

Dairy Grazing

Selecting the Right Forage

Forages are the foundation of a successful pasture-based dairy. So when forage yield or quality drops, so does milk production. Successful forage systems consider more than annual forage yield or milk production per acre. They also consider plant persistence, long-term sustainability, cost per unit of milk produced and, ultimately, profitability. Graziers should consider all of these factors before developing a forage system for their farms.

From a biological perspective, there are three important concepts to understand when planning a forage system:

1. Forage yield and yield distribution
2. Forage quality
3. Stand persistence or reliability

Although these three concepts are interrelated, the following discussion examines each of them separately.

Forage yield and yield distribution

Many producers consider yield the most important attribute for any forage. Clearly, forages that do not yield well cannot be part of a productive forage program. But annual yield alone should not be used to select forages for pasture-based systems. For these systems, distribution of yield throughout the growing season is far more important than annual yield.

As an example, consider the two forages in Figure 1. Notice that forage A and forage B have the same annual yield. However, forage A produces 80 percent of its growth in May while forage B has a more even distribution of yield throughout the growing season. Forage A might be great for hay production, but forage B would be far superior for grazing all season long.

Although forages vary in their seasonal yield distribution, no forage is productive during all seasons of the grazing year. An important principle for developing a productive forage program for a pasture-based dairy is using the inherent differences in seasonal growth patterns to provide grazing for as much of the year as possible. This publication simplifies this process by providing diagrams that show the typical yield distribution for several forages used in Missouri. Use these diagrams to build a forage system that provides grazing for as much of the season as possible.

Reviewed from M168, *Dairy Grazing Manual*, by
Robert Kallenbach, Forage State Specialist, Division of Plant Sciences

Dairy grazing publication series

This publication is one in a series about operating and managing a pasture-based dairy. Although these publications often refer to conditions in Missouri, many of the principles and concepts described may apply to operations throughout the United States. A list of the publications in this series is available online at <http://extension.missouri.edu/m168>.

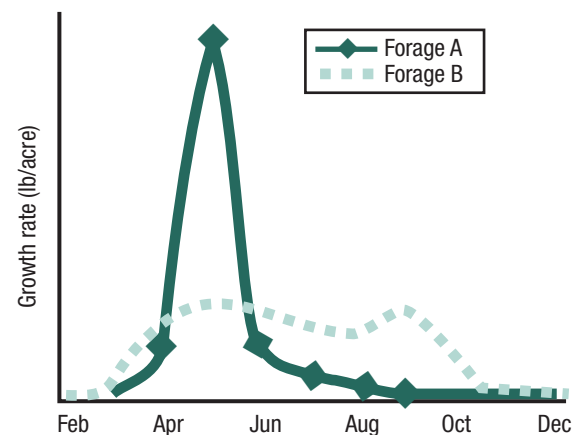


Figure 1. Yield distribution of two unique forages.

Forage quality

Almost any “mainstream” forage can be managed for dairy-quality feed. Some forages inherently contain more energy and protein than others, but nearly any can be managed to produce milk from pasture. The overriding concept here is that forage must be kept in a vegetative stage of growth to be of acceptable quality for milk production. In practice, this means that most cool-season grasses and short warm-season grasses such as bermudagrass and caucasian bluestem should be grazed when they reach 5 to 8 inches in height. Tall warm-season grasses should be grazed when they are 10 to 14 inches high. Waiting any longer than this will reduce forage quality as well as milk production.

Keeping the grass in a vegetative stage of growth may be difficult to do on a whole-farm basis, especially in late spring. During late spring, grass growth often exceeds what the milking herd can consume. Paddocks that become more mature than the guidelines mentioned above should be “skipped” in the rotation and the milking herd “moved

forward” to less mature paddocks. The “skipped” or mature paddocks should be harvested for hay or silage, or grazed by dry cows or other nonlactating livestock as soon as is feasible. These paddocks can again be part of the rotation for the milking herd after the grass has been harvested and shows 5 to 8 inches of regrowth.

Stand persistence or reliability

Many producers undervalue long-term stand persistence of many perennial forage species. Considering that it costs \$75 to \$250 per acre to establish a new forage, it pays to make stands last.

Persistence mechanism

Although we tend to equate persistence with the survival of individual plants, from a producer’s perspective we are more interested in the “persistence of yield or productivity.” In some cases, stand persistence may be the survival of individual plants, but in other instances it may involve the natural reseeding capability of a species (for example, annual lespedeza or crabgrass). What is important to know is the “mechanism” each species uses to persist. For instance, birdsfoot trefoil is a short-lived perennial legume. It is short-lived because it is susceptible to several root and crown rot diseases. But if birdsfoot trefoil is given a 45- to 60-day rest period to reseed every other year, stands can last almost indefinitely. Its persistence mechanism is *reseeding*. Similarly, annual lespedeza and crabgrass pastures can act almost as perennials if given a reseeding period each year.

On the other hand, a species such as alfalfa does not reseed well in Missouri. Instead, it relies on the survival and development of the individual plants that were seeded. Thus, its persistence mechanism is *plant longevity*. Species that use plant longevity to persist must be carefully selected so that adapted varieties are planted. For these types of forages, it is most important to select varieties that can tolerate less-than-ideal soil or environmental conditions or that show resistance to common diseases or insects.

Vegetative propagation is another persistence mechanism. An example of a plant that uses this mechanism is smooth brome grass. Smooth brome grass has rhizomes, or “underground runners,” that continually develop new plants to thicken the stand. Forages that use this persistence mechanism are often among the easiest to maintain.

In summary, understanding what mechanism your forages use to persist is the first key to managing for maximum stand life.

Soil environment

Another factor that influences stand persistence is the soil environment. The most important aspects of the soil

environment are the depth, drainage and fertility of your soils. For example, alfalfa is one of the most productive and nutritious forages available on well-drained and fertile soils. However, it does not survive well on poorly drained soils and does not tolerate low soil fertility. In this situation, a better choice might be to plant reed canarygrass and manage it to provide dairy-quality feed.

Picking a species adapted to your soil environment is key to a persistent forage. Table 1 lists the tolerance of many forages to poor soil drainage and low soil fertility. Use it as a guide to choose a species that matches the soil environment of your operation.

Cold hardiness and drought tolerance

Forages also should be selected for cold hardiness and drought tolerance. Many forages might survive a mild winter or a wet summer, but what happens when growing conditions are less than ideal? Under these conditions, differences in forage species become apparent. For instance, if we have a wet, cool summer, both timothy and orchardgrass persist quite well. However, when the weather turns dry, timothy does not persist as well because it has a shallower root system. Table 1 should be helpful in selecting a forage that can withstand less than ideal growing conditions.

Management

Management also plays a vital role in stand persistence. Almost no forage can survive poor management and be productive. The major management factors that influence stand persistence are grazing frequency, residual leaf area after grazing and planned rest periods for reseeding or fall growth. For more information on management factors that influence stand persistence, see MU Extension publication M184, *Design and Management of a Dairy Pasture*.

Summary

Several forages are available to graziers. Selecting a set of forage species based on yield distribution, forage quality and stand persistence is key to building a successful forage system for a pasture-based dairy. Before planning a forage system, become familiar with the key characteristics of the forages adapted to your region. The following pages provide an overview of the advantages and disadvantages of perennial and annual forages. They also lay a foundation for understanding how to put these species to work in your pasture-based dairy.

This publication replaces Chapter 5, *Selecting the Right Forage*, in MU Extension publication M168, *Dairy Grazing Manual*. Original authors: Robert Kallenbach and Greg J. Bishop-Hurley, University of Missouri.

Table 1. Quick guide to forage species adaptability.

Species		Yield potential	Tolerance to poor drainage	Tolerance to low soil fertility	Tolerance to drought	Tolerance to heat	Overwintering ability	Suitability for wildlife habitat
Cool-season grasses	Annual ryegrass							
	Kentucky bluegrass							
	Orchardgrass							
	Perennial ryegrass							
	Prairiegrass							
	Reed canarygrass							
	Small grains							
	Smooth bromegrass							
	Tall fescue (endophyte-free)							
	Tall fescue (endophyte-infected)							
	Timothy							
Warm-season grasses	Bermudagrass							
	Big bluestem							
	Corn						—	
	Crabgrass						—	
	Eastern gamagrass							
	Indiangrass							
	Old World bluestem							
	Pearlmillet						—	
	Sorghum-sundangrass						—	
	Switchgrass							
Legumes	Alfalfa							
	Birdsfoot trefoil							
	Clover, alsike							
	Clover, crimson							
	Clover, kura							
	Clover, red							
	Clover, white							
	Hairy vetch							
	Lespedeza, annual						—	
Other								
	Brassica species							

Legend

- Excellent
- Very good
- Good
- Fair
- Poor

Table 2. Quick guide to forage species establishment.

