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MASON STATE NURSERY: A MODEL FOR

Prairie Plant Production

R Kasten Dumroese,
Stewart Pequignot,
and David Horvath

Figure 1 • Nursery workers harvesting wild quinine (Parthenium integrifolium *L. [Asteraceae]*).

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Abstract

More than 250 native Illinois plant species have been grown either bareroot or in containers at Mason State Nursery. Seedling production is facilitated by collecting seeds from natural populations and by seed production areas at the nursery, and an extensive array of seed processing equipment. Some propagation techniques are included.

KEYWORDS: tall grass prairie, forbs, bareroot nursery, container nursery

NOMENCLATURE: Taft and others (1997)

At left • Asclepias tuberosa L. var. interior (Woodson) Shinners (Asclepiadaceae).

In the 1970s, the Illinois Department of Natural Resources (IDNR) began expanding its activities to protect and manage prairie and other community areas of the state. Originally two-thirds of Illinois was prairie but by the 1960s less than 1% remained, therefore prairie restoration on IDNR lands was an important component of this new direction (Pequignot 1993). IDNR had 2 objectives: 1) establish prairies so citizens and visitors to Illinois could see and appreciate unique prairie communities; and 2) save genetic resources found within Illinois' prairie communities (both plant and animal). In 1977, the IDNR Division of Forest Resources was approached for assistance in establishment of grass seed collection areas because the nursery program had available land for seed collection areas, an experienced work force, and equipment for collecting and processing seed was on site or nearby (Piquignot 1993).

At onset of the prairie program, IDNR envisioned a program growing only 6 grass species, but soon 10 to 12 forbs were added. And addition of new species did not stop there. By 1998, the nursery had grown over 250 species; annually, 50 to 60 prairie species are grown. IDNR defines native plant material as Illinois endemics. Annual production of all plant types may include, depending on seed availability and demand, about 59 native tree and shrub species, 56 prairie forb species, 9 warm season grasses, 21 woodland understory trees, shrubs, and forbs, and 76 wetland species. As the program developed, most notable was the decrease in introduced conifers and shrubs and an increase in native hardwoods (Table 1).

TABLE 1

Percentages of plant types grown at Mason State Nursery in 1957 and 1994

Plant type	1957	1994
Conifers	72	23
Shrubs	23	0
Native shrubs	0	9
Native hardwoods	5	64
Native forbs	0	4

Seed Collection, Processing, and Storage

The initial problem with native plant production was lack of seed availability for desired tree, shrub, forb, and grass species, particularly Illinois seed sources. Tree seeds are collected by state biologists, nursery personnel, and the public within 3 seed zones in the state. To supplement collection, seed orchards have been established by seed zone at Mason and Union state nurseries. Over 20 ha (50 ac) of oak (*Quercus* spp. [Fagaceae]) have been established (Table 2), plus some black walnut (*Juglans nigra* L. [Juglandaceae]) and green ash (*Fraxinus pennsylvanica* Marsh [Oleaceae]).

TABLE 2

Oaks (Fagaceae) in seed orchards at the Illinois state nurseries

White oak (*Quercus alba* L.)
Swamp white oak (*Q. bicolor* Willd.)
Spanish oak (*Q. falcata* Michx.)
Bur oak (*Q. macrocarpa* Michx.)
Northern red oak (*Q. rubra* L.)
Black oak (*Q. velutina* Lam.)

Shrub seeds were collected, mostly from central and northern Illinois, to get an adequate representation of genotypes. This mixture of genotypes of various shrubs was used to start an on-site 2-ha (5-ac) seed production area that now yields nearly all the seeds used by the Mason State Nursery and its sister, Union State Nursery.

For prairie plants, early efforts involved IDNR Heritage Biologists and nursery staff collecting seeds from remnant prairie populations. Once planted at the nursery, bareroot forbs are usually grown 2 y. During the second season, seeds are harvested for future crops. Seed production from crop plants is augmented by a nearly 3-ha (8-ac) forb seed production area. Around 385 kg (850 lb) of forb seeds are annually harvested from both seed sources. Although seeds have been harvested with a modified combine, usually seeds are hand-picked (Figure 1). Hand harvesting is necessary on plants with delicate seeds or uneven height. The main benefit of hand picking is that it reduces the amount of "junk" that would have to otherwise be removed during processing. For most forbs, seeds do not ripen at the same time, so seed heads are allowed to mature and dry in trays before cleaning. Some species, like lance leaf coreopsis (*Coreopsis lanceolata* L. [Asteraceae]) and yellow coneflower (*Ratibida pinnata* (Vent.) Barnhart [Asteraceae]), produce seeds over the entire season, so nursery staff pick a median date for harvest. The nursery also established wetland plant seed production areas.

