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Influence of Seeding Method and Seed Mix Diversity on Native Plant Restoration Success Following Oil and Gas Pipeline Installation in South Texas

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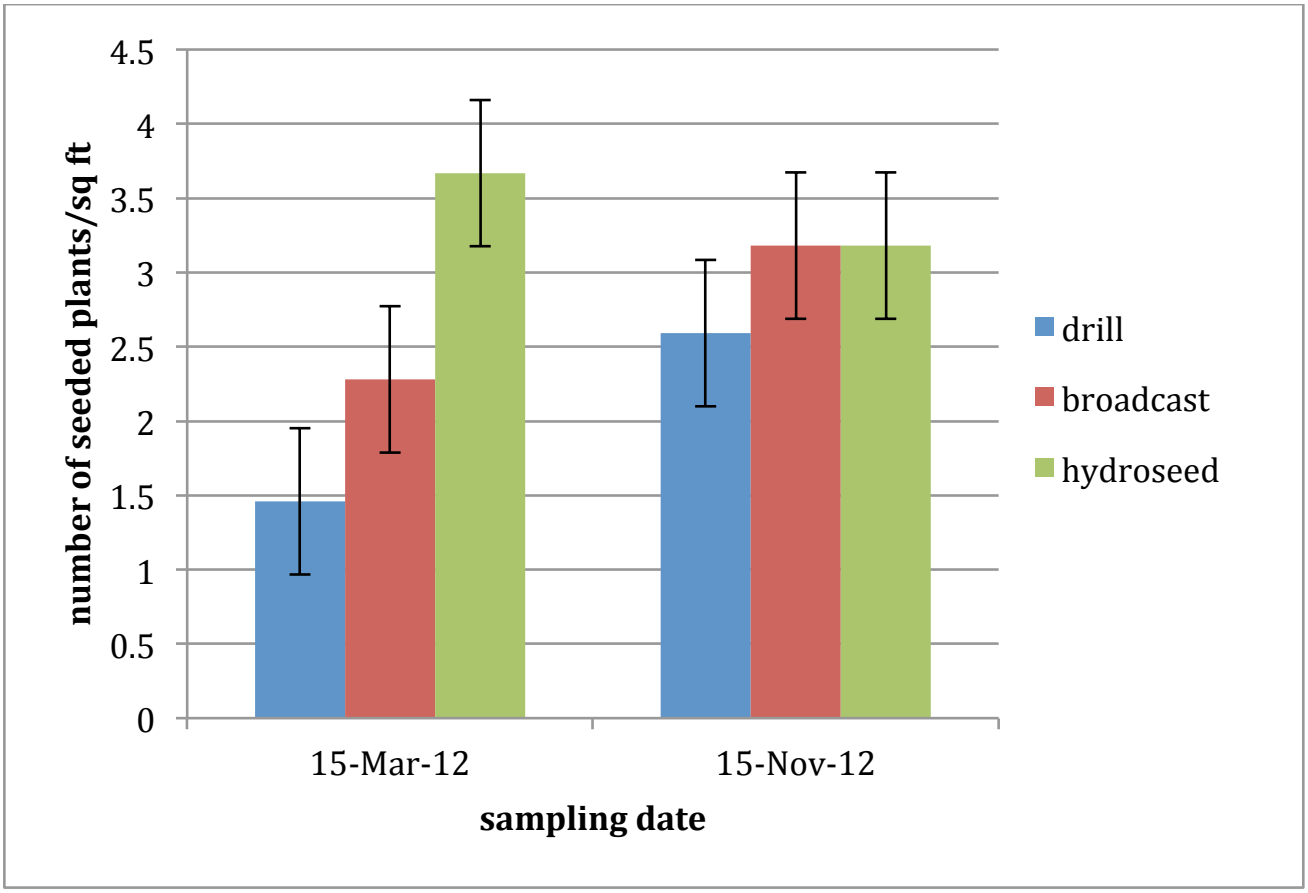

Figure 1. Seeded plant density of the three different planting techniques 3 and 9 months post planting.

Oil and gas production activities are often met with mixed emotions by private landowners in southern Texas. There is the obvious financial benefit to the landowner, but there is also the associated loss of wildlife habitat. Seeding method and seed mixture diversity are two key considerations for successful native plant reseeding to mitigate wildlife habitat loss. *South Texas Natives* (STN) has done considerable research to provide answers to frequent questions about these topics in relation to oil and gas production in southern Texas.

