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Effect of a forage-type soybean cover crop on wheat forage production and animal performance in a continuous wheat pasture system

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ABSTRACT

This research was conducted over 4 consecutive years (2010 to 2014) to investigate the effects of tillage system [no-till (NT) vs. conventional tillage (CONV)] and NT with a summer legume cover crop (NTCC) on forage production and performance of growing steers in a continuous wheat pasture cropping system on 18, 1.6-ha dedicated wheat fields (n = 6 fields per establishment method). Soybean forage production averaged 2,034 ± 346.2 kg of DM/ha in July. Cover crops were grazed for an average of 33 ± 2.4 d, with ADG averaging 0.62 ± 0.28 kg/d and total gain per hectare averaging 108 ± 24.4 kg/ha. Although, forage mass was less ($P < 0.01$) for NTCC than NT or CONV in November, it did not differ ($P \geq 0.15$) due to treatment the remainder of the production year. In the autumn, ADG of NT and NTCC tended ($P \leq 0.08$) to be greater than CONV, whereas in the spring ADG of NT and NTCC was greater ($P < 0.01$) than CONV. Body weight gain per hectare of the steers grazing wheat pasture was 45 kg greater ($P \leq 0.03$) for NT than NTCC and CONV. The added gain during the summer for NTCC produced total system BW gain per hectare that was greater ($P = 0.03$) than CONV and not different ($P = 0.84$) from NT. This added production could potentially provide economic incentives by offsetting costs of cover crop establishment for NT producers to include cover cropping in their systems, in addition to the agronomic benefits provided.

Key words: cover crop, growing calf, tillage system, wheat pasture

INTRODUCTION

Cover crops have been touted to provide green, growing cover to reduce soil erosion, suppress weeds and pests, and improve water infiltration (Andrews, 2011). Coale et al. (2001) reported that rye (*Secale cereal*), wheat (*Triticum aestivum*), barley (*Hordeum vulgare* L.), and triticale (× *Triticosecale rimpaui* Wittm.) accumulate residual soil N, reducing the potential for NO_3-N leaching into groundwater. Cover crops have been shown to improve soil physical characteristics and improve soil productivity by increasing OM, reducing runoff and erosion, and moderating soil temperature. Parvin et al. (2004) reported that wheat cover crops increased the yield of cotton (*Gossypium hirsutum* L.) by almost 12%, and the net value of the cover crop averaged $120/ha. Singer and Kohler (2005) found soybean [*Glycine max* (L.) Merr.] and corn (*Zea mays*) grain yields were reduced when rye cover crops were used in a corn–soybean rotation in Iowa. These reductions in grain yield may be attributed to the difficulty in stand establishment of row crops with excessive residue levels present from the proceeding cover crop. These residue levels can easily be reduced if livestock grazing were integrated into the cover cropping system. Cox et al. (2015) reported that calves grazing oat (*Avena sativa*)-brassica cover crop gained 1 kg/d, which was concluded to be cost competitive with steers fed silage diets in dry lot. In a dual purpose (forage and grain production) wheat system, Andrews (2011) found cover crops had no effect on wheat-forage yield potential, but systems with legume cover crops had greater wheat forage production potential than systems with grass cover crops. Without the benefit and income from grazing, it may be difficult for farmers to economically justify the use of cover crops due to the cost of establishment and difficulty of management in crop rotation systems. Therefore, this research was designed to investigate the effects of tillage system [no-till (**NT**) vs. conventional tillage (**CONV**)] and NT with a summer legume cover crop (**NTCC**) on forage production and performance of growing steers in a continuous wheat pasture cropping system.

The authors declare no conflict of interest.
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MATERIALS AND METHODS

All procedures in the following experiments conducted at the University of Arkansas Division of Agriculture Livestock and Forestry Research Station near Batesville, Arkansas (35°50′N, 91°48′W; elevation 150 m) were approved by the University of Arkansas Institutional Animal Care and Use Committee (Protocol #12044).

Treatments and Pasture Establishment

This research was conducted over 4 consecutive years (2010 to 2014) comparing 3 wheat pasture establishment methods (CONV, NT, or NTCC) on eighteen 1.6-ha dedicated wheat fields (n = 6 fields per establishment method).

