

Species Life Span

Most species in a prairie seed mix are perennials. The seed mix should also include species like: partridge pea, *Chamaecrista fasciculata* (annual) and black-eyed susan, *Rudbeckia hirta* (biennial). These species readily germinate and grow large in the first growing season, covering more bare soil, thereby reducing potential soil erosion. Their rapid growth may reduce weed abundance in early establishment too. Perennials will provide long-term diversity and stability in the planting.

Appropriate Seed Sources

Seed derived from multiple remnant sources within the region of the planting site may be better adapted to the climate and soils of a site than seed from distant sources (Williams et al. 2006). Seed used for a native planting in Iowa should be certified as to origin and be derived from Iowa prairie remnants whenever possible.

Seed Cost

Deciding how many of the more expensive forbs to include depends upon the seed budget and the preference of the person paying for the seed. Consider including some expensive forbs in seed mixes; costs can be controlled by lowering seeding rates of the expensive species. We advocate planting for maximum diversity. It is better to include more species in the seed mix and lower seed rates than to plant fewer species with higher seed rates.

Nurse Crops

Nurse crops are usually cereal grain crops that are planted with the natives. The readily germinating seed and quickly maturing plants make nurse crops good competitors against weeds and are effective at holding the soil in place on erodible sites while native seedlings are getting established. Due to their life history characteristics, nurse crops tend to diminish from the prairie planting by the second or third year (see Table 2 for a list of nurse crops).

To request copies, or for more information, call the Tallgrass Prairie Center at 319.273.3836.

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A roadside right-of-way planted in fall with winter wheat (nurse crop) and prairie seed. This photograph was taken the following spring – taller plants are winter wheat and shorter plants are natives.



A CRP field planted to oats (right) and prairie seed in late spring to stabilize the soil and reduce weeds. Oats were planted at 1 bushel/acre and seeded with a no-till grass drill. Photograph was taken in late June.

Table 2. Nurse Crop Recommendation

Planting Scenario	Nurse Crop	Seeding Rate
Spring planting on a level site	Oats	16 pounds/acre
Spring planting on a sloped site	Oats	32 pounds/acre
Fall planting on a level site	Winter Wheat	15 pounds/acre
Fall planting on a sloped site	Winter Wheat	30 pounds/acre

Christiansen, P., and M. Müller. 1999. *An Illustrated Guide to Iowa Prairie Plants*. University of Iowa Press. Iowa City, Iowa.

Henderson, K., and C. Kern. 1999. *Integrated Roadside Vegetation Management Technical Manual*. Roadside Management Program. University of Northern Iowa. Cedar Falls, Iowa.

Meyer, M.H., and V.A. Gaynor. 2002. *Effect of seeding dates on establishment of native grasses*. *Native Plants Journal* 3(2): 132-138.

Williams, D., G. Houseal, and D. Smith. 2006. *Growth and reproduction of local ecotype and cultivated varieties of *Panicum virgatum* and *Coreopsis palmata* grown in common gardens*. Pages 55-60 In D. Egan and J. Harrington. (eds.), *Proceedings of the Nineteenth North American Prairie Conference*. University of Wisconsin-Madison.

Developing a Seed Mix (using the seed calculator)

High-quality seed of hundreds of native prairie species is commercially available today. The cost of seed varies greatly by species, but forb seed can be costly. The Tallgrass Prairie Center has developed a seed calculator program to design seed mixes based upon the number of seeds per square foot for each species. The seed calculator will automatically calculate the cost of seeds based upon species selected and their cost. Seed cost can be rapidly recalculated with changes in species selection and seed quantities using the seed calculator. Seeding rate is the total number of live seeds sowed per unit area (seeds per square foot). Go to tallgrassprairiecenter.org for a free copy of the seed calculator. When using the seed calculator, consider the following recommendations.

