



Intercropping Legumes with Native Warm-season Grasses for Livestock Forage Production in the Mid-South

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Introduction

Native warm-season grasses (NWSG), such as switchgrass, big bluestem, indiagrass and eastern gamagrass have always been part of the North American prairies and increasingly are being used to fill summer production gaps left by cool-season forages. Cool-season forages, such as tall fescue and orchardgrass, are species that grow best and produce the majority of their digestible

energy during cooler months. NWSG can supplement cool-season forage grasses, as they are adapted to hot, dry summer conditions. In addition, various legumes may be used to complement native grass forages and help improve or maintain available nutrition and yield (Figures 1 and 2). Recent studies have demonstrated that legumes can be interseeded into established switchgrass to increase

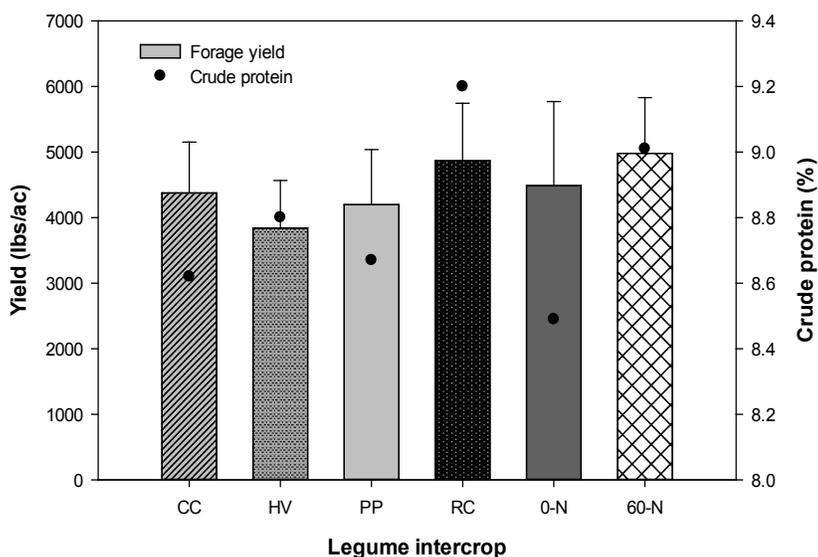


Figure 1. Switchgrass forage yield and average crude protein content (for switchgrass only, harvested early to mid-June) averaged over two years (2009-2010) and for two locations in Tennessee with various legume intercrop species (CC=crimson clover; HV=hairy vetch; PP=partridge pea; RC=red clover).

soil nitrogen, thereby reducing fertilizer costs and weed pressure while enhancing forage yield and quality.

Although legumes have been used in cool-season pastures and hayfields, they are not widely used in NWSG production. However, given the trends in the price of nitrogen fertilizers in recent years, interseeding legumes could become an important management practice. Guidelines for NWSG forage production call for 60-90 lbs N per acre annually after the establishment year. However, even under optimal management, plants usually take up only 40-60 percent of applied fertilizer, meaning about half of the fertilizer applied is not used and is generally lost to groundwater or volatilization. Replacing nitrogen fertilizers with legumes in hay or grazing systems can be more efficient and cost-effective. Legumes also can increase soil-organic carbon and phosphorus and suppress weed growth by competing for water and nutrients. Lastly, research from our studies has shown that switchgrass forage yields can be as much as 20 percent higher when legumes are planted as an intercrop.

Over the past five years, research at the University of Tennessee has focused on identifying legumes that are compatible with lowland varieties of switchgrass. Research also has been conducted using legumes in NWSG grazing systems. Many of the lessons learned from switchgrass studies can be applied to NWSG more generally. Therefore, we cover the broader group in this publication. Although our research continues, this publication provides the most up-to-date information available.

