Effect of Native Warm-season Grass Canopy Development and Characteristics on the Establishment and Production of Forage Legumes

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ABSTRACT

The establishment and persistence of legumes in grass mixtures is often constrained by their ability to exploit environmental niches within the stand. The leaf arrangement and canopy development varies greatly between native warm-season grasses (NWSG) species, and a closer examination of this variability in canopy architecture in relation to legume production may provide further insight into successfully maintaining these mixtures in sustainable forage-livestock systems. Twenty three varieties of NWSG were either fertilized with 80 kg N ha[1] or interseeded with either red clover [*Trifolium pratense* L.] or sericea lespedeza [*Lespedeza cuneata* (Dum. Cours.) G. Don]. There was a significant ($P < 0.01$) interaction between NWSG species and the perecent of legume species during the season. The percentage of red clover remained unchanged in the eastern gamagrass [*Tripsacum dactyloides* (L.) L.], but declined in mixture with the other three grass species. The proportion of sericea lespedeza increased during later dates when interseeded into eastern gamagrass and switchgrass [*Panicum virgatum* L.], but remained consistent throughout the season in big bluestem [*Andropogon gerardii* Nash] and indiangrass [*Sorghastrum nutans* (L.) Nash] stands. The presence of sericea lespedeza was higher ($P < 0.01$) than red clover in the switchgrass stands at the end of the season, but was not different from the amount of red clover in big bluestem, eastern gamagrass, and indiangrass stands during the same period. Eastern gamagrass appeared to be compatible with either red clover or sericea lespedeza due to a more open canopy and earlier harvest date, which allowed more light to penetrate lower into the canopy. The more erect growth habit of sericea lespedeza may have allowed it to be more compatible with switchgrass than red clover. Although the percentage of sericea lespedeza was unchanged for big bluestem and indiangrass, the later harvest date allowed these species to maintain a maximized LAI longer into the season and may lead to poor persistence of both legume species. Variety effects for legume compatibility within a NWSG species were detected ($P < 0.08$) for switchgrass and indiangrass. However, these effects were primarily due to later maturing varieties allowing for higher initial legume percentages and no differences ($P > 0.30$) were detected in the varieties by the end of the season.

INTRODUCTION

- In Kentucky, livestock production relies almost exclusively on cool-season forages, which may become limiting during the summer months
- Native warm-season grasses (NWSG) are better adapted to warmer, drier conditions and have been shown to maintain livestock during the "summer slump" of cool-season species
- These forage species are also lower in nutritive value, which makes the interseeding of legumes to improve the quality of available forage more of a vital concern
- However, the persistence of legumes species in NWSG stands is an on-going concern for many producers
  - The persistence of legumes species in mixtures with grasses is often constrained by their ability to exploit environmental niches, such as openings within the canopy
- A majority of research has focused on examining the persistence of various legume species between species of NWSG
- There has been little work done examining the variability of legume compatibility within a species of NWSG despite the known differences in canopy development and architecture that may occur between varieties
- The objective of this study was to examine the variability of NWSG canopy architecture in relation to the production and persistence of cool-season and warm-season forage legume species

MATERIALS AND METHODS

- The experiment was conducted at the University of Kentucky (UK) Spindletop research farm on the former UK NWSG variety trial that included 4 species of NWSG and 23 total varieties:
  - **Big bluestem [*Andropogon gerardii* Nash]**: *'Kaw', 'Pawnee', 'Roundtree', 'Wapiti', and a western Kentucky (KY) ecotype*
  - **Eastern Gamagrass [Tripsacum dactyloides (L.) L.]**: *'Highlander', 'Iuka', 'Jackson', 'PMK 24', and two KY ecotypes collected from Hart and Mead Counties*
  - **Indiangrass [Sorghastrum nutans (L.) Nash]**: *'Big Barren', 'Cheyenne', 'Nebraska 54', 'Osage' and a KY ecotype collected from Washington County*
  - **Switchgrass [Panicum virgatum L.]**: *'Alamo', 'Cave-in-Rock', 'Trailblazer' and three West Virginia ecotypes*
- *'Kenland'* red clover [*Trifolium pratense* L.] and *'AU Grazer'* sericea lespedeza [*Lespedeza cuneata* (Dum. Cours) G. Don] were strip-planted into blocks at 11 and 21 kg PLS ha^{-1}, respectively
  - A control strip with no interseed legume species recieved 80 kg N ha^{-1}
- Leaf area index (LAI) and other canopy characteristics were estimated approximately every 3 weeks with a Li-Cor LAI-2000 plant canopy analyzer
- The amount of each legume species was estimated using a visual rating system at one month after seeding, before each harvest, and at the end of the growing season
  - **Rating System**: **1** = < 20% of seeded row visible; **5** = > 80% of seeded row visible
- Yields were determined when all varieties of a species of NWSG had reached a reproductive stage of growth
  - Eastern gamagrass and switchgrass had sufficient forage available for a harvest later in growing season
- Data analyzed as a randomized complete strip-block design with multiple harvest and day of year analyzed as a repeated measures

