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 (this concept and supporting information presented by I. Noy-Meir, 1973, Desert Ecosystems: Environment and Producers. Annual Review of Ecology and Systematics 4:25-51).

- 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 will be greater for coarse-textured soil than for fine-textured soils.

Revegetation Seeding Rates and Mixes

- *20 to 40 pure live seed (PLS) per square foot – drilled seed*. Seeding rate studies have shown that seeding rates in excess of 40 PLS (pure live seed as determined from seed testing) seed per lineal foot for drilled seed do not generally provide any benefit. If a seed mix is expensive, then a rate of 20 PLS per foot might be adequate (depending on the species, seed costs can range from a minor to a substantial portion of the overall seeding process).
- *40 to 60 PLS per square foot – broadcast*. When broadcasting seed, higher rates are usually recommended because fewer of the seed will end up at optimum burial depth.
- *Recommended total seeding rate for a mix – 40 to 60 PLS*. 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.
- *Common usage – 40 PLS per square foot.*

An example of seed mix calculations for a species mixture adapted to an arid sandy site. 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.

Common Name	No. of PLS/Pound PLS	Moisture Use	Availability	Relative Cost (per pound)
Indian ricegrass (IR)	160,000	very xeric	yes	medium
Black grama (BG)	1,300,000	very xeric	maybe	high
Sand dropseed (SD)	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	?	–

- Species mixture based upon adaptation and availability
- Selected mix percentages based on cost, seed size, and likely germination – IR 25%, BG 15%, SD 60%
- PLS rates per square foot (based on mix proportions and a total of 40 PLS/ft^2) – IR 10, BG 6, SD 24
- Number of PLS per acre (PLS/ft^2 x 43,560 ft^2/acre) – IR 435,000, BG 260,000, SD 1,050,000
- Pounds PLS per acre (number of PLS/acre divided by number of PLS/pound) – IR 2.7, BG 0.20, SD 0.19
- Hypothetical pure live seed (PLS) from seed testing – IR 0.70, BG 0.40, SD 0.85
- Bulk pounds per acre (PLS pounds/acre divided by PLS fraction) – IR 3.9, BG 0.50, SD 0.22

For additional information about seeding native grasses, contact the Los Lunas Plant Materials Center at 505-865-4684.

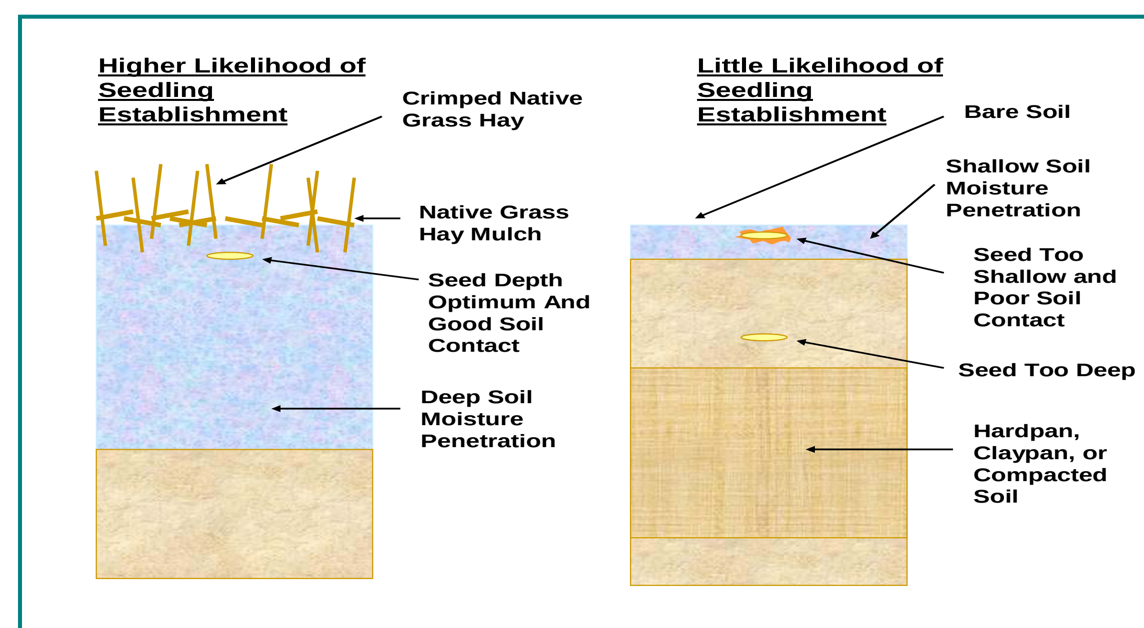
Basic Guidelines for Seeding Native Grasses in Arid and Semi-Arid Ecoregions

David R. Dreesen, Agronomist
USDA-NRCS Plant Materials Center
Los Lunas, NM

Grass seeding is an uncertain endeavor even in the best of circumstances, but in the arid Southwest it is an extremely risky venture. New Mexico USDA-NRCS standards and specifications for critical area planting and range planting provide detailed information on seeding native grasses. This brochure is intended to present the important factors that influence the success of seeding native grasses in the arid and semi-arid Southwest. 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).

