



Forage Yield, Quality, and Root Characteristics of Birdsfoot Trefoil-Tall Fescue Pastures



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Introduction

- Birdsfoot trefoil (*Lotus corniculatus* L.; BFT) is a perennial forage legume that contains condensed tannins (CT).
- BFT has the capability of yielding highly productive pastures when grown with tall fescue (*Schedonorus arundinaceus* (Schreb.) Dumort.; TF), however the effect of the grass-legume mixture on below-ground characteristics remains unknown.
- Does BFT CT content and TF endophyte infection status interact to affect above- and below-ground productive of perennial pastures?

Objective

Our objective is to determine the optimum BFT and TF cultivars that enhance forage yield, quality, soil respiration, and root characteristics in binary pasture mixtures that vary in BFT CT content and TF endophyte infection status.

Materials and Methods

Location: MSU Agronomy Farm, East Lansing, MI
Design: Randomized Complete Block Design (RCBD) with a split plot treatment arrangement and two blocks. Main plots are comprised of four TF cultivars ('Martin II Protek', 'Martin II E-', 'KY 31 E+', 'KY 32 E-'). Subplot consisted of eight BFT seed sources with varying CT content ('Common', 'Bull', 'Bruce', 'Pardee', 'Oberhaunstädter', 'AC Langille', two sources 'Norcen' (1 & 2)).

- BFT was planted in July 2014, over-seeded with TF in March 2015 and re-planted in August 2015 due to poor grass establishment.
- In 2015, plots were subjected to three high-intensity, short duration grazing events in June, August, and November. 2015 served as the first of three grazing season.
- Nutritive composition from each grazing event was determined using near infrared reflectance spectroscopy (NIRS, Foss model 6500, WinISI software). Analysis included crude protein (CP), rumen undegradable protein (RUP), neutral and acid detergent fiber (NDF, ADF), and digestible neutral detergent fiber (dNDF).
- Forage biomass was estimated nondestructively using a rising plate meter (RPM), calibrated monthly. RPM was used to monitor available forage biomass and determine when grazing threshold of 3 to 4.4 Mg/ha had been reached.
- Root samples were collected from a subset of four BFT cultivars: 'Norcen2', 'Pardee', 'Bruce', 'Oberhaunstädter'. Roots were isolated from soil cores (2.5-cm radius, 15-cm depth) collected in November 2015 and analyzed using WinRHIZO Basic (Regent Instruments, Quebec City, Quebec, Canada).
- Soil respiration was measured using the Solvita CO₂-Burst method on the above subset of BFT cultivars.
- Statistical analysis was performed using the PROC MIXED procedure software in SAS (SAS, Inc., Cary, NC). Main effects and interactions were considered significant when $P < 0.05$; means were separated using contrasts and LSD.