RESULTS AND DISCUSSION

Forage Yields:

- The total seasonal forage yield of eastern gamagrass (7,613 kg ha^{-1}) was lower ($P < 0.05$) than big bluestem, indiangrass, and switchgrass (10, 259 kg ha^{-1})
- The yields of the commercially available varieties of eastern gamagrass ('Highlander', 'Jackson' 'Iuka' and 'PMK 24') were higher ($P < 0.05$) than the two KY ecotypes (8,632 vs. 5,573 kg ha^{-1})
  - Variety had little effect ($P > 0.35$) on the production of big bluestem, indiangrass, and switchgrass
- Forage yields of NWSG stands interseeded with legumes were similar ($P > 0.30$) to N-fertilized control, regardless of species or variety

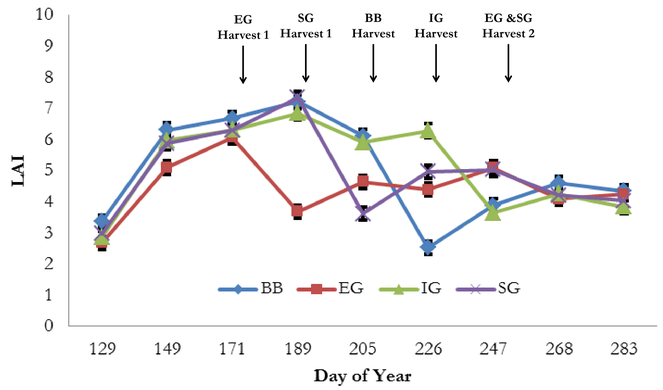

Figure 1. Leaf Area Index (LAI) for big bluestem (BB), eastern gamagrass (EG), indiangrass (IG) and switchgrass (SG). Error bars refer to ± SED.

Canopy Traits:

- Due to its earlier maturity, eastern gamagrass was harvested earlier in the season (Day of year: DOY 175), followed by switchgrass (DOY 193), big bluestem (DOY 207), and indiangrass (DOY 228) (Fig. 1)
  - An additional harvest occurred later in the season for switchgrass (DOY 249) and eastern gamagrass (DOY 256)
- Prior to its harvest, leaf area index (LAI) was lower ($P < 0.10$) for eastern gamagrass and the other NWSG species through DOY 149, and was lower than big bluestem on DOY 171
- There was little difference ($P > 0.30$) in LAI for the other species of NWSG for the remainder of the season until the species was harvested (Fig. 1)
- The canopies of eastern gamagrass allowed more ($P < 0.10$) light to reach the soil surface when measured at various incident angles (i.e. gap fractions) during the early portion of the growing season (DOY < 149) (data not shown)
- By DOY 149, the amount of light penetrating the canopy was minimal for all species and was not significantly different than zero (data not shown)

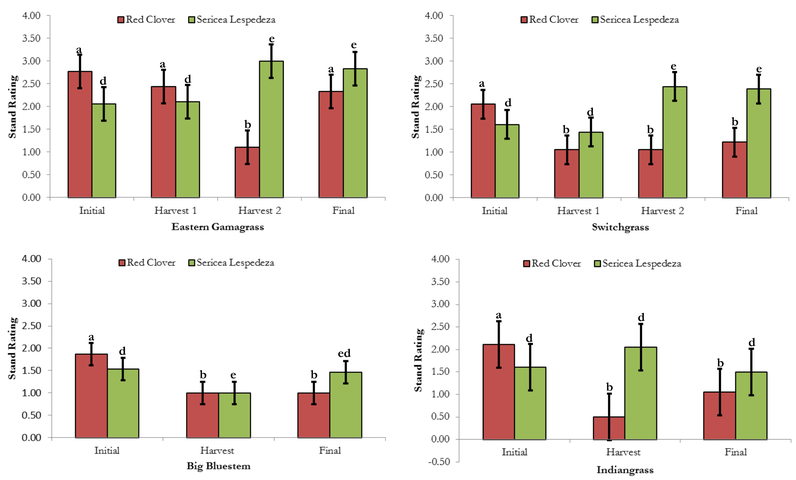

Figure 2. Average stand rating (1-5 in 20% increments) during the season for red clover and sericea lespedeza interseeded in each NWSG species Error bars refer to ± SED. Letters refer to significant difference at $P < 0.05$ level within a given legume and NWSG species treatment.