1. All prairie reconstructions should be planted with a minimum of 40 seeds per square foot. Planting fewer than 40 seeds per square foot may result in a weedy plant community. For slopes 3:1 or greater, we recommend 60 to 80 seeds per square foot because of potential loss due to erosion.
2. Always use a nurse crop on erodible sites (Table 2).
3. Develop a species-diverse seed mix. Include a minimum of 6 grasses (cool- and warm-season), 3 sedges, and 25 forbs (5 legume and 20 nonlegume species).
4. A 50:50 mix of grass and sedge to forb seed will produce a prairie planting rich in forbs. Therefore, if the seeding rate is 40 seeds per square foot, 20 seeds per square foot are grass and sedge seed, and 20 seeds per square foot are forb seed.
5. Choose grass, sedge, and forb seed native to your region and most appropriate for the soil moisture conditions of the site.
6. Include annual, biennial, and perennial forb species in the seed mix. Generally, 1 seed per square foot of native annuals and biennials will result in many adult plants. Annuals and biennials should not exceed 10% of the total forb seed. Try to equalize the number of seed per square foot of the perennial forbs as much as your budget will allow.
7. Consider including some expensive species that are appropriate for the site at a seeding rate that you can afford. If the site conditions are appropriate, add a little cream false indigo, prairie phlox, or flowering spurge. A small amount of seed is better than no seed.
8. For a dormant planting, increase the seeds per square foot of warm-season grass species by 50% due to increased seed mortality (Henderson and Kern 1999; Meyer and Gaynor 2002). For example, if the seed mix contains 20 grass and sedge seeds per square foot for a nondormant seeding, 30 seeds per square foot should be used for a dormant seeding. A possible exception to this may be switchgrass (*Panicum virgatum*), which has a hard seed coat that can overwinter. Seeding rate of switchgrass need not be changed for a dormant seeding.
9. Planting seed at the proper depth (1/8 to 1/4 inch) and ensuring good seed-to-soil contact are essential for any seed to germinate and establish. Proper seed placement is less certain when broadcast-seeding. If broadcast-seeding methods are used, seeding rates for grasses, sedges, and forbs should be increased up to 30% (Henderson and Kern 1999).

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Designing Seed Mixes

Content by Dave Williams

PRAIRIE RESTORATION SERIES

A well-planned seed mix is essential to reconstructing a diverse and stable plant community. Selecting species for any native planting involves knowing the physical characteristics of the site (soil type, hydrology, slope, aspect, and sunlight exposure) then choosing the most appropriate native plants for that site. All native plantings should include grasses, sedges, and forbs (both legume and non-legume species). The seed mix should also include annual, biennial, and perennial species to foster both early establishment and maintain long-term diversity.

The cost and availability of the seed is often the primary factor in determining which species and how much seed of a species gets included in a seed mix. Seeding calculators are valuable tools to enable practitioners to develop diverse seed mixes within a seed budget. It is also important to consider the source of seed and the ratio of forb to grass species in the mix. A well-planned seed mix will result in a diverse, weed-resistant prairie plant community that will last a lifetime.



Tallgrass Prairie
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Criteria for Species Selection

Selecting the appropriate species of native plants is one of the first steps in planning a reconstruction project. Each soil type is a unique blend of sand, silt, clay, and organic matter that affects how the soil drains and retains water. Every plant species has evolved to grow within a certain range of soil moisture conditions. Planting species that are best adapted to the soil moisture(s) of the site will ensure their persistence in the planting. To determine the soil type and drainage class of your site, visit with your local Natural Resources Conservation Service (NRCS) office to obtain a soils map or look online at www.nrcs.usda.gov.

Soil Types/Moisture

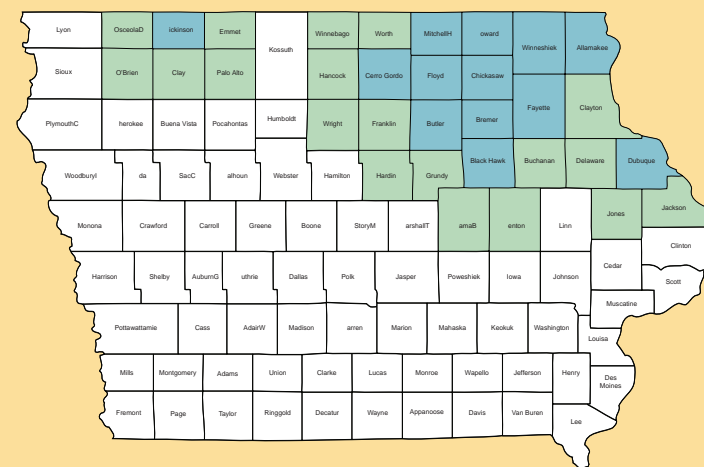
There are five general soil moisture categories: wet (hydric), wet-mesic, mesic (moderate), dry-mesic, and dry (xeric). Hydric soils include poorly drained, and very poorly-drained soils that typically have standing water for part or most of the growing season. These areas may harbor prairie remnants because they were typically too wet to farm. Wet-mesic soils include somewhat poorly drained lighter colored clay soils. Mesic soils include well drained and moderately well drained, dark loamy soils. Dry-mesic soils include somewhat excessively drained glaciofluvial, eolian, and thick loess soils. Xeric soils include excessively drained sandy or gravelly soils and shallow loam soils often found on steep slopes and ridges. See Table 1 for a recommended native seed mix for 1-acre mesic soil sites in Iowa (except Loess Hills).

