Chapter 5

Establishment

Nwsg can provide excellent habitat for many wildlife species and provide an alternative source of forage for livestock producers. The benefits of nwsg, however, cannot be realized until establishment is successful. Unfortunately, some landowners' attempts to establish nwsg have failed and it is widely acknowledged that establishing nwsg can be slow, especially if certain steps are not taken. Reasons for establishment failure vary, but the most common include drilling (or covering) seed too deep, inadequate weed control, planting too late in the growing season and using inadequate equipment for sowing the fluffy seed of bluestems and indiangrass. Recent equipment innovations and information concerning the use of various herbicides have helped increase establishment success considerably. **Another problem is expectations.** Too often, landowners do not realize what a successful stand of nwsg looks like as it is establishing (especially for wildlife habitat). And in many cases, planting is not even necessary.

Fig. 5.1 An amazing array of plants can arise from the seedbank—some prettier than others! This rough blazingstar was found growing in a field previously covered with tall fescue in Loudon County, TN. Eradicating the tall fescue and managing the field with fire stimulated the seedbank, which included many wildflowers.

Evaluating the seedbank

In the top few inches of soil, there is an untold amount of seed from a wide variety of plants. This collection of seed is called the seedbank. Most of these seeds were produced by plants that once grew on the site, but some were brought in by wind, water and wildlife. The seedbank is the primary base for succession — the way plants arise without being "planted." Surprisingly, many of these seeds can remain viable in the soil for hundreds of years; some lose viability (die) within a year or two. This is extremely important to landowners interested in wildlife. **If seed from desirable plants are present in the seedbank, quality early-successional habitat may be developed without planting, which saves time and**

Fig. 5.2 Does this look ugly to you? If so, you are a poor quail/rabbit manager! This is quality early-successional vegetation—broomsedge bluestem, blackberry, goldenrod, beggar's-lice, native lespedeza and sumac—with an open ground structure. This particular vegetative community provides nesting, brooding and escape cover for bobwhites. And you wouldn't take 10 steps before you jumped a rabbit.

Fig. 5.3 Powerline rights-of-ways and roadsides are good places to check and see what the seedbank holds in a particular area. Usually, these areas are sprayed every 3–5 years to kill/suppress woody growth. As a result, the native herbaceous groundcover often flourishes.

money. Plants such as blackberries, broomsedge, ragweed, pokeweed and partridge pea provide excellent food (seed and/or forage) and/or cover (nesting, brooding, escape) for many wildlife species without planting. There are many other plants that may germinate from the seedbank to enhance early-successional cover for wildlife. Some choice "weeds" include: native lespedezas, beggar's-lice, low panicgrasses, smartweeds, wild strawberry, stick-tights, 3-seeded mercury, bluestems, Carolina geranium, butterflypea, milkpea, perennial sunflowers, doveweed, goat's rue, wild bean and nut rushes. Because of natural successional processes, fire and disking can stimulate and perpetuate many of these species.

Fig. 5.4 Native lespedezas, such as this *L. virginica*, are among the most-preferred plants for bobwhites. Their seed value is tremendous and they can provide quality brooding cover as well.

Wildlife managers use the seedbank by creating conditions that allow these seed to germinate. The seedbank is most often suppressed by introduced non-native grasses, such as tall fescue, bermudagrass, johnsongrass, crabgrass, orchardgrass, dallisgrass, bromegrasses, bluegrass, timothy and bahiagrass. Although some of these grasses are more competitive than others, when present, all of them replace and compete against native

Fig. 5.5 This newly revived oak savanna on the Catoosa WMA in Cumberland County, TN is the perfect example of a long-lived seedbank. The year after a pine beetle epidemic (2001–02) eradicated the pine in this previous closed-canopy mixed pine-hardwood stand, the Tennessee Wildlife Resources Agency began using fire to manage the area. What was an understory of scattered woody saplings and dead leaves is now a thriving early succession community with numerous species of native grasses, legumes and other forbs, none of which were planted.

Figs. 5.6, 5.7, and 5.8 This is often what happens when tall fescue is eradicated. The plot was sprayed in April 2004 with 2 quarts per acre of a glyphosate herbicide. The plot was disked in fall 2004 and by May 2005, ragweed and other forbs from the seedbank dominated the plot and offered quality brooding cover. By August 2005, the ragweed and sticktights (*Bidens*) were flowering and preparing to produce seed—seed that would not have been available if the tall fescue had not been killed.

April 2004

May 2005

August 2005

vegetation that would better serve various needs of wildlife. By killing non-native grass cover, conditions improve for seed in the seedbank to germinate. Burning dead material off a field after spraying, followed by disking, further stimulates the seedbank to germinate.

Fortunately, most nwsg seed remain viable in the seedbank for an exceptionally long time. This is most evident when openings are created in forested areas. Many (if not most) forests in the Mid-South today were once agricultural fields or early-successional openings, historically maintained by plowing or fire (either from lightning or Native Americans). When full sunlight reaches the ground, plants begin growing that have not been present since the forest canopy closed, often 80–100 years ago, or more. The seedbank present in these newly created fields is often rich with a wide variety of early-successional herbaceous species, including nwsg, that have been waiting to germinate for a long time. In many areas, there is enough nwsg seed present that planting is not necessary. Certainly, if 10–30 percent of the vegetative cover is nwsg, planting is not necessary to provide quality early-successional habitat for most wildlife species that would use that habitat. Even if nwsg coverage is less than 10 percent, this coverage will increase if dormant-season fire is used to maintain the habitat type. If planting is warranted, herbicide treatment is usually not necessary in newly created openings that were previously forested.

Seed quality, germination and Pure Live Seed (PLS)

When planting is necessary, seed quality should be an initial consideration. Purity of nwsg seed is often low (50–70 percent) because of an inordinate amount of inert material (stems, leaves, etc.). In addition, the germination rate may only be 50–60 percent. Fortunately, this information is printed on a tag sown onto the seed bag. From the seed tag, the percentage of pure live seed (PLS) can be calculated. This figure is then used to determine the bulk-seeding rate. **This is a critical step when weighing seed and determining the seeding rate prior to planting!** Failure to do so will almost certainly result in disappointment.

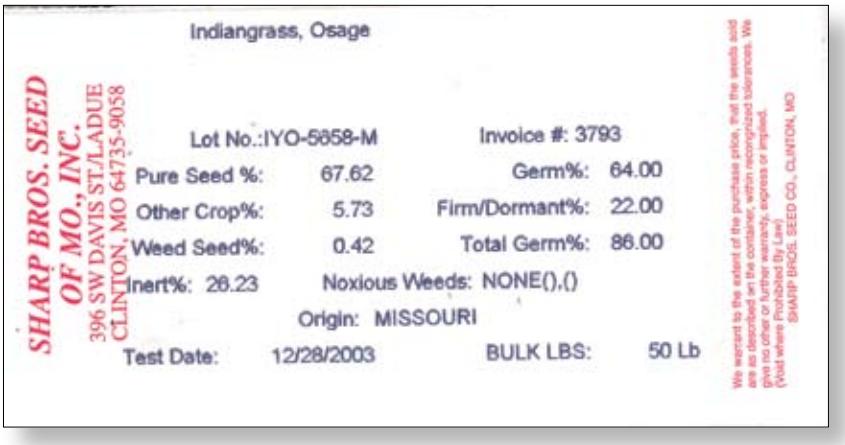


Fig. 5.9 Never plant nwsg without reading the seed tag and calculating PLS.

PLS is calculated as follows:

Seed: Indiangrass (Osage)

Pure Seed: 67.62%	Germination: 64.00%
Other Crop: 0.05%	Firm/Dormant: 22.00%
Weed Seed: 0.42%	Total Germination: 86.00%
Inert: 26.23%	Noxious Weeds: NONE
Origin: MISSOURI	Test date: 28 December 2003

67.62% (pure seed) × 86.00% (total germination) ÷ 100 = 58.15% PLS
To plant 6 lbs PLS per acre: 6 lbs (desired rate) ÷ 58.15 (PLS) × 100 = 10.32
Therefore, 10 lbs of bulk material from the seed bag should be planted per acre.

