Propagating Native Grass Seed and Seedlings

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Abstract

J. Herbert Stone Nursery produces over 20,000 pounds of native grass seed annually from 36 species endemic to public lands in the western states. Nursery seedbeds are established from wild seed collections. Each collection (referred to as seedlot) is grown separately from other seedlots of same species to prevent cross pollen contamination. Sowing, culturing, harvesting and storage practices for seed and seedling production are discussed. Methods and strategies for achieving successful restoration projects using native grass seed and seedlings are also addressed.

Keywords

restoration, federal nurseries, seed propagation, public lands, source identified seed

Introduction

J. Herbert Stone Nursery began it's native grass program in 1991. Up until that point the plant materials our nursery produced were almost entirely bareroot conifer seedlings used for reforestation projects on public lands. Our interest in developing a native grass program was in response to the rising demands of many public land management specialists for source identified native grass seed needed in restoration projects. Most sources for native grass seed and plants were not readily available in large quantities at that time, especially seed originating from specific geographic locations on public lands. We also hoped to diversify our line of plant products since the long term needs for conifer seedlings were declining sharply from the high levels of the previous decade. Over the last eight years our program has evolved and grown. Today we produce over 12 tons of grass seed annually from 50 acres of land. We have experience growing 36 species of grasses for clients in Oregon, Washington, Montana, California and Alaska. Along the way we have gained insight and experience which we would like to share in this paper.

Nursery Site Description

Our nursery is located in Southwestern Oregon several miles west of Medford. The long growing season and dry climate of our area are very conducing for producing grass seed. The growing season for grasses begins in mid March as the average daily temperatures reach 47° F. Seed heads develop during spring and are ready to harvest in the late spring and early summer. Average temperatures during June and July are 65 and 72° F. with average maximum temperatures for those months at 83 to 90° F. Summers are dry with typically less than 4 inches of rainfall occurring between May and September. Total precipitation for our area is 19 inches with most of this occurring as rainfall. Our 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 previous farming practices.

Seed Production

Field Collected Seed

Our clients send us field-collected seed from stands of native grasses found on public forest or range sites. From the time of collection, seed sources are kept separate to maintain the genetic integrity of the collection (referred to as seedlots). Our clients typically collect seed in mid to late summer when the seed is ripe by either cutting or stripping the seed from the stalk and placing into a paper bag to dry. It is cleaned and sent to us for storage or sowing soon after the collections are made.

Sowing

Unlike conifers, most grass species require no special seed treatment or stratification before sowing. Species which do require pre-treatment include green fescue (*Festuca viridula*) and all species in the genera Danthonia and Acnatherium (previously named Stipa). Seeds from these species are either scarified with sandpaper, soaked in cold running water for six hours or treated with gibberellic acid, then spread on screens and placed in stratification rooms maintained at 33° F and 100% humidity. Seedlots are monitored frequently for mold as well as for moisture. After 90 days the seed is ready to sow. Seedlots requiring no stratification are simply removed from storage and sown.

Seed is sown on four foot wide raised beds through a modified Oyjard seed drill. It is placed in rows 12 inches apart, pressed into the soil with rollers and immediately covered with a 3/8 inch layer of sawdust. Daily irrigations are made when the seed zone begins to dry out. This regime is continued until the seedlings emerge through the sawdust mulch which generally occurs within 7 to 14 days after sowing, however Brome species may take up to a month to germinate.

Our sowing calculations determine how many pounds of seed to sow per acre (or equivalent for lots less than one acre) to produce approximately one live plant per inch of sown seed row. The amount to sow is based on actual seeds per pound measurements, as well as seed germination and purity tests for each seedlot when this information is available. The calculations are further modified by a field performance factor that has been developed over the years for each species at our site. General sowing factors for the major species that we grow are shown in Table 1.