Table 1. Mesic Soil Seed Mix

Grass/Sedge	Scientific Name	Seeding Rate (seeds per square foot)	Quantity Needed (Ounces PLS*)
Slender Wheatgrass	<i>Agropyron trachycaulum</i>	1.00	6.3
Big Bluestem	<i>Andropogon gerardii</i>	3.00	13.1
Side-oats Grama	<i>Bouteloua curtipendula</i>	3.00	15.1
Yellow Fox Sedge	<i>Carex annectens</i>	1.00	0.5
Copper-shoulder oval sedge	<i>Carex bicknellii</i>	0.25	0.6
Plains oval sedge	<i>Carex brevior</i>	0.25	0.4
Long-awned bracted sedge	<i>Carex grvida</i>	0.02	0.1
Field oval sedge	<i>Carex molesta</i>	0.25	0.4
Canada Wildrye	<i>Elymus canadensis</i>	1.00	7.0
Switchgrass	<i>Panicum virgatum</i>	2.00	5.5
Little Bluestem	<i>Schizachyrium scoparius</i>	3.00	8.5
Indian Grass	<i>Sorghastrum nutans</i>	3.00	11.4
Tall Dropseed	<i>Sporobolus compositus</i>	5.00	7.3
Prairie Dropseed	<i>Sporobolus heterolepis</i>	0.75	2.2
TOTAL		23.5	78.3
Forbs (Legumes)	Scientific Name		
Leadplant	<i>Amorpha canescens</i>	0.25	0.6
Milk Vetch	<i>Astragalus canadensis</i>	1.00	2.6
White Wild Indigo	<i>Baptisia alba</i>	0.03	0.8
Cream False Indigo	<i>Baptisia bracteata</i>	0.01	0.3
Partridge Pea	<i>Chamaecrista fasciculata</i>	0.30	4.8
Purple Prairie Clover	<i>Dalea purpurea</i>	2.00	5.8
Showy Tick Trefoil	<i>Desmodium canadense</i>	0.25	2.0
Illinois Tick Trefoil	<i>Desmodium illinoense</i>	0.25	2.5
Licorice Root	<i>Glycyrrhiza lepidota</i>	0.05	0.6
Round-Headed Bush Clover	<i>Lespedeza capitata</i>	0.10	0.5
TOTAL		4.2	20.5
Forbs (Non-Legumes)	Scientific Name		
Wild Garlic	<i>Allium canadense</i>	0.10	0.5
Canada Anemone	<i>Anemone canadensis</i>	0.05	0.3
Thimbleweed	<i>Anemone cylindrica</i>	0.05	0.1
Prairie Sage	<i>Artemisia ludoviciana</i>	1.00	0.2
Swamp Milkweed	<i>Asclepias incarnata</i>	0.15	1.4
Butterfly Milkweed	<i>Asclepias tuberosa</i>	0.08	0.8
Whorled Milkweed	<i>Asclepias verticillata</i>	0.05	0.2
Prairie Indian Plantain	<i>Cacalia plantaginea</i>	0.01	0.1
New Jersey Tea	<i>Ceanothus americanus</i>	0.05	0.3
Prairie Coreopsis	<i>Coreopsis palmata</i>	0.10	0.4
Pale Purple Coneflower	<i>Echinacea pallida</i>	0.25	2.1
Rattlesnake Master	<i>Eryngium yuccifolium</i>	0.20	1.2
Flowering Spurge	<i>Euphorbia corollata</i>	0.15	0.8
Grass-leaved Goldenrod	<i>Euthamia graminifolia</i>	1.00	0.1
Bottle Gentian	<i>Gentiana andrewsii</i>	0.50	0.1
Bigtooth Sunflower	<i>Helianthus grosseserratus</i>	0.20	0.6
Prairie Sunflower	<i>Helianthus laetiflorus</i>	0.03	0.3
Ox-eye Sunflower	<i>Helopsis helianthoides</i>	0.75	5.2
Prairie Blazingstar	<i>Liatris pycnostachya</i>	0.20	0.8
Wild Bergamot	<i>Monarda fistulosa</i>	1.00	0.6
Stiff Goldenrod	<i>Oligoneuron rigidum</i>	1.00	1.1
Prairie Phlox	<i>Phlox pilosa</i>	0.03	0.1
Prairie Cinquefoil	<i>Potentilla arguta</i>	1.00	0.2
Common Mt. Mint	<i>Pycnanthemum virginianum</i>	1.00	0.2
Yellow Coneflower	<i>Ratibida pinnata</i>	1.00	1.5
Black-eyed Susan	<i>Rudbeckia hirta</i>	1.00	0.5
Compass Plant	<i>Silphium laciniatum</i>	0.02	1.3
Showy Goldenrod	<i>Solidago speciosa</i>	1.00	0.5
Smooth Blue Aster	<i>Symphotrichum laeve</i>	1.50	1.2
New England Aster	<i>Symphotrichum novae-angliae</i>	0.75	0.5
Purple Meadow Rue	<i>Thalictrum dasycarpum</i>	0.10	0.4
Prairie Spiderwort	<i>Tradescantia bracteata</i>	0.10	0.4
Ironweed	<i>Vernonia fasciculata</i>	0.50	0.9
Culver's Root	<i>Veronicastrum virginicum</i>	2.00	0.1
Golden Alexanders	<i>Zizia aurea</i>	0.50	2.0
TOTAL		18.4	26.8

