Seeding Native Grasses in the Arid Southwest

NRCS New Mexico

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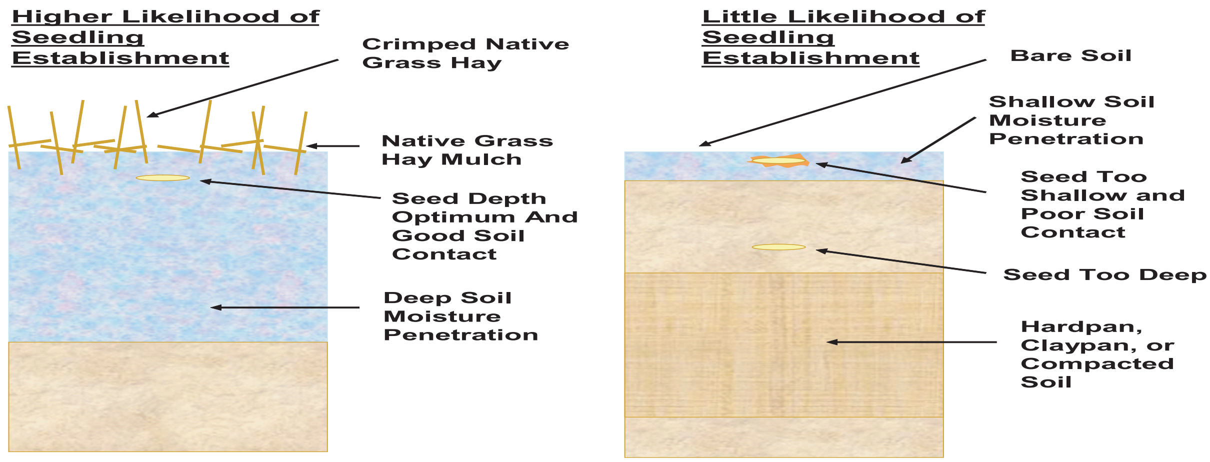
Grass seeding is an uncertain endeavor even in the best of circumstances, but in the arid Southwest it is an extremely risky venture. This technical note is intended to present the important factors that influence the success of seeding native grasses in the arid and semi-arid Southwest. New Mexico USDA-NRCS standards and specifications for critical area planting and range planting provide detailed information on seeding native grasses. To access the USDA-NRCS standards and specifications for critical area planting, go to (http://efotg.nrcs.usda.gov/references/public/NM/342spec.pdf). To access the USDA-NRCS range planting specifications, go to (http://efotg.nrcs.usda.gov/references/public/NM/550.pdf).

Factors Influencing Success

- *Seeding Depth* - The depth of seed placement is a critical factor affecting seedling emergence and survival. Shallow seeding depths provide high rates of seedling emergence; however, greater soil moisture is generally found with increasing depth. Therefore, decisions on seed burial depth have to consider these counterbalancing effects which are critical to seedling emergence and survival.
- *Seed Dormancy* – When seeding most crops, the grower wants rapid and uniform seed germination and seedling emergence. In the case of arid land seeding, an advantageous trait of some grass species is seed dormancy which allows the seed to remain un-germinated and persist for later precipitation events. If seed of a non-dormant species is planted and then less than optimum moisture conditions occur, most of the seed will germinate but die from lack of sufficient soil moisture. Therefore, the presence of some dormant seed is an advantage because it provides a reserve of viable seed for anticipated better moisture conditions in the future.
- *Soil Compaction* – Following germination, the ability of seedling roots to follow moisture downward is critical for seedling establishment as the soil dries from the surface. This rapid root extension can be inhibited by shallow compaction zones or restrictive layers that physically impede root growth. Prevention of soil compaction in the first place or tillage to breakup compaction zones are essential considerations in seeding plans.
- *Seed Contact With Soil Particles* – Large voids in the soil surrounding the seed can reduce the ability of seed to take up soil moisture. These voids can also reduce upward capillary movement of soil moisture that can retard seed germination and seedling growth. Seeding practices should address methods to facilitate adequate seed to soil contact if the soil conditions warrant.
- *Soil Moisture* - Without a doubt, the most important factor affecting the success of arid land seeding is soil moisture. A succession of significant precipitation events are needed to provide sufficient amounts of moisture for germination, root development, and eventual establishment. In arid regions of the Southwest, this type of rainfall pattern is most likely to happen but does not consistently occur during the summer monsoon season.
- *Mulch Application* - Mulching with the proper amount of weed-free material provides the maximum benefit from what little precipitation is received in arid regions. A layer of mulch offers the following benefits:
  - retards evaporation of surface soil moisture,
  - reduces the drying effect of wind,
  - limits water erosion and the displacement of soil and seed, and
  - enhances the infiltration of precipitation by protecting the soil surface from raindrop impact and any resulting surface sealing.
- *Soil Texture* – The influence of soil texture on the infiltration of precipitation and the depth of moisture penetration can be a key variable in seeding success. In arid regions, sandy soils can provide more effective soil moisture for grass seedling establishment than finer-textured soils.