- *Seed Depth – Emergence versus moisture*. The depth of seed placement is a critical factor; the goal is to balance shallow seeding depths to allow high rates of emergence versus better soil moisture conditions found with increasing depth which are critical to seedling survival.
- *Dormancy – An advantageous trait for seed to persist for later precipitation events or future years.* If less than optimum moisture conditions have allowed most seed to germinate but then die of desiccation, the presence of some dormant seed can be advantageous because it provides a reserve of viable seed.
- *Soil Compaction – Survival is dependent on rapid root extension*. The ability of seedling roots to follow the downward drying front can be inhibited by shallow compaction zones or claypans.
- *Seed to Soil Contact – To facilitate imbibition of soil moisture by seed*. Large soil voids can prevent adequate seed to soil contact and reduce upward capillary movement of soil moisture that can retard germination and growth
- *Moisture Relations and Soil Texture – Infiltration depth versus water holding capacity*. Without a doubt, the most important factor in arid ecoregions is soil moisture. The influence of soil texture on the depth of moisture penetration can be a key variable in seeding success.
- *Mulch – Essential in arid regions*. A layer of mulch retards evaporation, reduces wind and water erosion, and aids infiltration; mulching provides the maximum benefit from the small amount of precipitation received in arid climates. Application of the proper amount of weed-free material is important.
- *Weed Control – Limit the weed seed bank.* Dense stands of annual and perennial weeds can out-compete seedling grasses for soil moisture, light, and nutrients, and prevent establishment.
- *Grass Types and Planting Dates – Cool-season (CS) versus warm season (WS)*. The type of photosynthetic pathway determines the optimum temperatures (70-75^{o}F for CS and 85-95^{o}F for WS) and temperature limitations (40^{o}F for CS and 55^{o}F for WS) for growth and germination (these optima and limits are adapted from K.J. Moore et al. in Warm Season Grasses, Agronomy Series 45 and C.J. Nelson in Cool Season Grasses, Agronomy Series No. 34).

Seeding scenarios that either favor or hinder grass seedling establishment.



Seeding Depth for Optimal Emergence Under Ideal Moisture Conditions

- Recommended seeding depths for most native grasses are ¼- to ½-inch deep. However, some large seeded native species (such as wheatgrasses) can be seeded somewhat deeper – between ½- and 1- inch deep.
- Some extremely small seed, 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.
- A few species can emerge successfully from deep burial (as much as 2 inches), including Indian ricegrass.

Seeding Grasses and Weed Control

- *Reduce the weed seed bank in the surface soil by controlling weeds for several years prior to seeding on severely weed-infested sites (herbicides, mowing, burning…).* Do not 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 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.
- *Apply pre-emergent herbicides before weed emergence, or apply post-emergent broadleaf herbicides 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.
- *Mow weeds in grass sward before annual weeds set viable seed.* After grass seedlings have become established, properly timed mowing can reduce weed seed formation and its subsequent dispersal.
- *Do not add nitrogen fertilizer at the time of seeding because weed species usually will be favored.*

This photo shows a dense stand of the annual weed *Kochia* that proliferated after the removal of saltcedar in the Middle Rio Grande Bosque.

Mulch Application After Seeding

Mulch application provides one of the few opportunities to preserve limited soil moisture; also the mulch can increase infiltration.

- *Native grass hay is the most desirable mulch for large seeding projects*. Native grass hay that is free of weed seeds is one of the most effective materials for mulching large seeding projects, and if it has some residual grass seed of locally adapted species, so much the better. Apply mulch so it is dense enough to shade the soil and prevent wind desiccation, but not so dense as to retard grass emergence (for example, apply a porous layer of hay with some soil still visible). This mulch thickness often corresponds to 1 to 2 tons per acre. In addition, the hay should be crimped into the soil to minimize loss of hay by wind or water erosion.
- *Hydromulch wood fiber and erosion control blankets.* Hydromulch and erosion control blankets are expensive, but they may be the only effective mulch alternatives for steep slopes. Tackifiers added to the slurry are required to glue the hydromulch in place, and staples or pins are required to secure blankets.
- *Wood or bark chips.* Wood and bark chips can be effective mulches if applied in a thin layer after 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 also incorporating excessive amounts of litter into the soil.
- *Gravel mulch*. Even gravel or rock mulch can be effective if not applied too thickly. For example, a thin layer of gravel mulch can aid the emergence of the native grass galleta while 1½- to 2-inches can prevent its emergence.

Precipitation – The Master Input

Precipitation is the “master input” controlling biological processes in arid and semiarid regions.

- *Pattern of soil moisture availability*. The pattern of soil moisture after the initial, biologically-significant rain will determine the fate of the seeding. Most native grasses will germinate following this moisture event. It is important that <u>either</u> emerging seedlings have sufficient vigor to survive the first dry period, <u>or</u> 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.
- *Species with variable timing of germination will be favored in arid environments.* The chances of some seed germinating at the most opportune time for establishment is increased by seeding species that germinate only partially after the initial moisture event. The remaining viable seed will be available for germination during later significant moisture events.
- *Consistent rainfall*. Because warm-season grasses require warm soil temperatures to germinate (greater than 60^{o} F), they try to establish during seasons when the evaporative loss of soil moisture is, as a rule, high. A steady rainfall pattern is needed to provide sufficient amounts of moisture for germination, root development, and eventual establishment. Temperature and precipitation summary (TAPS) data (http://www.wcc.nrcs.usda.gov/climate/climate-map.html) is available for weather stations in most counties and presents the variability in monthly precipitation totals and the expected frequency of 0.1 inch events.

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 (the following data was adapted from I. Noy-Meir, 1973, Desert Ecosystems: Environment and Producers. Annual Review of Ecology and Systematics 4:25-51).

- Following a precipitation event in arid regions, the moisture in the top 2- to 4-inches of soil can dry out very rapidly. This happens because of a high-evaporative demand from high solar input, low humidity, and drying winds (little water remains available for plant uptake).
- Deeper soil moisture (4- to 12-inches deep) can persist for several weeks.
- Moisture under unsaturated conditions at depths below 12-inches is primarily used for plant transpiration with very little moisture lost to evaporation or deep drainage.