Species	Ease of establishment ¹	Seeding rate for pure stands (lb/acre) ²		Seeding dates		Preferred seeding depth (inches)	Months from seeding to first grazing	Preferred soil pH	
		Broadcast	Drilled	Spring	Fall				
Cool-season grasses	Annual ryegrass	E	30	25	—	8/15 – 9/15	¼	2	5.5 – 7.5
	Kentucky bluegrass	E – M	10 – 15	8 – 10	2/1 – 4/1	—	¼	2 – 4	5.5 – 7.0
	Orchardgrass	M	15 – 20	10 – 15	3/15 – 4/30	8/15 – 9/15	¼ – ½	3 – 6	5.5 – 7.0
	Perennial ryegrass	M	15 – 30	15 – 20	3/15 – 4/30	8/15 – 9/15	¼ – ½	2 – 4	5.5 – 7.0
	Prairiegrass	M	30 – 40	25	2/1 – 4/1	8/15 – 9/15	¼ – ½	2	6.0 – 7.0
	Reed canarygrass	M – D	8 – 12	8	3/15 – 4/30	8/15 – 9/15	¼ – ½	2 – 4	5.5 – 7.5
	Small grains	E	100 – 130	90 – 110	—	9/1 – 10/15	¾ – 1	2	5.5 – 7.5
	Smooth brome	M	15 – 20	10 – 15	3/15 – 4/30	8/15 – 9/15	¼ – ½	4	5.5 – 7.0
	Tall fescue	M	15 – 20	10 – 15	3/15 – 4/30	8/15 – 9/15	¼	3 – 6	5.5 – 7.0
	Timothy	E	8	3 – 6	2/1 – 4/15	9/1 – 10/1	¼ – ½	2 – 4	5.5 – 7.5
Warm-season grasses	Bermudagrass (sprigged)	M	—	25 – 30 bu/acre	4/1 – 6/1	—	1 – 2	10 – 12	5.5 – 7.5
	Big bluestem	M – D	8	6	4/15 – 5/31	—	¼ – ½	12 – 24	5.5 – 8.0
	Corn	E	—	25,000 seeds/acre	4/25 – 5/15	—	1 – 1½	2 – 3	5.5 – 7.0
	Crabgrass	E	4	3 – 4	2/1 – 5/31	—	¼ – ½	1 – 2	5.5 – 8.0
	Eastern gamagrass	D	—	10	4/15 – 6/1 [†]	11/1 – 2/1 [‡]	1 – 1½	24	5.5 – 7.5
	Indiangrass	M – D	8	6	4/15 – 5/31	—	¼ – ½	12 – 24	5.5 – 7.5
	Old World bluestem	M	3	2	4/15 – 5/15	—	¼ – ½	4 – 6	5.5 – 7.0
	Pearlmillet	E	20 – 30	15	5/1 – 6/15	—	½ – 1	2	5.5 – 7.5
	Sorghum-sundangrass	E	30 – 35	20 – 25	5/1 – 6/30	—	½ – 1	2	5.5 – 8.0
	Switchgrass	M	8	6	4/15 – 5/31	—	¼ – ½	12 – 16	5.5 – 7.5
Legumes	Alfalfa	E	20	15 – 20	4/1 – 4/30	8/15 – 9/15	¼ – ½	2 – 4	6.5
	Birdsfoot trefoil	M	6 – 8	5	2/1 – 4/1	8/15 – 9/15	¼ – ½	2 – 4	5.0 – 6.0
	Clover, alsike	E	6	4	2/1 – 4/1	8/15 – 9/15	¼	2 – 4	5.5 – 7.0
	Clover, crimson	E	25	20	—	8/15 – 9/15	¼	4 – 6	6.0
	Clover, kura	D	10 – 14	10	3/15 – 5/1	—	¼	18 – 24	6.0
	Clover, red	E	8	6	2/1 – 4/30	8/15 – 9/15	¼ – ½	2 – 4	6.0
	Clover, white	E	2	1 – 2	1/15 – 4/15	8/15 – 9/15	¼ – ½	2 – 4	6.0
	Hairy vetch	M	30 – 35	25 – 30	—	9/1 – 11/15	1	4 – 6	5.5 – 7.0
	Lespedeza, annual	M	15	10	2/1 – 4/15	—	¼ – ½	2 – 3	5.5 – 6.0
Other	Brassica species	M	—	2 – 4	4/1 – 5/13	8/15 – 9/15	¼	2 – 3	5.5 – 6.0

¹ Ease of establishment: E = Easy, M = Moderate, D = Difficult

[†] Stratified seed

² Seeding rates on a pure live seed basis

[‡] Unstratified seed

Cool-season grasses

Annual ryegrass (*Lolium multiflorum* Lam.)

Annual ryegrass is increasingly being used for fall and winter pasture, particularly in southern Missouri. Annual ryegrass is easy to establish and, under ideal conditions, capable of producing 2,000 to 3,000 lb/acre of forage within 60 days of planting. If you manage to leave a 3- to 4-inch stubble, total season yields can approach 13,000 lb/acre in southern Missouri. Annual ryegrass retains its

forage quality well over winter. In a vegetative state, annual ryegrass is often more than 18 percent crude protein and has acid detergent fiber (ADF) levels of less than 26 percent. As a result, all classes of livestock produce well on it. The drawbacks to annual ryegrass are a lack of winter hardiness, particularly from unadapted cultivars, and annual establishment costs.

Origin: Southern Europe

Adaptation to Missouri: Best adapted to southern Missouri.

Growth habit: Nearly sod-forming annual bunchgrass.

Blade: Rolled in bud, bright green, upper surface dull, prominently ridged, lower surface smooth, glossy, keeled, smooth margins.

Sheath: Smooth, split, green, pink at base.

Ligule: Obtuse, membranous, about $\frac{1}{15}$ inch long.

Auricles: Overlapping, pointed, blunt and distinct.

Seed head: Flat, awned, spikelets alternate edgewise up stem.

Fertilization: 75 lb N/acre at establishment. Apply an additional 40 to 60 lb N/acre in late February and again in early April. Phosphorus and potassium to soil test.

Timing of production: 60 percent of growth from Feb. 1 to May 1.

When to begin grazing: When the grass reaches 6 to 8 inches in height.

When to cut for hay: Early boot stage, typically in late April.

Lowest cutting or grazing height: 3 inches

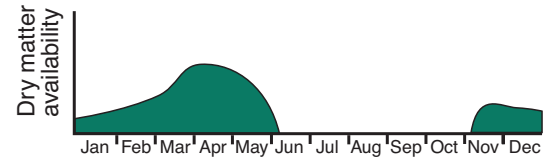
Fall management: Light grazing possible in late fall if a 4-inch stubble is maintained throughout winter.



Seed head



Annual ryegrass



Yield distribution of annual ryegrass in Missouri.



Overlapping auricles

Collar region

Cool-season grasses

Kentucky bluegrass (Poa pratensis L.)

Thirty years ago, Kentucky bluegrass was the predominant cool-season grass in northern Missouri. Although it is not as popular as it once was, Kentucky bluegrass is still part of many grazing systems. It is often found in weaker stands of other cool-season grasses because it has rhizomes and tends to fill in where other plants have died. Kentucky bluegrass makes most of its growth in spring and

is palatable to cattle. Although it tolerates frequent grazing or clipping, cattle often overgraze Kentucky bluegrass pastures. Ideally, it should not be grazed closer than 2 or 3 inches. Kentucky bluegrass does not tolerate hot weather and as a result is unproductive in midsummer. In addition, it becomes dormant during dry weather, although plants often recover after severe droughts.

Origin: Europe

Adaptation to Missouri: Best adapted to the northern half of the state

Growth habit: Rhizomatous, sod-forming, perennial.

Growth habit: Nearly sod-forming annual bunchgrass.

Blade: Folded in bud, V-shaped, keeled, parallel sided, narrows to boat-shaped tip, margins smooth to slightly scabrous, lower side dull.

Sheath: Compressed, smooth, closed when young, later split, glabrous.

Ligule: Truncate, membranous, about $\frac{1}{30}$ inch long in lower leaves, longer in upper leaves.

Auricles: Absent.

Seed head: Panicle open, pyramid shaped.

Fertilization: 40 to 60 lb N/acre in late February or early March; phosphorus and potassium to soil test.

Timing of production: 75 percent of growth before June 15.

When to begin grazing: When the grass is 6 to 8 inches high.

When to cut for hay: Early boot stage.

Lowest cutting or grazing height: 2 to 3 inches

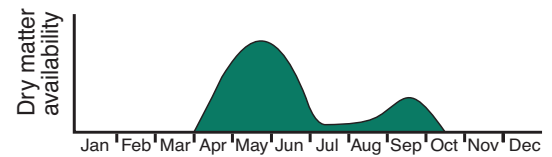
Fall management: Light grazing possible in September and October. Leave a 4-inch stubble for winter.



Seed head



Kentucky bluegrass



Yield distribution of Kentucky bluegrass in Missouri.



Collar region

Cool-season grasses

Orchardgrass (Dactylis glomerata L.)

Orchardgrass is a popular grass for pasture, green chop, silage and hay throughout the central part of the eastern United States. The high rainfall, moderate winters and warm summers of southern Missouri make that region an optimal orchardgrass habitat. Under such conditions, orchardgrass both grows and tillers rapidly, which makes it especially useful in early spring pastures. Forage yields of 7,000 to 10,000 lb/acre are not uncommon under good management. Orchardgrass is more drought-tolerant than timothy or Kentucky bluegrass but is not as drought-

tolerant as smooth brome or endophyte-infected tall fescue. Orchardgrass does not persist as well as other cool-season grass species because it is susceptible to overgrazing, winter kill and leaf rust. Orchardgrass matures earlier than most other cool-season grasses, which makes early grazing or harvesting a must if high-quality feed is to be obtained. Choosing a variety that matures late can help increase forage quality. It is considered more wildlife friendly than tall fescue.

Origin: Europe and North Africa

Adaptation to Missouri: Statewide

Growth habit: Perennial bunchgrass.

Blade: Folded in bud, cross section V-shaped at base, sharply keeled, taper to an acute point, margins smooth to scabrous.

Sheath: Smooth, open, distinctively flattened and keeled.

Ligule: Truncate, membranous, $\frac{1}{10}$ to $\frac{1}{8}$ inch long.

Auricles: Absent.

Seed head: Stiff, mostly compact panicle with lower branches longer than those at top.

Fertilization: 40 to 60 lb N/acre after first grazing or harvest in spring; follow with another 40 lb N/acre after second grazing if conditions permit. Also, apply 40 to 60 lb N/acre mid-August for fall pasture. Phosphorus and potassium to soil test.

Timing of production: 60 percent of growth before June 15.

When to begin grazing: When the grass reaches 6 to 8 inches in height.

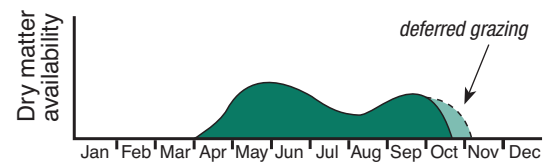
When to cut for hay: Early heading stage, typically in late April or early May.

Lowest cutting or grazing height: 4 inches

Fall management: Grazing possible in September and October; leave a 6-inch stubble for winter.



