# Forb Seed Production at J. H. Stone Nursery

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## Abstract

J. Herbert Stone Nursery began producing native forb seed in 1996. Nursery seedbeds are established from source-identified wild seed populations collected on public lands. Each collection (seedlot) is maintained separately from other seedlots of the same species to prevent cross-pollination. Sowing, culturing, harvesting and storage practices for seed propagation are discussed.

**Keywords**

Restoration, native plants, federal nurseries, seed propagation, public lands, source-identified seed, forbs

## Introduction

Site-specific, source-identified native seed is important for use in the restoration of public lands. In 1996, we were asked by public land managers to produce site-specific native forb seed for their projects. This was the beginning of the native forb program at J. Herbert Stone Nursery. Although our program is in it's infancy it is our hope that we will be able to provide native forb seed increase opportunities for any interested public land manager in the future. Stone nursery was originally established as a conifer nursery in the late seventies. This began to change in 1991, when Stone Nursery began a native grass seed program in response to the demand of many public land management specialists for site specific, source-identified seed. As we became established in native grass seed production, we began tc receive many requests for native forb seed. For us it was a natural extension of out native grass seed program. We were interested in diversifying nursery products be-

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cause long term needs for conifer seedlings were declining. Over the past six years the forb program has grown and today we have grown over 30 species of fortis. This year we produced 1000 lbs. of forb seed from 2 acres of land.

## Nursery Site Description

Our 3 11-acre nursery is located in Southwestern Oregon several miles west of Medford. We have a long growing season and a dry climate, which appears to be beneficial for forb seed production. Our growing season begins in March as daily temperatures average between 47-57 ° F. Flowers develop during spring and are ready for harvest from mid May through October depending on the species. Average minimum temperatures from May through October range from 55-75 ° F, while average maximum temperatures range from 67-92° F. Average annual precipitation is 19 inches, mostly as rainfall. Summers are dry with typically less than 4 inches of rainfall occurring between May and September. Nursery soils are deep and fairly well drained. They are mildly acidic (pH 5.5 to 6.0), sandy loam soils with relatively high fertility levels due to several decades of conifer production.

## Seed Production

Starter seed from wild native populations is collected from specific public forest or range locations. Wild forb seed ripens from early summer to late fall. Dried seed heads, pods etc. are removed from the plant stalks by stripping, cutting or vigorous shaking. These are placed in a paper bag for further ripening and drying. Depending on the need, the collection can be hand cleaned or sent to a seed extractory. Obtaining clean, pure seed is critical for sowing through our machinery and for sowing in the nursery beds. Each collection is maintained as a distinct seedlot with it's own unique identity.

### Seed conditioning

Forb seed conditioning requirements for the species that we have worked with vary widely. Conditioning or stratification can be thought of as treatments that simulate normal environmental conditions to overcome latent dormancy and trigger seed germination. We have used the following conditioning techniques to promote forb seed germination; cold — wet stratification, peat stratification, scarification, sulfuric acid, natural stratification and no stratification. Cold — wet stratification involves soaking seed in water for a period of time followed by cold storage at 3 3° F and high humidity for 30 to 120 days. Peat stratification involves soaking the seed in water, then placing the seed in moist peat that is held at 33 ° F for 30 to 120 days. Scarification is a mechanical or chemical abrasion of the seed coat usually followed by cold — wet stratification. Natural stratification is simply sowing the seed in the fall and exposing the seed to winter conditions. For some species no seed conditioning is required and seed sown in the fall germinates immediately. Also, it is possible that the process of drying and extraction alone is somehow a form of conditioning. In general, fall sowing and natural stratification appears to be the best strategy for forb germination and plant development.

### Sowing

Seedlots for seed production are sown in the fall on fumigated soil. Phosphorous and potassium are incorporated at rates of 250 to 300 pounds per acre prior to bedforming. We sow the seed on four foot wide raised seedbeds in four bands which are 0.75" deep, 1.25" wide and 12 inches apart with a modified Oyjord seed drill. Packing wheels on the drill press the seeds into the soil. A layer of sawdust just thick enough to cover the seed is then placed on top of the seedbed. Constant moisture is maintained in the seed / soil / sawdust interface with irrigation until the fall rains begin. Most germination takes place within 10 to 21 days after sowing, however some seed germinates over winter.

Target density for seed production is one plant per inch of seed row or 12 plants per square foot of seedbed. Seedlot test information such as the number of seeds per pound, germination percentage, purity and previous field performance are used to determine how many pounds of seed per acre to sow. Unfortunately, most seedlots do not have any tests per-

formed prior to sowing because they are collected late in the season and the amounts are too small to test. Another reason that germ tests are not done is that germination techniques haven't been developed. In these situations, the judgment and experience of the program manager and the seed drill operator are used to determine adequate sowing rates.