- *Weed Control* - Dense stands of annual and perennial weeds can out-compete seedling grasses for soil moisture, light, and nutrients - and prevent establishment. Control of weeds prior to seeding to prevent the buildup of a bank or reservoir of weed seed in the soil is essential for seeding success.
- *Cool-season (CS) Versus Warm Season (WS) Grasses*. Grass species belong to one of two basic physiological types. Cool-season grasses have optimum growth temperatures of 70-75°F with growth generally halting at around 40°F. Optimum growth of warm-season grasses occurs at 85-95°F and growth ceases at about 55°F. In the Southwest, cool-season grasses predominate in higher precipitation regions at higher elevations and warm-season grasses in more arid lower elevation areas. In the western state's Great Basin cool-season grasses are common in arid areas where winter precipitation predominates.

Seeding scenarios that either favor or hinder grass seedling establishment.



Seeding Depth for Optimal Emergence Under Ideal Moisture Conditions

- *General Recommendation for Most Native Species* - Seeding depths recommended for most native grasses are ¼- to ½-inch deep. However, some large seeded grasses (usually cool-season native species such as wheatgrasses) can be seeded somewhat deeper – between ½- and 1- inch deep.
- *Very Small Seed* - Some extremely small seed (one to several million seed per pound), such as many of the dropseeds (*Sporobolus* species) and some of the muhlys (*Muhlenbergia* species), should be surface broadcast; such small seed will be buried by raindrop impact or during mulch application and crimping.
- *Tolerant of Deep Burial* - A few species can emerge successfully from greater depths (as much as 2 inches) and deep burial is usually recommended for these species. As an example, Indian ricegrass (*Achnatherum (Oryzopsis) hymenoides*) is generally sown more than an inch deep in the fall or winter to allow exposure to prolonged cold moist conditions needed to maximize germination.

Seeding Grasses and Weed Control

- *Weed Seed Bank* - It is of paramount importance to control weeds several years prior to seeding on severely weed-infested sites. It is essential not to underestimate the importance of controlling invasive annual weeds prior to seeding. Recently this has been most obvious in those areas that have undergone saltcedar control. The proliferation of kochia *(Bassia (Kochia) scoparia*) and other annual weeds on these sites has precluded any seeding until the weed seed bank can be drastically reduced. The key to controlling weeds is to prevent them from going to seed in their first year of growth; the dispersal of additional weed seed will only compound the weed problem. Herbicidal control is recommended and can be very effective especially on small weed seedlings. Mowing annual weeds before they set viable seed can prevent dispersal of additional weed seed. If the annual weed species hold on to their seed as they dry out, burning the weed stand may be an effective control method.

- *Herbicide Use After Seeding* - Pre-emergent herbicides can be applied before weed emergence or post-emergent broadleaf herbicides can be applied after grass seedlings are established. The susceptibility of some native grasses to post-emergent broadleaf herbicides as well as any residual pre-emergent herbicide needs to be considered before application. The role of precipitation is critical because it will determine how deep the pre-emergent herbicide penetrates into the soil*,* and whether weed seeds will imbibe sufficient moisture to be vulnerable to the herbicide.
- *Mowing Weeds In Established Grass Stands.* After grass seedlings have become well established, properly-timed mowing before annual weeds set viable seed can reduce weed seed formation and its subsequent dispersal.
- *Fertilization* - Nitrogen fertilizer should not be applied at the time of seeding because weed species usually will be favored over the grasses. Application of nitrogen after the grass seedlings have become established will generally boost growth but depending on the species in the seed mix and the timing of application it may favor certain species. This enhancement may be undesirable in wild-land restoration where the grasses will have to subsist on atmospheric input of nitrogen. In arid wild-land settings with typical soils, the addition of phosphorous or potassium is usually not warranted.