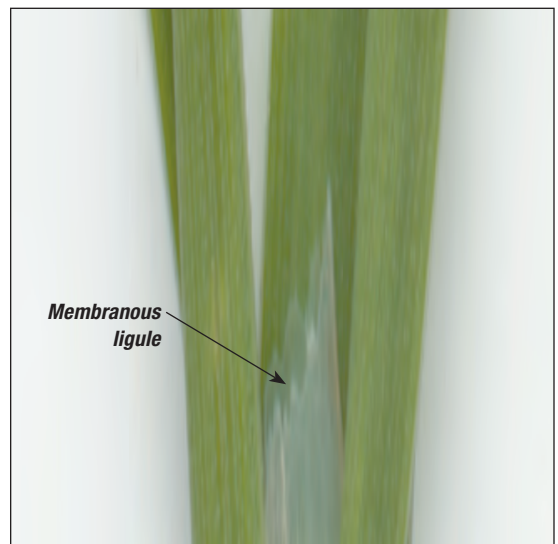
Seed head



Yield distribution of orchardgrass in Missouri.



Orchardgrass



Collar region

Cool-season grasses

Perennial ryegrass (Lolium perenne L.)

Perennial ryegrass is routinely used for cattle and sheep pasture in Australia and New Zealand. In Missouri, it persists best in the southern part of the state. Under good management, it is a high-quality and high-yielding grass; forage yields of 10,000 lb/acre have been reported in southern Missouri. Like tall fescue, perennial ryegrass produces most of its yield during spring and autumn but lags behind other grasses in midsummer. Perennial ryegrass

is aggressive under high rainfall and moderate temperatures and might crowd out other forage species under such conditions. It is not as tolerant of drought and temperature extremes as other cool-season grasses. Lack of persistence across the state has caused producers to avoid perennial ryegrass. Cultivars with improved plant persistence are currently being developed.

Origin: Southern Europe

Adaptation to Missouri: Best adapted to southern Missouri.

Growth habit: Perennial bunchgrass.

Blade: Folded in bud, keeled, ridged upper surface, smooth and glossy lower surface, margins slightly scabrous, tapered to tip.

Sheath: Compressed to cylindrical, smooth, pale green, reddish at base, closed or split.

Ligule: Thin, truncate to obtuse, membranous, rounded or toothed, about $\frac{1}{16}$ inch long.

Auricles: Small, clawlike.

Seed head: Flat, awnless spikelets alternate edgewise up stem.

Fertilization: 40 to 60 lb N/acre after the first grazing or harvest in spring, followed by another 40 lb N/acre after the second grazing if growing conditions permit. In addition, 40 to 60 lb N/acre should be applied in mid-August for fall pasture. Phosphorus and potassium to soil test.

Timing of production: 60 percent of growth before June 15.

When to begin grazing: When the grass reaches 6 to 8 inches in height.

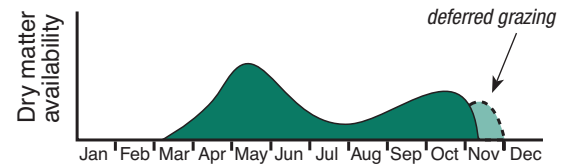
When to cut for hay: Early heading stage, typically in late April or early May.

Lowest cutting or grazing height: 3 inches

Fall management: Grazing possible in September and October if a 4-inch stubble is left for winter.



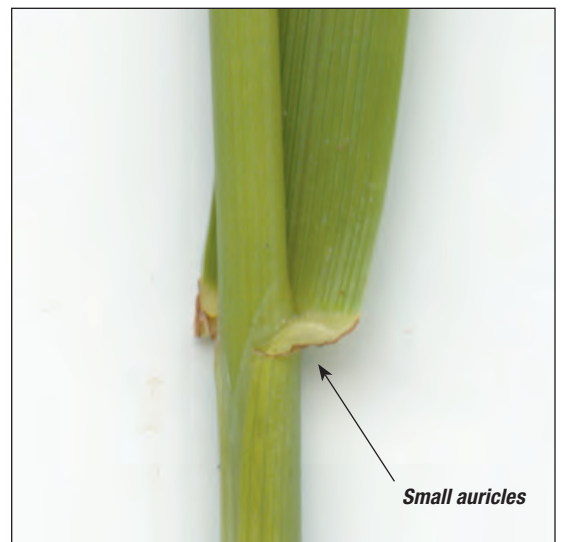
Seed head



Yield distribution of perennial ryegrass in Missouri.



Perennial ryegrass



Collar region

Cool-season grasses

***Prairiegrass (Bromus wildenowii* Kunth)**

Prairiegrass, often called Matua grass, is a cool-season perennial bunchgrass. Despite its name, prairiegrass is not native to North America. Prairiegrass is adapted to well-drained and fertile soils where the soil pH is 6.0–7.0. Generally, soils that support good alfalfa production work well for prairiegrass. Prairiegrass produces well in summer as long as soil moisture is adequate, and it overwinters well if a 5-inch stubble is left in autumn. Despite the productivity of prairiegrass under ideal conditions, individual plants do not persist well in the Midwest. Stands

are best maintained by allowing for a reseeding period every year. One reason prairiegrass does not persist well is that it is a “jointed grass.” This means that prairiegrass elevates its growing point above ground during tiller development. Grazing or cutting prairiegrass after the growing point has been elevated above grazing or cutting height dramatically reduces subsequent regrowth and may result in plant death. As a result, prairiegrass does not tolerate continuous grazing, so it is best suited for rotational grazing with long rest periods.

Origin: The Pampas grasslands of South America

Adaptation to Missouri: Statewide

Growth habit: Short-lived, perennial bunchgrass.

Blade: Emerging leaf rolled, but may appear folded. Upper surface pubescent with hairs in distinct rows, bottom half often glabrous, margins rough.

Sheath: Oval, densely covered with soft hairs, slightly compressed, keeled.

Ligule: Membranous, white, fringed, split along margin, about 1/3 inch long.

Auricles: Absent.

Seed head: Open, drooping panicle with flat, compressed and large spikelets.

Fertilization: Apply 30 to 40 lb N/acre in early spring followed by 30 to 40 lb N/acre after each grazing to maximize regrowth. Phosphorus and potassium to soil test.

Timing of production: Early spring; late summer and early autumn.

When to begin grazing: When the grass reaches 8 to 10 inches in height. Allow a regrowth period of 28 to 42 days.

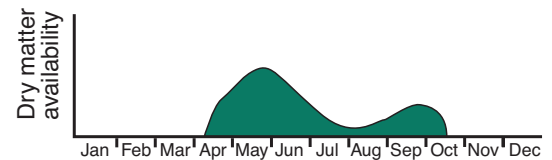
When to cut for hay: Boot stage

Lowest cutting or grazing height: 3 inches

Fall management: Light grazing possible in fall if a 5-inch stubble is left for winter.



Seed head



Yield distribution of prairiegrass in Missouri.



Prairiegrass



Collar region

Cool-season grasses

Reed canarygrass (*Phalaris arundinacea* L.)

Reed canarygrass is a tall, coarse, rhizomatous perennial grass. Its most distinctive characteristic is that it will survive on poorly drained soils or under flooded conditions better than any other cool-season grass. It is also drought-tolerant because of its deep and extensive root system. Reed canarygrass is nutritious in its vegetative state but becomes coarse and unpalatable as it matures. Old cultivars contain several alkaloids that can depress animal performance.

However, many new cultivars have lower levels of these compounds. Many producers find reed canarygrass difficult to establish because the seeds often germinate slowly and irregularly. However, once established, it will out-compete other grasses in a mixed pasture. It can be quite useful if grazing begins early in the season and it is kept in its vegetative form.

Origin: Worldwide

Adaptation to Missouri: Statewide

Growth habit: Rhizomatous, sod-forming, perennial.

Blade: Rolled in bud, flat, sharp pointed, midrib prominent on lower surface, margins scabrous.

Sheath: Split, smooth, glabrous, pale pink, round, with membranous edges.

Ligule: White, membranous, pubescent on back, about ¼ inch long, margin smooth or serrate, usually split. Auricles: Absent.

Seed head: Mostly compact panicle.

Fertilization: 40 to 60 lb N/acre after the first grazing or harvest in spring, followed by another 40 lb N/acre after the second grazing if growing conditions permit. Phosphorus and potassium to soil test.

Timing of production: 50 percent of growth before June 15.

When to begin grazing: When grass is 6 to 8 inches tall.

When to cut for hay: Just prior to heading.

Lowest cutting or grazing height: 3 to 4 inches

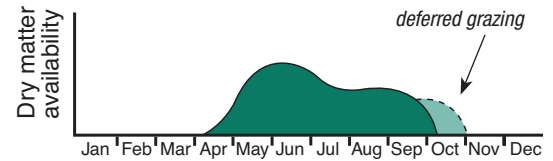
Fall management: Light grazing possible in September and October. Leave a 6-inch stubble for winter.



Seed head



Reed canarygrass



Yield distribution of reed canarygrass in Missouri.



Collar region

Cool-season grasses

Small grains

The small grains, primarily wheat and rye, are used extensively in Kansas, Nebraska, Oklahoma and Texas for winter pasture for stocker calves, but they can fit into pasture systems in Missouri as well. If planted around Sept. 1, wheat or rye will produce enough forage for an initial grazing by late November under normal conditions. Wheat and rye continue to grow through the winter, although they grow slowly during cold spells. Rye generally produces 30 to 60 percent more forage than wheat. In a vegetative

state, small grain pasture is often more than 20 percent crude protein and 23 to 28 percent acid detergent fiber. Wheat and rye remain in a vegetative state until mid- to late March; as a result, forage quality is fairly constant from November through late February. Rye matures three to four weeks earlier than wheat and thus is hard to manage for high-quality feed after March. In addition, small grain pasture is susceptible to trampling damage under muddy conditions.

Origin: Near East and Europe

Adaptation to Missouri: Statewide

Cereal rye (*Secale cereale* L.)

Blade: Leaf bud rolled, about 12 veins, twisted clockwise, pubescent, not shiny green on lower surface.

Sheath: Open, pubescent (slight to very hairy).

Ligule: Short, membranous.

Auricles: Very short.

Seed head: There is one spikelet at each rachis node and two fertile florets in each spikelet.

Oat (*Avena sativa* L.)

Blade: Leaf bud rolled. Glabrous with about 12 veins, twisted counter-clockwise.