South Texas Natives is a project of the Caesar Kleberg Wildlife

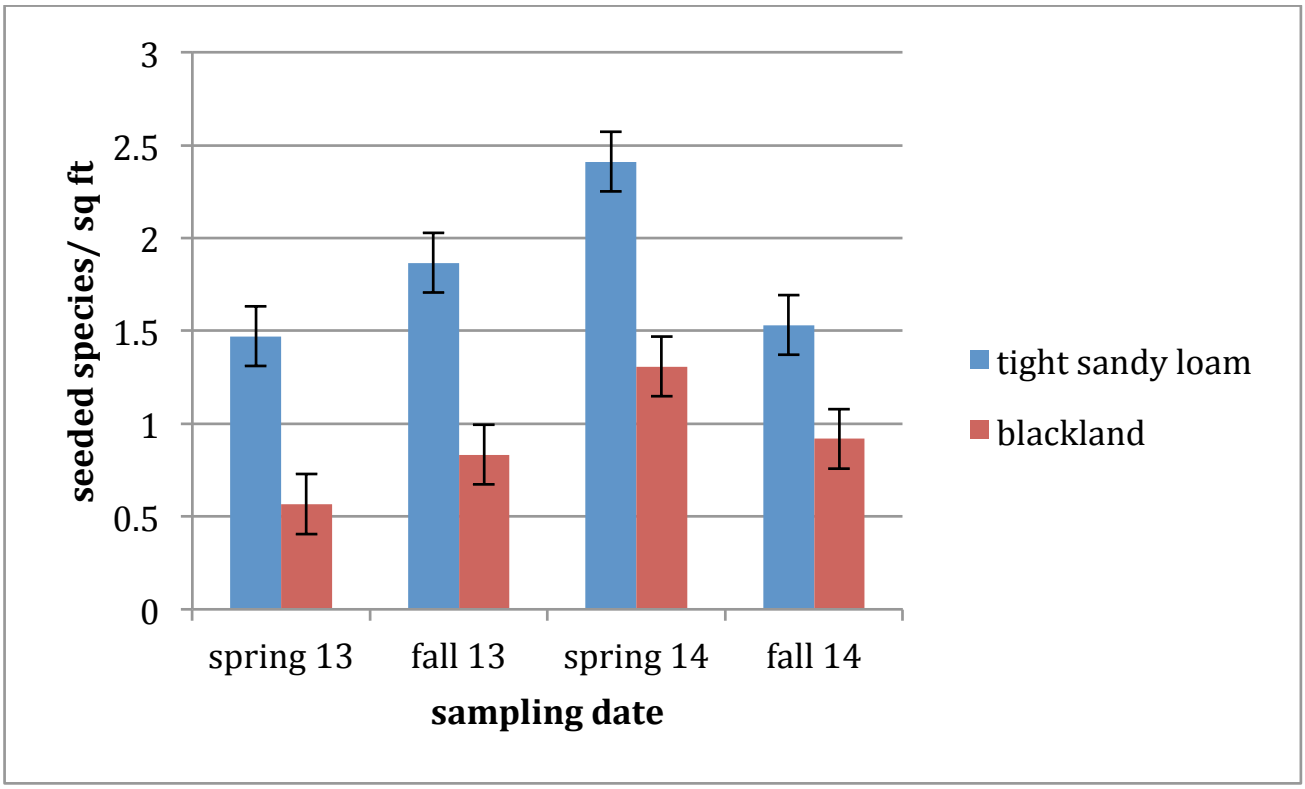

Figure 4. Seeded plant density of both seed mixes at all sampling dates.

Research Institute at Texas A&M University-Kingsville. STN's mission is to develop and promote native plants for the restoration and reclamation of habitats on private and public lands. In order to achieve this mission, STN develops ecotypic native seed germplasms for use in southern Texas, works with commercial seedsmen to ensure that adequate supplies are produced for restoration projects, and researches effective planting techniques using the released seed sources. To date, STN and its collaborators have released 25 ecotypic native seed germplasms for use in southern Texas, which have resulted in commercial seed for restoration plantings on 20,000-50,000 acres annually. Prior to the first releases made by STN, there was little to no native plant material available that was adapted to southern Texas for use in restoration and reclamation projects.