Canopy Traits (cont.):

- Similar to LAI, the amount of light entering the canopy at each of the measured angles increased immediately after the harvest for each NWSG species, but were similar ($P > 0.10$) during the remainder of the growing season when all stands had recovered following defoliation
  - Eastern gamagrass, switchgrass, big bluestem, and indiangrass stands went 26, 44, 58, and 79 days with minimal light reaching the lower portions of the canopy before first harvest
- Variety effects were detected ($P < 0.05$) inconsistently for multiple gap fractions in eastern gamagrass, indiangrass, and switchgrass stands, but appear to be due to later maturing varieties during the early part of the growing season only
- Varieties of a specific NWSG species had no effect ($P > 0.20$) on LAI
- The interseeding of either legume species also had no effect ($P > 0.35$) on LAI or the measured gap fractions of the canopies

Legume Establishment & Persistence:

- The presence of red clover was highest ($P < 0.05$) within eastern gamagrass stands, and despite a decrease before the second harvest (Fig. 2), remained consistent ($P > 0.50$) between the start and end of the season
  - The percent of red clover decreased ($P < 0.05$) in the other NWSG stands during the same period
- The amount sericea lespedeza increased ($P < 0.05$) in the stands of eastern gamagrass and switchgrass, but remained unchanged ($P > 0.65$) in the big bluestem and indiangrass (Fig. 2)
- At the end of the season, the amount sericea lespedeza was higher ($P < 0.01$) than red clover in switchgrass stands, but there was no difference ($P > 0.10$) between the legumes species for the other grasses
- The KY ecotype of big bluestem had ($P < 0.01$) less legume species (Avg. stand rating = 1) than the commercially available varieties (Avg. stand rating = 1.39) (data not shown)
- Differences in legume compatibility were detected ($P < 0.10$) between varieties of switchgrass and indiangrass over time, but appear to be due to a higher initial legume ratings in later maturing varieties (Fig. 3)
  - There was no difference ($P > 0.30$) in legume stand rating for varieties of these species by end of the season
- No differences ($P > 0.20$) in legume stand ratings were seen between varieties of eastern gamagrass

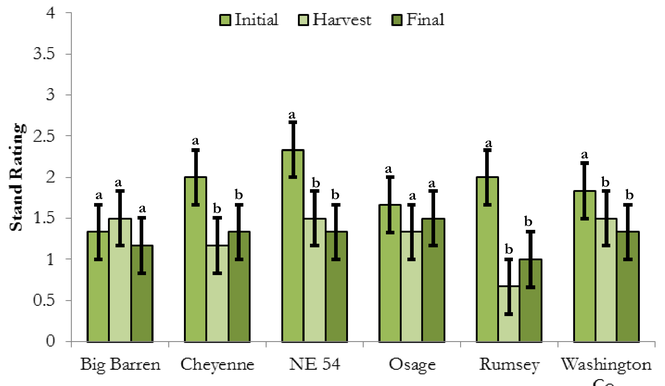

Figure 3. Average stand rating of legumes (1-5 in 20% increments) in varieties of indiangrass. Error bars refer to ± SED. Letters refer to significant difference at $P < 0.05$ within a specific variety.

SUMMARY

- Interseeding legume species into stands of NWSG did not increase seasonal forage yields
  - Forage nutritive value analysis is under way to determine the effect on forage quality
- Although some variety differences were detected, the compatibility of legumes appeared more dependent upon NWSG species
- Either red clover or sericea lespedeza appeared to be compatible with eastern gamagrass due to the latter's more open canopy and early maturation
- The percent of red clover decreased in big bluestems, switchgrass, and indiangrass stands and is most likely due to an extended period of shading by these grass species
- The amount of sericea lespedeza increased during the season when interseeded with switchgrass, which suggests that its similar timing of growth and more erect growth habit may make it a more suitable legume species for this grass, ***if managed properly***
- Although the percent of sericea lespedeza did not decline when interseeded with big bluestem and indiangrass, its presence was low (i.e. < 30% of seeded row) in these stands and may be indicative of incompatibility in future growing seasons