Sheath: Open, usually glabrous.

Ligule: Long, acute, toothed, membranous.

Auricles: Absent.

Seed head: Open panicle with a single spikelet on each rachis branch.

Wheat (*Triticum aestivum* L.)

Blade: Leaf bud rolled. about 12 veins, twisted clockwise, pubescent (slight to very hairy).

Sheath: Open, pubescent (slight to very hairy).

Ligule: Membranous.

Auricles: Short with blunt tips and pubescent.

Seed head: Single spikelet at each rachis node. Three to five florets per spikelet.

Fertilization: 75 lb N/ acre at establishment. An additional 40 to 60 lb N/ acre can be applied in late February if needed. Phosphorus and potassium to soil test.

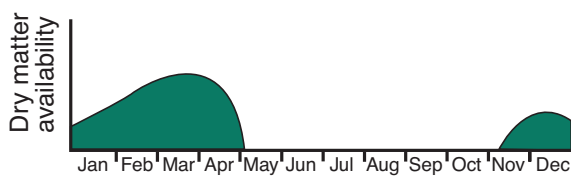
Timing of production: 70 percent of growth from Feb. 1 to May 1.

When to begin grazing: When the grass reaches 8 inches in height.

When to cut for hay: Boot stage, typically in late April or early May.

Lowest cutting or grazing height: 4 inches

Fall management: Grazing possible in late fall if a 4-inch stubble is maintained throughout winter.



Yield distribution of small grains in Missouri.



Wheat



Seed head



Collar region

Cool-season grasses

Smooth bromegrass (*Bromus inermis* Leyss.)

Smooth bromegrass is a cool-season grass often used for hay, pasture, silage, green chop and erosion control. Its responsiveness to nitrogen fertilizer, ability to grow well with legumes, good drought-tolerance and excellent overwintering capacity make it important throughout the northern United States. Although Missouri is on the southern edge of its range, smooth bromegrass still

provides a valuable resource for many farmers. Smooth bromegrass can easily suffer from overgrazing and does not regrow as well as other cool-season grasses. It is important to avoid clipping or grazing smooth bromegrass shorter than 4 inches. Fields clipped or grazed shorter than this do not regrow well or persist very long.

Origin: Eastern Europe

Adaptation to Missouri: Especially good in northern Missouri

Growth habit: Rhizomatous, sod-forming, perennial.

Blade: Rolled in bud, flat and narrow, tapers to tip, smooth on top, distinct “W” at midpoint of leaf, dull on lower side, margins smooth to rough.

Sheath: Round, smooth, closed near top, lower sheath pubescent.

Ligule: Membranous, truncate to rounded, $\frac{1}{10}$ inch.

Auricles: Absent.

Seed head: Open drooping panicle, often one-sided, spreading.

Fertilization: 30 to 40 lb N/acre following the first grazing or harvest in spring. In addition, apply 40 to 60 lb N/acre in mid-August for fall pasture. Phosphorus and potassium as needed.

Timing of production: 80 percent of growth before June 15.

When to begin grazing: When the grass reaches 8 inches in height.

When to cut for hay: Early heading stage, typically about mid-May.

Lowest cutting or grazing height: 4 inches

Fall management: Light grazing or haying possible through October if a 6-inch stubble is left for winter.



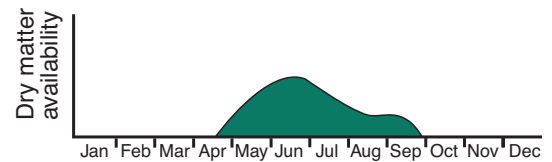
“M” shaped watermark on blade



Seed head



Smooth bromegrass



Yield distribution of smooth bromegrass in Missouri.



Collar region

Cool-season grasses

Tall fescue (*Festuca arundinacea* Schreb.)

Tall fescue is one of the most popular grasses in the United States. It is grown on more than 34 million acres nationwide. Because of its hardiness and adaptability, it is used for several purposes, including silage, hay, pasture and erosion control. Tall fescue is most nutritious in early spring and again in autumn. In addition, tall fescue has a waxy leaf surface that helps it retain its forage quality through winter better than any other perennial grass. As a result, many producers stockpile tall fescue for deferred grazing in winter. There are also many negatives associated with tall fescue. This cool-season grass does not provide a quality

habitat for wildlife. In addition, most tall fescue is infected with an endophyte, a fungus that produces compounds that are toxic to cattle. If cattle eat tall fescue that carries the endophyte, they exhibit reduced weight gains and reduced milk yields as well as a number of more serious illnesses such as fescue foot. Although endophyte-free tall fescue does not have this problem, it does not persist as well as tall fescue that contains an endophyte. There are new varieties of tall fescue that contain nontoxic endophytes. These varieties are reported to give good livestock performance and persist longer than endophyte-free types.

Origin: Europe

Adaptation to Missouri: Statewide

Growth habit: Rhizomatous, nearly sod-forming, perennial bunchgrass.

Blade: Rolled in bud shoot, ribbed and somewhat rough top surface, glossy lower surface, prominent midrib and veins, margins scabrous.

Sheath: Round, generally smooth, split, large.

Ligule: Truncate, membranous, up to 1/10 inch long.

Auricles: Small, short, pubescent.

Seed head: Contracted panicle.

Fertilization: 40 to 60 lb N/acre mid-August for fall or stockpile pasture. In spring, 40 to 60 lb N/acre after the first grazing or harvest. If pasture is lacking, follow with another 40 lb N/acre after the second grazing. Phosphorus and potassium to soil test.

Timing of production: Produces 70 percent of its growth between April 1 and June 15.

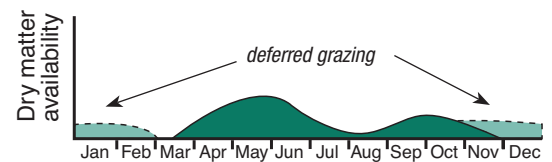
When to begin grazing: When the grass reaches 6 to 8 inches in height.

When to cut for hay: Late vegetative to early boot stage.

Lowest cutting or grazing height: 3 to 4 inches



Seed head



Yield distribution of tall fescue in Missouri.



Tall fescue



Collar region

Cool-season grasses

Timothy (*Phleum pratense* L.)

Timothy is a relatively late-maturing, short-lived perennial grass that is best adapted to cool, moist regions. Timothy has a fibrous and relatively shallow root system. Because it does not develop a deep root system, it does not persist well under drought conditions. It is intolerant of hot weather but is among the most winter hardy of the cool-season grasses. Timothy's forage quality is often better than many other cool-season grasses in the spring because

it matures three to four weeks later than orchardgrass or tall fescue. Timothy is relatively easy and inexpensive to establish, but it does not compete well with other grasses. It is considered one of the more friendly grasses for wildlife habitat. Cattle like timothy, but the plants cannot survive close or frequent grazing. If you use timothy, you should practice rotational grazing.

Origin: Northern Europe

Adaptation to Missouri: Best adapted to the northern half of the state.

Growth habit: Perennial bunchgrass.

Blade: Rolled in bud shoot, flat, often twisted, bluish color, tapers to tip, smooth, glabrous, ridges on upper surface lower side is dull and smooth, margins scabrous.

Sheath: Closed, smooth, rounded, often swollen below ground.

Ligule: Membranous, white, toothed, often with a distinct notch, up to 1/8 inch long.

Auricles: Absent.

Seed head: Spikelike, dense, compact, cylinder shaped.

Fertilization: 40 to 60 lb N/acre in late February or early March. Phosphorus and potassium as needed.

Timing of production: 75 percent of growth before June 15.

When to begin grazing: When grass is 6 to 8 inches tall.

When to cut for hay: Just prior to heading.

Lowest cutting or grazing height: 3 to 4 inches

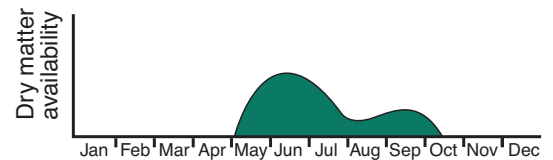
Fall management: Light grazing possible in September and October. Leave a 6-inch stubble for winter.



Seed head



Timothy



Yield distribution of timothy in Missouri.



Collar region

Warm-season grasses

Bermudagrass (Cynodon dactylon (L.) Pers.)

This perennial warm-season grass is used for forage and erosion control in the warmer portions of the United States, including the southern third of Missouri. In southern Missouri, annual forage yields in the 10,000 lb/acre range are possible with good management. Under typical management, bermudagrass is of moderate quality for both hay and pasture uses. However, forage quality and yield can be excellent if bermudagrass is well fertilized with nitrogen

and frequently grazed or harvested. Bermudagrass has some limitations. Because it must be established from vegetative sprigs, it is sometimes difficult to establish. Producers must take care to control weeds during establishment. Once established, bermudagrass is aggressive and can crowd out other species, which also makes it a poor choice for wildlife habitat.

Origin: Southeast Africa

Adaptation to Missouri: Southern third of state

Growth habit: Rhizomatous, stoloniferous, sod-forming perennial.

Blade: Folded in bud, sharp tip, smooth or sparsely pubescent, scabrous margins, conspicuous midrib.

Sheath: Slightly compressed, split, loose, sparsely pubescent, tuft of hairs at the junction of the blade and sheath.

Ligule: Fringe of hairs, $\frac{1}{10}$ to $\frac{1}{5}$ inch long.

Auricles: Absent.

Seed head: Panicle with 3 to 7 narrow branches.

Fertilization: 50 to 100 lb N/acre mid-May after grass "greens up." Apply 75 to 100 lb N/acre every 30 days thereafter. Phosphorus and potassium to soil test.

Burning management: If needed, in early spring three weeks before the last killing frost.

Timing of production: 85 percent of growth between May 15 and Sept. 15. More even yield distribution than most other warm-season grasses.

When to begin grazing: When grass is 6 inches tall.

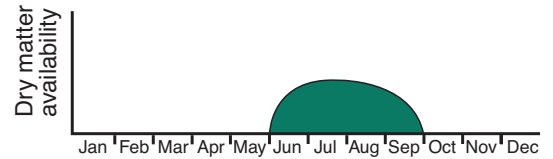
When to cut for hay: June 1 and every 28 days thereafter.