Results

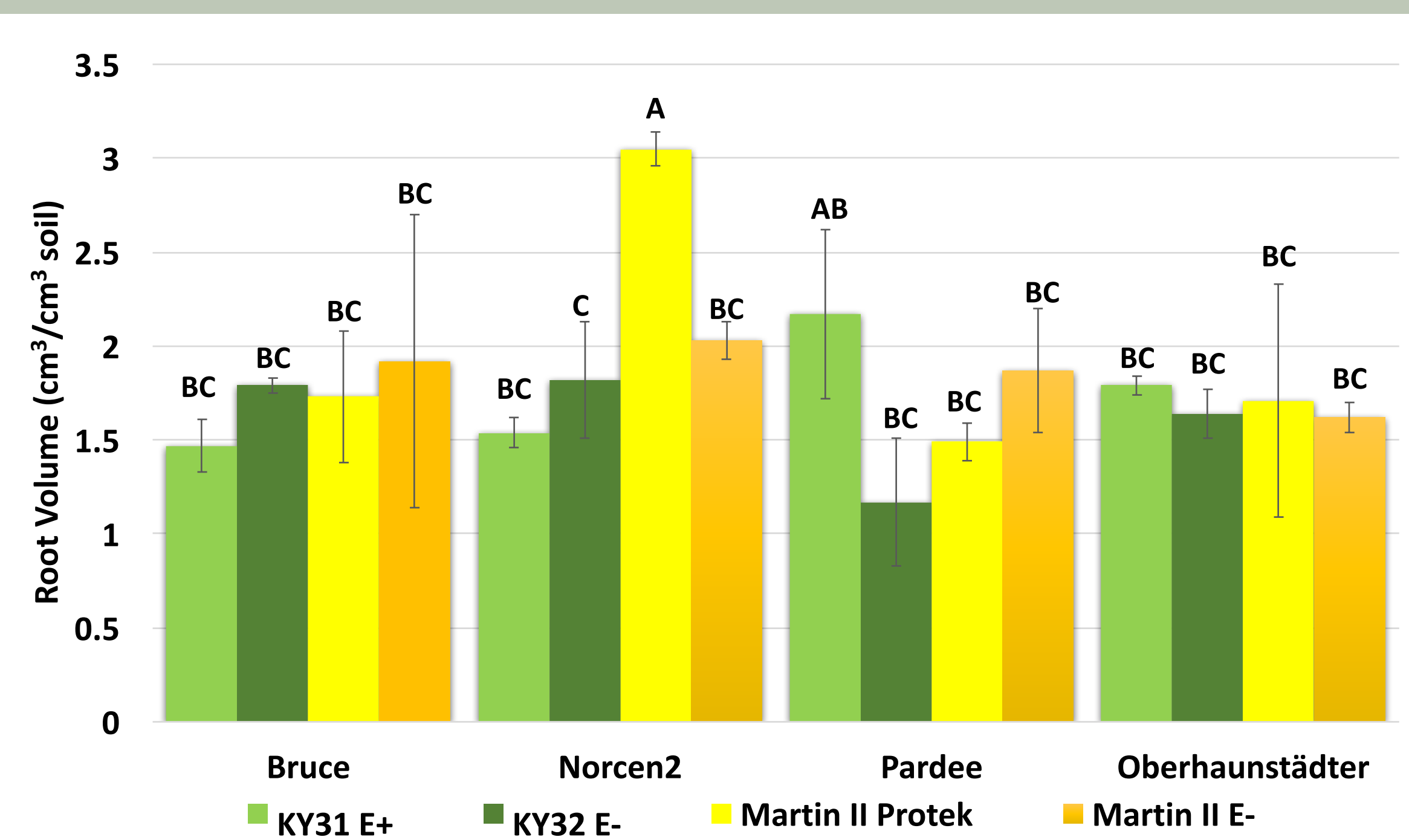


Figure 1. Root volume of binary mixtures of BFT and TF cultivars (mean ± SEM). Values marked by the same letter are not significantly different (LSD, $\alpha=0.05$).

