POTENTIAL FOR USING MYCORRHIZAL PLANTS TO REVEGETATE TEXAS HIGHWAY RIGHT OF WAYS

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ABSTRACT

The use of mycorrhizal plants to revegetate Texas highways is being studied. Construction of a highway produces an environment with tremendous environmental problems for revegetation, which limits plant establishment. An important objective in revegetating highway right of ways is establishing more desirable sod cover crops and native plants, particularly on adverse cut and fill slopes. Mycorrhiza are by definition the beneficial symbiotic association of a fungus with the roots of a plant. Mycorrhizal fungi improve survival and establishment of revegetation plants under adverse sites. Use of mycorrhizal plants is one potential technique for improving the establishment of highway vegetation under difficult Texas environmental conditions with minimal maintenance.

For the past two years research has involved studying use of mycorrhizal fungi in revegetating Texas highway sites near Austin, Beaumont, Winnie, and Kerrville. To date the study has revealed that the two Austin highway sites and Kerrville site II caused greatest revegetation problems due to slope of the sites, soil texture, and the potential for soil erosion. Tests to determine mycorrhizal activity were done with bioassays utilizing green sprangletop (Bouteloua curtipendula) sideoats 'El Reno' (Leptochloa dubia) and bermudagrass (Cynodon dactylon). Bermudagrass showed the greatest colonization which could be of practical importance in ultimately reducing fertilization practices of bermudagrass stands. Green sprangletop, sideoats, and bermudagrass had nearly 100% survival in all highway sites. Mycorrhizal plants in Austin site I responded better than in site II and greater plant growth occurred in all mycorrhizal colonized grasses at low vs zero fertility levels. Survival of Mondale pines was from 30% - 80%. At the two Kerrville

highway sites mycorrhizal treated green sprangletop, sideoats, and bermudagrass had better stands than non-mycorrhizal plants. An interesting observation was that nonfertilized mycorrhizal grasses had comparable growth to fertilized nonmycorrhizal grasses. Mycorrhizal Chinese Tallow (Sapium sebiferum) had more dramatic growth differences than Live Oak (Quercus virginiana). Greenhouse fertility x mycorrhizal studies have shown increased growth of grass species with increasing fertility levels; mycorrhizal colonized plants had greater growth than noninoculated controls.

IMPLEMENTATION STATEMENT

Results indicate a growth benefit to mycorrhizal inoculated grasses and woody revegetation plants, particularly at zero fertility levels. Evaluations are being conducted to determine survival and plant stand over the next two years in selected Texas highway right of way sites.

FUTURE PLANS

Future plans call for testing new transplanting and seeding systems with mycorrhizae for highway plantings of native Texas grass and woody plant species such as Texas madrone, mountain laurel, oaks, evergreen sumac, tall grama, etc. There is a need to develop practical methods for incorporating mycorrhizal fungi during seeding of highway sites.

In summary great benefits can result from utilizing new seedage and transplanting techniques which incorporate mycorrhizae in highway plantings. There are excellent Texas herbaceous and woody plants that diversify the landscape, add to roadside stability, are tolerant of adverse highway sites, yet require minimal maintenance and establishment costs. This research is showing that mycorrhizal fungi improve the initial establishment and growth of these plants.

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Construction of a highway produces an environment with tremendous problems for revegetation. The two most important reasons for revegetating along highways are to reduce erosion and minimize drainage water pollution.

It is important to note that only living roots of perennial plants (grasses, legumes, herbaceous flowers, and woody species) have the necessary soil binding qualities to satisfactorily prevent slope erosion and water pollution.

HIGHWAY REVEGETATION PROBLEMS

An important objective in revegetating Texas highway right of ways is establishing more desirable sod cover crops and native plants, particularly on adverse cut and fill slopes. Construction on a highway leads to newly exposed sub-soil layers which may be biologically void, have no microbes to aid in soil weathering and no beneficial mycorrhizal fungi to enhance plant growth. Other factors which stress plants and limit their growth in the diverse highway sites in Texas are inadequate soil moisture, poor soil structure, abnormally high soil temperature, and insufficient fertility.

Due to these problems the selection of plant material capable of surviving on highly disturbed sites is presently severely limited. New propagation, production, seeding, and transplanting techniques are needed to improve the survivability and establishment of more desirable roadside plants.