Lowest cutting or grazing height: 3 inches

Fall management: Do not hay or graze after Sept. 1.



Seed head



Yield distribution of bermudagrass in Missouri.



Bermudagrass



Collar region

Warm-season grasses

Big bluestem (*Andropogon gerardii* Vitman)

Big bluestem used to be the dominant grass in the native prairies of Missouri. Today, this perennial warm-season bunchgrass is used for forage and wildlife habitat. Big bluestem grows statewide, and it is currently found on about 1 million acres in Missouri. It produces good quality hay and will persist indefinitely if properly managed. It is both winter- and drought-hardy and does better in poorly

drained soils than some other warm-season grasses. It is also compatible with many other forage species. However, it is slow to establish, and thus weeds can make establishment a problem. It works well in a planned grazing system if it is not allowed to become mature before grazing and if a 6-inch or greater stubble height is maintained to encourage regrowth.

Origin: North America

Adaptation to Missouri: Statewide

Growth habit: Tall, rhizomatous, perennial bunchgrass.

Blade: Flat, glabrous on bottom, scabrous on top with rough margins. Base of new shoots flattened, lower portion of blade and sheath pubescent.

Sheath: Flattened, often shorter than internodes, glaucous, and purplish.

Ligule: Membranous, sometimes fringed, about $\frac{1}{10}$ inch long.

Auricles: Absent.

Seed head: Usually 3 (but up to 7), purplish, spike-like racemes per stem.

Fertilization: 40 to 60 lb N/acre when grass is 3 to 5 inches tall. Phosphorus and potassium to soil test.

Burning management: Every year or two, when new growth is 1 to 2 inches tall.

Timing of production: Produces 70 percent of its growth between June 15 and Aug. 31.

When to begin grazing: When grass is 12 inches tall.

When to cut for hay: Boot stage

Lowest cutting or grazing height: 6 inches

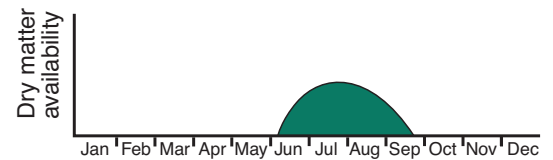
Fall management: Do not hay or graze after Sept. 1.



Seed head



Big bluestem



Yield distribution of big bluestem in Missouri.



Collar region

Warm-season grasses

Corn (*Zea mays* L.)

Although corn, or maize, has been grown in Missouri for more than 100 years, only recently has its value as a grazing crop been recognized. Under ideal conditions, corn can produce more feed per acre than just about any other crop. It maintains feed quality well after it reaches maturity. Corn in dairy systems is used in two ways: (1) grazed in

midsummer as “green” corn, or (2) chopped for silage and fed as a supplement when pasture growth slows. Results from midsummer grazing trials suggest that dairy cows can produce 70 pounds of milk per day per cow on corn. The major obstacles to using corn for grazing are its susceptibility to drought and high input costs.

Origin: Central America

Adaptation to Missouri: Statewide, although best adapted to northern Missouri

Growth habit: Tall, erect, annual.

Blade: Broad, flat, without cross venation; rolled in bud, not basally aggregated.

Sheath: Shorter than the internodes, open, pubescent.

Ligule: Fringed membrane.

Auricles: Absent.

Seed head: Separate male (tassel) and female (ear) inflorescences.

Fertilization: 100 to 150 lb N/acre annually. Maintain 40 lb/acre P and 300 lb/acre K.

Timing of production: 70 percent of active growth occurs between June 1 and Aug. 30.

When to begin grazing: Grazing can begin anytime after the corn reaches 5 feet.

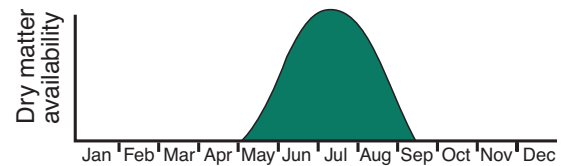
When to cut for silage: When the kernels show $\frac{2}{3}$ milkline.



Tassel



Corn



Yield distribution of corn in Missouri.



Collar region

Warm-season grasses

Crabgrass (*Digitaria* spp.)

Crabgrass is a warm-season annual that is easy to establish. Stands of crabgrass can last almost indefinitely if managed to encourage volunteer reseeding. Although often considered a weed, crabgrass is a high-quality forage that can produce 6,000 to 10,000 lb/acre of dry matter annually.

The majority of the dry matter is produced from mid-June to August. Crabgrass is adapted statewide and tolerates poorly drained soils well but is not cold hardy. It responds well to split applications of nitrogen at establishment and then again after the first grazing.

Origin: Southern Africa

Adaptation to Missouri: Statewide

Growth habit: Sod-forming annual.

Blade: Leaf bud rolled. Leaves broad, open, flat, pubescent.

Sheath: Open with overlapping margins, shorter than internodes, pubescent.

Ligule: Thin truncate membrane, toothed margin, about $\frac{1}{10}$ inch long. Shorter on first few blades.

Auricles: Absent.

Seed head: Slender spikes, several pairs arising from the tip of the stalk.

Fertilization: 40 lb N/acre at establishment. Apply 60 lb N/acre after first cutting or grazing. Phosphorus and potassium to soil test.

Timing of production: 80 percent between mid-June and August.

When to begin grazing: Before it reaches 10 inches in height.

When to cut for hay: Boot stage.

Lowest cutting or grazing height: 3 inches

Fall management: Remove grazing livestock from pasture two to three weeks before first frost to ensure adequate seed production.



Seed head



Crabgrass in early spring



Crabgrass



Collar region

Warm-season grasses

Eastern gamagrass (Tripsacum dactyloides (L.) L.)

Eastern gamagrass, the king of bunchgrasses, is used for pasture, hay and silage. It grows well in wetter areas but prefers deep, well-drained soils. Eastern gamagrass lends itself to pasture-based operations because it has a more even distribution of yield over the grazing season than do many other warm-season grasses. It also has better forage quality than many other warm-season grasses. Despite these

advantages, eastern gamagrass has a few problems. Seed production is difficult, and gamagrass is slow to establish. Furthermore, it is easily overgrazed. Eastern gamagrass grows well throughout Missouri but is most popular in the central and western regions of the state. Despite its limitations, eastern gamagrass can be an important part of a forage system.

Origin: Eastern North America

Adaptation to Missouri: Statewide

Growth habit: Rhizomatous, perennial bunchgrass.

Blade: Flat, glabrous or sometimes pubescent on upper surface near ligule, scabrous margins, prominent midrib.

Sheath: Round, smooth, split, glabrous, sometimes pubescent near top.

Ligule: A short ring of hairs, truncate.

Auricles: Absent.

Seed head: Panicle, composed of 1 to 4 raceme-like branches.

Fertilization: 50 lb N/acre in spring when grass is 3 to 5 inches tall. Apply 50 lb N/acre every six weeks thereafter. Phosphorus and potassium to soil test.

Burning management: Every year or two, in early spring before new growth is 1 inch long.

Timing of production: 85 percent of growth between May 15 and Aug. 31.

When to begin grazing: When grass is 14 inches tall.

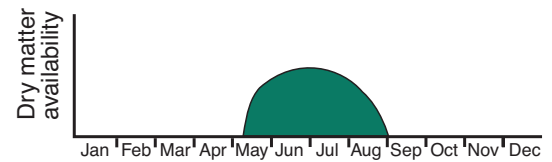
When to cut for hay: Very early boot stage.

Lowest cutting or grazing height: 8 inches

Fall management: Do not hay or graze after Sept. 15.



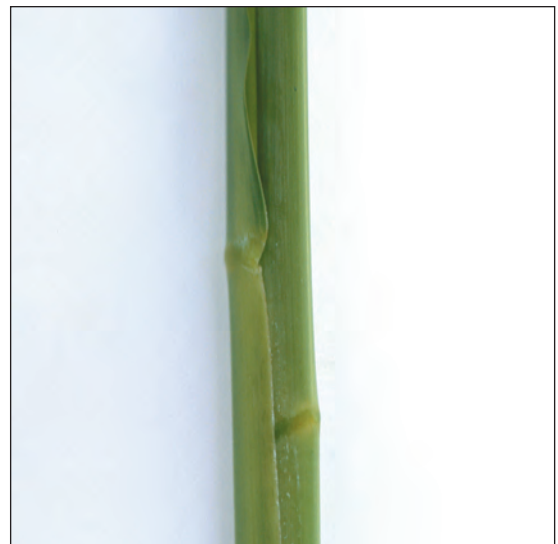
Seed head



Yield distribution of eastern gamagrass in Missouri.



Eastern gamagrass



Collar region

Warm-season grasses

Indiangrass (*Sorghastrum nutans* (L.) Nash)

Indiangrass is a native, perennial warm-season grass with a number of uses, from a forage crop to conservation and wildlife habitat. Indiangrass can grow throughout the state, but it is best grown in mixtures with other native warm-season grasses. It matures two or three weeks later than big bluestem, and because it does not begin reproductive

growth until later in the season, it can be of high quality both as pasture and hay. However, Indiangrass has trouble establishing itself without proper weed control and does not grow well in poorly drained areas. Its weaknesses are that it does not produce abundant forage until late in the season and has poor regrowth potential.

Origin: North America

Adaptation to Missouri: Statewide

Growth habit: Tall, rhizomatous, perennial bunchgrass.

Blade: Flat, pointed, narrower base, often glaucous, prominent midrib near base.

Sheath: Smooth, rounded to flat, upper shorter than the internodes, usually glabrous.

Ligule: Membranous, thick, stiff, about $\frac{1}{10}$ inch long, flanked by pointed auricles.

Auricles: Prominent "rabbit ear" auricles.

Seed head: Narrow, oblong panicles, large, dense and bronze-yellow.

Fertilization: 40 to 60 lb N/ acre in spring when grass is 3 to 5 inches tall. Phosphorus and potassium to soil test.

Burning management: Every year or two, when new growth is 1 to 2 inches tall.

Timing of production: Produces 70 percent of its growth between July 1 and Aug. 31, two to three weeks later than big bluestem.