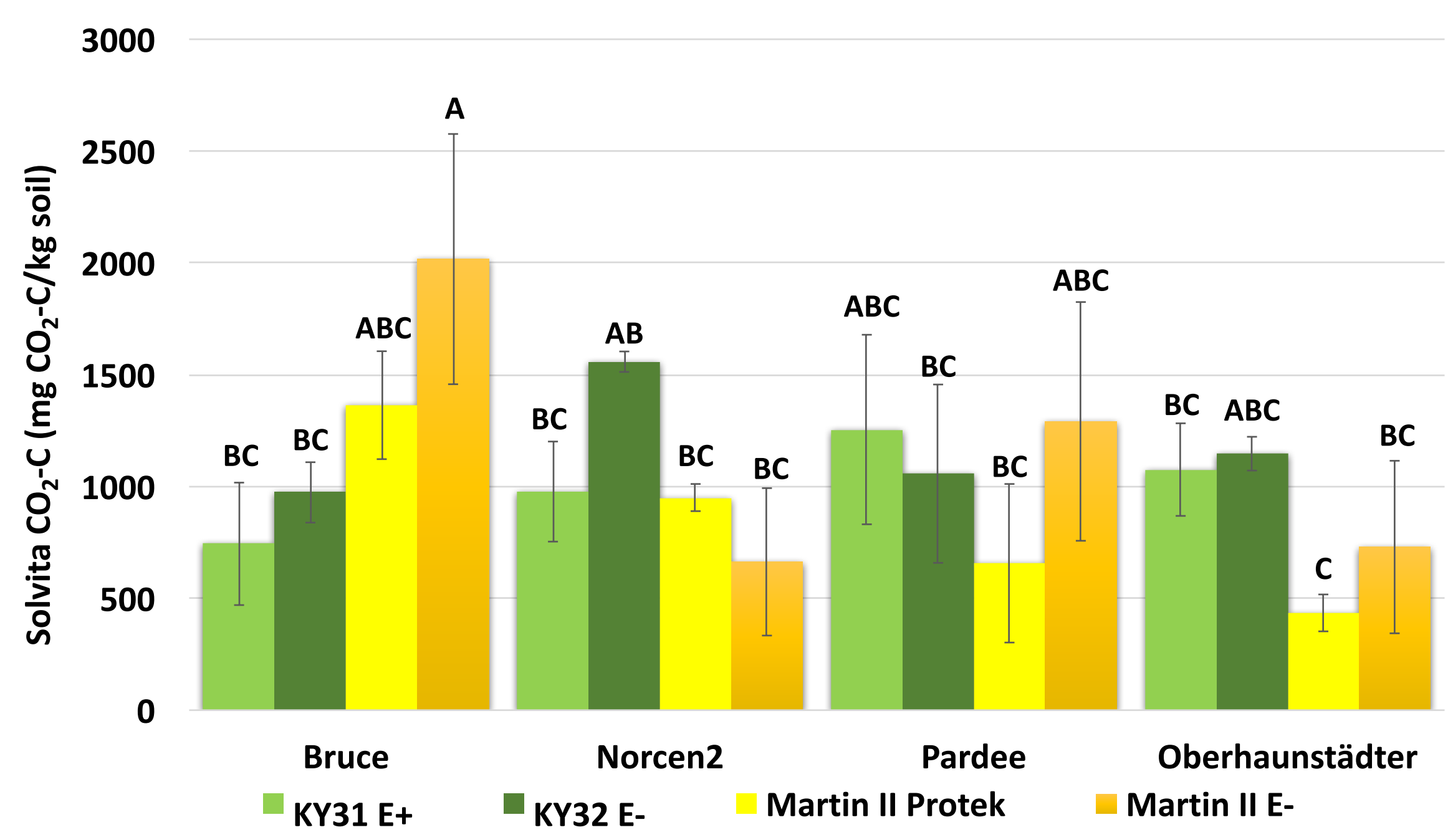


Figure 2. Microbial respiration in pasture soils growing binary mixtures of BFT and TF, as measured using the Solvita CO₂-Burst method (mean ± SEM). Values marked by the same letter are not significantly different (LSD, $\alpha=0.05$).

- Available forage biomass exceeded 2.9 Mg/ha for all grazing events.
- There were no differences among treatments (TF*BFT, $P > 0.05$) for root mass (0.44 mg/cm³), root length (3083 cm/cm³), root surface area (262 cm²/cm³), root average diameter (0.27 mm), or root volume (1.79 cm³/cm³), expressed on a per unit soil volume basis.
- (Fig. 1) Planned contrasts demonstrated Norcen2 BFT had greater root volume when grown with Martin II Protek than when grown with KY31 E+ ($P < 0.05$).
- For Norcen2, root mass (0.8 vs 0.34 mg/cm³, $P < 0.05$), root length (4417 vs 3039 cm/cm³, $P < 0.05$), and root surface area (409 vs 241 cm²/cm³, $P < 0.05$) were also greater when grown with Martin II Protek than KY31 E+, respectively.



First grazing event, June 2015

- There was no difference among treatments (TF*BFT, $P > 0.05$) for soil microbial respiration.

- (Fig. 2) Single-degree of freedom contrasts indicated differences in soil microbial respiration between some TF and BFT combinations, but there was no distinct pattern of effects. Additional years of data collection should help clarify this finding, but it appears that it is possible to influence soil biological activity through choice of TF and BFT cultivars.

- (Fig. 3) Oberhaunstädter had the lowest CP content among BFT cultivars in every cutting and when averaged over all three cuttings.

- (Fig. 4) Oberhaunstädter had the greatest RUP content among BFT cultivars, which is consistent with reports of moderate to high CT in this cultivar. AC Langille had greater RUP than Common, Bruce, and Norcen2. CT analyses for our samples are pending to further investigate this finding.