Ninety percent of seedlots are sown in the fall from October 1 through November 15 and the remainder is sown in the spring (February through April). While both seasons produce similar seedling germination and survival rates, fall is the preferred season for sowing. We have found that there are less weeds associated with fall sowing because the cooler climate during that period limits the germination and growth of many of the local weed species. By the time the fields are dry enough to sow in the spring, temperatures are much warmer and more favorable for weed seed germination and growth. Another consideration for fall-sowing is higher seed yields. Fall-sown seedlots will always produce higher yields the following summer than spring-sown seedlots. However some species like California fescue (*Festuca californica*) and June grass (*Koeleria cristata*) do not produce seed the first year regardless of the season sown (see Table 1).

Seedlots must be located in our nursery so that pollen from other seedlots of the same species do not mix. The minimum distance we have established is 150 feet. As the numbers of seedlots increase (we currently maintain over 200 seedlots) so does the challenge of placing popularly requested species. For example, at present we are maintaining 23 seedlots of blue wild-rye

(*Elymus glaucus*). Finding locations for new seedlots of this species is becoming increasingly difficult due to the fact that there are only a few areas left within our 215 acre nursery where seedlots of this species are not closer than 150 feet. Further constraining our options is the potential for some species to hybridize. Bottlebrush squirrel tail (*Elymus elimoides* - previously named *Sitanion hystrix*), blue wild-rye (*Elymus glaucus*), meadow barley (*Hordeum brachy-antherum*) and bluebunch wheatgrass (*Pseudoregneria spicatum* - previously named *Agropyron spicatum*) have this potential and are separated by 150 feet. Even with these constraints, our nursery still has ample room for more seedlots, especially for those of less requested species.

Culturing

Grass plants grow at minimal rates during the winter after seedling emergence. As temperatures begin to rise in March, so does the rate of growth. Plants are in full vegetative growth in April and have begun to develop seed heads. During the rapid growth period (mid-March through first week of May), the beds are fertilized three times with a total of 300 pounds of Triple 13 (13-13-13) and soils are irrigated frequently to minimize plant stress. After seed harvest, the remaining stubble is immediately removed by either bailing or mulching the material into the tractor paths. Hay bails are identified by seedlots and are kept separate since most contain unharvested seed. These bails are purchased by our clients for seed mulching or used as erosion structures in a variety of restoration projects. Grass beds are irrigated minimally during the summer but more frequently in the fall to encourage root growth. One application of 100 pounds of ammonium nitrate is made during the first week of October.

Monitoring each seedlot on a weekly basis during the spring for insects, diseases and weeds is critical during this period. Over the years we have encountered sod webworm, rusts, smut, mites and powdery mildew. These diseases and insects tend to be specific to certain species and genera and generally can be controlled successfully with cultural or chemical treatments. Weed control is a costly, year-round endeavor requiring a wide range of tools to control. We begin by sowing in fumigated ground to reduce exposure to soil borne diseases and eliminate weed seeds. This is essential when sowing into areas previously grown in native grass seed because residual seed from previous crops can germinate

Table 1: Sowing factors and harvest yields for some commonly grown grasses at J. Herbert Stone Nursery

Species	Seeds per Pound	General Sowing Rates (pounds per acre)	Average Harvest Yields (pounds/acre) Rough Cleaned Seed			
			1st Year	2nd Year	3rd Year	4th Year
Bromus carinatus (California brome)	40,000-80,000	17	800	700	400	*
Bromus laevipes (chinoak bromegrass)	90,000-100,000	11	950	600	250	0
Bromus vulgaris (Columbia brome)	70,000-120,000	11	200	300	0	0
Deschampsia elongata (slender hairgrass)	1,000,000-2,000,000	1.5	900	450	500	0
Deschampsia caespitosa (tufted hairgrass)	1,000,000-2,000,000	1.5	100	400	200	400
Elymus glaucus (blue wild-rye)	80,000-150,000	11	500	450	450	400
Festuca californica (California fescue)	150,000-160,000	13	0	250	300	300
Festuca idahoensis (Idaho fescue)	350,000-500,000	8.5	100	400	400	300
Hordeum brachyantherum (meadow barley)	100,000-120,000	12.5	200	350	350	450
Koeleria cristata (June grass)	1,000,000-3,000,000	4	0	500	350	450
Melica harfordii (Hardford's melic)	140,000-150,000	13	500	500	350	400
Poa secunda (pine bluegrass)	850,000-1,500,000	4	200	400	0	0
Acnatherium occidentalis (needlegrass????)	300,000-350,000	?	150	200	100	*