USE OF MYCORRHIZAL FUNGI IN REVEGETATION

By definition, "mycorrhiza", is the beneficial symbiotic association of a fungus with the roots of a plant. All potential Texas highway revegetation plants will naturally form beneficial associations with mycorrhizal fungi, provided the fungi are already in the soil or they are incorporated during seedage or transplanting. Use of mycorrhizal plants is one potential technique for improving the establishment of vegetation under minimal maintenance. This technique may eliminate or reduce the high energy input costs of fertilizer, water, and the labor needed in repeated application of nutrients and irrigation to plants, as well as repeated planting in adverse sites.

Nearly all important plants have beneficial symbiotic relations with mycorrhizal fungi under natural conditions. It is well documented that mycorrhizal fungi can increase plant growth and survival by making the plant more efficient in taking up water and nutrients from the soil, and improving plant tolerance to temperature, water, nutritional and disease stress (2, 4, 7, 8).

Newly distributed highway and strip mine soils have virtually no viable mycorrhizal spores present (4, 5, 6, 9). However, the potential benefits of utilizing mycorrhizal fungi for revegetating disturbed highway and strip mine soils are known (1, 3, 9).

There are some excellent native Texas herbaceous and woody plants that need to be considered for highway sites, in conjunction with mycorrhizal fungi. Some of these plants include green sprangletop (Bouteloua curtipendula), sideoats 'El Reno' (Leptochloa dubia), tall grama (Bouteloua pectinata), Texas mountain laurel (Sophora secundiflora), Live oak (Quercus virginiana), and Texas persimmon (Diospyros texana). In-

corporating mycorrhizae could improve existing highway vegetation and increase transplanting success, seeding, and survial of more desirable plant species.

Managing naturally occurring mycorrhizal-plant relationships is a potential low cost method of (1) improving revegetation results associated with highway maintenance-construction programs, (2) improving drought and nutritional tolerance of existing highway vegetation and, (3) diversifying the Texas highway landscape by increasing stands of more desirable plants.

RESULTS TO DATE

For the past two years research has involved studying potential use of mycorrhizal fungi in Texas highway sites near Austin, Beaumont, Winnie, and more recently in Kerrville. To date the study has revealed that the two Austin highway sites and Kerrville site II caused greatest revegetation problems due to slope of the sites, soil texture, and the potential for soil erosion.

Tests to determine mycorrhizal activity were done with bioassays utilizing green sprangletop, sideoats 'El Reno' and bermudagrass. These tests indicated mycorrhizal activity in all five sites: Winnie, Austin I and II, Kerrville I and II; however, few viable spores were found in the three adverse sites. Mycorrhizae identified as Glomus spp. were present in soil samples.

Bermudagrass showed the greatest colonization which could be of practical importance in ultimately reducing fertilization practices of bermudagrass stands. Green sprangletop, sideoats, and bermudagrass had nearly 100% survival in all highway sites. Mycorrhizal plants in Austin site I responded better than in site II and greater plant growth occurred

in all mycorrhizal colonized grasses at low vs zero fertility levels. Survival of Mondale pines was from 30% - 80%, but species more adapted to the climatic conditions of Texas need to be examined in future studies.

Revegetation species were evaluated in September 1983, at the two Kerrville highway sites. The second site was the most difficult due to the slope and soil texture, however, with no fertilization, mycorrhizal treated green sprangletop, sideoats, and bermuda grass had better stands than nonmycorrhizal plants. An interesting observation was that non-fertilized mycorrhizal grasses had comparable growth to fertilized nonmycorrhizal grasses. Mycorrhizal Chinese Tallow (Sapium sebiferum) had more dramatic growth differences than Live Oak (Quercus virginiana).

Greenhouse fertility x mycorrhizal studies have shown increased growth of grass species with increasing fertility levels; mycorrhizal colonized plants had greater growth than noninoculated controls.

Chemical analysis of tissue is currently being done. Results indicate a growth benefit to mycorrhizal inoculated grasses, particularly at zero fertility levels. Evaluations will be conducted to determine survival and plant stand over the next two years.

FUTURE PLANS

Future plans call for testing new transplanting systems with mycorrhizae for highway plantings of native Texas grass and woody plant species such as Texas madrone, mountain laurel, oaks, evergreen sumac, tall grama, etc. There is a need to develop practical methods for incorporating mycorrhizal fungi during seeding of highway sites.

In summary, great benefits can result from utilizing new seedage and transplanting techniques which incorporate mycorrhizae in highway

plantings. There are excellent Texas herbaceous and woody plants that diversify the landscape, add to roadside stability, are tolerant of adverse highway sites, yet require minimal maintenance and establishment costs. This research is showing that mycorrhizal fungi improve the initial establishment and growth of these plants.