Intercropping Principles For Successful Legume Establishment

When two or more crops are grown together, each must have adequate space. To arrive at a proper legume density, maturity dates and growth habit must be considered. With respect to maturity dates, a grower can either plant species that mature before NWSG need growing space or plant species that can grow compatibly with the grasses. Other important points to consider for obtaining a healthy stand of legumes include:

- Follow recommended planting dates for legumes.
- Practice effective weed and pest control.
- Reseeding and persistence of legume intercrops (Figure 3).
- Nitrogen fixation efficiency and total biomass of legumes.

Primary considerations when selecting legume species include planting date, field history and soil drainage. Seeding dates for cool-season legumes in the Mid-South are typically early fall and mid-February through March.



Figure 2. Switchgrass and clover growing together before a forage harvest in Tennessee

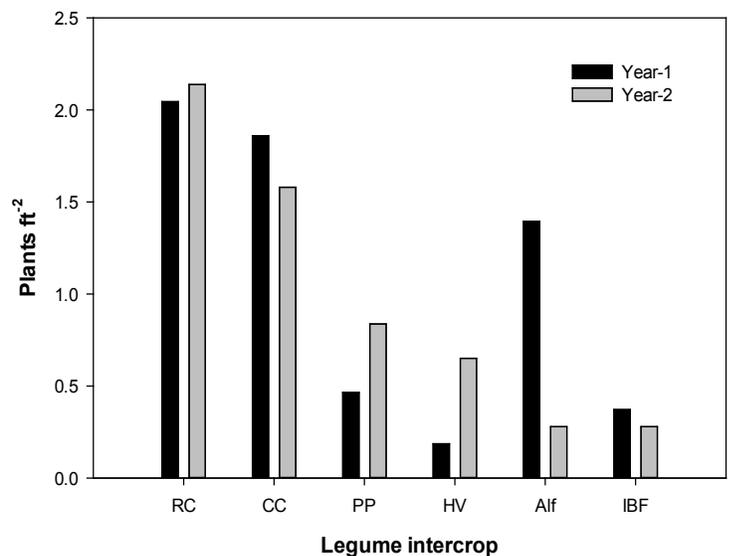


Figure 3. Legume (RC = red clover; CC = crimson clover; PP = partridge pea; HV = hairy vetch; Alf = alfalfa; IBF = Illinois bundleflower) persistence for year one (planting year) and volunteer reseeding in lowland switchgrass averaged over two locations in Tennessee and two years (2009-2010) when harvested in early June each year.

Seeding dates for warm-season legumes range from winter through early May, depending on species (Table 1). The site should be free of herbicide residues that could injure legumes (consult herbicide labels for intervals between product application and planting legumes). In addition, well-drained sites without compacted soils are best for legumes.

Legume density and N contribution depend on seeding rate, seeding date, weather after seeding and competition from the grass. The legumes discussed below have the ability to supply adequate nitrogen (>60 lbs N

Table 1. Legume groups, seeding rate, seeding date, and their respective inoculant type for successful nodule colonization. [Note: to prevent legume competition in spring, the lower seeding rate interval may be recommended].

Legume	Seeding rate	Seeding date	Inoculant code	Bacterium
	lbs PLS ac ⁻¹			
Clover group				
Ladino clover	3-6	Feb-April	A	<i>Sinorhizobium meliloti</i>
Red clover	5-10	Dec-March	A	"
Crimson clover	6-12	Dec-March	A	"
Pea and vetch				
Illinois bundle flower	7-10	March-April	C or "Garden"	<i>Rhizobium leguminosarum</i> <i>biovar viceae</i>
Common vetch	7-10	Dec-March	C or "Garden"	"
Cowpea group				
Partridge pea	12-20	Dec-April	EL	<i>Bradyrhizobium</i> spp.
Alfalfa group				
Alfalfa	12-16	Dec-March	A	<i>Sinorhizobium meliloti</i>

Inoculant information adapted from UT Extension publication PB1769 "A guide to successful wildlife food plots: blending science with common sense."

per acre) and eliminate the need for N fertilizer as long as legumes cover 30 percent of the area (or approximately 0.5-1.3 legumes per square feet depending on species). Legume seeding rates must be adjusted to reduce the potential for excessive competition with NWSG early in the season. Dense stands of cool-season legumes that overtop emerging NWSG in the spring (late March through April) can reduce grass growth and may weaken stands. Therefore, it is critical to reduce dense legume cover through an early harvest or grazing; however, forage should be mixed with grasses to prevent bloat. The species discussed below have proven successful for interseeding into established lowland switchgrass stands.