In 1978, the nursery planted 1.2 ha (3 ac) of 5 species of prairie grass. By 1997 over 8 ha (20 ac) of seed production area for 9 species were in place, generating over 900 kg (2000 lb) of seeds (Table 3). Some prairie seeds, both forb and grass, are still collected off-site for special planting projects.

Once most of the seeds have dehisced, seeds are further processed on-site with a variety of equipment (Table 4), developed, tested, and modified through years of trial and error and cooperation with the USDA National Seed Tree Laboratory.

Seeds are stored in sealed plastic bags in fiber barrels (have an inner tar paper layer that mice will not chew through) and kept between 0 and 4 °C (32 and 40 °F). Seeds are stored as dry as possible. Viability of most seeds drops off after a couple of years, but it usually does not remain in storage that long before planting. Nursery staff try to maintain a 2- to 5-y supply of shrub seed and at least a 1-y supply of forbs to cushion

see Prarie Plants on page 14

Solidago rigida *L. (Asteraceae).*

TABLE 3

Prairie grass species (Poaceae) in seed production areas at Mason State Nursery

Big bluestem (*Andropogon gerardii* Vitman)
Side-oats grama (*Bouteloua curtipendula* (Michx.) Torr.)
Ice cream grass (*Eragrostis trichodes* (Nutt.) Wood)
Prairie switch grass (*Panicum virgatum* L.)
Little bluestem (*Schizachyrium scoparium* (Michx.) Nash)
Indian grass (*Sorghastrum nutans* (L.) Nash)
Northern dropseed (*Sporobolus heterolepis* (Gray) Gray)
Porcupine grass (*Stipa spartea* Trin.)
Gama grass (*Tripsacum dactyloides* (L.) L.)

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Prarie Plants *from page 12*
against shortfalls and keep some flexibility in planting time.

Greenhouse Production

Greenhouse production is limited to threatened and endangered plants, species with just a few seeds available, grasses for special planting projects, and forbs not grown in bareroot beds because their roots grow so densely the plants cannot be easily lifted (Table 5). Three crops are usually produced, starting with a grass crop sown in late December. Because prairie forbs are warm season plants, crops are germinated in a greenhouse with day temperatures of 21 to 27 °C (70 to 80 °F) and night temperatures of 18 to 24 °C (65 to 75 °F). Greenhouse crops are then transitioned through a polyhouse and finally to a shadehouse for hardening.

Forb and wetland seeds require stratification before sowing. Generally equal amounts of seeds and vermiculite are mixed, dampened, and stratified 3 to 4 mo at 1 to 2 °C (34 to 36 °F). After dibbling, 3 to 5 seeds are sown into Ropak Multi-Pot #6 containers (98 ml [6 in^3] volume, 12 cm [4.8 in] depth, 581 cavities per m^2 [54/ft^2]) filled with Pro-Mix PGX (3:1; peat moss:vermiculite) amended with Osmocote plus minors (17N:6P_2O_5:10K_2O; 4.7 kg/m^3 [5 oz/ft^3]). The Osmocote has an 8 to 9 mo release rate at 21 °C (70 °F). Osmocote fertilizers with faster release rates appear to cause damage to young seedlings, especially grasses. Seeds are covered to 1X their depth with the same medium. Seedlings with their first set of true leaves developed also receive Peters Acid Special (21N:7P_2O_5:7K_2O) at rates between 50 and 100 ppm N early in the crop cycle (the first 1 to 2 mo) to supplement the Osmocote. The rate is gradually increased to 200 ppm N. The top layer of medium is allowed to dry out thoroughly before irrigating. Forbs are thinned to 1

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seedling per cavity before the plants develop extensive root systems. Grasses are not thinned, but are clipped or mechanically mowed back to 10 to 15 cm (4 to 6 in) to facilitate irrigation and prevent lodging. Before plants are moved to the polyhouse or shadehouse, fertilizer rates are decreased back to 50 ppm N and temperatures are reduced to ambient to encourage hardening.

Grasses, forbs, and wetland plants are all grown as a 1-y crop, ready for outplanting in fall. Generally, nursery staff promote shipping material in the trays. Otherwise, material is extracted and stored. Forbs must be very dry or else they are susceptible to mold; susceptibility varies by species.