Dormancy of nwsg seed can be a problem for eastern gamagrass and switchgrass. It has long been known that 2–3-year-old seed sometimes germinates better than new seed. Germination can be estimated (if not identified from a seed tag) using a "rag doll" germination test. This involves placing a pre-determined number of seed (such as 100) in a moistened paper towel, which is rolled up and placed in a Zip-lock® bag. Place the bag in a warm area for 5–7 days. Remove the paper towel and count the number of seeds that have germinated. Remove those seeds. Replace the bag, wait another 5–7 days and count the number of germinated seeds again. Now divide the total number of germinated seeds by the total number of seeds placed in the paper towel. This will provide a fair estimate of germination.

Problems associated with high dormancy (germination rate < 50 percent) can be improved with wet-chill treatments (cold stratification) and buying pre-treated seed (probably the most convenient option for most landowners). Wet-chilling involves soaking seed placed in a mesh bag overnight in water. Allow the bag of seed to drip dry the following morning for a few hours before storing in a cool location (such as a cellar or walk-in cooler set at approximately 40–45 F). Switchgrass seed should be chilled at least two weeks; eastern gamagrass seed should be chilled for six weeks. After the chilling period, the seed is removed from the bag and allowed to air dry. For best results, the seed should be sown immediately after air-drying. However, if seeds are dried out completely, dormancy may return. If all of the seed are not sown, the remainder may be stored after air-drying thoroughly. Optimally, the chilling process should be conducted during March/April.

Obviously, the wet-chilling process is supposed to simulate natural conditions as if the seed were lying in the ground through winter. However, germination and establishment success may be better with the wet-chill-

ing process than planting in the fall. Perhaps the best option for eastern gamagrass seed is buying pre-treated seed (cold-stratified before shipping). It is important that this seed be planted immediately upon arrival. If not planted immediately, the seed may be stored in refrigeration for a short time (no more than two weeks). Some seed companies offer seed that also has been treated with a fungicide prior to shipment.

Use of Plateau® and Journey® herbicides

Plateau® (released in April 1996) and Journey® (released in May 2004) herbicides contain ammonium salt of imazapic as an active ingredient. Imazapic controls several problematic competitors (such as tall fescue and crabgrass—see herbicide labels for complete list of plants controlled) with relatively little harm to many plant species desirable for wildlife (such as bluestems, indiangrass, blackberries and legumes). Imazapic has residual soil activity with a half-life of 60 days after spraying; therefore, it can be applied preemergence as well as postemergence and provide a relatively long window of time for competition control.

Plateau® contains 23.6 percent ammonium salt of imazapic (one gallon contains 2.0 pounds of imazapic), while Journey® contains 8.1 percent ammonium salt of imazapic as well as 21.9 percent glyphosate (one gallon contains 0.75 pound of imazapic and 1.5 pounds of glyphosate). Both herbicides can be used to prepare sites for planting and treat undesirable species prior to planting nwsg; however, because Journey® contains glyphosate, higher rates of Journey® should not be sprayed over existing stands of several nwsg species while growing. Table 5.1 can be used to convert rates of Journey® to equivalent rates of Plateau® and glyphosate.

Fig. 5.10 Applying Journey® just prior to drilling nwsg offers postemergence control of existing vegetation as well as preemergence control for several weeks.

A word about surfactants...

The use of surfactants is critical for success of postemergence herbicide applications. Surfactants, or spray adjuvants, are water- or oil-soluble substances added to herbicides to modify or enhance the effectiveness of the active ingredient. Surfactants are surface-active agents that produce physical changes at the interface of the liquid herbicide mixture and the surface of the plant. Surfactants help herbicides stick, spread, wet, penetrate and disperse on the surface of plants. Hence, surfactants are not added to preemergence applications, only postemergence. Surfactants make many herbicides more effective by helping the herbicide penetrate the plant.

Surfactants include soaps and synthetic surfactants. Surfactants may be anionic, cationic, amphoteric or non-ionic, based on their ionization in water. Soaps are anionic (negatively charged) and are not used with herbicides because they form insoluble salts that precipitate. Synthetic anionic surfactants are not usually used alone because they may react with other ions (possibly the active ingredient in the herbicide solution); however, anionic surfactants are excellent wetting agents and may be used with nonionic surfactants to improve the wetting properties of an herbicide mixture. Cationic surfactants are derived from ammonia and are not usually used with herbicides because they are phytotoxic and precipitate readily in hard water (water with a relatively high concentration of calcium, magnesium and/or iron). Amphoteric surfactants have positive and negative charges, but are not normally used with herbicides. Non-ionic surfactants (NIS) do not ionize in water; therefore, they do not form insoluble salts and can be used with hard water. NIS are outstanding emulsifiers, forming stable emulsions, which enables them to make many herbicide formulations much more effective. NIS are also good dispersing agents, excellent detergents, do not foam much and have low phytotoxicity and low mammalian toxicity. All of these properties, along with the fact that NIS are more soluble in cold water than hot water, make them very attractive for use in solution with many herbicides.

Crop oil concentrates (COC) are petroleum- or vegetable-based oils that increase the absorption of herbicides into plant leaves. Methylated seed oil (MSO), for example, is a vegetable-based COC that enhances the uptake of certain herbicides. COC usually contain 80 percent oil and 20 percent NIS. Depending upon the application, some herbicide labels may recommend COC rather than NIS because of the inherent phytotoxic properties of COC. COC alone can alter the structure of cell membranes, thus causing damage to plants. That is why NIS are normally used with selective herbicide applications, while COC are typically used with "burn-down" applications where the intention is to kill all vegetation present. Nonetheless, it is important to use a high-quality surfactant and follow the herbicide label instructions, as some herbicides perform better with MSO than NIS.

Liquid nitrogen fertilizers, such as urea-ammonium nitrate or ammonium sulfate, may increase the uptake of postemergence herbicides. They are not, however, surfactants, even though they may be recommended on some herbicide labels as an additive to the spray mixture.

Table 5.1 Equivalent rates of Journey®, Plateau® and Roundup®				
Journey® rate (ounces)	**Plateau® equivalent (ounces product)**	**Roundup® equivalent (ounces product)**	**Imazapic (pounds)**	**Glyphosate acid equivalent (pound)**
32	12.0	16.0	0.188	0.375
24	9.0	12.0	0.141	0.281
16	6.0	8.0	0.094	0.188
12	4.5	6.0	0.070	0.141
8	3.0	4.0	0.047	0.094

Even though glyphosate can kill growing nwsg, demonstration plots have shown that Journey®, when applied at rates as high as 22 ounces per acre, can be used to "clean-up" weeds within a nwsg stand. Nwsg were stunted at higher rates, but the integrity of the grass stands remained intact (see Figures 5.11 and 5.12).

Some nwsg are more tolerant to imazapic than others (Table 5.2). The bluestems and indiangrass are quite tolerant to imazapic. However, growth of these grasses can be stunted by higher rates (10–12 ounces of Plateau® per acre) when sprayed over young seedlings (see Figure 5.13). Postemergence applications (especially higher rates) should not be applied until seedlings have reached the four-leaf stage or until it is apparent the majority of the herbicide will be taken up by competitive weeds that have overgrown the grass seedlings.

Fig. 5.11 This mixed nwsg stand was planted in May 2005. A strip (in front of biologist) was sprayed postemergence in June 2005 with 11 ounces per acre of Journey®. Although the grass was stunted, by August 2005, it is obvious the grass was doing fine.