Mulch Application After Seeding

Mulch application provides one of the few opportunities to preserve limited soil moisture on arid lands. Various types of materials can serve as effective mulches. A number of factors are important in selecting mulch materials including cost, availability, being free of weed seeds, efficient application, and ability to stay in place.

- *Native Grass Hay* - One of the most effective materials for mulching large seeding projects is native grass hay that is free of weed seeds. If the native grass hay has some residual grass seed of locally adapted species, so much the better. The mulch should be applied so it is dense enough to shade the soil and prevent wind desiccation, but not so dense as to retard grass seedling emergence. Properly applied hay mulch should form a porous layer with some soil still visible. This thickness of mulch often corresponds to an application rate of 1 to 2 tons per acre. Any type of hay or straw should be crimped into the soil to minimize loss of hay by wind or water erosion.
- *Hydromulch Wood Fiber and Erosion Control Blankets* – Some of the only effective mulch options for steep slopes are hydromulch wood fibers and erosion control blankets. The material and labor costs of these alternative are substantial and may be cost prohibitive. Tackifiers added to the hydromulch slurry are required to glue the hydromulch fibers in place, and staples or pins are required to secure erosion control blankets.
- *Wood or Bark Chips* - Wood and bark chips can be effective mulches if applied in a thin layer <u>after</u> seeding. In order to seed into plant litter such as wood chips, the mulch layer would need to be moved aside to allow seed placement into mineral soil without incorporating excessive amounts of wood chips into the soil. Grass seed requires intimate contact with mineral soil to allow germination and eventual establishment.
- *Gravel or Rock Mulch* - Even gravel or rock mulch can be effective if not applied too thickly. A single layer of gravel or rock with visible soil between the pieces of aggregate can provide many of the benefits of organic mulches; however, gravel or rock mulch materials will have much greater temperature extremes. Excessively high temperatures from solar input could yield lethal conditions for seed in close proximity to rock or gravel. Radiational cooling of the mulch at night can be sufficient to allow dew formation especially between and under rocks.

Precipitation – The Master Input

Precipitation is the "master input" controlling biological processes in arid and semiarid regions. The pattern of soil moisture after the initial, biologically-significant rain will have a great impact on the fate of the seeding. Many native grass species will germinate following this moisture event. If the soil dries rapidly, some species may not have imbibed sufficient moisture to germinate. It is important that either emerging seedlings have sufficient vigor to survive the first dry period, or that ungerminated seed remain viable after the first dry period. One or the other of these strategies will allow survival of seed or seedlings through dry periods that will follow this moisture event.

Because warm-season grasses require warm soil temperatures to germinate (greater than 60° F), they try to establish during the late spring and summer seasons when the evaporative loss of soil moisture is, as a rule, very high. A rainfall pattern of successive and significant precipitation events is needed to provide sufficient amounts of moisture for germination, root development, and eventual establishment.

Soil Moisture Distribution in Arid Environments

Precipitation that is able to infiltrate the soil surface has varying degrees of persistence depending on how deep it percolates.

- Following a summer rainfall event that allows deep infiltration in arid regions, the moisture in the top 2- to 4-inches of soil can dry out very rapidly. This happens because of the high-evaporative demand from high solar input, low humidity, and drying winds. Therefore, little water remains available for seed imbibition, seed germination, seedling root growth, and seedling establishment.
- If the infiltration event provides deeper soil moisture (4- to 12-inches deep), this moisture can persist for several weeks and is available for seedling root growth and establishment.
- Moisture under unsaturated conditions at depths below 12-inches is primarily used for plant transpiration with very little of this moisture lost to evaporation or deep drainage. This moisture would only be available to older grass plants with an extensive root system.