The CONV was managed similar to the management described in the studies by Bowman et al. (2008) and Morgan et al. (2012), where fields were disked once with an offset cutting disk following removal of calves from fields in June, chisel plowed 2 times in June and July, and then disked 2 times with a finishing disk before planting in September. Residue cover of the CONV fields was estimated by visual appraisal to be <5%. No-till fields were subjected to a summer chemical fallow as described by Bowman et al. (2008) and Morgan et al. (2012). Fields were sprayed with applications of 4.68 L/ha of glyphosate [N-(phosphonomethyl) glycine; Roundup Original Max, Monsanto Co., St. Louis, MO] during the summer in early June and in late August before planting for annual grass and weed control, and wheat was then direct seeded into the residue of the previous crop. The NTCC fields were no-till planted to forage-type soybeans (Large Lad RR, Eagle Seed Co., Weiner, AR) in mid-May as a cover crop. This particular cover crop was selected because of the N fixation potential and the glyphosate resistance trait potentially expanding weed control options during the summer period. Soybeans were killed in mid-August, and wheat was then direct seeded into the standing soybean residue.

Soybean Cover Crop Establishment. Following removal of steers from wheat pastures at the end of the spring graze-out period, fields assigned to summer cover crop establishment treatment received a burn down application of 4.68 L/ha of glyphosate [N-(phosphonomethyl) glycine; Roundup Original Max] on May 9, 2010; May 11, 2011; May 1, 2012; and May 20, 2013. The soybeans, which were a variety selected for forage production, were established by planting 50 kg/ha using a 3.7-m grain drill (model 750, John Deere and Co., Moline, IL) in 17.8-cm rows to a depth of approximately 2.5 cm. Following planting, the soybeans were allowed to develop to the R2 (full flowering) stage in mid-July each year (July 12, 18, 16, and 11 for 2010, 2011, 2012, and 2013, respectively) and were rotationally grazed by bred replacement heifers (n = 192, BW = 264 ± 27.0 kg) stocked at 4.9 heifers/ha until August 16, 19, 15, and 15 for 2010, 2011, 2012, and 2013, respectively. Upon removal of heifers from fields, cover crops were desiccated by a single application of 4.68 L/ha of glyphosate [N-(phosphonomethyl) glycine; Roundup Original Max] and 4.68 L/ha 2,4-dichlorophenoxyacetic acid (Weedar 64, Nufarm Americas Inc., Chicago Heights, IL).

Wheat Pasture Establishment. Wheat (Jamestown, University of Arkansas Division of Agriculture, Colt, AR) was sown into fields beginning on August 30, 2010; August 29, 2011; September 1, 2012; and August 29, 2013 using a 3.7-m grain drill (model 750, John Deere and Co.) in 17.8-cm rows to a depth of approximately 2.5 cm. Each field was individually soil tested, fertilized, and limed to meet soil test recommendations (Chapman, 1998). Nitrogen was applied to each field as ammonium nitrate at a rate of 68 kg of actual N/ha in the autumn at planting in early September and in the spring before initiation of the spring grazing period in February.

Animal Husbandry Practices

Preconditioned steers (n = 754, BW = 239 ± 26.7 kg) of English and Continental breeding grazed 1.6-ha wheat pastures in the autumn and spring. Steers were preconditioned at the research site for a minimum of 42 d using methods similar to those described by Poe et al. (2013) and Richeson et al. (2015) before turnout, gaining 0.7 ± 0.09 kg/d during preconditioning. Individual steer BW was recorded at the initiation and termination of grazing following a 16-h withdrawal period from feed and water. All steers were implanted according to treatment protocol (Richeson et al., 2015) in 2012; in all other years all steers were implanted on the day of turnout onto pasture with 40 mg of trenbolone acetate, 8 mg of estradiol, and 29 mg of tylosin (Component TE-G with Tylan, Elanco Animal Health, Greenfield, IN).

During the autumn, pastures were continuously stocked beginning when forage height was visually estimated to have reached approximately 20 cm in early November of each year. At the end of winter grazing period, all cattle were removed when forage mass reached <1,000 kg of DM/ha, a level that limits OM intake by calves (Redmon et al., 1995), or when forage growth accelerated, necessitating the increase in stocking rate for the graze-out period. In mid-February, a new set of steers was placed on each pasture for spring graze-out. At the end of the spring graze-out period, all cattle were removed from pasture when residual forage mass (Redmon et al., 1995) or forage maturity reduced nutritive quality (CP or digestibility; NRC, 1996) to limit animal performance. Steers in all pastures were allowed free access to drinking water sourced from a well in automatic-fill freeze-proof containers (Mirafount 3390; MIRACO Livestock Water Systems, Grinnell, IA).

Forage Sampling and Analysis

Sampling. Forage mass in each pasture was estimated monthly during the grazing season using a calibrated disk meter with 20 sampling points per pasture (Michell and Large, 1983). Calibration samples were collected by clip-