When to begin grazing: When grass is 12 inches tall.

When to cut for hay: Early boot stage

Lowest cutting or grazing height: 6 inches

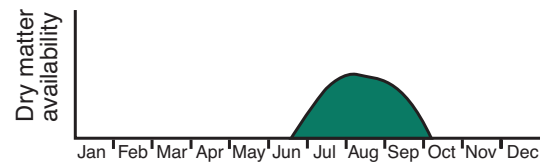
Fall management: Do not hay or graze after Sept. 1.



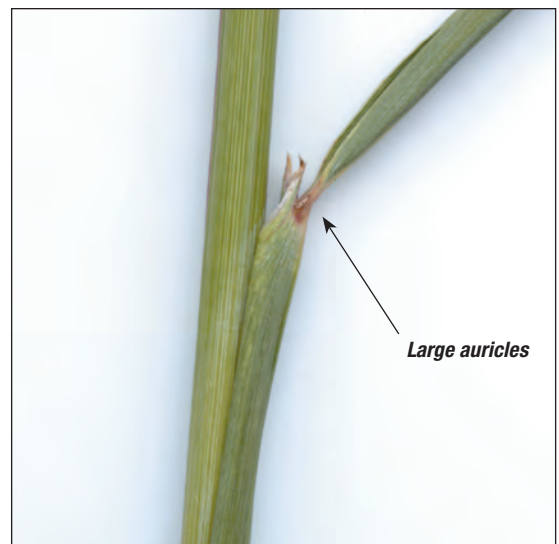
Seed head



Indiangrass



Yield distribution of Indiangrass in Missouri.



Collar region

Warm-season grasses

Old World bluestems e.g., Caucasian bluestem (*Bothriochloa bladhii* (Retz.) S.T. Blake)

The Old World bluestems are a group of warm-season grasses imported from Russia. They are not related to native bluestems such as big and little bluestems. Caucasian bluestem is the most commonly grown Old World bluestem and finds its widest use in southern Missouri. Caucasian bluestem tolerates heavy grazing; in fact, for forage quality to be acceptable for dairy cows, caucasian bluestem must not be allowed to grow taller than 6 inches. It is also winter-

hardy and easier to establish than many other warm-season grasses. It tolerates shallow and infertile soils better than many other species. However, caucasian bluestem is best grown by itself because of its aggressiveness. It does not grow well on poorly drained soils. Finally, its nutritive value plummets if it is not well fertilized with nitrogen or if it is permitted to form seed heads.

Origin: Russia

Adaptation to Missouri: Southern half of Missouri

Growth habit: Nearly sod-forming, perennial bunchgrass.

Blade: Glabrous, prominent midrib, taper to a fine point.

Sheath: Smooth, slightly keeled.

Ligule: Inconspicuous, fringed membrane.

Auricles: Absent.

Seed head: Elongated panicle, pale green to purplish, axis longer than branches.

Fertilization: 50 lb N/acre in spring when grass is 3 to 5 inches (mid-May). Apply another 50 lb N/acre every 30 to 40 days thereafter. Phosphorus and potassium to soil test.

Burning management: Every year or two, in early spring before any new growth is present (early April).

Timing of production: Late May through mid-September.

When to begin grazing: When grass is 6 inches tall.

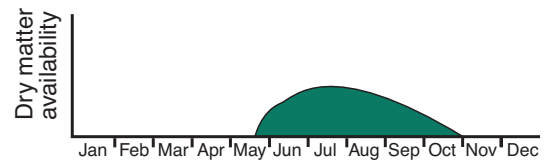
When to cut for hay: Late boot stage

Lowest cutting or grazing height: 2 inches

Fall management: Do not hay or graze after Sept. 30.



Seed head



Yield distribution of Old World bluestems in Missouri.



Caucasian bluestem



Collar region

Warm-season grasses

***Pearlmillet* (*Pennisetum americanum* (L.) Leeke)**

Pearlmillet is an annual warm-season grass that produces most of its forage during midsummer. Other millets, such as proso, foxtail, Japanese or German, are often used in silage or hay mixtures, but they produce less forage and have a shorter grazing season than pearlmillet. Pearlmillet is an excellent choice for warm-season pasture in the Ozarks because it tolerates acidic soils and drought. Pearlmillet can produce 8,000 to 12,000 lb/acre of forage when harvested

to a 6- to 10-inch stubble after accumulated growth reaches a height of 18 to 30 inches. Unlike sorghum-sudangrass, it does not contain prussic acid. It responds well to split applications of nitrogen at establishment and then again after the first grazing. Pearlmillet is a nitrate accumulator when water is lacking. It should be tested for nitrate levels before grazing during or immediately after a drought.

Origin: North-central Africa

Adaptation to Missouri: Statewide

Growth habit: Tall, erect, annual.

Blade: Flat, long, scabrous, and slender, with smooth to pubescent surface, prominent midrib, lanceolate.

Sheath: Purplish, split, open and pubescent.

Ligule: Short and pubescent.

Auricles: Absent.

Seed head: Compact, conical, spike-like panicle.

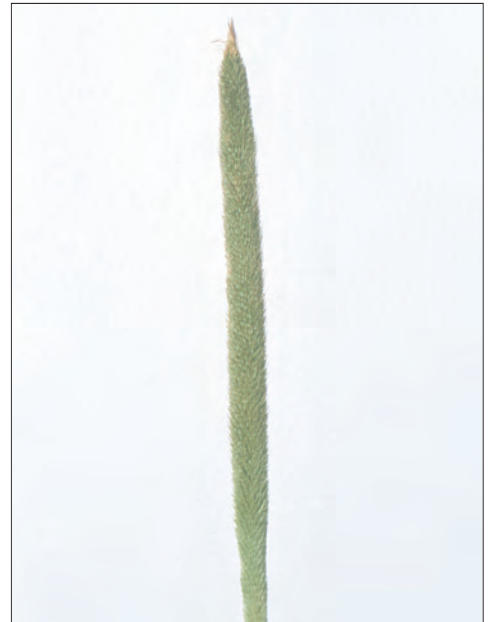
Fertilization: 60–90 lb N/acre at establishment. Thereafter apply 40–60 lb N/acre after each cutting or grazing. Phosphorus and potassium to soil test.

Timing of production: 90 percent of production occurs in June, July and August

When to begin grazing: When it reaches 18–30 inches

When to cut for hay: When it reaches 36 inches

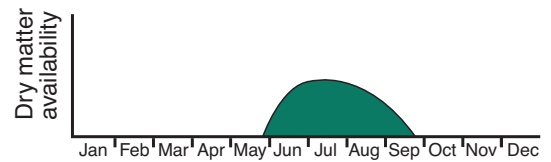
Lowest cutting or grazing height: 8 inches



Seed head



Caucasian bluestem



Yield distribution of pearlmillet in Missouri.



Collar region

Warm-season grasses

***Sorghum-sudangrass* (*Sorghum bicolor* (L.) Moench)**

Sorghum-sudangrass is a warm-season annual hybrid developed by crossing tall, stemmy sorghum with leafy sudangrass. It is adapted statewide for summer grazing and is well-suited for growing in drought conditions. Sorghum-sudangrass can produce 8,000 to 16,000 lb/acre of dry matter when harvested to a 6- to 10-inch stubble after accumulated growth reaches a height of 24 to 36

inches. It also responds well to split applications of nitrogen at establishment and then again after the first grazing. However, sorghum-sudangrass sometimes produces toxic levels of nitrate and prussic acid, both of which are aggravated by drought and frost. It is less tolerant of acid soils than pearl millet and prefers levels of 5.5 or higher.

Origin: Northeast Africa

Adaptation to Missouri: Statewide

Growth habit: Tall, erect, annual.

Blade: Waxy and glabrous, conspicuous midrib, flat, sharp-pointed, rolled in bud, margins scabrous.

Sheath: Glabrous, compressed, keeled, shorter than the internodes, open.

Ligule: Tall, ($\frac{1}{20}$ to $\frac{1}{5}$ inch) abrupt, ciliate, jagged tipped, wider than sheath.

Auricles: Absent.

Seed head: Loose, open, erect, panicle with numerous branches.

Fertilization: 60 lb N/acre at establishment. Thereafter, apply 40 to 60 lb N/acre after each cutting or grazing. Phosphorus and potassium to soil test.

Timing of production: 90 percent of production occurs in June, July and August.

When to begin grazing: When grass reaches 24 inches in height. (Note: To avoid prussic acid, do not graze when grass is shorter than 18 inches. It is also best to delay grazing for 14 days after frost or drought stress.)

When to cut for hay: When it reaches 30 to 36 inches in height.

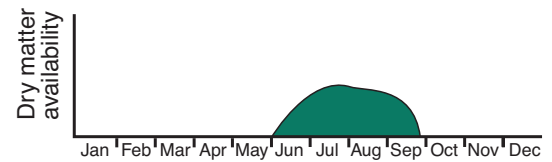
Lowest cutting or grazing height: 8 inches



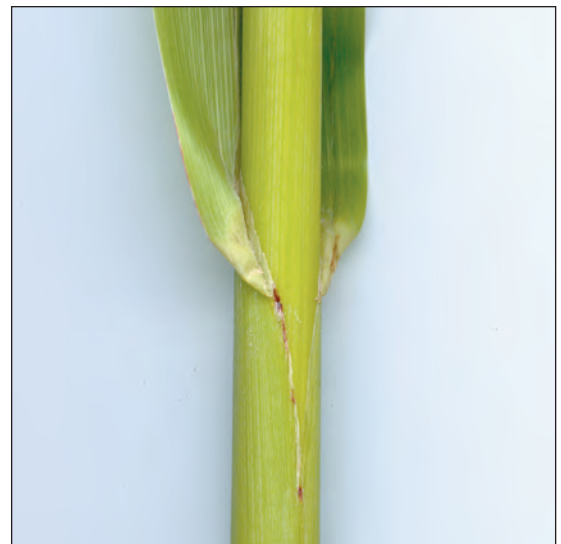
Seed head



Sorghum-sudangrass



Yield distribution of sorghum-sudangrass in Missouri.



Collar region

Warm-season grasses

Switchgrass (*Panicum virgatum* L.)