*insufficient data

along with currently sown seed. Removing unwanted native grasses from a bed by hand is difficult since many of the species have similar forms and appearances. Cultural methods such as sowing in the most favorable season (discussed above) and establishing and maintaining a high density grass cover can significantly reduce weed establishment. However bare soil still exists in the paths and beds and are fertile sites for wind-borne weed seed to become established. Wind-borne seed is reduced by controlling the weeds in and around the nursery fields through mowing and cultivation. Herbicides are used to treat tractor paths, pipelines and shoulders of roads. Tractor paths are tilled with a path weeder on a monthly basis and weeds within the beds are periodically removed by hand. Hand weeding to rogue out non target grasses is critical in the month prior to seed harvest since seed collections must be free of any foreign seed.

Harvesting

The seed harvesting season begins as early as mid May and lasts as late as mid September with the bulk of the harvest occurring between mid June and mid July. Speed and timing of seed ripening will vary from year to year and is strongly influenced by spring and summer temperatures. First to ripen are California fescue (*Festuca californica*), green fescue (*Festuca viridula*) and most of the Poa species. Trailing at the end of the season are the Bromus, Elymus and Acnatherium species. Each seedlot is monitored for seed ripeness. As seeds mature, seedlot monitoring intensifies from a weekly to a daily basis. Seed is considered ready to harvest when it is hard and pulls easily from the seed stalk.

Several methods are employed for seed harvesting depending on the species. The primary method of harvesting is by swathing and combining. Swathing is the process of cutting the base of the seed stalk and laying it on the surface of the bed to dry. Two to four days after swathing, the cut material is processed through a combine which removes the seed from the stalk. Swathing accomplishes several objectives. First drier plant materials are quicker and easier to process through the combine. Second seed is less likely to dislodge by wind or rain when laying on the surface of the bed which reduces the risk of seed loss during high wind and rainstorm events that typically occur during this period in our area. Overall, swathing creates more flexibility in scheduling seedlots for harvesting. Species in the genus Acnatherum (previously named Stipa) develop seed throughout the summer and must be harvested periodically up to four times in a season to obtain optimum yields. These species are harvested with a brush harvester which gently strips the ripen seed from the stalk, leaving the unripened seed and plant intact for later harvests.

Harvest yields vary considerably by species, seedlot, climate and age of seedbed. Table 1 shows the average seed yields we have obtained by major species and age of the seedlot. The table shows the seed production characteristics of a each species. Species such as blue wild-rye (*Elymus glaucus*), meadow barley (*Hordeum brachyantherum*) and Hardford's melic (*Melica harfordii*) produce seed the first year and maintain these yields indefinitely. Other species like Columbia brome (*Bromus vulgaris*) an pine bluegrass (*Poa secunda*), produce seed for several years and then die back. Still others, Idaho Fescue (*Festuca idahoensis*) and California Fescue (*Festica californica*), take several years to reach optimum seed yields, then maintain these yields for many years.

Seed Processing and Storage

Once a seedlot is harvested, it is placed in a drying bin. These large trays have screened bottoms and are stacked fives high over a warm air duct. Air is heated to 100° F and drawn through the set of bins for a 12 hour period. At this point the seed moisture is checked and those seedlots that have seed moisture contents between 5 and 8 % are removed. Seedlots with higher moistures continue to dry until the desired moisture content is reached. Dried seed is placed in plastic bags in boxes. They are stored in coolers set at 34° F or freezers at 2° F for long term storage. We have found that most seed stored under these conditions can remain viable for at least eight years and probably much longer.