Table 5.2 Tolerance of native warm-season grasses to imazapic[1]	
Species	**Rate (oz / ac)**
Big bluestem	<12
Little bluestem	<12
Broomsedge bluestem	<12
Indiangrass	<12
Switchgrass	2–4[2]
Eastern gamagrass	2–6[2]
Sideoats grama	2–8[2]

[1] Plateau® Herbicide Label; BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709

[2] Expect stand thinning and possible loss of stand at higher rates.

Fig. 5.12 This mixed nwsg grass stand was planted in March 2005. A strip (in front of biologist) was sprayed postemergence in June 2005 with 22 ounces of Journey®. Obviously, the grasses were stunted by the herbicide application; however, problem weeds (note cocklebur in unsprayed area to left of strip) were controlled very well. By August 2005, the grasses were doing quite well and the resulting bare ground space was very beneficial for quail and other wildlife.

A preemergence application within one week after planting (4–8 ounces per acre Plateau® or 16–21 ounces Journey®) is recommended when establishing bluestems and indiangrass (Tables 5.1, 5.2 and 5.3). Preemergence applications provide the best weed control (especially crabgrass, johnsongrass and foxtails) and usually create "clean" conditions at the ground level, which provides excellent habitat for brood-rearing upland game birds (Table 5.4).

Some species, such as switchgrass, eastern gamagrass and sideoats grama, cannot tolerate higher rates (10–12 ounces Plateau® per acre) of imazapic and stand thinning may occur even at lower rates (2–4 ounces Plateau® per acre). When planted as part of a mixture, a relatively small percentage of switchgrass and sideoats grama usually germinates and grows with a preemergence application (6–8 ounces Plateau® per acre). Postemergence applications may lead to better survival and growth of sideoats grama and switchgrass if they are included in a nwsg mixture. Because of the susceptibility to imazapic, other herbicides are recommended when planting pure stands of switchgrass or eastern gamagrass (discussed under the *Competition Control and Herbicides* sections).

Fig. 5.13 When spraying Plateau® or Journey® postemergence over nwsg, it is important to allow the seedlings to reach at least the 4-leaf stage before spraying. This big bluestem seedling was severely stunted (notice dead top growth) when sprayed with 12 ounces of Plateau®. A few weeks later, it is beginning to produce new growth from below. The best technique for postemergence spraying is to allow the nwsg to reach the 4-leaf stage or when it is apparent the majority of the herbicide will be taken up by competitive weeds that have overgrown the nwsg seedlings.

Table 5.3 Influence of imazapic on native warm-season grass seedling density[1] at the Knoxville Experiment Station, 2002. (Harper and others, 2003)

Plateau® Treatment	Seedling density (plants/m²)				
	BB[2]	LB	IG	SG	SO
PRE 8 oz	81	60	54	12	15
PRE 12 oz	72	45	58	6	18
POST 8 oz	48	73	50	20	38
POST 12 oz	36	63	47	19	38
Untreated	29	47	43	39	23

[1] All grasses top-sown at 10 pounds PLS per acre.

[2] BB=big bluestem, LB=little bluestem, IG=indiangrass, SG=switchgrass and SO=sideoats grama.

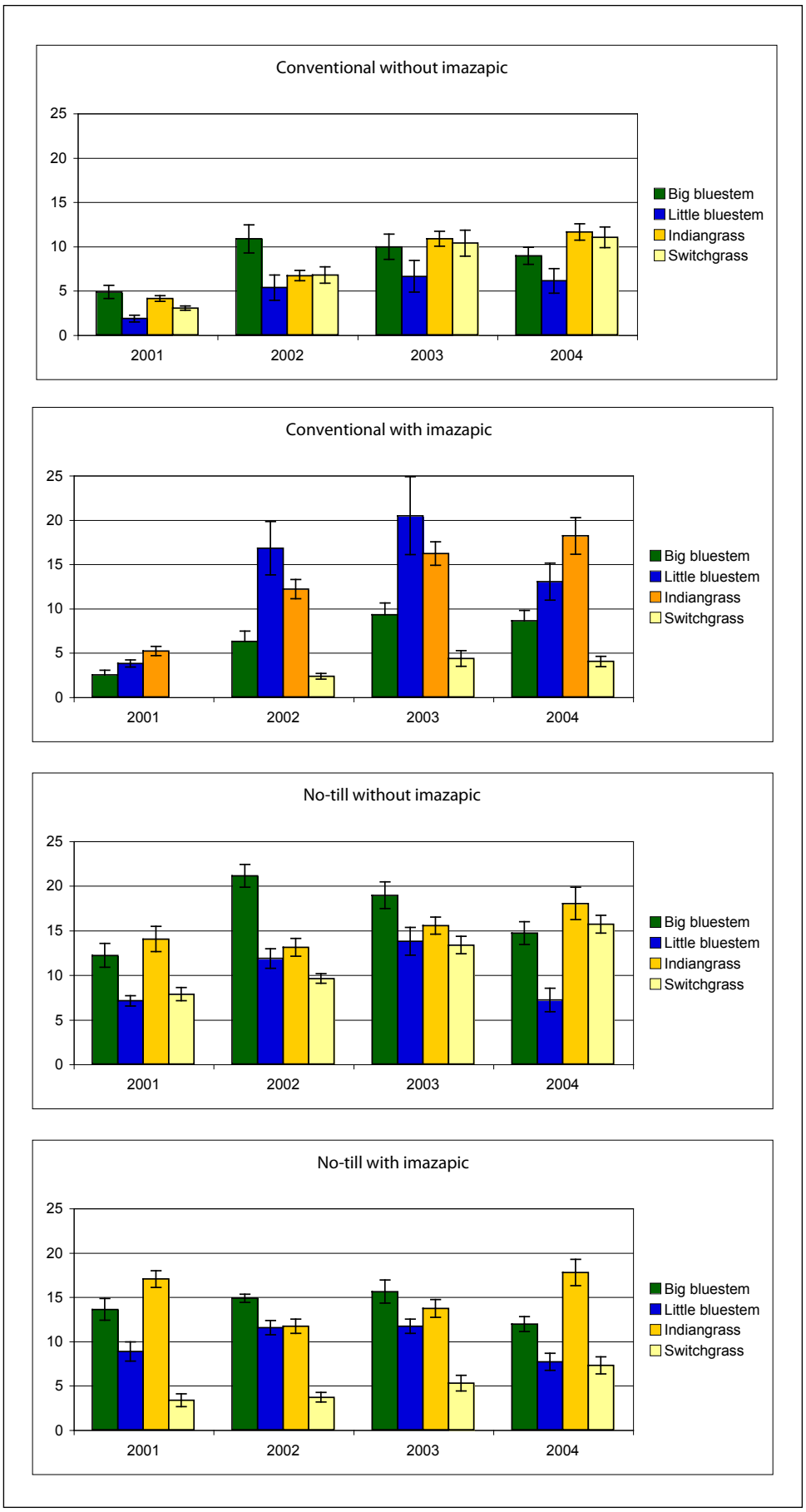


Fig. 5.14 These data show the change in number of nwsg bunches over time following planting in 2000 at the Middle Tennessee Research and Education Center (Harper and others 2002; Jones and others 2004). All plots were planted at 8 pounds PLS per arce. Plots with imazapic were sprayed with Plateau at 8 ounces per acre. Regardless of planting method, most species increase in density over time. It is also obvious, imazapic applications reduce coverage of switchgrass

Table 5.4 Influence of imazapic (Plateau) on percent control of crabgrass, spotted spurge and fall panicum at the Knoxville Experiment Station, 2002. (Harper and others, 2003)

Treatment	Crabgrass	Spotted spurge	Fall panicum
PRE 8 oz	100	99	99
PRE 12 oz	100	99	99
POST 8 oz	62	68	38
POST 12 oz	69	76	44
Untreated	0	0	0

Competition control

Nwsg do not compete well with non-native grasses, such as tall fescue, bermudagrass, crabgrass and johnsongrass. Control of non-native grasses, as well as many broadleaf competitors, is **critical** to successfully establishing nwsg. It is particularly important to eradicate perennial competitors **before** planting. There are several solutions to weed-control problems with various scenarios based on field-crop histories and seedbank composition. For example, recommendations for establishing nwsg for haying/grazing in a field previously covered with tall fescue are completely different from those recommendations for establishing nwsg for wildlife in a newly created field previously covered with a stand of shortleaf pines (where, most likely, an herbicide application would not be needed). Similarly, competition control for establishing a field of nwsg for wildlife may be quite different from competition control for establishing nwsg for haying or grazing.