Switchgrass is a native, perennial warm-season grass grown on an estimated 1 million acres in Missouri. Although its greatest use is for pasture, it is also widely used for hay production, soil conservation and wildlife habitat. Switchgrass tolerates poorly drained soils fairly well and is adapted to a wide range of growing conditions. It is easier to establish than many other warm-season grasses.

Switchgrass dominates in the early years of establishment of mixed native warm-season grass plantings but declines after 10 to 12 years. Switchgrass must be grazed early in the season or the grass easily becomes overmature and of poor quality. Switchgrass is useful if grazing begins early in the season and it is kept in a vegetative stage of growth.

Origin: North America

Adaptation to Missouri: Statewide

Growth habit: Tall, rhizomatous, perennial bunchgrass.

Blade: Elongated, flat, rough margins, and a triangular patch of hair at base of upper surface.

Sheath: Round, smooth, split, shorter than internodes, often red or purplish at base.

Ligule: A dense ring of hair.

Auricles: Absent.

Seed head: Open, diffuse panicle, usually $\frac{1}{3}$ to $\frac{1}{2}$ as wide as long.

Fertilization: 40 to 60 lb N/acre when grass is 3 to 5 inches tall. Phosphorus and potassium to soil test.

Burning management: Every year or two, when new growth is 1 to 2 inches tall.

Timing of production: Produces 40 percent of its growth in June, two to three weeks earlier than big bluestem.

When to begin grazing: When grass is 10 to 12 inches tall.

When to cut for hay: Late vegetative to early boot stage.

Lowest cutting or grazing height: 6 inches

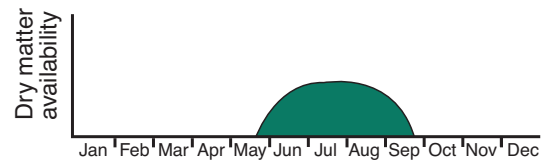
Fall management: Do not hay or graze after Sept. 1.



Seed head



Switchgrass



Yield distribution of switchgrass in Missouri.



Collar region

Legumes

Alfalfa (Medicago sativa L.)

Alfalfa is a perennial legume that is one of the most important forage crops in the United States. Generally used for hay or silage, it is increasingly used to provide high-quality pasture in rotational grazing systems. Its deep root system allows it to withstand drought better than most other legumes. Alfalfa grows well with other grasses in a

mixture. However, alfalfa grown alone can cause bloat in grazing animals, and alfalfa itself is prone to a number of insect and disease problems. Alfalfa produces and persists poorly on shallow or poorly drained soils and should not be planted on such sites. Despite this, alfalfa is important statewide, and it is grown on more than 700,000 acres.

Origin: Asia Minor and the Middle East

Adaptation to Missouri: Statewide

Growth habit: Erect, perennial.

Leaf: Usually pinnately trifoliate, stalk of middle leaflet longer than others, arranged alternately on stems. The upper third of the oblong leaflets toothed.

Stems: Flemish types hollow, other types solid; 5 to 30 stems per plant originating from crown.

Stipules: Stipules are slender and fused to the petiole, usually serrate.

Flowers: Arranged loosely in racemes, usually blue or purple, some yellow or white, 10 to 20 flowers in a cluster, borne in axils of upper leaves.

Fertilization: No N needed if nodulated. Maintain 40 lb P/acre and 300 lb K/acre. Magnesium, sulfur and boron to soil test recommendations.

Timing of production: 50 percent of annual production between April 1 and June 30.

When to begin grazing: In early- to midbud stage. Needs a 30-day rest period between grazings.

When to cut for hay: Late bud to early bloom

Lowest cutting or grazing height: 1 inch

Fall management: Do not cut or graze after Sept. 15.



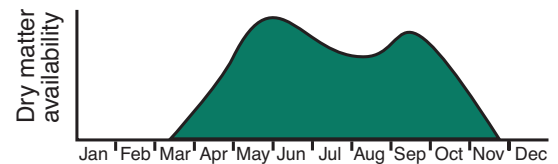
Leaf



Flower bud



Alfalfa



Yield distribution of alfalfa in Missouri.



Flower

Legumes

Birdsfoot trefoil (Lotus corniculatus L.)

Birdsfoot trefoil is a short-lived perennial legume capable of producing high-quality forage on soils where other legumes do not survive. Although it generally yields less than red clover and alfalfa when cut for hay, it often gives better performance than these legumes when grown in a grass/legume pasture. Unlike many other perennial

legumes, birdsfoot trefoil does not cause bloat in cattle. However, it does not tolerate continuous grazing or frequent haying. It is also prone to a number of diseases and pests that make management for reseeding essential. Although birdsfoot trefoil may grow statewide, it is best adapted to northern Missouri.

Origin: Mediterranean basin

Adaptation to Missouri: Statewide but persists better in northern Missouri.

Growth habit: Semi-erect to prostrate, short-lived perennial.

Leaf: Pentafoliolate, alternately on short stalks with two leaflets at the petiole base resembling stipules, pointed leaflets are mainly glabrous and not serrated.

Stems: Decumbent, with stems arising from the crown, often branched.

Stipules: Glandiform, tiny, dark.

Flowers: Yellow, may be tinged with orange or red, borne in clusters of 4 to 8 at the end of the flower stalk.

Fertilization: No N needed if nodulated. Maintain 30 lb P/acre and 250 lb K/acre.

Timing of production: 70 percent of annual production between April 1 and June 30.

When to begin grazing: Often based on the height of the grass in the mixture. Few if any pure stands exist.

When to cut for hay: Not normally cut for hay unless it is mixed with a companion grass. Harvest based on the maturity of the grass.

Lowest cutting or grazing height: 4 inches

Fall management: Avoid severe grazing from Sept. 15 until the first hard killing frost.



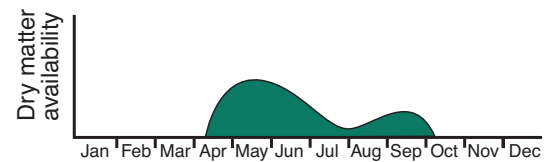
Leaf



Seed pods



Birdsfoot trefoil



Yield distribution of birdsfoot trefoil in Missouri.



Flower

Legumes

Clover, alsike (Trifolium hybridum L.)

Alsike clover is a short-lived perennial grown on an estimated 300,000 acres in Missouri. Alsike clover's claim to fame is that it tolerates wet, heavy soils and flooding better than most other legumes. Alsike clover stems are weak, and the plant lodges easily. For this reason, it is almost never grown in pure stands and is only seldom used for

hay. Although it is not as productive as red or white clover, alsike clover withstands grazing well. It produces best in a rotational grazing system where it is grazed to a 3-inch stubble height every 28 to 35 days. Alsike clover's nutritive value is similar to white clover, and cattle find it palatable.

Origin: Northern Europe

Adaptation to Missouri: Statewide

Growth habit: Semi-erect to prostrate, short-lived perennial.

Leaf: Trifoliate leaves are stalkless with glabrous, obovate, toothed margins.

Stems: Smooth and slender, often hollow.

Stipules: Large, glabrous, taper to a point, wrap around leaf stems.

Flowers: White to pinkish rose and forms a dense round head. Flowers are borne along the length of the stem, with youngest flowers at top.

Fertilization: No N needed if nodulated. Maintain 30 lb/acre P and 250 lb/acre K.

Timing of production: 70 percent of annual production between April 1 and June 30.

When to begin grazing: Often based on the height of the grass in the mixture. Few if any pure stands exist.

When to cut for hay: Not normally cut for hay unless it is mixed with a companion grass. Harvest based on the maturity of the grass.

Lowest cutting or grazing height: 3 inches

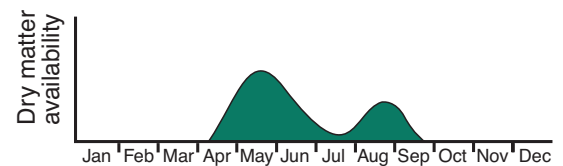
Fall management: Avoid severe grazing from Sept. 15 until the first hard killing frost



Leaf



Alsike clover



Yield distribution of alsike clover in Missouri.



Flower

Legumes

Clover, crimson (Trifolium incarnatum L.)

Crimson clover is a winter annual legume grown to a limited extent in Missouri. It does not produce appreciable forage in the fall but grows rapidly in early spring. It grows well under a wide range of soil types and conditions, but is not adapted to sites where there is standing water. It grows well in association with other winter annual grasses and is

an efficient nitrogen fixing crop. Cattle find crimson clover quite palatable, and because of its high protein and low fiber content, they produce well when grazing it. Crimson clover's main limitation is its narrow window of use in Missouri, with good grazing available only from late March through mid-May.

Origin: Southern Europe

Adaptation to Missouri: Statewide

Growth habit: Erect, winter annual.

Leaf: Palmately trifoliate, broadly obovate at tip, narrow at base, densely pubescent, no watermarks.

Stems: Pubescent stems with few side branches arise from crown.

Stipules: Rounded with purple edges, reddish/yellow, ruffled top.

Flowers: Bright crimson, conical, erect, terminal racemes well above the last leaf.

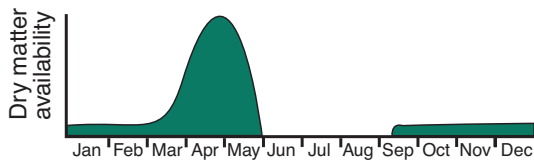
Fertilization: No N needed if nodulated. Maintain 30 lb/acre P and 250 lb/acre K.

Timing of production: 80 percent of annual production between March 15 and May 31.

When to begin grazing: Often based on the height of the grass in the mixture. In pure stands, grazing should begin when the clover reaches 6 inches in height.

When to cut for hay: Midbloom

Lowest cutting or grazing height: 3 inches



Yield distribution of crimson clover in Missouri.



Leaf



Individual plant



Crimson clover



Flower

Legumes

Clover, kura (Trifolium ambiguum Bieb.)

