The Expanding Potential for Native Grass Seed Production in Western North America[1]

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Abstract-Native grass seed production under cultivation has been practiced for many years but its extent has been limited by 1) lack of plant material, 2) seed planting, harvesting, and conditioning problems, and 3) inadequate markets. Numerous releases of native grasses (germplasm or cultivars) of many species by the USDA-NRCS Plant Materials Centers and other programs are in commercial production (Alderson and Sharp 1994). Specialized seed planting, harvesting, and conditioning (cleaning) equipment is now commercially available, allowing for successful seed production of species with seeds that shatter or are awned, chaffy, or fluffy. With the advent of policies and laws favoring the use of native seeds, production is generally far below market demands. A more sophisticated marketing system would help develop the native grass seed industry and enhance opportunities for both buyers and sellers.

BIOLOGY AND ADAPTATION

Like other plants, grasses can be categorized into C-3 (cool-season) or C-4 (warm-season) types according to their photosynthetic pathways. Cool-season grasses generally require a winter vernalization period and/or a short-day period followed by sufficiently long days for flowering. Flowering occurs earlier when plants are moved north and later when moved south, Optimal growth temperature ranges from 70 to 75^{o}F. Cool-season grass seedlings have an elongating coleoptile through which the first leaf emerges ("festucoid" development) (Ries and Hofmann 1991, Nelson and Moser 1995). The coleoptile node, where rooting initiates, remains below the soil surface with the seed. Planting cool-season grass seed too deep may prevent coleoptile emergence. The use of depth bands permits seeding at the proper depth (Horton et al.). Though there are several exceptions, e.g., inland saltgrass, prairie cordgrass, alkali cordgrass, sand dropseed, and alkali sacaton, most native grasses of the Intermountain Region are cool-season because of the preponderance of precipitation in the cooler months. Many are wheatgrasses and wildryes of the Triticeae tribe (Asay and Jensen 1996 a,b). Cool-season grasses may be planted in late summer, early spring, or late fall (dormant seeding) (Smith and Smith).

A special category of C-3 grasses is represented by the Stipeae tribe, i.e., the needlegrasses and ricegrasses (Stubbendieck and Jones 1996). Unlike other cool-season grasses, this group is unable to store fructans in the vacuole, a mechanism for storing carbohydrates at cool temperatures (Chatterton et al. 1989). Thus, their minimal and maximal growth temperatures are greater than for fructan-accumulators. Many Stipeae species are photoperiod-insensitive and require no vernalization, e.g., Indian ricegrass and green needlegrass. Stipeae species may be found in climates too warm for other C-3 grasses.

Warm-season grasses do not require a vernalization period, but may require sufficiently short days for flowering (Moser and Vogel 1995). Plants flower later when moved north and earlier when moved south (Moser and Vogel 1995, Voigt and Sharp 1995). Optimal growth temperature ranges from 80 to 85 OF. The warm-season grass seedling has an elongating shoot (mesocotyl) extending above the seed that elevates the coleoptile node ("panicoid development") (Ries and Hofmann 199 1, Nelson and Moser 1995). If the roots become exposed, the seedling can quickly desiccate. Thus, establishment of warm-season grasses is generally more difficult than cool-season grasses. Therefore, planting warm-season grass seed too shallow often causes poor stand establishment. Most native grasses in the Great Plains and Southwest are warm-season, not only because of high summer temperatures, but also because of the preponderance of precipitation in the warmer months. Warm-season grasses are best planted in late spring (Moser and Vogel 1995).

As a rule-of-thumb, both cool- and warm-season grasses may be successfully moved 300 miles north or 200 miles south from their point-of-origin (Smith and Smith). A 550-foot change in elevation corresponds to 100 miles of latitude. These guidelines should be modified for particular species and sites by consideration of snow cover (snowfall and wind), evaporation, length of growing season, soil drainage, and slope/aspect. Grasses adapted to coarse-textured soils may frostheave in heavier soils. Grasses adapted to heavy-textured soils may desiccate in coarser soils. Growth often improves when plants are moved north from their points of origin because of longer summer daylengths (Smith and Smith). However, this may increase the risk of winterkill or, in the case of warm-season grasses, hinder seed production because of the shortened growing season.

SEED PRODUCTION

Seed dormancy hinders stand establishment of many cool- and warm-season native grass species. Seed dormancy is determined by both the genotype of the mother plant and the environment (temperature and moisture) during seed maturation. The most common approach for breaking seed dormancy in seed fields is the late-fall dormant planting. A wet winter allows natural stratification, the subsequent loss of physiological seed dormancy, and early spring establishment, thereby avoiding the deleterious effects of late spring or summer droughts.