Bareroot Production

Soils at Mason are sandy to sandy loams (52% to 75% sand) with generally low fertility and organic matter levels. Bareroot production begins with late summer methyl-bromide chloropicrin fumigation (390 kg/ha [350 lb/ac]). About 10 ha (25 ac) of tree, shrub, and forb seeds are sown annually during fall to allow natural seed stratification (Table 6). During bed formation, winter wheat is mixed in at a rate of 112 kg/ha (100 lb/ac), and then crop seeds are drilled in. Large nuts are sown with custom-made seeders while most other species are drilled with a Love/Øyjord seeder. Prairie plant seeds are drilled or planted to a depth 1X their diameter. Wheat germinates and grows during fall, providing seedbed protection, especially from wind erosion. The wheat overstory, by shading soil to keep soil temperatures lower, also prevents germination in early spring when emergents could be damaged by frost. Because wheat can be actively growing throughout the late winter and early spring season, an application of glyphosate (Roundup Ultra; 3.6 l/ha [1.5 qt/ac]) can be used to kill the wheat and "release" the beds. If crop seeds germinate before wheat can be sprayed, an

Figure 2 • Echinacea pallida *(Nutt.) Nutt. (Asteraceae) seedlings.*

TABLE 4

Seed processing equipment used for native plant production

Equipment	*Provider*	*Description*
ALMACO low-profile thresher (LPR-UMB-G)	ALMACO Box 296 Nevada, IA 50201	Like a miniature combine, it's the primary step in cleaning seeds from small plots.
WESTRUP brushing machine (HA-400)	WESTRUP, Inc 1400 Preston Road Plano, TX 75093	This brush debearder removes appendages (wings, hairs, and awns) from dry seeds. It also reduces clusters of seeds (maple, ash) into single seeds. Makes seeds flowable so they can be further processed.
Carter Day indent seed separator (No. 3 Uni-Flow)	Carter Day International, Inc 500 Seventy-third Ave, NE Minneapolis, MN 55432	It separates longer particles (needles, pieces of stems) from shorter particles (usually seeds).
Clipper fanning mill (A2552)	Clipper 805 South Decker Drive Blufton, IN 46714	Separates different sized materials by using a combination of a fan and a series of plates with different sized holes.
Crippen fanning mill (GX-360-4-RH)	Crippen Mfg Co, Inc PO Box 128 Alma, MI 48801	Seeds and impurities are pushed up through a chamber in an air stream provided by a fan. Lighter trash and empty seeds are removed.
Aspirator (18990)	Gene M Jesse Mfg, Inc 1627 Nord Ave. Chico, CA 95926	Removes light material from seeds by drawing a vacuum up a duct. The system is very powerful but with precise adjustment it will clean small seeds (spruces) as well as large seeds (oaks).
Dybvig macerator	Melvin Dybvig 4025 Rio Vista Milwaukee, OR 97222	Used to burst fleshy fruits. Water washes away the pulp. Can also be used to dewing or to break apart dry fruits, but this technique can be dusty.

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Figure 3 • Bareroot beds of native forbs at Mason State Nursery.

application of fluazifop (Fusilade; 1.2 l/ha [1 pt/ac]) can be applied.

Trees and Shrubs

All fertilizer is top dressed. Ammonium sulfate (21N:0P_2O_5:0$K_2$0) is applied at 112 kg/ha (100 lb/ac) N once a week for 3 wk in May or early June, then another 28 to 34 kg/ha (25 to 30 lb/ac) N is applied weekly for 4 to 6 wk. *Quercus* and *Juglans* species are undercut at 15 cm (6 in) when trees are about 25 cm (10 in) tall to promote lateral roots and keep height growth under control. Root pruning is done on cloudy days just after an irrigation. Most tree species are grown at about 55 seedlings per m^2 (5 per ft^2) and as 1+0s. The exceptions, grown as 2+0s, include white oak, pecan (*Carya illinoensis* Wang. [Juglandaceae]), shagbark hickory (*Carya ovata* (Mill.) K. Koch), kingnut hickory (*Carya laciniosa* (Michx.) Loudon), and red pine (*Pinus resinosa* Ait [Pinaceae]).

Forbs

Although most forbs (Table 7) can be grown as 1+0s, they are usually carried over to the second year so a seed crop can be harvested. Prairie forbs require less fertilizer and irrigation than tree and shrub crops and are usually planted on the "poorest" nursery soils, as long as the soil is well drained. About 56 kg/ha (50 lb/ac) of ammonium sulfate are applied 2 or 3 times in May and early June, as well as 1 application of 85 kg/ha K_2O (75 lb/ac). Forbs are only irrigated to promote germina-

TABLE 5

Non-inclusive list of container-grown prairie forbs and reasons for not growing them bareroot