Controlling tall fescue and other perennial cool-season grasses

Fig. 5.15 For best results, cool-season grasses (e.g., tall fescue and orchardgrass) should be 8–10 inches high and actively growing when sprayed. Although spraying in the fall is the best time to spray, spring applications can be successful as well.

When converting a field of perennial cool-season grass to nwsg, the optimum time to spray the existing cover is in the fall before planting the following spring (see Fig. 2.36) This is because cool-season grasses are actively growing during October and November, but growth is concentrated primarily in root development as carbohydrates, amino acids and other compounds are being translocated and stored in preparation for hard frosts and freezing temperatures. In the spring, growth is directed towards leaf (forage) production with rapid photosynthesis taking place in an effort to ultimately produce seed. Because compounds are being translocated to the roots in fall, a reduced herbicide rate is possible. Glyphosate (the active ingredient in Roundup®) is the most common multi-use herbicide used to kill cool-season grasses. For fall (October/November) applications, a rate of 1–2

Figs. 5.16a and b Preparing the site before spraying is very important to ensure a complete kill. It is always best to "clean" a field in preparation for spraying. This is done by burning, haying or grazing the field to encourage fresh growth and reduce senescent grass leaves that will block the herbicide from coming in contact with growing grass.

Fig. 5.16a

Fig. 5.16b

quarts per acre of Roundup® is recommended. For spring (March/April) applications, a full two quart per-acre rate is recommended. One quart per acre of a COC or one pint per acre of MSO should be added if the herbicide does not include surfactant.

Before spraying, the field should be burned, hayed, grazed or mowed and allowed to re-grow. Burning or haying is recommended because most of the vegetative material is removed from the field, providing less chance for the herbicide to be "blocked" by senescent (dead) leaves and other material. To facilitate rapid uptake of the herbicide, perennial cool-season grasses should be actively growing and 6–10 inches in height. Waiting until cool-season grasses begin to flower and seed before spraying will produce less-than-desirable results. To help ensure a complete kill, 17 pounds per acre of liquid nitrogen (28-0-0) may be added to the herbicide mixture. After spraying, the field should not be manipulated (mowed, disked, burned) for approximately two weeks, allowing time for the plants to uptake the herbicide and to realize full efficacy (Note: glyphosate activity may be slowed by cool weather).

When wildlife habitat is the objective, many fields of tall fescue can be enhanced without planting nwsg. By simply eradicating the

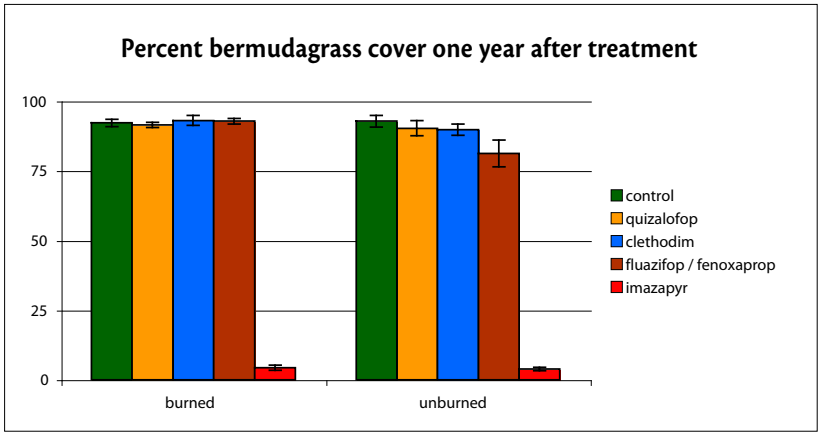
Fig. 5.17 This tall fescue field looks great—it is ready to kill! A few weeks after haying, grass growth is 8–10 inches and adequate moisture has the field green and actively growing.

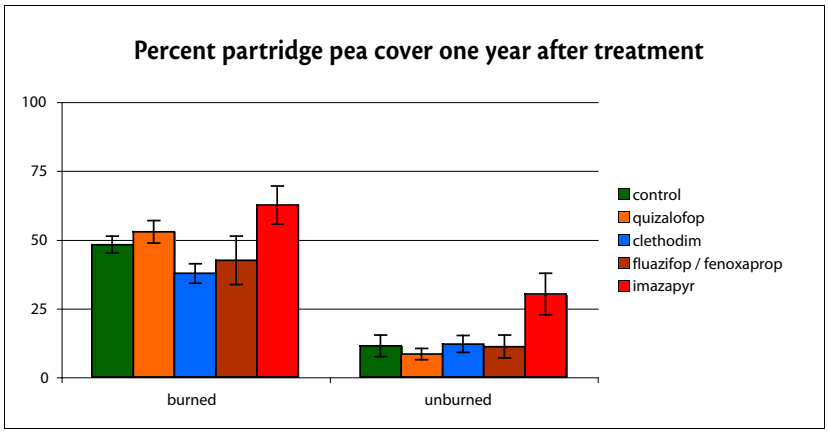
non-native cover and allowing the seedbank to germinate, quality early-successional cover may develop within two growing seasons (depending upon the composition of the seedbank). To achieve this, the field must be treated as described above. Once the tall fescue has browned over, the field may be burned and then disked to stimulate the seedbank. The field should be checked periodically, especially in April and October for recurring tall fescue. It is not uncommon for tall fescue to re-occur where residual seed germinated several months later. Spot-spraying these areas with glyphosate or imazapic will provide long-term control.

Controlling bermudagrass

Bermudagrass is best controlled with imazapyr (24 ounces of Arsenal AC® per acre with 2 pints of MSO). Before spraying, the field should be burned in late winter (if not hayed) to reduce standing dead vegetation and ensure herbicide contact with growing grass after spring green-up. Burning also helps stimulate forb coverage, especially desirable legumes, such as partridge pea (Fig. 5.18).

Fig. 5.18 Research conducted by Bond and others (2005) in Georgia showed imazapyr (active ingredient in Arsenal AC®) was most effective in killing bermudagrass. Plots that were burned pre-treatment contain more desirable legumes (such as partridge pea) than unburned plots.





Bermudagrass is extremely difficult to eradicate. In fact, it is virtually impossible to eliminate bermudagrass with a single spraying. Patience and persistence are required when dealing with this exotic scourge. Unfortunately, if a spot or two of bermudagrass is left in the field, it may eventually spread over the rest of the field if left untreated. Repeat applications are always necessary.

After the initial spraying, the field should be disked prior to spring green-up following the initial herbicide application and left fallow, allowing the seedbank to germinate. This will stimulate residual bermudagrass as well. The field should be checked through the growing season and spot-sprayed as necessary. The following late winter/early spring, the field should be disked again to further stimulate the seedbank. Again, the field should be monitored throughout the following growing season and residual bermudagrass treated as appropriate. After two growing seasons of monitoring and treatment, the field should be ready for sowing nwsg the following spring (if nwsg have not already emerged from the seedbank).

Another technique often used to eradicate bermudagrass is growing a Roundup Ready® crop, such as soybeans. This technique has produced mixed results. Even after using a Roundup Ready® crop for two years, residual bermudagrass may appear the following growing season. Spot-spraying and persistence is always necessary.