For restoration projects involving hand sowing, broadcast sowing or hydromulch seed application, combine-harvested seed can be used without additional cleaning. This seed is referred to as "rough cleaned" seed and represents approximately 60 to 85% purity. Seed that will be sown through a seed drill or whirlygig requires further

cleaning and at the clients request will be processed at the Bend Pine Seed Extractory or a private extractory. Species with attached awns are difficult to harvest and clean because the awns cling to each other, creating a mass of interlocking seeds, impossible to sow. Species with attached awns are in the genera Achnatheum, Pseudoregneria and Elymus and must be processed to remove the awns.

Field Sowing

Experience in using native grass seed for restoration projects has accumulated as native seed has become available for restoration projects. Many of our clients have found that native grass seed performs as well or better than non native grass seed. Basic to the success of any native grass project is a good understanding of soil and climatic conditions. Not all native grass species will survive or grow equally well on any given site. Which species and techniques to use must be determined on a site by site basis. Species selection can be made by observing the species inhabiting similar, non disturbed sites. Developing techniques for seedling establishment comes with experience. If there are doubts, a simple field test can be conducted to evaluate the success of the species or technique (such as type of seed covering material or sowing depth). The test can be as simple as sowing a known number of seeds in a short line at several areas on the site using several species or techniques. Weekly or bi-weekly visits to count the number of germinants and seedling growth habits can help characterize the dominant limiting factors. In turn this will lead to developing the best methods and appropriate species to use for establishing native grasses on that site.

Seedling Production

When to Use Seedlings

Direct sowing of native grass seed might not always be the best choice for meeting the objectives of the project. An alternative is planting grass seedlings. Circumstances where this could be appropriate are when 1) seed is valuable, 2) field germination is low, 3) sites are harsh, and 4) a quick establishment of plants is important (weed control, erosion control or esthetics). Seedlings can be grown in containers or as bareroot. We have grown both stocktypes but have had more experience with containerized plants.

Containerized Seedlings

Native grasses have been grown successfully in containers at our nursery. Generally these seedlings have been planted on disturbed sites where sown seed has faired poorly - low germination, poor survival or inadequate growth. Several different sized containers have been used but we have found that a Styro6 (a 6 cubic inch cavity) seedling performs very well on harsh sites. Seed is sown in a general potting mix 90 days prior to the expected planting date. Winter or spring-sown seedlots are started in the greenhouse but moved outside when the average daily temperatures approach 50° F. Liquid fertilizer (9-45-15) is applied several times after seedling emergence and plants are irrigated when blocks have begun to dry out (50 to 75% of available moisture). Seedlings have reached their optimum shoot growth (4 to 6 inches tall) approximately 90 days after sowing. By this time, roots are actively growing and the root plug holds together well. We have found that this is the optimum time to plant. Seedlings left in containers after this point will continue to vigorously grow and soon collapse under their weight, leaving a mass of foliage that is susceptible to disease. These seedlings have a much lower chance of survival and growth even if their tops are pruned back.

Bareroot Seedlings

We have experimented with growing bareroot grass seedlings for field outplanting. Like container stock, sowing must be done three to four months prior to outplanting but this can change depending on the temperatures during the growing period. Ease of lifting and handling seedlings is specific to the species and sowing densities - the higher the densities, the more likely that plants will be lifted as sod and not as single plants. Seedling handling is generally more difficult than containers because each plant must be singulated before planting.

Field Plantings

We have found that bareroot and containerized seedlings can remain viable in cold storage for up to 45 days after lifting. However most of our stock is planted immediately after the seedlings are lifted or extracted. On dry sites, seedlings that are planted at least one

to two inches deeper than the base of the seedling and planted in small depressions perform very well. Seedlings that are planted in moist soils should continue active root growth and quickly become established on the site.

Conclusion

For years we have heard comments like, "we should be restoring disturbed sites with native grasses but there's never any seed available or suitable for our area". We believe that comments like these no longer ring true. Over the years there have been private seed growers as well as federal nurseries taking up the challenge to produce bulk supplies of source identified seed for public land management agencies. 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, farmers and the public.