Threatened and endangered	***Limited seeds available***	***Grasses for special projects***	***Root too densely to lift***
Illinois false aster (*Boltonia decurrens* (Torr. & Gray) Wood [Asteraceae])	Yellow coneflower (*Ratibida pinnata* (Vent.) Barnhart [Asteraceae])	Prairie switch grass (*Panicum virgatum* L. [Poaceae])	Wild bergamot (*Monarda fistulosa* L. [Lamiaceae])
Kankakee mallow (*Iliamna remota* Greene [Malvaceae])	Prairie alumroot (*Heuchera richardsonii* R. Br. var. *grayana* Rosend., Butt. & Lak. [Saxifragaceae])	Gama grass (*Tripsacum dactyloides* (L.) L. [Poaceae])	Pasture rose (*Rosa carolina* L. [Rosaceae])
Royal catchfly (*Silene regia* Sims [Caryophyllaceae])	Obedient plant (*Physostegia virginiana* L. [Lamiaceae])	Side-oats grama (*Bouteloua curtipendula* (Michx.) Torr. [Poaceae])	Partridge pea (*Cassia fasiculata* Michx. [Caesalpiniaceae])

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tion and to wash in top-dressed fertilizers (Figure 2). Prairie forbs are disease free, although some species can be damaged by insects. Seedbed densities range from 44 to 670 seedlings per m^2 (4 to 60 per ft^2), depending on species and seed cleanliness (Figure 3).

Before lifting, forbs must be dormant, having either experienced a killing frost or an "artificial frost" with paraquat (2.4 l/ha [1 qt/ac]) to burn off the foliage. Stems are cut back to the ground. Forbs must be lifted when roots are dry to prevent storage mold problems. Root stocks are placed in plastic bags and kept in refrigerated storage. As with container forbs, nursery staff encourage fall planting to circumvent storage problems.

Forbs are often planted by volunteer crews that sometimes have problems planting stock upside down. Despite this, plantation success is very good. The native prairie plants are much more plastic in terms of pre-planting handling and planting conditions than tree and shrub species.

Understory Plants

Nursery staff have grown over 20 species of understory plants as part of an emphasis to provide an entire hardwood ecosystem. Because of seed dormancy mechanisms that are difficult to overcome and low demand for seedlings, understory plants are not a large component of annual production. Some of the interesting understory plants grown include pawpaw (*Asimina triloba* (L.) Dunal [Annonaceae]), cinnamon fern (*Osmunda cinnamomea* L. [Osmundaceae]), spicebush (*Lindera benzoin* (L.) Blume [Lauraceae]), ginseng (*Panax quiquefolius* L. [Araliaceae]), Jack-in-the-pulpit (*Arisaema triphyllum* (L.) Schott [Araceae]), and may apple (*Podophyllum peltatum* L. [Berberidaceae]).

Summary

Augmenting seeds collected from the wild with those from production plants, Mason State Nursery successfully propagates over 250 species of Illinois native plants. The basic propagation techniques are essentially the same as those used to grow the more "traditional" conservation plants, although processing native plant seed requires additional equipment.

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TABLE 6

Ten commonly grown tree and shrub genera produced as bareroot stock at Mason State Nursery, with the number of species in that genera in parentheses

Hickory—*Carya* Nutt. Juglandaceae (3)
Pine—*Pinus* L. Pinaceae (3)
Hawthorn—*Crataegus* L. Rosaceae (1)
Oak—*Quercus* L. Fagaceae (16)
Sumac—*Rhus* L. Anacardiaceae (3)
Plum—*Prunus* L. Rosaceae (3)
Dogwood—*Cornus* L. Cornaceae (3)
Redbud—*Cercis* L. Caesalpiniaceae (1)
Bald cypress—*Taxodium* Rich. Taxodiaceae (1)
Chokeberry—*Aronia* Medic. Rosaceae (1)

TABLE 7

Ten bareroot-grown prairie forbs at Mason State Nursery

Apiaceae:

Rattlesnake master (*Eryngium yuccifolium* Michx.)

Asteraceae:

Smooth blue aster (*Aster laevis* L..)
New England aster (*Aster novae-angliae* L.)
Prairie coreopsis (*Coreopsis palmata* Nutt.)
Rough blazing star (*Liatris aspera* Michx.)
Prairie blazing star (*Liatris pycnostachya* Michx.)
Pale purple coneflower (*Echinacea pallida* (Nutt.) Nutt.)
Wild quinine (*Parthenium integrifolium* L.)
Yellow coneflower (*Ratibida pinnata* (Vent.) Barnhart)
Western sunflower (*Helianthus occidentalis* Riddell)

Author Information

R Kasten Dumroese
Research Scientist
Forest Research Nursery
Department of Forest Resources
University of Idaho
Moscow, ID 83844-1137
dumroese@uidaho.edu

Stewart Pequignot
State Forester
Division of Forest Resources
Illinois Department of Natural Resources
PO Box 19225
Springfield, IL 62794-9225
spequignot@dnrmail.state.il.us

David Horvath
Nursery Manager
Mason State Nursery
Division of Forest Resources
Illinois Department of Natural Resources
17855 N County Road, 2400 E
Topeka, IL 61567
dave_horvath_at_con084p8@dnrmail.state.il.us

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