Fall is the preferred season for sowing at our site for several reasons. Many species germinate and grow, producing greater yields the following summer than spring-sown seed. Seeds can also be naturally conditioned in situ when sown in the fall. We have found that the cool fall temperatures limit the germination and growth of many of the local weed species and as a result weed competition is reduced. Fall sowing also allows us to spread the nursery workload more evenly throughout the year. Due to soil conditions, ground preparation in the fall is easier to accomplish at our site.

Seedlot locations are selected using a minimum isolation distance of 150 feet between collections of the same species so that the pollination contamination potential is reduced. The isolation distance of 150 feet is based on native grass parameters. So far, we are not experiencing any difficulty finding space for forb plantings.

### Culturing

After germination and seedling emergence, plants grow at minimal rates during the winter. As temperatures begin to rise in mid to late February, forbs respond with increased growth rates. Rapid vegetative growth occurs in March to early April and flowers begin to appear. During this period beds are treated with 3 applications of ammonium nitrate (100 pounds/acre) and plants are irrigated frequently to increase plant vigor and promote seed production. For established older plantings, the early growth period beds are fertilized with 250-300 pounds of triple 13 with trace elements. After seed harvest the remaining stubble is removed with a silage chopper that mulches the material into the tractor paths. Post harvest plants are maintained with minimal irrigations. Early in the fall, irrigations are increased to encourage root growth. One application of ammonium nitrate (100 pounds/acre) is made early in October.

Monitoring for insects, disease and weeds is critical during the rapid growth and flowering period. Forbs have a broad spectrum of pest problems such as rust, smut, thrips and mites. These pests are generally specific to certain species and are usually controlled with cultural or chemical treatments. Because the seedbeds are often in place for several seasons, weed control is the most significant pest problem we encounter. It is a costly, year-round endeavor requiring a wide range of tools. We begin with soil fumigation. While the main reason for fumigation is to eliminate or reduce soil borne pathogens, it also controls seed germination from previous forb or grass crops as well as wind borne weed seed. Cultural methods such as sowing in the fall and establishing and promoting a high-density forb cover can reduce weed populations. However, exposed spaces remain available in tractor paths and beds and are fertile sites for weed to thrive. Weed seed is reduced by controlling weeds in and around nursery fields through mowing and cultivation. Tractor paths are periodically treated by mechanical cultivation or tilling. Herbicides are used to treat paths, pipelines and shoulders of roads. Hand removal of weeds within the beds is our main method of weed control. It is effective but costly, and there is a level of education necessary in order to distinguish between weeds and crop plants.

### Harvesting

Forb species are harvested from mid May to late October. Seed ripening is strongly influenced by the climactic conditions during the early spring and mid summer. Cooler temperatures and higher precipitation will slow *seed* maturation. On our site Ranunculus species ripen first, followed by Plagiobothrys and the lupines. The last forbs to be harvested are Achillea, Spirea and Aster. As the harvest season begins each seedlot is monitored on a weekly basis for seed ripeness. The monitoring process intensifies as each seedlot matures, with routine daily and even hourly evaluation checks. Determination of forb seed maturity is based on embryo development, seed color, ease of removal, seed loss and personal judgment. Most individual plants or even flowers on a plant do not mature at the

same time. Judgment is used to set the harvest date to obtain the maximum amount of harvestable seed for each seedlot.

The diversity of forbs grown at the nursery has led to diversity in harvesting methods. Our primary method of forb harvesting is to thresh with a combine. Since most of our forb crops have limited, manageable amounts of vegetation, a combine can easily cut the material and process it through the drum and concave. Seeds are easily dislodged from the pods or seed heads while stems, leaves and other debris are separated out with directed air and sieving.

For crops with a large amount of biomass, we use a swather and then we thresh with a combine. Swathing is the process of cutting the plant and placing it on the surface of the bed to dry. Two to three days after swathing, the plants are processed through a combine. Swathing accomplishes several objectives. Drier plant materials are quicker and easier to process through a combine. Seeds of swathed plants are less likely to be dislodged by wind or rain because the plants are massed or grouped together at the bed surface and protected from storm events. Seed ripening can continue after swathing, which extends the window for harvesting resulting in greater flexibility.

