration, milk fat and protein yield, milk somatic cell linear score, and milk urea nitrogen did not differ between diets (all $P > 0.15$). Fat-corrected and energy-corrected milk yield (Figure 2B) were similar across diets (both $P > 0.50$). Because dry matter intake was lesser for the triticale diet but milk production did not differ, feed efficiency, defined as energy-corrected milk yield/dry matter intake, was greater for the triticale diet (1.71 vs. 1.48 ± 0.04; $P = 0.04$; Figure 2C). The DMI response was somewhat surprising and it would be interesting to see if it is repeated in a more intensive study measuring intake of individual cows. The fact that milk yield was not different and milk fat tended to increase supports the utility of TCS in lactation rations at up to 15% of the diet DM.

Conclusions

A winter cover crop blend of triticale and crimson clover produced more than 3 tons DM/a of a silage containing more than 20% crude protein. Soil phosphorus and potassium removed through both the hay and silage totaled 38 and 320 lb/a, respectively. Mid- to late-lactation cows fed TCS at 15% of diet DM had reduced feed intake but similar energy-corrected milk yield, resulting in greater feed efficiency. Overall, double cropping corn with a winter triticale/crimson clover mix produced additional forage of sufficient quality to sustain high milk yields in a carefully-formulated diet, while also removing soil nutrients that are of concern when considering manure management.

Following the 2016-2017 trial, several management changes were implemented for the crop planted in 2017. Nitrogen was applied prior to planting at a rate of 50 lb/a to promote both forage yield and greater P uptake. Instead of no-tillage management, vertical tillage was used to reduce weed problems and improve the seed bed. The seeding rate of triticale was decreased to 90 lb/a and crimson clover increased to 10 lb/a, because in some locations in the previous year, clover growth appeared to be suppressed by the triticale. Due to the low quality of the fall-harvested hay in 2016, no fall harvest will be taken, although light-intensity grazing may be considered for heifers. It is anticipated that a similar winter cropping strategy will help the K-State Dairy Teaching and Research Center to meet its forage and nutrient management goals for the foreseeable future.

Table 1. Nutrient composition of the triticale/crimson clover silage

Nutrient analysis, % of DM (unless otherwise specified)	
Dry matter, % as-fed	32.7
Crude protein	21.1
Acid detergent fiber	35.4
Neutral detergent fiber (amylase-treated)	52.6
Non-fiber carbohydrate	8.20
Net energy for lactation, Mcal/kg	1.41

Table 2. Phosphorus and potassium removal from the 110 acres of triticale/crimson clover hay (cut November 2016) and silage (chopped April 22, 2017)

	Triticale/crimson clover hay[1]	Triticale/crimson clover silage[2]
DM harvested, ton/a	0.38	3.0
Phosphorus, % DM	0.61	0.56
P removed, lb/a	4.68	33.63
Potassium, % DM	5.56	4.70
Potassium removed, lb/a	42.70	282.28

[1]120 round bales at 1100 lb each (64% DM).
[2]1,001 as-fed tons harvested (33% DM).

Table 3. Ingredient and nutrient composition of the control and triticale diets

Item	Control	Triticale/crimson clover
Ingredient, % of DM		
Corn silage	24.9	22.5
Triticale/crimson clover silage	---	15.0
Alfalfa hay low[1]	9.73	3.11
Alfalfa hay high[2]	9.34	3.11
Grass hay	1.56	
Wet corn gluten feed[3]	22.8	22.8
Cottonseed	3.98	3.97
Expeller soybean meal[4]	---	1.90
Lactation grain mix[5]	27.6	27.6
Nutrient concentration, % of DM (unless otherwise specified)		
DM, % as-fed	60.5	52.7
Crude protein	17.3	17.9
Acid detergent fiber	17.8	18.0
Neutral detergent fiber	28.4	29.9
Non-fiber carbohydrate	39.7	37.0
Starch	24.6	23.8
Crude fat	4.96	5.71
Ash	9.71	9.46
NE_L,[6] Mcal/lb	0.74	0.76