Bunchgrasses predominate in the dry-summer climate of the Great Basin, but in the Great Plains rhizomatous species are common. In many species, particularly rhizomatous cool-season grasses, heading declines rapidly after the first few seasons. Cultivation between rows to prevent sod-binding and the timely application of nitrogen fertilizer can increase heading and seed production. For increased seed production, grasses should be fertilized during production of seedhead meristems, i.e., before heading begins (Bolton et al. 1996). Cool-season grasses, therefore, should be fertilized in fall. Fertilization in spring will encourage vegetative growth at the expense of reproductive growth. Because of their later growth pattern, warm-season grasses can be fertilized in spring. As part of the natural environment, late-spring bums benefit stands of many warm-season Great Plains species by stimulating tillering (Moser and Vogel 1995).

SEED HARVESTING AND CONDITIONING

While species with determinate flowering and good seed retention are suitable for direct-combining, seeds of many native grasses are often a challenge to harvest. This may result from floral indeterminacy, seed shattering, or often both. These mechanisms may be helpful to the species In an evolutionary sense, but in a seed field they are obviously undesirable. Floral indeterminacy, the uneven ripening of the seed on a plant within or between heads, makes the choice of optimal harvest time problematic. Indeterminate flowerers may be successfully harvested at multiple points in time with seed strippers, but in practice most of the seed is collected at the initial harvest. Seed strippers do not work well with species that shatter, as they tend to increase shattering (Smith and Smith). Indeterminate, shattering species are best swathed under high humidity, windrowed, and picked up later after seed maturation in the windrow (Bolton et al. 1996).

Both hammer mills and debearders are used to remove awns (Bolton et al. 1996), but debearders are preferred because they cause less seed damage. The debearder removes awns by rotating a beater with pitched arms on a shaft within a steel drum (Smith and Smith). The steel drum has posts that protrude inward toward the beater. The drum posts may be adjusted to increase or decrease clearance with the beater post arms. Clearance, speed, and time must be calibrated for maximal awn removal and minimal seed damage.

RELEASE OPTIONS FOR PLANT MATERIAL

In the past, most native seed was marketed as either "common" or as a named cultivar. Common seed could not be certified because it had no "genetic identity". However, recent rule changes made by the Association of Seed Certifying Agencies facilitate certification of seed as germplasm that previously would have been sold as common seed. Release of germplasm does not require as great a degree of scrutiny as the traditional cultivar release. This certification mechanism is referred to as the alternative release system (Young 1995). Wildland-harvested seed or seed increased in a cultivated setting from wildland harvest may be certified by the site of origin, i.e., "source- identified". After evaluation with other accessions of the same species, the seed source may be officially released and registered as a "selected" class of certified germplasm. Additional testing would qualify material for the "tested" class. Further documentation of its merit would qualify the material for a traditional cultivar release. Therefore, in theory, the same material could be released more than once upon acquisition of greater documentation. The alternative release system combines the advantages of verified geographic source identity and minimized delays in release relative to the traditional cultivar release. As well as single-site material, a composite, in the case of a self-pollinated species, or a polycross, in the case of a cross-pollinated species, of seeds originating from multiple sites may qualify. The USDA-NRCS Plant Materials Program is now routing most of its grass releases though the alternative release system, using primarily the "selected" class.

Another concept in the release of native plant material is the ecological cultivar or "ecovar" (Wark et al. 1995). The objective of ecovar development is to provide material that is as genetically diverse as possible yet is agronomically improved for traits related to seed production. Ecovars would generally combine material from many different sources, although these would likely be from the same geographic region. At this time, no ecovars have been released. The greatest efforts in ecovar development are occurring in the prairie provinces of Canada.

MARKETING CHANNELS

Native grass seed is harvested from both wildland stands and cultivated fields. Grass seed production from cultivated fields will increase in the future because wildland harvest is limited (for some species, nonexistent) but is unlikely to meet demand. In contrast, most shrubs have seed production difficulties that discourage cultivated production. The shrub seed "picking" industry continues to thrive off wildland stands despite the release of plant material for commercial use. Wildland harvest of grass seed will continue to play a part in the seed industry for certain species that occupy level terrain, are found in near-monoculture, are difficult to establish or harvest in a cultivated setting, or demand only small quantities of site-adapted seed. Wildland seed harvest fluctuates greatly from year to year because of weather conditions, primarily moisture availability. Therefore, weather greatly influences prices.

Seed cleaning plants may contract seed production out to individual growers or pickers, produce seed in-house on their own fields, or both. Considerable trade occurs between seed companies, particularly those relatively distant geographically, to stabilize inventories and satisfy needs of regular retail customers. Some seed brokers neither grow nor clean seed, but attempt to "buy low and sell high" and offer additional services such as germination testing and consulting. Warehousing facilities are becoming increasingly important for government agencies with needs for short-notice restoration projects. Warehousing allows them to maintain supplies and hedge on prices. Conservation nurseries may wish to emphasize seed production of species that are only intermittently available in commerce as well as geographically important sources of more commonly available species.

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