The need for STN was created by a paradigm shift that has occurred over the last 20 years in southern Texas where many landowners shifted primary land use from livestock production to recreation including fee- or lease-hunting of wildlife. This land use shift influenced a gradual change away from planting non-native forage species for restoration to the current use of "wildlife habitat friendly" native species. Coupled with the discovery and exploration of the Eagle Ford Shale oil and gas play necessitating large

Figure 2. Pipeline ROW planted with a diverse ecotyipc seed mix on the right side of the post and unseeded areas left of the post.

Figure 3. Pipeline ROW in Wilson County following planting.

amounts of land reclamation activity, land use changes have resulted in an immediate need for ecotypic native seed, effective seeding technologies, and educational efforts to inform land owners and managers of new products and technologies.

In order to meet these goals, STN in collaboration with Texas A&M Agrilife Extension, Texas Parks and Wildlife Department, and the United States Department of Agriculture-Natural Resources Conservation Service (USDA NRCS), conducted two separate plantings on newly constructed pipeline rights-of-ways (ROWs) in the Eagle Ford Shale region of southern Texas. We evaluated four different seeding techniques and three different seed mixes on two different private ranches affected by newly constructed ROWs. These plantings were installed with the purpose of testing the ability of native plants to be used in restoration necessitated by oil and gas activities.

Live Oak County, Texas Pipeline ROW Restoration Project

The first planting was conducted approximately 10 miles north of Three Rivers, TX, in Live Oak County. This planting was designed to compare broadcast seeding, drill seeding, and hydroseeding on three different soil types. Plantings were completed on February 27, 2012 and were seeded using the same seed mix containing 23 species of native grasses, forbs, and legumes. The seed mix for this project consisted of 75 percent early and mid-successional plants in the hopes of quickly establishing cover. The remaining 25 percent of the seed mix was split evenly between late successional grasses, forbs, and legumes. All seed sources included in the seed mix were developed by STN, and all are currently produced by commercial seedsmen. Three days prior to planting, the nine 0.18-ac plots were laid out and sprayed with a mixture of glyphosate and 2,4-D amine herbicides at a rate of 22 oz/acre and 6 oz/acre, respectively. Seeding was conducted in three ways. Broadcast seeding was done with a seeder mounted on a tractor. Drill seeding was done with a Truax Flex II no-till drill. Hydroseeding was conducted with a Finn T120 hydroseeder with a 70/30 wood fiber/cellulose hydromulch blend produced by Second Nature® applied at a rate of 2,500 lbs/acre (Pawelek et al. in press).

Each planting technique was replicated on three different soil

Figure 5. Restored pipeline ROW in Wilson County 1 year post planting.

Figure 6. Diverse plant community established on a restored pipeline ROW in South Texas.

types. Site one was a Pavelek clay loam, which is classified as shallow ridge ecological site and is characterized by a gravelly loam surface texture over hard caliche. The second site was a Choke silty clay loam, a deep calcareous fine sandy loam or sandy clay loam characterized as a gray sandy loam ecological site. The third site was a Rosenbrock clay, which is a deep fertile clay in the rolling Blackland ecological site (Soil Survey Staff 2014).

Data were collected bi-annually in spring and fall beginning in spring 2012. Vegetation sampling was done using a five-square-foot frame to count plant density at 25 random locations in each treatment plot. All plant species rooted within the frame were identified and counted.

Rainfall at this site was favorable for plant establishment with the site receiving 7 in. of rain in the first three months post seeding. All planting methods were successful in terms of acceptable establishment of seeded species within three months post planting according to the USDA NRCS range planting practice standards (USDA NRCS 2014), which was used as our criteria for evaluation. NRCS rates a planting successful when it has at least 0.5 seeded plants per square foot by one year after seeding. At the first sampling date (May 15th 2012), there were no differences in plant density of seeded plants among the three soil types. Differences were found for the density of seeded plants among the three different seeding methods at the first sampling date. Hydroseeding averaged 3.67 seeded plants/ ft^2, which provided 60 percent more seeded species than drill seeding (1.46 seeded plants/ft^2) (Figure 1). Broadcast seeding was not different than the other two seeding treatments averaging 2.28 seeded plants/ft^2. By the second sampling date (nine months after seeding), there were only small differences among techniques having only 0.5 plants/ft^2 difference among all three treatments (Figure 1). Although we found no differences in the number of seeded species per square foot, there were differences in species composition documented among the soil types.

