PROBLEMS IN ESTABLISHING OR MAINTAINING VEGETATION ON ROADSIDES

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ABSTRACT

Tests were installed during the period 1968-70 to investigate the modification of roadside soil materials restricted by physical or chemical characteristics limiting plant growth, to determine the utility of plant materials for roadside use, and to develop chemical treatments for controlling unwanted vegetation.

A plasticity index (PI) value greater than 16 signifies a poor tendency toward granulation and other properties desirable in a plant growth medium. This physical condition can be modified in some, but not all, cases by admixing agricultural gypsum, certain cationic polymers and polyurethane.

Sediments contained in materials from the Weches and Queen City formations may show pH as low as 1.8. This extreme acidity can be neutralized by lime applications as high as 50 tons per acre, based on potentiometric titration, to establish a vegetative cover. Maintenance surface lime applications, beginning 3 years after initial treatment, will be required to retain the sod cover.

Seedings in Texas for erosion control can be extended to the 15-inch isohyet provided the soil material is sandy, not extremely saline, and competitive plants are controlled.

Buffalograss at this time should be seeded in a mixture of other materials adapted to northwestern Texas, rather than alone.

Perennial weeds growing in shoulder pavements were controlled by program sprays of fenac/dicamba combined with either prometone or bromanil. Mowing adjacent to median plantings may be facilitated by a combination contact-pre-emergence treatment.

Key words: erosion control, soil acidity, liming, soil granulation, plasticity index, potentiometric titration, prometone, bromoxynil, fenac, dicamba, herbicides.

IMPLEMENTATION STATEMENT

These studies on vegetation establishment and vegetation control have produced the following results which should be considered:

1. Plantings for erosion control are feasible to a line extending south from the western boundary of the Panhandle. Seedings should be restricted to sandy materials which are not salty.

2. Mulching material containing seeds which will germinate and compete with seeded stands should not be used.

3. Buffalograss should be continued as a component of seeding mixtures in northwestern Texas. Treated seed should be specified if the premium is not great.

4. The treatments specified for perennial weeds should not be used where crops or other plants may be damaged.

Work is continuing on modification of restrictive soil properties and to develop herbicidal treatments for perennial weeds and maintenance of landscape plantings.

INTRODUCTION

Vegetation on a right-of-way is both an asset and a liability. A living pavement of vegetation protects roadsides against erosion. On the other hand, plants growing in an asphaltic pavement accelerate breakup of the surface or become nuisances in other ways. Consequently, establishment, maintenance and control of vegetation within the highway facility are management operations based on judgments derived from research and experience.

This report describes tests underway to establish a cover of desired plants to control unwanted vegetation.

PART A: VEGETATION ESTABLISHMENT

SOIL AND CLIMATE PROBLEMS

Highly plastic clay materials found on roadsides throughout eastern and less commonly in other parts of Texas are poor growth media for plants. These clay materials swell and shrink with wetting and drying, and lack the porosity to provide the aeration and moisture needed for plant growth. In an earlier report (McCully and Bowmer, 1969), we showed that grass establishment could be related to the plasticity index (PI) of the soil material. Only marginal results were obtained where the PI exceeded 15; no plants were established where the PI was 25 or greater. The problem facing the engineer is the creation of an "instant" soil from the plastic clay materials exposed during construction. Stockpiling topsoil and plating a slope face is an expensive operation.

Some soil materials in northeastern Texas uncovered during highway construction are too acid to support a stand of vegetation needed for erosion control. Sediments comprising the Weches and associated geologic formations contain sulfides which are converted to sulfuric acid upon contact with atmospheric conditions. The acidity of these soil materials can be as low as pH 1.8, while the lowest level plants will tolerate is in the range of pH 4.0 - 4.5.

In western Texas, establishment of vegetation for erosion control is hampered by limited rainfall and by a shortage of adapted plant materials. Additional plant materials are needed as well for the clay soils in eastern Texas.

PROCEDURES

Problem sites are selected in consultation with the contact study individual. Specific test locations are organized following inspection of the site. Plot size depends on the slope area available and the number of treatments. Where possible, replications are used to separate identifiable site features such as slope direction or obvious soil differences. Treatments are assigned, soil samples are taken and a

SUMMARY

This report describes tests installed 1968-70 to study the establishment of a grass turf for erosion control and to control unwanted plants growing in shoulder pavements and median barriers. Significant results are described. The specific objectives of this study are:

1. To determine habitat restrictions together with biological requirements, plant materials, procedures to establish a vegetative cover for erosion control.

2. To develop methods for controlling unwanted plants growing in engineering facilities.

One phase of the study considered the modification of roadside soil materials having either physical or chemical characteristics which limited or prevented establishment of vegetation. Soil materials which are poor physically have a high clay content, and a plasticity index greater than 15 seems to be associated with a poor stand of grass. Materials having a PI greater than 25 usually support few if any plants. PI, as an estimate of vegetation establishment, needs further refinement.

Materials having a high PI were treated with admixtures of lime, gypsum, and with both natural and synthetic organic materials. These admixtures were incorporated into the surface six inches of soil using a pulvi-mixer. Several materials such as gypsum, several cationic polymers and polyurethane,improved vegetation establishment in specific tests, but none was universally effective. Natural organic materials, hay and composted garbage, did not improve stands, and heavier rates were detrimental.