For species with tiny air-borne seeds such as *Microseris lanatum* or *Aster hallii,* a Flail vac seed stripper is used. Stripping utilizes a spinning brush that moves over a crop, pulls the plants in and removes seed. It is mounted to a front loader on a tractor and powered with a hydraulic motor. It is used for plants that aren't compatible with the blowers that accompany the threshing process in a combine. Harvest purity for crops that have been stripped is lower than those that have been threshed because the brushes tend to pull a lot of stems off with the seed.

Another stripping machine that we use is the Native Prarie seed stripper (model 410). This is essentially a self-contained stripping unit that is pulled by a small quad ATV. The operator orients the brush and adjusts the speed and then moves through the bed. We are interested in this method because we think it can be easily used anywhere there are desired forb (or grass) species in relatively pure stands.

Of course we still use the oldest methods of seed harvesting — hand collecting. Early in the forb program we harvested many species by hand until we became familiar with the seed characteristics. Hand harvesting works but it is quite time consuming and costly. This season we hand harvested *Madia sativa* or coast tarweed because it was so sticky that none of our equipment would work. It turned out to be so difficult that we could hardly collect the seed by hand. In this species natural habitat seed is easy to collect because it is low growing. But at the nursery it grew to over 6 feet in height and we could barely move through the bed to pick the seed.

Although we have been growing forb crops for several years we don't have firm harvest yield data. We have seen that the yields vary considerably by species, seedlot, growing season and the age of the seedbed. An additional complication is that several species don't produce seed until the second or even third growing season. Table I shows comparative yields for forb species.

**Table 1. Projected yield (pounds per acre) based on forb plot yields at Stone Nursery**

| Species | Est. Yield |
|---|---|
| *Achillea millifolium* | 340 |
| *Anaphalis margaritacea* | 90 |
| *Aster hallii* | 350 |
| *Astragalus canadensis* | 660 |
| *Beckmania syzigachne* | 500 |
| *Boisduvalia densaflora* | 600 |
| *Downingia elegans* | 220 |
| *Downingia yina* | 180 |
| *Eriogonum racemosum* | 100 |
| *Eriophyllum lanatum* | 300 |
| *Gratiola ebracteata* | 1000 |
| *Grindelia intergifolia* | 380 |
| *Lupinus latifolius* | 200 |
| *Lupinus polyphyllus* | 300 |
| *Lupinus rivularis* | 850 |
| *Lupinus sericeus* | 380 |
| *Madia elegans* | 800 |
| *Madia sativa* | 300 |
| *Microseris laciniata* | 180 |
| *Orthocarpus bracteatus* | 50 |
| *Plagiobothrys figuratus* | 150 |
| *Prunella vulgaris* | 320 |
| *Ranunculus occidentalis* | 120 |
| *Ranunculus orthorhyncus* | 180 |
| *Spirea betulifolia* | 170 |
| *Stachys mexicana* | 160 |
| *Wyethia angustifolia* | 320 |

## Seed processing and storage

After a seedlot is harvested it is placed in a drying bin. The bottoms of these drying bins have fine mesh screen on the bottom to keep the seed in but

allow air passage. Bins are stacked six high over a plenum. Warm air (100° F) is blown into the plenum and up through the seed bins. After 12 hours of drying, seed samples are removed from the bins and the moisture content is measured with a Mettler moisture analyzer or with oven drying. Oven drying requires at least 4 hours while the Mettler test takes only 5 to 8 minutes. When the moisture content is between 5 to 8% the bin is taken off the stack and the seed is packaged. Dried seed is placed in plastic bags in boxes, weighed, labeled and palletized for storage. Packaged seed is placed into cold storage at 33 - 35° F or freezer storage at 2° F. Seed stored in these conditions can remain viable for many years.

### Seed cleaning

Our harvesting techniques produce seed that is "field cleaned". Seed purity values can range from 65 to 95% depending on the species and the harvest method. For restoration projects that use hydro-mulching, hand sowing or broadcast sowing this level of purity is not a problem. Sowing with a seed drill or other device that needs to have consistent seed flow, requires further cleaning at a facility like the Bend Seed Extractory in central Oregon. They have been cleaning most of our forb and grass seed. Through trial and error, they have perfected techniques for species that we've produced.

Forb seed production presents us with many challenges and opportunities. Since there are species being grown that represent many different families, huge variation exists in seed conditioning requirements, ability to plant the seed, plant culturing and seed harvesting. Most of the time the results are worth the efforts, especially when we can see more than a 100-fold increase in seed harvested from the original collection amount. Every growing and harvesting season we learn more and there is so much more to know. It is exciting to accept the challenges that each new forb species brings. On the horizon we believe there are opportunities in bulb production from forb seed and more container forb production. At J. Herbert Stone Nursery we are committed to the continued development of this program and we are pleased to share this knowledge with government agencies and the public.