- (Fig. 5) Oberhaunstädter had the lowest digestible NDF among BFT cultivars, suggesting CT in this cultivar could potentially reduce forage dry matter intake

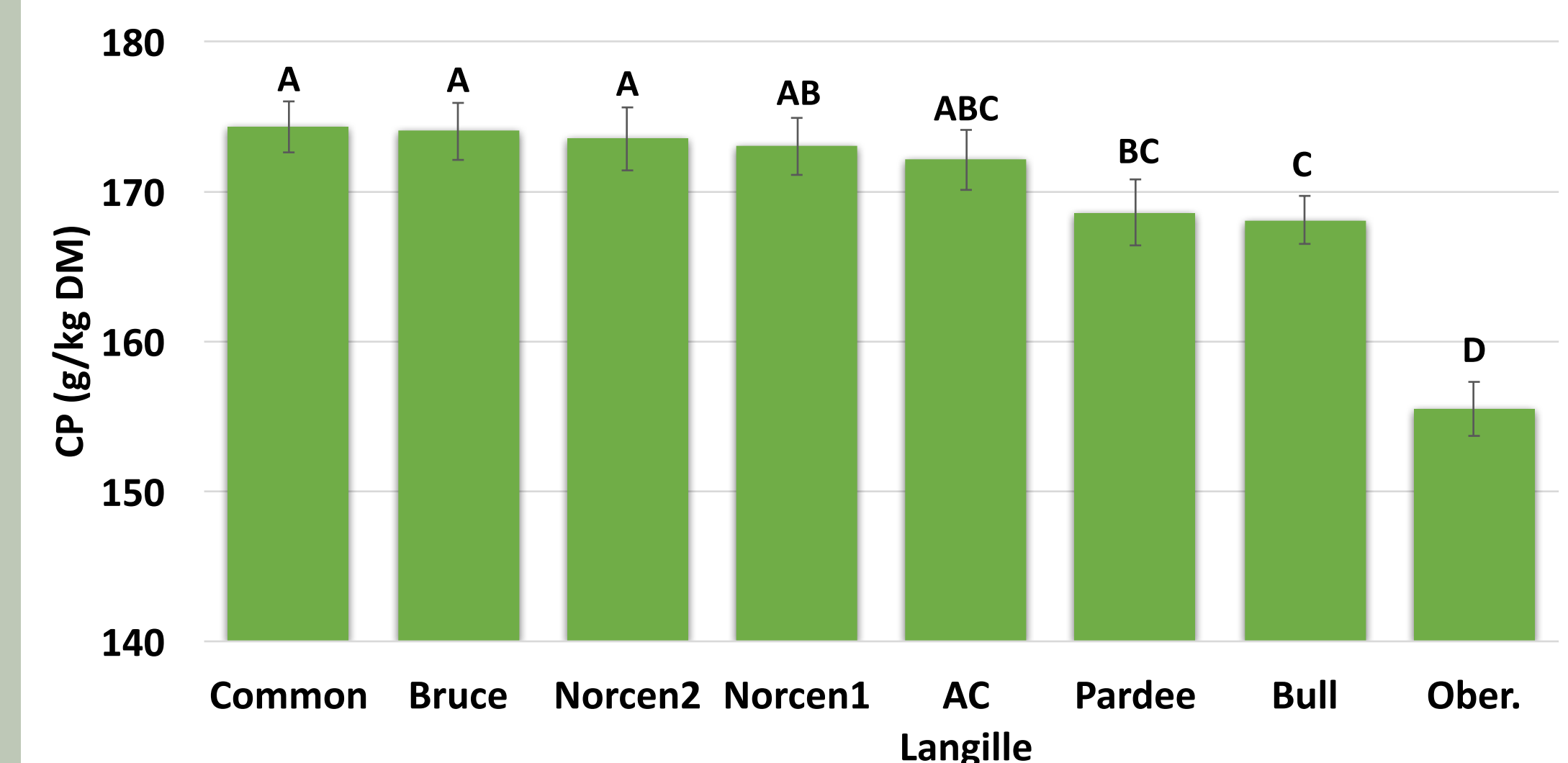


Figure 3. Average crude protein of BFT component in BFT-TF binary mixtures across three grazing events in 2015 (mean ± SEM). Values marked by the same letter are not significantly different (LSD, $\alpha=0.05$).