Controlling johnsongrass and crabgrass

Where johnsongrass and crabgrass are known to exist, a preemergence application of imazapic (such as 8 ounces of Plateau® per acre) is strongly recommended when planting bluestems, indiangrass, sideoats grama or mixtures of these species. When establishing switchgrass or eastern gamagrass, johnsongrass and crabgrass should be sprayed the summer prior to planting. Although residual seed will still be present in the seedbank, the objective is to reduce the seedbank of these warm-season competitors as much as possible before planting nwsg. When sprayed postemergence, johnsongrass is best controlled when the grass reaches 18–24 inches in height at the whorl (the first set of three leaves on the plant stem). Optimally, crabgrass should be sprayed before reaching 4 inches in height; however, acceptable control may be achieved if crabgrass is sprayed before flowering. Both crabgrass and johnsongrass can be killed postemergence with a glyphosate herbicide at 2 quarts per acre or clethodim (Select®) at 10–12 ounces per acre. When spraying Select® (or a glyphosate product without surfactant), COC or MSO should be added to the mixture as appropriate. Another herbicide that can be used in switchgrass plantings (as well as other nwsg) to control johnsongrass is OutRider® (sulfosulfuron). A preemergence application (2 ounces per acre) or postemergence application (2 ounces per acre) after nwsg have become well-established (past the 4-leaf stage) should control johnsongrass as well as several other competitors. When spraying postemergence, a nonionic surfactant should be added at 0.5 percent by volume (2 quarts per 100 gallons of solution).

Fig. 5.19 When establishing pure stands of switchgrass, eradicating existing competition (such as, bermudagrass and crabgrass) prior to planting is especially important as there are no selective herbicides that will remove these competitors and not harm switchgrass.

Weed control in retired rowcrop fields

If left fallow, retired crop fields converted to nwsg may require herbicide treatment the growing season prior to planting to help control annual weed growth and their addition to the seedbank. Winter annuals should be sprayed in late winter/early spring before planting nwsg. A glyphosate herbicide application of 1–2 quarts per acre will control or suppress common winter annuals such as henbit, purple deadnettle, common chickweed and ground ivy. In crop residue, a preemergence application of an imazapic herbicide (such as 6–8 ounces per acre of Plateau®) usually promotes an excellent stand when planting bluestems, indiangrass and sideoats grama. A preemergence application of OutRider® (2 ounces per acre) also can be used to control several competitors when planting nwsg in retired rowcrop fields.

Weed control when establishing pure stands of switchgrass or eastern gamagrass

Switchgrass and eastern gamagrass are not very resistant to imazapic (Table 5.2). Therefore, other herbicides and competition control practices are needed when establishing these grasses for haying and grazing operations. Control of existing vegetation is critical and should be addressed thoroughly (as discussed above) because herbicide applications are limited for competing non-native warm-season grasses (such as bermudagrass and crabgrass) after switchgrass or eastern gamagrass germinates. A preemergence application of Atrazine 4L® (refer to label for various restrictions) at 2 quarts per acre will control many broadleaf and grass competitors (refer to label for species controlled/suppressed). Postemergence broadleaf competition can be controlled/suppressed with an application of 2,4-D® and/or dicamba (Banvel®, Clarity® or Overdrive®) with an NIS. Overdrive® can be used during or after establishment to control broadleaf competitors. Overdrive® has a 0-day haying or grazing restriction, which allows producers to graze an established stand of nwsg after spraying without a waiting period.

Another practice is to mow competitive weeds before they flower and seed. Shading limits growth of nwsg considerably and prolonged shading can kill nwsg. The mower should be set relatively high so the switchgrass or

Fig. 5.20 Although nwsg can be established and grow relatively well in soils with low fertility, collecting a soil sample and getting it tested is a good idea, especially if nwsg are established for haying/grazing where maximum production is desired.

eastern gamagrass is not clipped any more than necessary. This method is usually less successful than herbicide applications, but many producers have seen switchgrass and eastern gamagrass out-compete non-desirable plants during the second growing season after planting where the competition was not allowed to flower and produce seed.

pH and fertilizer requirements

One of the biggest advantages to establishing nwsg is that they are adapted to the soils of the Mid-South. Essentially, that means they can grow in nutrient-deficient soils with a low pH. Most of the soils in the Mid-South are slightly to strongly acid, extensively weathered and ultimately leached of nutrients. Often, soil pH is below 5.5 with low nutrient levels. With such a low pH, most of the nutrients present are unavailable to plants. Nonetheless, nwsg will germinate and grow in most of these soils without additions of lime and fertilizers. Optimum growth, however, cannot be attained on nutrient-deficient soils. Before planting nwsg, a soil sample should be collected and sent off for testing, just as if a row crop was being planted. Increasing the pH to 6.0–6.5 and maintaining P and K at medium levels (19–30 and 91–160 pounds available per acre, respectively) are recommended when significant production is desired.

Application of N at planting is generally not recommended because it will stimulate weed competition. However, if bluestems and/or indiangrass is planted and Plateau® is applied preemergence, 15–30 pounds of N per acre may be added once the grasses are 4–6 inches high if adequate moisture is available. If planting pure stands of switchgrass or eastern gamagrass, N should not be applied until the stand is established and weeds controlled. For optimum growth, especially when establishing nwsg for pasture or hayfield, P and K may be elevated to high levels (31–120 and 161–320 pounds available per acre, respectively). In addition, up to 60 pounds of N can be applied either in April/May, after cutting hay and/or after removing livestock from the paddock.

Seedbed preparation

Once the competition is controlled, the seedbed should be prepared before planting. If drilling seed, a firm and "clean" seedbed, free of deep thatch and other material, is desired. This will enable the seed to be planted

Fig. 5.21 NWSG can be drilled directly into dead sod if the thatch layer is not too deep. When fields are sprayed in the fall prior to spring planting, thatch is not a problem as is evident in this field that has just been planted with a no-till drill.

adjacent to mineral soil, which should increase germination success. If the seed is planted in deep thatch, germination and seedling survival may be less than desirable. Cleaning the seedbed is best achieved by burning. A firebreak should be constructed around the field by discing a strip one or two tractor-widths wide. This is important because the firebreak will be used every 2–3 years as the field is maintained with prescribed fire. If the dead material on the field is sparse and/or only a few inches high, no preparation may be necessary.

If the seed is to be top sown (or broadcast), the seedbed should be prepared by conventional tillage techniques. If the soil needs amendment, it is best to do so at this time to ensure the lime and fertilizer are well-incorporated. To ensure firm seed-to-soil contact and improve germination and seedling survival, the seedbed should be cultipacked before and after seeding. Top-sown seed should not be covered by disking because it covers the seed too deep.

Fig. 5.22 Cultivated seedbeds can be planted by drilling or top-sowing. If top-sowed, the site should be cultipacked after planting, not disked. Here, a riparian buffer strip is being drilled with nwsg after the seedbed was prepared by conventional tillage.

Planting techniques, timing, seeding depth and seeding rate

Drilling and top-sowing

Native warm-season grasses can be established by planting with a no-till drill (see Appendix 5) or by top-sowing (broadcast seeding). If planting bluestems and/or indiangrass, a drill with a specialized seed box containing "picker wheels" is necessary. Without this design, the fluffy seed of these grasses lodge in the seed chute and are not planted. Finding a drill designed to plant these grasses should not be a problem. Truax™, Great Plains™ and others make suitable models and many drills are available for use by state wildlife agencies, the Natural Resources Conservation Service and Soil Conservation Districts. If the seed are top-sown, a spreader with a similar device designed to "pick" fluffy seed from the hopper is required. Simply throwing the seed up in the air and allowing the wind to spread the seed usually results in a patchy stand, which may be fine, depending upon objectives. There have been mixed results using cracked corn, pelletized lime, cottonseed hulls or fertilizer as a seed carrier in traditional planting equipment. Using the proper equipment is highly recommended to successfully establish nwsg. Switchgrass can be top sown or planted using the clover seed box on a grain drill, while eastern gamagrass should be planted with a corn planter. Eastern gamagrass is usually planted in rows 18–24 inches apart, but some people like to plant rows only 12 inches apart to reduce stool size and make stems more upright so haying is easier.