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Fig. 1. Gullies and rills caused by erosion in a steep Texas highway site.

Fig. 2, 3. Transplanting herbaceous woody plant revegetation species in a site with a steep slope and undesirable soil texture.

Fig. 4. Four months of herbaceous and woody species planted in late spring in Kerrville highway site II.

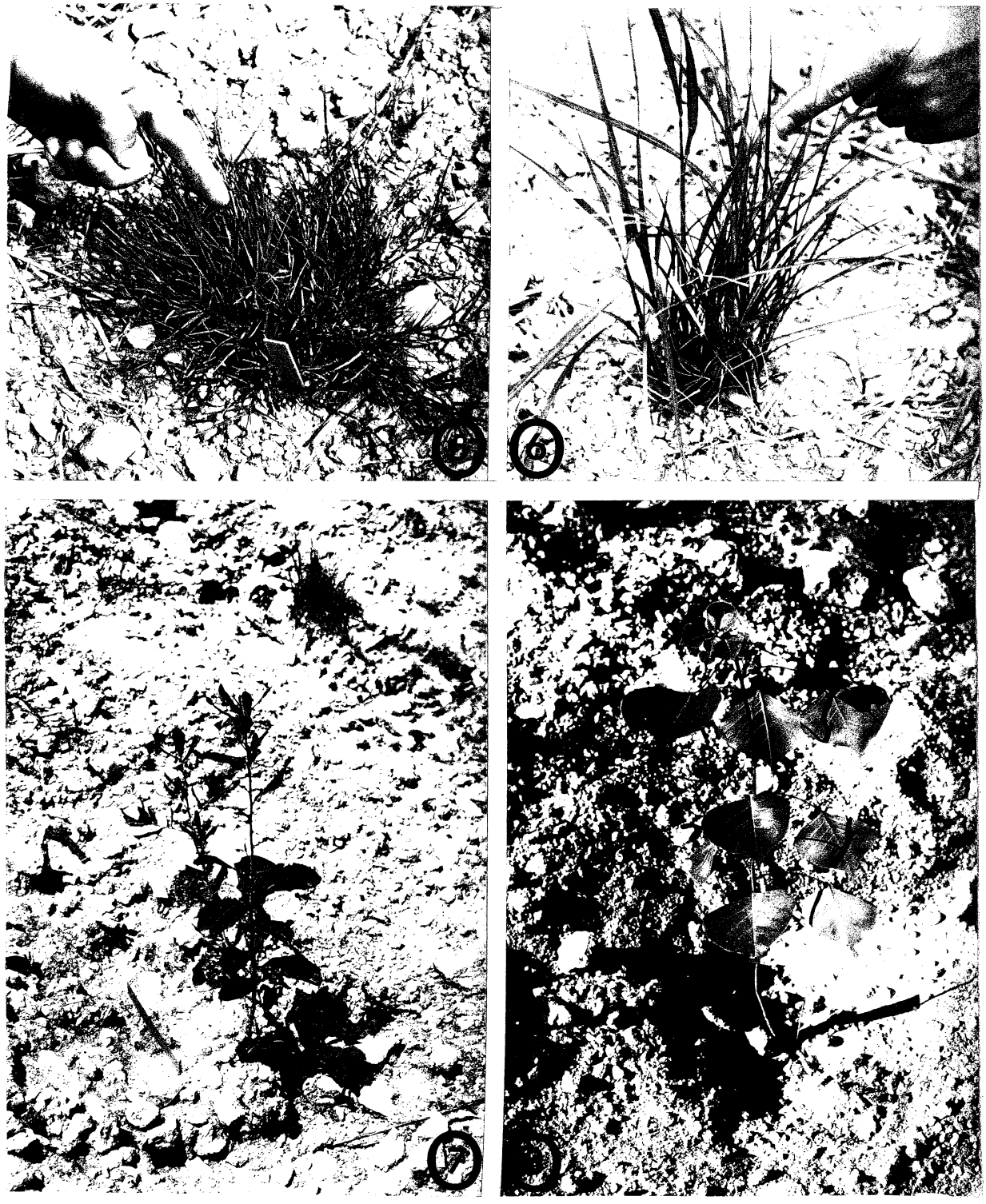

Fig. 5-8. Mycorrhizal fungi treated revegetation species planted in Texas Highway sites: 5. Bermudagrass, 6. Green Sprangletop, 7. Live Oak, and 8. Chinese Tallow.