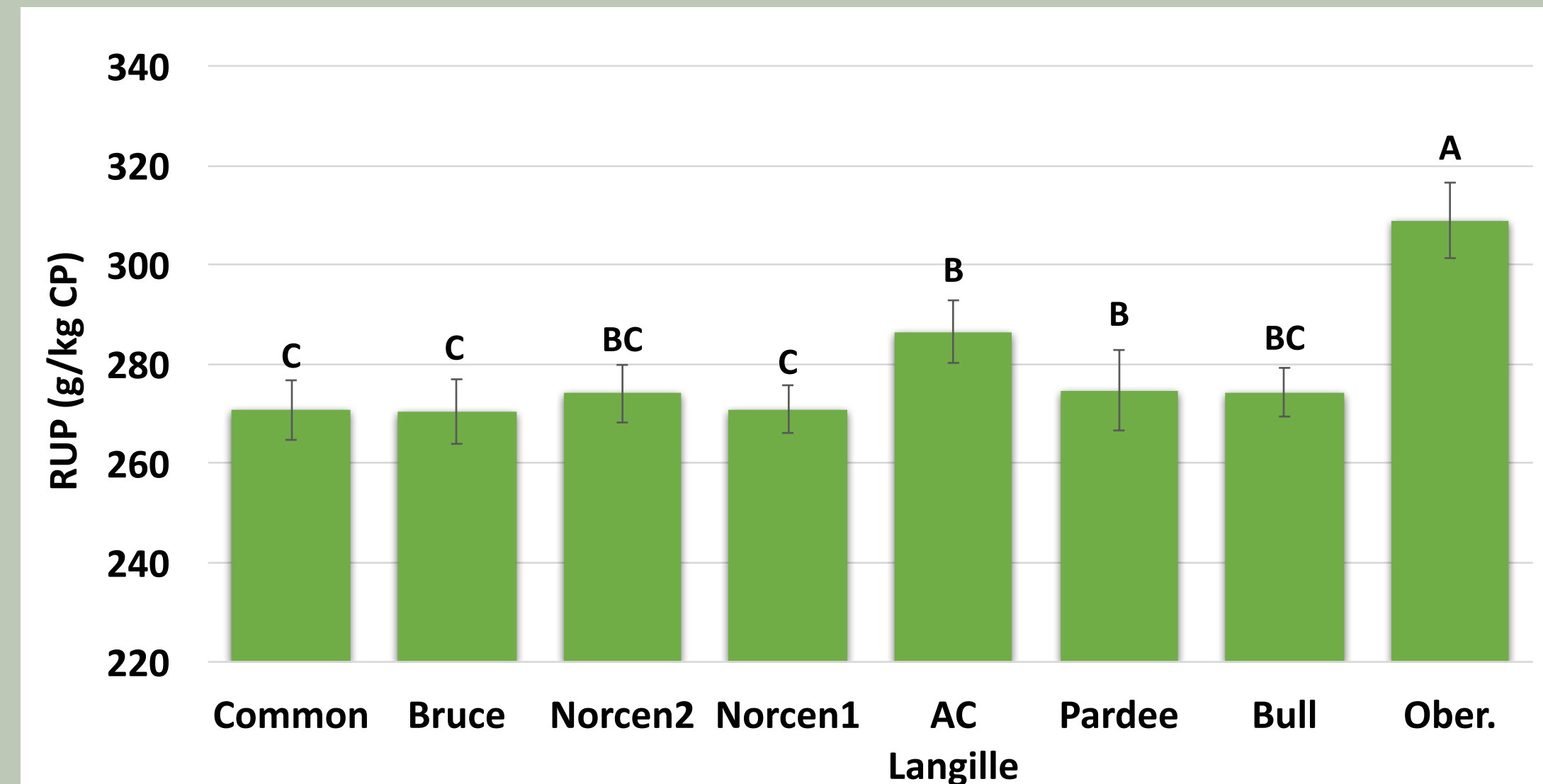


Figure 4. Average rumen undegradable protein of BFT component in BFT-TF binary mixtures across three grazing events in 2015 (mean ± SEM). Values marked by the same letter are not significantly different (LSD, $\alpha=0.05$).