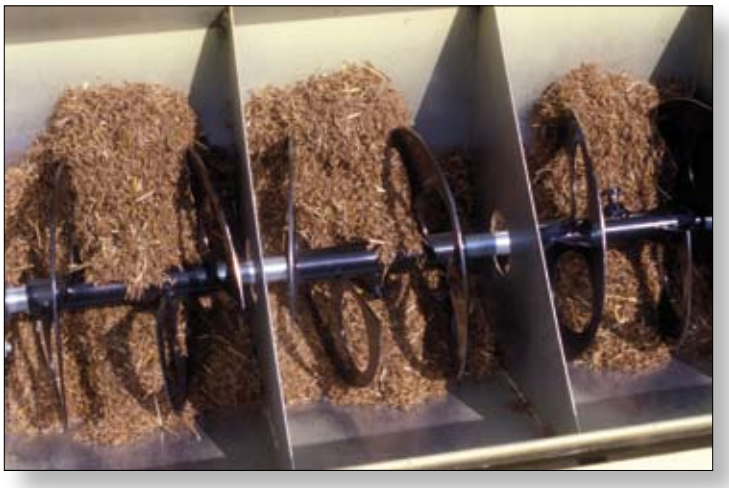


Fig. 5.23 and 5.24 Drills with "picker wheels" and agitators in the seed box (such as this Truax™) are recommended when planting bluestems and indiangrass. This ensures an even flow of seed and prevents seed lodging in the box.

Timing of planting

Nwsg are best planted from mid-April through May in the Mid-South. This is a major consideration. Because germination and seedling establishment can be slow, it is important to plant just before the soil temperature reaches approximately 58 degrees. This allows more time for germination and provides seedlings a better opportunity to

Troubleshooting tips when using a no-till drill

Most nwsg plantings are established by using a no-till drill. Drills designed for "fluffy" seed are necessary when planting bluestems and indiangrass because of the long seed awns and light weight of the seed. Several manufacturers offer this type of drill, including Truax™, Great Plains™ and others. These drills have two or more seed boxes designed for different types of seed, including one for fluffy nwsg seed. Agitators keep the fluffy seed from compacting, while picker wheels, located in the bottom of the seed boxes, extract seed and send them down an oversized drop tube designed to avoid seed bridging.

Fig. 5.25 Truax™ sprocket chart

Fig. 5.26 Seed output is adjusted on some drills, such as this Truax™, by a chain sprocket.

Non-fluffy nwsg also can be planted with these drills. Switchgrass seed can be planted in the seed box typically used for smaller seed, such as clovers. Sideoats grama can be planted in the seed box with the picker wheels or in the seed box typically used for larger seed, such as oats, wheat and rye.

Although these drills have aided tremendously in successfully establishing nwsg stands, it is critical that the drill is calibrated for the seed being sown and that attention is given to planting depth and rate. Many plantings have "failed" because the seed were drilled too deep, an inadequate seeding rate was used because the percentage of pure live seed was not calculated and/or because the drill was not calibrated, or too little seed was sown because the drill was not operating properly for some reason. Before using a drill to plant nwsg, inspect the machinery and become familiar with its operation. Appendix 5 provides information on the operation and maintenance of no-till drills.

Many state wildlife management agencies provide drills designed to plant nwsg free of charge to landowners. Drills are also available through some chapters of Quail Unlimited™ and Soil and Water Conservation District offices or may be rented through some state farmers' cooperatives or seed/equipment dealers. Typically, these drills see many hours of use and are not always in the best shape. It is important to check the seed flow from these drills and be sure the proper amount of seed is being planted. The calibration charts on these drills are usually correct when drills are new, but as they get older and parts wear, seeding rates may be higher or lower than those listed. Spending a few minutes before planting can prevent all of the seed being placed on a small portion of the field, or having to run over the field twice because the drill wasn't planting enough seed.

Often, there is little time for the landowner to become well-acquainted with a drill before use. However, merely filling the drill with seed, hooking to the tractor and taking off across the field usually results in disappointment. Even after

reading over the user's manual (if one is available), the landowner is often confronted with problems and confused about why the drill is not operating properly. Listed below are a few tips for successful operation and identifying problem sources.

1. Before going to get the drill, have the correct size hitch pin for towing the drill.
2. Make sure the tractor's hydraulic fittings match those for the drill.
3. Calculate the percentage of pure live seed (see p. 73–74) and calibrate the drill for the bulk rate of seed being planted and the desired planting rate.
4. Measure the field being planted— don't guess the acreage (the local FSA office can assist with determining field size from aerial photographs).
5. For best results, plant in a clean seedbed, without thatch buildup or much debris.
6. Make sure the chains on the opening coulters are not kinked and that coulters are in alignment with the seeding furrow.
7. Check all tubes to make sure they are not clogged (this should be evident when calibrating the drill) with mud or by mud daubers or spiders.
8. Check the planting depth bands and adjust planting depth, if necessary.
9. Make note of acreage on drill counter before planting.
10. Operate the drill for a short distance (100 feet) before planting the field and look for planted seed in the furrows. If you cannot see/find seed, it is not being planted! All seed should be within ¼ inch of the top of the ground (with the exception of eastern gamagrass). Approximately one-third of the seed should be lying on top of the furrow—not covered at all.
11. If seed cannot be found in the planting furrows and on top of the ground, check the planting depth. If depth bands are set correctly, check the output from each tube (this should have been done when calibrating drill). This can be checked easily by placing a plastic sandwich bag over the bottom end of each drop tube—attached with a rubber band—and operating the drill (or by jacking the drill up on the drive-wheel side and turning the drive wheel). If seed doesn't fall into one or more bags, check the hoses to see if they are clogged. If seed doesn't fall into one or more of the bags (or just a very few seeds trickle into one or two bags), the drill isn't operating. Make sure the drill has been engaged (some engage at the wheel hub). If so, then check the chain drive that adjusts the seeding rate. If that is positioned correctly, check the chain drive on the side of the drill (depending upon model) to make sure it is engaged and not off the drive wheel.

Fig. 5.27 It is critical to check drills thoroughly before use. Not only must the drill be calibrated before planting (according to PLS estimation), but general maintenance is also required. This drill wasn't planting switchgrass. Why? The drop tubes coming out of the small seed box were clogged. Drop tubes, chain sprockets, seed boxes and grease fittings all need attention before planting.

Fig. 5.28 and 5.29 Planting seed too deep may be the number one cause of establishment failure. Nwsg seed (with the exception of eastern gamagrass) should not be planted (or covered) deeper than ¼ inch! When drilling seed, as much as 30 percent of the seed should be obvious on top of the planting furrow. When checking furrows for planting depth, it is common to find seed just on top of the ground in places, while the seed is barely underneath along most of the furrow.

become established and develop deeper root systems before potential dry periods of mid- to late summer. Later plantings in June are often successful, but reduced germination and slower initial growth are more likely.

Seeding depth

No-till drills should be set where seed are planted no more than ¼ inch deep. In fact, approximately 30 percent of the seed should be visible (on top of the planting furrow) after planting. This is one of the most important factors in successful establishment. When a seed germinates, it must push its way through the soil to the surface (if not on top of the surface) so it can receive sunlight. Once in the sun, it can produce its own energy. Until that happens, the seedling depends on stored energy to grow. Thus, the deeper a seed is planted, more energy is required for the seedling to emerge from the soil. Nwsg seeds (with the exception of eastern gamagrass) contain very little stored energy.