Overall results from this study site showed that successful establishment of ecotypic native species can be accomplished with all three seeding techniques on Eagle Ford Shale ROWs. The effects of seeding technique on establishment are similar to those seen by other researchers throughout the U.S., who have reported that given adequate moisture, a variety of seeding techniques can

be successful (Hardegree et al. 2011). Observationally, areas seeded with the diverse mix of ecotypic native seed out performed unseeded areas adjacent to our research plots in terms of vegetation coverage (Figure 2).

Wilson County, Texas Pipeline ROW Restoration Project

The second pipeline reseeding project was conducted approximately 20 miles east of Floresville, TX, in Wilson County. This project was a factorial experiment designed to examine the differences in establishment between two different seed mixes on two different ecological sites using two different planting techniques. We planted both seed mixes with both seeding methods in two plots at each site. The first mix was a "high diversity mix" (HDM) and was made up of 31 native grasses and forbs. The second mix was a "grass only mix" (GOM), which would be considered a standard ecotypic native seed mix used presently on many ROWs. This mix was made up of 10 of the most common native grasses that are medium to short in stature.

The two seeding techniques used in the project were drill seeding using a Truax Flex II® native seed drill and broadcasting using a Trillion® broadcast seeder. The two ecological sites included in this project were a tight sandy loam and a Blackland. The Blackland site has soils that are deep, dark-colored calcareous clays with large water holding capacity and high shrink-swell properties. The tight sandy loam site has very deep, well-drained sandy clay soils (Soil Survey Staff 2014). Similarly to the project in Live Oak County, this ROW was sprayed with a mixture of glyphosate and 2,4-D prior to planting to control emergent weedy vegetation prior to planting. At this location herbicide was applied on February 26, 2013, and seeding was conducted on March 6 (Figure 3).

Data were collected in the same manner as the Live Oak county project beginning June 2013, approximately three months post-seeding. At three months post-seeding, all treatment combinations had successful (≥0.5 seeded plants/square foot) establishment as per NRCS standards. Unlike the Live Oak project, here we saw no seeding treatment effect at any sampling date. Thus, for the purpose of comparing seed mixes and ecological sites, data collected from planting methods were combined. There also was no difference in density of seeded species between the two seed mixes throughout the length of the study. Although there were no differences in plant density between the two seed mixes, with the HDM mix averaging 1.4 seeded plants/ft^2 and the GOM averaging 1.2 seeded plants/ft^2, there was a significant difference in the number of seeded species that established, with the HDM averaging 10 seeded species/plot, almost twice as many species as the GOM which averaged 6 seeded species/plot.

We found a difference in seeded species density between the two ecological sites at each sampling date. The Blackland site had plant densities that ranged from 0.57 to 1.3 seeded plants/ft^2, while on the tight sandy loam site plant densities ranged from 1.4 to 2.4 seeded plants/ft^2 (Figure 4). A difference in seeded species establishment was also observed between the two sites with the tight sandy loam site averaging 9 species while the Blackland site averaged 6 species.

Results from this study reaffirm the ability of ecotypic native seed material to be used successfully in the revegetation of oil and gas pipelines. It is also interesting to note that even though the less diverse seed mix was successful at establishing vegetation, fewer seeded species established. This result is similar to those found by Piper (2014) who found that there was little increase in seeded species cover between a 12- and 20-species seed mix, but there were more species observed in the higher diversity mix. The higher number of seeded species could result in more wildlife use or ability to withstand invasion by exotic grasses (Falk et al. 2013). It is also of note that although there were three times as many species in the HDM there were on average less than twice as many species that established. Although the higher number of seeded species in the HDM would seem inherently true, Grman and Brudvig (2014) found that only at large spatial scales and in favorable growing conditions did increased seed mix diversity

increase beta diversity. This site also showed a large difference between restoration results between the two adjacent ecological sites. We suggest these differences show the need for diverse seed mixes to maximize performance across variable soil types that might occur along the length of a linear reclamation site such as a pipeline ROW (Figures 5 and 6).

These two projects provide practical guidance to reclamation practitioners in several regards. First, ecotypic native seed sources are capable of meeting revegetation needs on new oil and gas pipeline ROWs in southern Texas in as little as three months post-planting given adequate moisture. Secondly, multiple planting techniques can be used successfully to establish native seeds in oil and gas pipeline ROWS. Third, the higher seed mix diversity, the better the chance that a single seed mix will provide adequate cover across multiple soil types or ecological sites. This should help enhance success and provide more diversity on the landscape.

Caesar Kleberg Wildlife Research Institute manuscript number 15-111.

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