Inverse Texture Effect

The term "inverse texture effect" has been proposed to indicate that in arid regions, coarse-textured soils have more useable soil moisture than fine-textured soils. Coarse-textured soils hold less water per unit depth, but much of the water in arid regions is sufficiently deep to avoid evaporation, whereas in fine-textured soils most of the water from small infiltration events is easily lost to evaporation

The depth of wetting is proportional to the amount of infiltrating precipitation divided by the soil moisture storage capacity. The storage capacity is 4–9% for sands, 11–15% for sandy loams, and 17–23% for fine-textured soils. The depth of soil wetting from a given infiltration event will be greater for coarse-textured soils than for fine-textured soils.

Revegetation Seeding Rates and Mixes

Seeding rates in excess of 40 PLS (pure live seed as determined from seed testing) per square foot do not generally provide any benefit for drilling seed of a single species. When broadcasting a single species, higher rates (40 to 60 PLS per square foot) are usually recommended because fewer of the seed will end up at optimum burial depth. These higher rates are also recommended for the total seeding rate for a mix (40 to 60 PLS per square foot). On sites that are extremely hard to revegetate, it is often useful to seed species with highly dormant seed, such as Indian ricegrass, at high rates (60 to 80 PLS per square foot) to create a seed bank that can germinate over several years. The proportion of each species will depend on the species composition of the desired plant community, seedling vigor (competition between species), seed size, seed dormancy, and PLS seed cost. If a seed mix is expensive, then a rate of 20 PLS per square foot might be adequate for acceptable seedling density; seed costs can range from a minor to a substantial portion of the overall seeding cost depending on the species. The most common recommended seeding rate for a single species or mixes is 40 PLS per square foot.

An example of seed mix calculations for a species mixture adapted to an arid sandy site is presented below. The selected species and proportions of the seed mix are based on the desired plant community, seed availability, pure live seed (PLS) cost, seed size, and number of PLS per pound. Hypothetical seed testing results are used in this example. Seed numbers per pound can be found in the PLANTS database, seed catalogs, and reference books.

Candidate species for a sandy arid site. Pure live seed (PLS) numbers, moisture use, presumed availability, and cost data needed for selecting species for a seed mix and calculating seeding rates.

Common Name	No. of PLS/Pound PLS	Moisture Use	Availability	Relative Cost (per pound)
Indian ricegrass	160,000	very xeric	yes	medium
Black grama	1,300,000	very xeric	maybe	high
Sand dropseed	5,600,000	xeric	yes	low
Spike dropseed	2,800,000	xeric	?	
Mesa dropseed	3,300,000	very xeric	?	
Giant dropseed	1,400,000	very xeric	?	–

An example of the calculations of seeding rates for a mix suitable for a sandy arid site

- In this example, 3 species were determined to be appropriate and available: Indian ricegrass (IR), black grama (BG), and sand dropseed (SD). A simple mix would apportion each species 33%; however, based on the reasoning below the percentages have been altered.
- Indian ricegrass has a large seed and high dormancy. It is assumed to have a fairly high likelihood of establishment so it does not have to be a major component of the mix. Black grama is an expensive small seed, so cost dictates that it should be a minor component. Sand dropseed is cheap and very small. Few of its seed will likely establish so its rate was increased. The mix percentages developed based on these cost, seed size, and likely germination assumptions are IR 25%, BG 15%, and SD 60%.
- Using the recommendation of 40 PLS rate per square foot for the total mix, the mix proportions yield the following PLS per square foot: IR 10, BG 6, and SD 24 pure live seed per square foot.
- The number of PLS per acre is calculated by multiplying the PLS/ft^2 by 43,560 ft^2/acre. These calculations yield the following PLS per acre: IR 435,000, BG 260,000, and SD 1,050,000 pure live seed per acre.
- The pounds PLS per acre are determined by dividing the number of PLS/acre by number of PLS/pound from the table above. The number of PLS pounds per acre are IR 2.7, BG 0.20, and SD 0.19 pounds pure live seed per acre.
- The hypothetical results from seed testing for the pure live seed (PLS) fractions are IR 0.70, BG 0.40, and SD 0.85 pure live seed per unit of bulk seed.
- The quantity of bulk pounds per acre can be calculated by dividing the PLS pounds/acre by the PLS fraction as follows: IR 3.9, BG 0.50, and SD 0.22 bulk pounds per acre.

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