Seeding depth should be checked by inspecting the initial furrows before the field is

Fig. 5.30 When top-sowing nwsg on a seedbed prepared by conventional tillage, cultipacking ensures firm seed-to-soil contact and improves germination rate and initial growth. Top-sown seed should not be covered by disking.

planted. A pocketknife is useful when inspecting planting furrows. All planted seed not on top of the furrow should be visible just under the soil surface. The only exception to this rule is eastern gamagrass, which should be planted approximately 1 inch deep. If the seed is top-sown, the seed should not be covered by disking, only cultipacked after sowing to ensure firm seed-to-soil contact.

Seeding rate

Seeding rates largely depend upon objectives for the planting. If sown for wildlife, a sparse stand of grasses (20–50 percent coverage) with abundant forbs and adequate bare ground is desired. If sown for forages, a denser stand of grass is desired. Thus, the seeding rate for wildlife habitat is less than that for a forage stand of nwsg. Recommended seeding rates are shown in Table 5.5. Although nwsg can be established by no-till drilling or top sowing with conventional tillage, germination success is increased when seed are drilled. As mentioned previously, many factors influence germination and stand success. However, soil moisture and the number of days until rain after planting are critical. When drilled, seed are somewhat protected in a microclimate afforded by the planting furrow. Desiccation and loss of seed viability are more likely when seed are top-sown, as they lie on top of the ground baking in the sun. To compensate for a possible reduction in germination, higher seeding rates may be used when broadcast seeding. For example, when establishing wildlife habitat, 6–8 pounds PLS of a big and little bluestem, indiangrass and switchgrass mixture might be top sown as opposed to drilling 3–5 pounds PLS of the same mixture.

Fig. 5.31 Nwsg intended for livestock forage are planted at a higher seeding rate than those stands intended specifically for wildlife habitat. Note the bunch density in this recently-planted big bluestem stand intended for hay production.

Table 5.5 Recommended seeding rates[1] (pounds PLS per acre) and planting dates for native warm-season grasses in the Mid-South.

Species	Wildlife Habitat	Forage Stand	Planting Dates
Big bluestem	3–5	10–12	mid-Apr–May
Little bluestem	3–5	10–12	mid-Apr–May
Indiangrass	3–5	10–12	mid-Apr–May
Sideoats grama	4–6		mid-Apr–May
Switchgrass	2–4	8–10	mid-Apr–May
Eastern gamagrass	4–6	10–12	mid-Apr–May

[1] All seeding rates are for a single-species planting. Single-species plantings, however, are not normally recommended, especially for wildlife habitat. Therefore, the rate of each species included in a mixture should be reduced according to the number of species in the mixture, the composition preferred and the desired structure of the resulting stand. The rates given in this table are for drilled plantings. Broadcast rates may be increased by approximately 50 percent.

Recommended mixtures for wildlife and forages

Single-species plantings are not recommended for wildlife habitat. That is not to say, however, that a pure stand of switchgrass, for example, will not benefit wildlife. Even a field of switchgrass hayed for livestock can provide cover for wildlife if the field is managed correctly, but its value is not equal to that of a mixed stand of nwsg along with a variety of wildlife-friendly forbs. Several nwsg mixtures have been developed for wildlife plantings in the Mid-South; however, most can be placed in one of two categories: a tall mixture or a short mixture. Tall mixtures are dominated by big bluestem, indiangrass and/or switchgrass, which normally range in height between 4–8 feet depending upon variety, soil moisture and available nutrients. Short mixtures are dominated by little bluestem, broomsedge (which is usually not planted, but occurs naturally) and/or sideoats grama. These normally range in height between 2–4 feet. Other short nwsg that might occur naturally include splitbeard bluestem, purpletop, several low panicgrasses and povertygrasses.

Mixtures are determined primarily by the objectives and preferences of the landowner. Tall mixtures can provide cover for ground-nesting birds, as well as those that nest aboveground (such as dickcissel, field sparrow, Henslow's sparrow and red-winged blackbird). Tall mixtures can also provide excellent cover for white-tailed deer, and brooding wild turkeys and bobwhite quail (provided there is desirable forb coverage). Thermal cover may be provided in winter for many wildlife species if sufficient structure is present and the grasses remain erect or lodge above ground. Such stands can become magnets for deer to bed in during the day. Short mixtures provide outstanding nesting cover for ground-nesting birds and excellent brood-rearing cover if desirable forb cover is present. Short mixtures also are aesthetically pleasing to many people, especially with a complement of wildflowers.

Fig. 5.32 Tall nwsg mixtures usually include some combination of big bluestem, indiangrass and/or switchgrass. Little bluestem might also be in the mixture, but the taller grasses dominate. Tall mixtures can provide quality nesting and brooding cover as well as winter and escape cover for many wildlife species.

A typical tall nwsg mixture intended for wildlife habitat might include (rates of PLS per acre):

1.5 lbs. big bluestem
1.0 lbs. indiangrass
1.0 lb. little bluestem
0.5 lb. switchgrass
1.0 lb. native legumes and other forbs

A typical short nwsg mixture intended for wildlife habitat might include (rates of PLS per acre):

3.0 lbs. little bluestem
2.0 lb. sideoats grama
1.0 lb. native legumes and other forbs

Fig. 5.33 This buffer of sideoats grama and little bluestem provides excellent nesting cover for a variety of bird species.

Fig. 5.34 Short nwsg mixtures normally include little bluestem, broomsedge bluestem and/or sideoats grama. Indiangrass or big bluestem might be included in small amounts, but the shorter grasses dominate the stand. Short mixtures provide quality nesting and brood-rearing cover for many wildlife species.

Figs. 5.35 and 5,36 Tall grasses often fall over in winter if there are no rigid forbs growing in association with the grasses (top photo). This is especially true with big bluestem, indiangrass and varieties of switchgrass that do not have large stems. Not only does this leave little cover for wildlife, it also leads to increased thatch build-up.
The "short" nwsg remain erect through winter and provide excellent nesting structure the following spring (bottom photo).

Tall or short mix? Which is best?

Most nwsg mixtures can be placed into one of two groups: tall or short. Predominant grasses in tall mixtures include big bluestem, indiangrass and/or switchgrass (depending on variety), while predominant grasses in a short mix typically include little bluestem, broomsedge and/or sideoats grama. Several other nwsg occurring naturally from the seedbank might also contribute to a short grass site.

There are several issues to consider when deciding whether to plant a tall or short mix, but structure is most important. Taller structure is good for wildlife cover, but it can be counterproductive in winter if the grasses fall over and do not remain erect and/or do not "lodge." This is most prevalent when few forbs are present in the field. Several forbs, such as ragweed, goldenrod, pokeberry and blackberry provide more rigid structure and help tall grasses remain erect through winter.

Another consideration is structure for building nests. Most birds prefer relatively fine grasses and other such material for nest construction. Ground-nesting birds (such as bobwhites and meadowlarks) find perfect structure for nesting at the base of broomsedge and little bluestem and sideoats grama. Indeed, these grasses, especially broomsedge, remain erect through winter and provide nesting structure for the following spring. These grasses have an abundance of leaf material near the ground and the leaves of these grasses are relatively narrow. Other birds that nest off the ground (such as field sparrows and dickcissels) use fine grasses (such as *Danthonia* spp.) for nesting material, but position their nests within more coarse material, such as stems of big bluestem or blackberry brambles.

Thus, a mixture of grass types and other vegetation is desired to provide optimum habitat for a variety of birds and other wildlife. But, if specific birds are the focus (such as bobwhites), specific structure should be the objective (such as a short mixture of nwsg).

Figs. 5.37 When a desirable complement of forbs are present, nwsg are more likely to remain erect through winter.