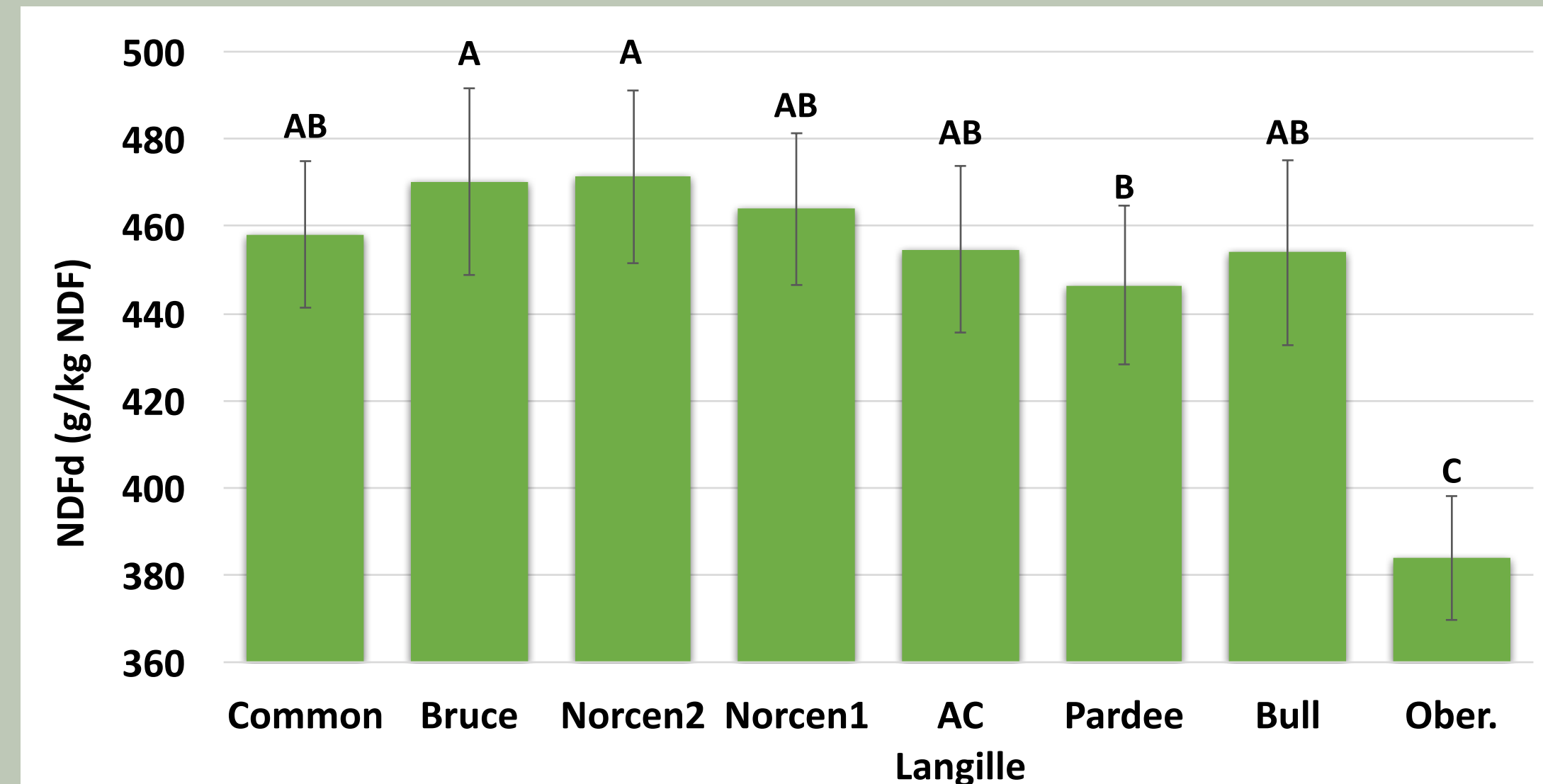


Figure 5. Average neutral detergent fiber digestibility of BFT component in BFT-TF binary mixtures across three grazing events in 2015 (mean ± SEM). Values marked by the same letter are not significantly different (LSD, $\alpha=0.05$).

Conclusions

- Interactions among BFT and TF cultivars relating to root characteristics and soil microbial activity show choice of TF/BFT mixtures can affect below-ground activity.
- Oberhaunstädter, which is reported to have moderate to high CT, had lowest CP and NDFd, but greatest RUP among BFT cultivars, suggesting an effect of CT content on forage quality.
- Data currently being collected from plots will allow for a better understanding of the interaction between BFT CT and TF endophytes as it affects above-and below-ground dynamics.

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