Red Clover

Red clover (Figure 4.) is a cool-season legume that is widely adapted and can complement NWSG production. However, it is a biennial or short-lived perennial (2-3 years) and may require periodic reseeding. Red clover should be planted September through March by broadcasting or using a no-till drill. Fall planting is acceptable but may increase the risk of competition during the early spring. While red clover is more tolerant to poorly drained soils than alfalfa, soils saturated for extended periods should be avoided. Red clover is tolerant to modest amounts of drought stress but does not persist well in sandy soils. See Table 1 for recommended seeding rates. Red clover has been the most successful legume

with respect to establishment and persistence during trials at the University of Tennessee.



Figure 4. Red clover flowering in a switchgrass pasture

White Clover

White (or ladino) clover is a cool-season legume that grows well over a variety of soils and climates; however, it prefers cool and wet conditions. White clover will grow in soils considered too acidic for red clover (Figure 4.) and alfalfa. This long-lived legume can be seeded February through April or August through September to a depth of 1/4 inch. The two greatest concerns when using white clover is its inability to survive extended dry periods and the potential for it to cause bloat in grazing livestock; however, any clover has the potential to cause bloat if it is not mixed in a grass stand where availability is reduced. In studies underway, switchgrass pastures that were interseeded with white clover yielded equivalent hay compared to 30 and 60 lbs N per acre.



Figure 5. White clover growing in tandem with switchgrass at a proper density

Crimson Clover

Crimson clover flowers earlier in spring than other clovers and produces high yields even in cool winters but has a shorter grazing season, maturing in late April. Crimson clover can be planted with a drill, a cultipacker-seeder, or can be broadcast from late August to October (Figure 6.). Crimson clover grows well in both sandy and clay soils that are well-drained and performs better than most other clovers on poor sites. Seeding depth should be 1/4 inch. In a reseeding experiment conducted at the University of Tennessee, crimson clover and red clover had the highest densities after annual reseeding. However, crimson clover stands that are well-established in the fall can be too competitive with NWSG in the spring; therefore, it is important to plant at a reduced seeding rate (for specific rates, see Table 1).



Figure 6. Clover seeded into NWSG stubble during grass dormancy

Partridge Pea

Partridge pea is a native, reseeding annual that is tolerant to low soil fertility and complements switchgrass well (Figure 7.). Partridge pea should be planted in February to March, and it grows during the summer months. Our research indicates that the annual average nitrogen replacement value of partridge pea is 60 lbs per acre. However, as cattle forage, there may be limitations relating to palatability because seeds can cause irritation in the digestive tract if consumed in large quantities. As such, its primary value may be in biofuel production.



Figure 7. Partridge pea growing in a switchgrass canopy

Common and Hairy Vetch

Hairy and common vetches are legumes that occur naturally throughout the South and are frequently found growing on roadsides and in fields and pastures (Figure 8.). They are well-adapted to moderately to well-drained soils. These vetches reseed readily for many years and will colonize low-fertility soils. No seedbed preparation is needed, and seed is usually no-till drilled 1/2 to 3/4 inch deep. Common vetch has less hard seed than hairy vetch, making it less of a potential weed problem, but it may require seed scarification. In a seed dormancy study, we determined that common vetch hard seed can be reduced by mechanically scarifying the seed coat, but such measures can be time-consuming. In addition, common vetch matures 10-14 days earlier than hairy, lessening competition with NWSG. Our research has measured fixation rates of 53 to 67 lbs N per acre for both vetches; thus, the addition of N fertilizer for grass growth is not necessary. Hairy vetch makes high-quality hay. However, because of its climbing growth habit, it may compete with and weaken NWSG stands and invade nearby fields. This can be mitigated through appropriate seeding rates (Table 1) and timely spring grazing. In some cases, mowing may be needed to manage excessive vetch competition.