[1]Lower quality alfalfa hay.
[2]Higher quality alfalfa hay.
[3]Sweet Bran (Cargill Inc., Blair, NE).
[4]Soy Plus (Landus Cooperative, Ames, IA).
[5]Grain mix contained 61.5% fine ground corn, 22.3% Soy Plus (Landus Cooperative, Ames, IA), 3.24% Kruse Lact. PMX, 3.86% ground limestone, 2.46% sodium bicarbonate, 2.46% Ca salts of long-chain fatty acids (Megalac R, Arm & Hammer Animal Nutrition, Princeton, NJ), 1.40 % XP Yeast (Diamond V, Cedar Rapids, IA, 0.56% Vitamin E (9070 IU/kg), 0.56% stock salt, 0.56% trace mineral salt, 0.89% magnesium oxide, 0.09% 4 Plex C (Zinpro Corp., Eden Prairie, MN), 0.05% Zinpro 120 (Zinpro Corp.), and 0.02% Rumensin 90 (Elanco Animal Health, Greenfield, IN).
[6]Net energy for lactation.

Table 4. DMI, milk yield, milk composition, and feed efficiency (ECM:DMI) for cows fed either the control or triticale diet

Item	Control	Triticale	SEM[1]	*P*-value
Dry matter intake, lb/day	55.90	48.36	3.44	0.02
Milk yield, lb/d	80.75	80.86	2.07	0.97
Milk fat, %	3.76	3.84	0.08	< 0.10
Milk protein, %	3.13	3.10	0.09	0.40
Milk lactose, %	4.90	4.88	0.04	0.47
Milk fat yield, lb/day	2.89	2.89	0.04	0.97
Milk protein yield, lb/day	2.49	2.38	0.09	0.21
Milk lactose yield, lb/day	3.92	3.79	0.11	0.09
Milk somatic cell linear score	2.86	2.90	0.42	0.90
Milk urea nitrogen, mg/dL	11.98	12.19	1.17	0.19
Fat-corrected milk yield, lb/day	81.61	81.61	1.50	1.00
Energy-corrected milk yield, lb/day	82.80	81.98	1.54	0.54
ECM:DMI[1]	1.48	1.71	0.11	0.04

[1]Energy-corrected milk divided by dry matter intake.

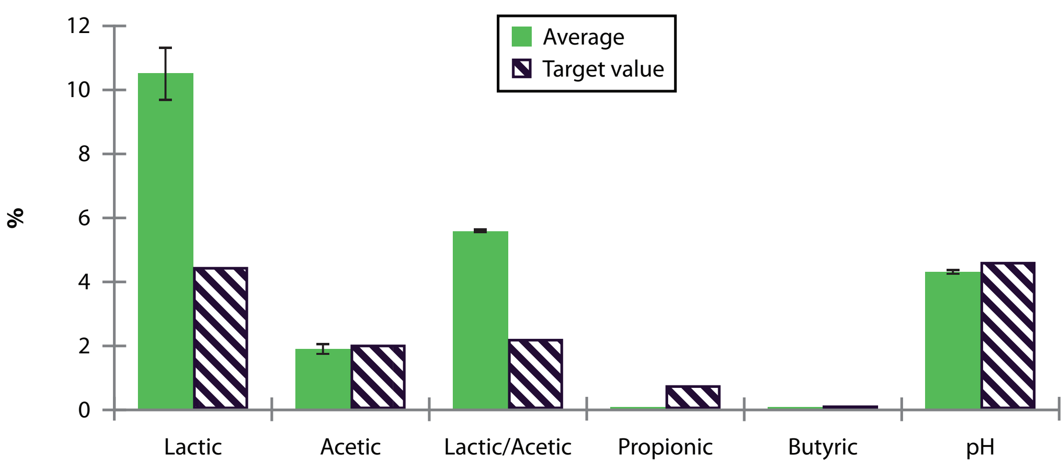

Figure 1. Fermentation analysis of the triticale/crimson clover silage. Solid bars are the average of the 3 samples sent in for analysis. Striped bars show the target value provided by Dairy One Forage Laboratory (Ithaca, NY).