Kura clover originates from the Caucasian region of Russia. It is one of the most persistent clovers and tolerates severe continuous grazing. Kura clover persists well because it has an extensive root and rhizome system. Initial regrowth in the spring consists of an upright stem containing a large white-pink flower. After defoliation, all regrowth consists of leaves and petioles that originate

from crowns. In trials in northern Missouri, kura clover has yielded more than 10,000 lb/acre annually once established. The forage is succulent and rivals alfalfa in feed quality. The biggest drawback to kura clover is its poor seedling vigor. With little or no production possible in the first 18 to 24 months after seeding, it is one of the slowest legumes to establish.

Origin: Russia

Adaptation to Missouri: Best suited to northern Missouri

Growth habit: Rhizomatous, semi-erect to prostrate perennial.

Leaf: Palmately trifoliate, glabrous, leaflets are lanceolate to ovate with toothed margins, glaucous undersides and often have white V-shaped markings, petioles glabrous to slightly pubescent.

Stems: Glabrous, short, prostrate to semi-erect stems, branch from crown.

Stipules: Membranous stipules with distinct veins.

Flowers: Large, white or pink, inflorescences have up to 175 white florets.

Fertilization: No N needed if nodulated. Maintain 30 lb/acre P and 250 lb/acre K.

Timing of production: 60 percent of annual production between April 1 and June 30.

When to begin grazing: Often based on the height of the grass in the mixture. Pure stands may be grazed when the clover reaches 8 inches in height.

When to cut for hay: Not normally cut for hay unless it is mixed with a companion grass. Harvest based on the maturity of the grass.

Lowest cutting or grazing height: 3 inches

Fall management: Avoid severe grazing from Sept. 15 until the first hard killing frost.



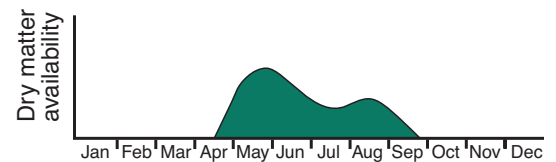
Leaf



Individual shoot



Kura clover



Yield distribution of kura clover in Missouri.



Flower

Legumes

Clover, red (Trifolium pratense L.)

Red clover is a short-lived, perennial legume grown on 7–10 million acres in Missouri. Although alfalfa has superior yield and quality under ideal conditions, red clover is much better adapted to the poorly drained, shallow or infertile soils frequently found on pasturelands. It is easier to establish than other legumes and works well in a

mixture with cool-season grasses. It has problems dealing with prolonged drought and root diseases. However, it can be reseeded rather easily and inexpensively. In fact, many producers broadcast 3 to 6 lb/acre of seed annually to maintain stands.

Origin: Asia Minor and southeastern Europe

Adaptation to Missouri: Statewide

Growth habit: Erect, short-lived perennial.

Leaf: Palmately trifoliolate, pubescent with a pale, crescent-shaped mark on upper surface.

Stems: Hollow, pubescent.

Stipules: Fused to petiole.

Flowers: Terminal on main and axillary stems, consists of many compound racemes with pink to purple florets, forming a dense head.

Fertilization: No N needed if nodulated. Maintain 30 lb P/acre and 250 lb K/acre.

Timing of production: 65 percent of annual production between April 1 and June 30.

When to begin grazing: Often based on the height of the grass in the mixture. In pure stands, grazing should begin when red clover is in the early- to midbud stage.

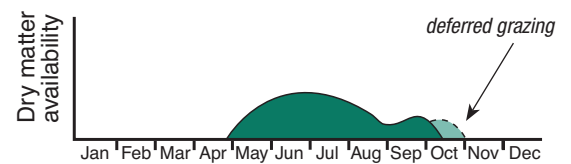
When to cut for hay: Early to midbloom

Lowest cutting or grazing height: 3 or 4 inches

Fall management: Avoid grazing below a 4-inch stubble height from Sept. 15 until the first hard killing frost.



Leaf



Yield distribution of red clover in Missouri.



Red clover



Flower

Legumes

Clover, white (Trifolium repens L.)

White clover is a legume adapted to cool, moist climates. In Missouri, it is presently grown on about 8 million acres of pastureland in combination with perennial cool-season grasses. Like other legumes, the forage it provides is both palatable and nutritious. All cattle relish white clover but have a tendency to overgraze it in mixed pastures.

A rotational grazing system helps manage this problem. White clover has good tolerance to poorly drained soils, but it is not drought-tolerant. In addition, white clover causes cattle to bloat if used as the only forage in the diet. Because of its high forage quality, white clover has wide application in grazing systems.

Origin: Mediterranean

Adaptation to Missouri: Statewide

Growth habit: Prostrate, stoloniferous, perennial.

Leaf: Palmately trifoliate, glabrous, arise from stolons on long petioles. Leaflets are ovate or circular with minutely serrate margins, often have V-shaped white mark, underside is shiny.

Stems: Prostrate, glabrous, solid, and develop stolons.

Stipules: Oblong to lanceolate, pale and translucent with a short point.

Flowers: Formed at the end of long peduncles. Florets are white, often tinged pink, forming an almost spherical head.

Fertilization: No N needed if nodulated. Maintain 30 lb P/acre and 250 lb K/acre.

Timing of production: 70 percent of annual production between April 1 and June 30.

When to begin grazing: Often based on the height of the grass in the mixture. Few if any pure stands exist.

When to cut for hay: Not normally cut for hay unless mixed with a companion grass. Harvest based on the maturity of the grass.

Lowest cutting or grazing height: 3 inches

Fall management: Avoid severe grazing from Sept. 15 until the first hard killing frost.



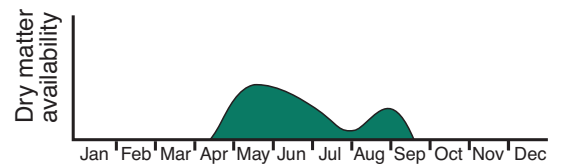
Leaf



Stolon



White clover



Yield distribution of white clover in Missouri.



Flower

Legumes

Hairy vetch (*Vicia villosa* Roth)

Hairy vetch is a winter annual legume used to a limited extent in Missouri. Hairy vetch is typically sown in late August or early September, and the plants generally form a crown before December. In spring, the plant produces weak branching stems or vines 3 to 6 feet long. Hairy vetch is commonly used in conjunction with cereal rye or wheat for silage. However, it also works well for early spring pasture.

It withstands trampling and provides grazing from mid-April through May. The feed value of hairy vetch is slightly lower than that of red clover or alfalfa. Well-nodulated hairy vetch can enrich the soil with 60 to 120 lb/acre of nitrogen through nitrogen fixation. The primary limitation to the use of hairy vetch is that it produces forage only during spring when many other forages are also productive.

Origin: Southern Europe

Adaptation to Missouri: Statewide

Growth habit: Climbing, prostrate, winter annual.

Leaf: Pinnately compound terminating in a tendril, each leaf with 10 to 20 pubescent elliptical leaflets.

Stems: Viny, slender, generally pubescent.

Stipules: Small, narrow, and pointed.

Flowers: One-sided, long peduncled raceme, usually purple or blue, 20 to 32 florets

Fertilization: No N needed if nodulated. Maintain 30 lb P/acre and 250 lb K/acre.

Timing of production: 80 percent of annual production between March 15 and May 15.

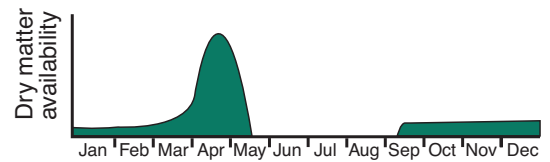
When to begin grazing: In spring once the vetch reaches 6 inches or more in height.

When to cut for hay: Early bloom.

Lowest cutting or grazing height: 3 inches



Hairy vetch



Yield distribution of hairy vetch in Missouri.



Leaf

Legumes

Lespedeza, annual (Kummerowia striata and K. stipulacea)

Annual lespedeza is primarily used as a pasture legume, although it is sometimes cut for hay. It provides high-quality forage in midsummer when other cool-season grasses and legumes are struggling. It also grows better than other legumes on infertile or shallow soils. Like birdsfoot trefoil, it does not cause bloat. However, it is not

problem-free. Its annual yield is lower than that of other legumes, and it does not have as broad a window of forage production. Korean types have proven susceptible to a number of foliar diseases. Annual lespedeza can be valuable in July and August.

Origin: Eastern Asia

Adaptation to Missouri: Statewide

Growth habit: Semi-erect, annual.

Leaf: Palmately trifoliate, leaflet on a short petiole, easily visible veins. Lower leaves spread, upper leaves erect.

Stems: Fine stems with hairs pointing down on *K. striata* and pointing upward on *K. stipulacea*.

Stipules: Small for *K. striata*; large and prominent for *K. stipulacea*.

Flowers: Flowers and sets seed in late summer and early autumn, florets are borne in short, axillary racemes; florets are reddish purple to white.

Fertilization: No N needed if nodulated. Maintain 20 lb P/acre and 200 lb K/acre.

Timing of production: 70 percent of annual production between June 15 and Aug. 31.

When to begin grazing: Often based on the height of the grass in the mixture.

When to cut for hay: Half to full bloom

Lowest cutting or grazing height: 4 inches

Fall management: Avoid severe grazing from Sept. 15 until seed is set. Lespedeza, annual (*Kummerowia striata* and *K. stipulacea*)



Leaf



Annual lespedeza



Flower

Other

Brassica species

Annual lespedeza is primarily used as a pasture legume, although it is sometimes cut for hay. It provides high-quality forage in midsummer when other cool-season grasses and legumes are struggling. It also grows better than other legumes on infertile or shallow soils. Like birdsfoot trefoil, it does not cause bloat. However, it is not

problem-free. Its annual yield is lower than that of other legumes, and it does not have as broad a window of forage production. Korean types have proven susceptible to a number of foliar diseases. Annual lespedeza can be valuable in July and August.

Origin: Mediterranean

Adaptation to Missouri: Statewide

Fertilization: Apply 75 lb N/acre at establishment.

Timing of production: 70 percent of annual production between Oct. 1 and Dec. 1.

When to begin grazing: Begin grazing to use the forage before early January.

Lowest cutting or grazing height: 0 inches — little regrowth potential.



Yield distribution of Brassica species in Missouri.



Turnip



Tyfon



Swede



Stemless kale

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