Figs. 5.38 It can easily be argued that broomsedge is the best all-around nwsg for wildlife. With stiff stems, it remains erect through winter better than any other nwsg. It provides unequaled nesting structure for bobwhites and, on many sites, attains a height (4 feet) that provides cover even for white-tailed deer.

Figs. 5.39 Meadowlark nest in broomsedge.

Figs. 5.40 and 41 Many birds prefer to construct nests with fine grasses. This Bachman's sparrow nest (left) has been constructed on the ground with low povertygrass (*Danthonia spicata*) amongst some broomsedge and sumac. This field sparrow's nest (right) was also constructed with fine grass material, but built off the ground within a bunch of big bluestem.

Table 5.6 Selected seedling wildflower and legume tolerance to Plateau® herbicide (4 oz per acre) in mixed grass/forb stands.[1]

Common name	Latin name	Preemergence	Postemergence
Aster, New England	*Aster novae*	No	Yes
Aster, prairie	*Aster tanacetifolius*	No	Yes
Sticktights	*Bidens frondosa*	No	Yes
Partridge pea	*Chamaecrista fasciculata/ nictitans*	Yes	Yes
Lance-leaved coreopsis	*Coreopsis lanceolata*	Yes	Yes
Plains coreopsis	*Coreopsis tinctoria*	Yes	Yes
Ox-eye daisy[2]	*Chrysanthemum leucanthermum*	Yes	Yes
Shasta daisy[2]	*Chrysanthemum maximum*	Yes	Yes
Purple prairieclover	*Dalea purpurea*	Yes	Yes
White prairieclover	*Dalea candidum*	Yes	Yes
Illinois bundleflower	*Desmanthus illinoensis*	Yes	Yes
Beggar's-lice	*Desmodium canadense*	No	Yes
Purple coneflower	*Echinacea purpurea*	Yes	Yes
Korean lespedeza[2]	*Lespedeza stipulacea*	No	Yes
Birdsfoot trefoil[2]	*Lotus corniculatus*	No	Yes
Alfalfa[2]	*Medicago sativa*	No	Yes
Lemon mint	*Monarda citriodora*	No	Yes
Upright prairie coneflower	*Ratibida columnifera*	Yes	Yes
Black-eyed Susan	*Rudbeckia hirta*	Yes	Yes
Crimson clover[2]	*Trifolium incarnatum*	Yes	Yes
White clover[2]	*Trifolium repens*	No	Yes

[1] Adapted from Plateau® Herbicide Label; BASF Corporation, 26 Davis Drive, Research Triangle Park, NC 27709

[2] Not native to North America

Selected forbs should be added to nwsg mixtures to provide enhanced brood habitat, invertebrate availability, seed production, forage and/or aesthetic value (Table 5.6). Planted forbs are intended to complement the forb community that should arise naturally from the seedbank. Forbs most often added to nwsg mixtures include partridge pea, Illinois bundleflower, roundhead lespedeza, perennial sunflowers, purple praireclover, purple coneflower and lance-leaved coreopsis. Many others might be added for aesthetics (such as black-eyed Susan and blazing star) and use by butterflies and/or hummingbirds.

Species and mixtures for livestock forage are generally determined by objectives, preference and potential problems with competitive weeds. For example, pure stands of switchgrass or eastern gamagrass can provide excellent forage for livestock. However, if crabgrass and/or johnsongrass are prevalent in the field to be planted, a mixture of big and little bluestem and indiangrass might be a better choice because imazapic can be used to help ensure successful establishment. Forbs are not typically added to nwsg mixtures intended for forage production in the Mid-South; however, some producers do add alfalfa in the mixture or seed into an existing stand in February/March after burning.

Evaluating establishment success—what to expect

It is not uncommon to visit a landowner who has sown nwsg and thinks his/her planting effort was a waste of time. This is especially true for fields planted for wildlife habitat. To some people, the field is not "pretty." It is not even. It is not green all over. And there may be lots of "weeds" coming up all over the field. This is all understandable and, in some cases, even intentional, but the landowner does not realize it. Most people are accustomed to sowing non-native cool-season grasses (such as tall fescue, orchardgrass,

Top seven reasons why native warm-season grass plantings fail:

1. Planted too deep—either drilled too deep or disked after topsowing.
2. Planted too late—planting in July often results in poor germination because of a lack of moisture or not enough time for adequate root development prior to drought conditions.
3. Inadequate weed control—no herbicide, the wrong herbicide or incorrect herbicide application is often the reason for stand failure.
4. Percentage of pure live seed not calculated—not enough seed was planted.
5. Drill not calibrated—not enough seed was planted.
6. Field planted when too wet—mud packed into the depth bands, coulters and/or seeding tubes—or after a hard rain packed a well-prepared seedbed.
7. No patience—the planting was actually a success, but the landowner failed to realize what a successful nwsg stand should look like during the year of establishment. Many successful stands have been disked under during the year of establishment when they would have made excellent wildlife cover and/or livestock forage if allowed to fully establish the following year.

Fig. 5.42 This is what you are looking for! This is a big bluestem seedling with its characteristic "fountain" appearance. Note the bare ground and lack of weeds germinating around the seedling. This is what should be expected from a properly applied preemergence herbicide.

timothy, bluegrass). These sod-forming grasses germinate and grow relatively quickly. As they develop, the ground takes on an ever-increasing green appearance, with small green seedlings coming up all over the field. These small grass seedlings are all pretty much the same size and the field has a very even, "clean" appearance. Within several weeks, the field is green all over and by the end of the first growing season, a turf has developed. This is NOT the case with nwsg!

Nwsg develop relatively slowly during the year of establishment. Most of the first-year plant growth is root development. Leaf and stem growth may not get more than 2 feet high by the end of the first growing season (even with big bluestem). In many cases, relatively little flowering occurs the first growing season and it is not until the second growing season that considerable aboveground biomass develops and the grasses flower and produce seed. However, if the correct planting procedures are followed and soil moisture and nutrition are not limiting, excellent growth will occur during the year of establishment with considerable aboveground biomass and extensive flowering.

It is also important to be able to identify a nwsg seedling. Most folks look out across the field and do not recognize the plants present. All they see are "weeds" coming up everywhere! Most nwsg seedlings have the appearance of a small fountain (Fig. 5.42) and they should not, on average, be close together (especially if wildlife habitat is the objective). Many of the "weeds" germinating and beginning to grow are actually desired forbs that provide cover and seed for wildlife. However, some of them may be undesirable and should be treated before they are able to flower and add to the seedbank.

Fig. 7.43 2 Sept 2005

Fig. 7.44 24 April 2006

Fig. 7.45 30 May 2006

Fig. 7.46 19 August 2006

Fig. 7.43-46 Expectations are everything. Most people would consider this planting a failure. Further, most would think more vegetation is required to keep the soil from eroding in this filter strip, which was planted in May 2005 (see Fig 5.22) at 4 pounds PLS per acre with indiangrass, little bluestem and a small amount of big bluestem. Native grass density increases naturally over time; however, a relatively light seeding rate (4 pounds PLS) will prolong the need for disking to reduce grass density. A light seeding rate also allows for more bare ground space, which is highly desirable for wildlife.

Checklist before planting nwsg

- ❑ If planting for haying/grazing, has a soil sample been collected and tested for lime and fertilizer requirements?
- ❑ Has the appropriate herbicide been identified for weed control prior to planting?
- ❑ Has the sprayer been calibrated?
- ❑ Has the appropriate species and variety of seed been located and purchased?
- ❑ Has the seedbed been prepared as needed?
- ❑ Has the percentage of pure live seed been calculated? Check dormancy for switchgrass and eastern gamagrass!
- ❑ Has the acreage been measured?
- ❑ Has the drill been calibrated and checked to see if it is properly dispensing seed through each drop tube?
- ❑ Has the planting depth been checked?
- ❑ Is it too late to plant?
- ❑ Depending on weed control and timing, would it be more sensible to wait until next spring to plant?