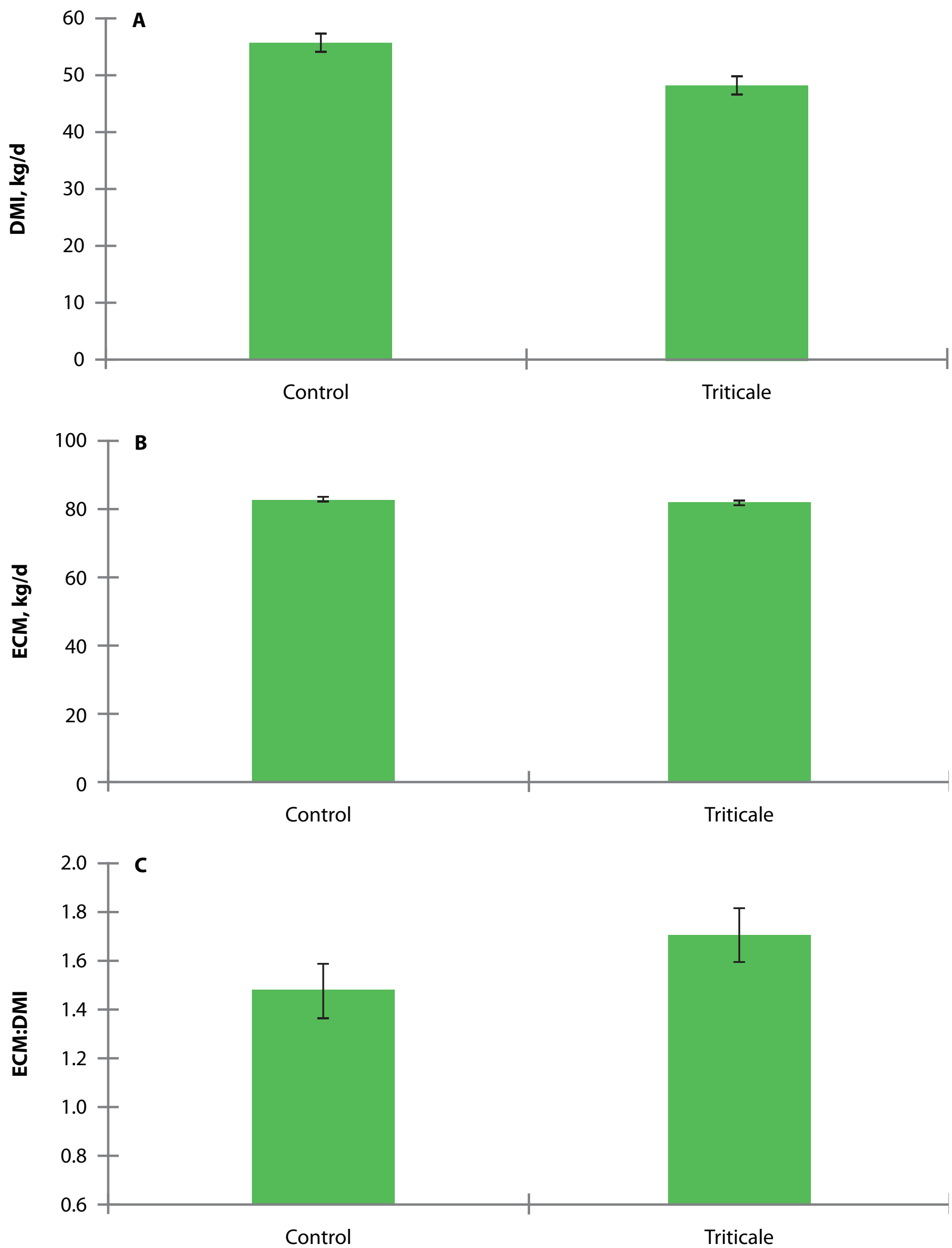

Figure 2. A) DMI was lesser for the triticale diet than the control (*P* = 0.02). B) Energy-corrected milk (ECM) was not different between diets (*P* = 0.54). C) Feed efficiency in cows on the triticale diet was greater than the control (*P* = 0.04). **P* < 0.05.