Figure 8. Hairy vetch growing in a switchgrass field

Alfalfa and Illinois Bundleflower

Alfalfa and Illinois bundleflower have had varying degrees of success in our studies, considering they have summer growth patterns and compete directly with NWSG growth. Both may be viable options, but establishment and persistence in our lowland switchgrass stands have been only marginally successful (Figure 3). When grown with shorter grass varieties/species (such as upland varieties of switchgrass, little bluestem, or even big bluestem and indiagrass), alfalfa and Illinois bundleflower may be more competitive and a better option.

Seed Inoculation Considerations and Practices

Although the majority of Rhizobium bacteria strains needed to nodulate legumes exist in soils, legume seed inoculation and timely planting may enhance legume establishment and, ultimately, the amount of nitrogen supplied. Thus, it is important to either purchase seed preinoculated (red clover and crimson clover) or to inoculate seed prior to seeding. Inoculate legume seed with legume-specific bacteria just prior to seeding to ensure nitrogen fixation (Figure 9.). Properly inoculated legumes may provide up to 200 lbs N per acre.

Inoculants are live bacterium. Keep them in cool environments (such as a cooler or refrigerator) with low humidity and out of direct sun and apply them to seed directly before planting. Dry conditions after planting will reduce inoculant success. It may not be necessary to inoculate seed at sites that have grown the same legume species within the past few years. Steps for successful inoculation include:

- 1) Purchase inoculant that is specific to the legume you are planting (Table 1) and store properly until planting date. Note: Use fresh inoculant each year.
- 2) Mix legume seed and inoculant in a bucket or other large container and add a commercial sticker according to label instructions (a sugar/water solution [4:1 water/sugar ratio] works just as well). Also, milk can be used as a sticking agent. Do not use soft drinks as their acidity may kill the bacterium. Make sure inoculum, seed and sticking agent are well-mixed; this can be done by hand. Add just enough water to coat the seed because too much water/moisture can create fungal disease and early germination if allowed to soak for too long. However, if commercial sticker is used, there is no need for the sugar/water solution. Do not add too much sticker, as it can cause seeds to clump together. Note: One bag of inoculant will treat a large amount of seed (approximately 50 lbs).
- 3) If too much “moisture” has been added to the seed, spread inoculum-treated seed in the shade on drying materials such as newspaper, cloth bags or breathable fabric until dry. Once dried, sow the seed to proper seeding depth/rate. If not seeded immediately, the seed should be placed in a cool space; however, if the seed dries appreciably or is allowed to sit for several days, re-inoculation will be required, unless a commercial sticker was used. Note: It is best to inoculate immediately prior to planting.

Seeds that come preinoculated have a stronger sticker and are often rolled in limestone or rock phosphate, which combats unfavorable conditions, such as low pH and temperature extremes, and can be stored for longer periods. Lastly, do not inoculate seed directly in the planter box, because inoculant and seed tend to separate when dry, leading to uneven seed coverage.



Figure 9. Nodules on legume roots (pink color indicates leghaemoglobin, an iron containing protein that converts nitrogen gas to a plant-usable form [ammonia])

Nwsg Legume Intercropping Study Conclusions:

- Alfalfa and Illinois bundleflower interseeded into NWSG germinated but were not able to grow under a dense switchgrass canopy.
- Red clover, partridge pea and crimson clover were the most persistent legumes for intercropping in NWSG forage systems.
- Partridge pea grows mainly during summer months and, if established at high densities, could compete directly with NWSG.
- Measured nitrogen fixation rates for partridge pea and common and hairy vetch were ≥ 53 lbs N acre.
- Reduce dense cool-season legume stands (≤ 30 percent total area) by either grazing or harvesting to prevent competition with NWSG early in the growing season.

For further information:

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