Slope and Aspect

The site conditions on a slope and the direction it faces (aspect) affect the establishment of native plants. The upper portion of a slope is usually drier than the lower portion; south and west aspects are relatively more xeric than the north and east aspects at the same elevation. Thus, there is a difference in species along the moisture gradient from top to bottom of a slope and around it as the aspect changes. Roadside rights-of-ways in particular often transition from dry to mesic to wet soils in a small area, and the changes in species composition associated with those soils' moistures can be dramatic. If the slope is gradual and the changes in moisture conditions can be easily seen, seeding species that match the moisture condition of the soil will improve establishment of those species. If the soil moisture gradient isn't as apparent, slopes can be "shotgun" seeded with all species, including species in the seed mix that match each moisture condition.



Legend: Potential Range Expansion (light blue), Historic Distribution (dark blue)

Historic Iowa distribution of prairie smoke (*Geum triflorum*) and additional Iowa counties that planting this species is recommended (Adapted from Christiansen and Müller 1999).

Species Geographic Distribution

Select species that are native to the region of the planting site. A "region" can be defined as the home county and the contiguous counties around it. If a species is not present in the region of the planting site, it should be left out of the seed mix. To obtain a list of tallgrass prairie species (grasses, forbs, and sedges) native to your county, visit the USDA-NRCS plants website at plants.usda.gov.

Species Light Requirements

Tallgrass prairie does best in full sunlight but will tolerate some shade (up to 20%). If the planting site is adjacent to a woodland and is subjected to reduced sunlight, choose species that are adapted to partial shading. Most seed catalogs group prairie species into three light categories (full sun, partial shade or savanna, and shade or woodland).



Species Diversity

Pheasant in forb-rich planting. A forb-rich prairie reconstruction provides nectar sources for insects — food for young pheasant chicks.

A prairie seed mix that includes species from each plant group (warm- and cool-season grasses, legume and non-legume forbs, and sedges) will result in a stable, weed-resistant plant community and it will attract and sustain wildlife. A species-rich prairie planting will eliminate germinating weed seed by being a better competitor for resources. It may be inexpensive on the front end of the project to plant only a few grass and forb species, but eliminating weeds that have invaded a native planting can be difficult and costly down the road. Species-diverse seed mixes should be strongly considered for all native plantings.



Invasion of Canada thistles into a species-poor native grass planting in Black Hawk County, Iowa.

A species diverse prairie reconstruction planted in 2001 at Big Woods Lake in Cedar Falls, Iowa. The seed mix included 79 species of grasses, sedges, and forbs — 61 species were detected in 2007.

Species Phenology

Tallgrass prairie plants have evolved to take advantage of available resources throughout the growing season. Some grasses and all sedges germinate, grow, and flower in spring or fall (cool-season plants), while others germinate in late spring, and grow and flower in the summer (warm-season grasses). For a prairie planting to resist non-native weed invasion, the planting must include native species from both cool- and warm-season grasses, forbs, and sedges. Leaving out cool-season grasses and sedges will expose the planting to weed invasion from plants like smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*).