Acid roadside materials (pH as low as 1.8) supported a stand of vegetation after liming. Lime rates should be based on potentiometric titration rather than pH, to accommodate exchangeable acidity not measured by pH. As much as 50 tons of lime per acre are indicated for some materials. Although a satisfactory grass stand was established, maintenance liming probably will be necessary after three years. This problem is common in Weches and Queen City geologic formations uncovered by construction.

Plant materials were evaluated for use under dry conditions, for reducing mowing costs and were compared with materials presently in use. The western (dry) limits of seeding was investigated in one test. The results from this test installed at a location receiving approximately 15 inches of precipitation annually were inconclusive. Considerable grain from the straw used as much sprouted and competed with the seeded plants.

Of the plant materials compared with recommended materials, only Kleberg and Old World bluestems performed worthy of further consideration.

Buffalograss, a low sodgrass native to the plains of northwestern Texas, commonly grows intermingled with other native plants. This plant material, on the basis of our tests and other field plantings, should be retained at this time as a component of the seeding mixture rather than being planted alone.

Perennial weeds growing in asphalt shoulder pavements, especially the persistent bindweed, can be controlled by program treatment using a mixture of fenac and dicamba with either prometone or bromanil. The application of dicamba is regulated by State law.

Tests were initiated in 1969 to chemically control plants interfering with mowing near median barriers. Results to date suggest that a combination of contact and pre-emergence herbicides may be useful to control many of these problem plants.

tentative date for installation is set with the local maintenance section. Equipment, planting seed, and other needed materials and services are provided by the local section. At installation admix materials were applied, tillage was done, plant materials were applied and the planted area was mulched.

SOIL AND PLANT MODIFICATION

1. Modification of soil physical problems. Original surface soils usually have an open granular structure which favors plant growth. This condition developed over many years through weathering, incorporation of organic matter, and absence of overburden. In contrast, subsurface clayey or shaly materials on the faces of cut or fill slopes are quite massive and possess little or no structure.

Granulation of these dense subsurface materials can be induced by tillage with a pulvi-mixer or scarifier, but the granules produced are unstable and puddle back into an amorphous soil mass on wetting. These subsurface materials often lie below the soil zone occupied by plant roots, so that organic matter, a primary force in soil granulation, is lacking.

Materials selected for testing were those usually involved in soil granulation, or would either maintain granular identity or perpetuate lines of weakness generated by tillage. Grass hay, composted garbage, calcitic lime and agricultural gypsum are examples of organic or mineral materials which promote granulation. The materials listed in Table 1 are representative of a vast array of synthetic polymers used on the soil surface as anti-crusting agents. Another candidate material is polyurethane, a waste product from the manufacture of insulation board.

Table 1. Characteristics of selected synthetic polymers.

Polymer*	Molecular Charge	Manufacturer
Aqua-gro	Non-ionic	Aquatrols, Inc.
CMC	Cationic	Hercules, Inc.
Gelgard	Cationic	Dow Chemical Company
Reten 210	Cationic	Hercules, Inc.
Sparan AP 30	Anionic	Dow Chemical Company

*Trade names are used for easy identification. No endorsement of named products is intended, nor is criticism implied of similar products which are not mentioned.

Study locations are shown in Figures 1A and 1B, and rates of admixture materials are listed in Table 2. Details of these tests follow:

Taylor County 1968 (THD District 8).

This test was installed in June on subsoils of the Abilene clay series along IH 20 in Taylor and Callahan counties. These slopes ranged from 15 to 45 feet in width, and individual test plots were 100 feet long (along the center line). Soil amendments were applied randomly in each of four replications post-tillage: Aqua-gro, 50 oz/1,000 sq ft; CMC, 100 and 150 lb/A; AP-30, 100 lb/A; and Reten-210, 100 lb/A. All materials except Aqua-gro were applied dry.

Following site preparation and application of soil amendments, a seed mixture containing 15 pounds of blue grama, 5 pounds sideoats grama, 4 pounds green sprangletop, and 5 pounds of Blackwell switchgrass* per acre was applied using a hydro-seeder. Four hundred pounds per acre of 16-8-8 fertilizer were applied in the seed slurry.

Brazos County 1968 (THD District 17).

This test was installed in mid-June along FM 2818 south of FM 2374 on clay subsoils of Lufkin-Tabor soils. Plot size varied on these backslopes which were 25 to 50 feet wide and 20 to 100 feet long. The soil amendments for this test duplicated those used in Taylor County. In addition, 2 T/A of agricultural gypsum and 4 and 8 T/A of grass hay were incorporated with tillage. A randomized design with 4 replications was employed.

A seed mixture containing 4 pounds of green sprangletop and 8 pounds of hulled common bermudagrass was laid down in a slurry with 400 pounds of 16-20-0 fertilizer per acre.

Rusk County 1968 (THD District 10).

This test was installed in mid-July along FM 850 east of US 259 and along FM 1249 east of FM 2276 on clayey materials underlaying Boswell-Susquehanna or Kirvin-Bowie-Cuthbert soils. Individual plots ranged from 0.14 to 0.40 acres, depending upon the nature of the individual cut slopes. Two tons per acre of gypsum and 4 and 8 T/A of grass hay were incorporated with tillage. Aqua-gro, 50 oz/1,000 sq ft; CMC, 100 and 150 lb/A; Seperan AP-30, 100 lb/A; and Reten 210, 100 lb/A were applied post-tillage.

After the soil amendments had been applied, a seed mixture containing 4 pounds of green sprangletop and 8 pounds of hulled bermudagrass together with 400 pounds of 16-8-8 fertilizer per acre were applied using a hydro-seeder.

*Scientific names are found in Appendix A.

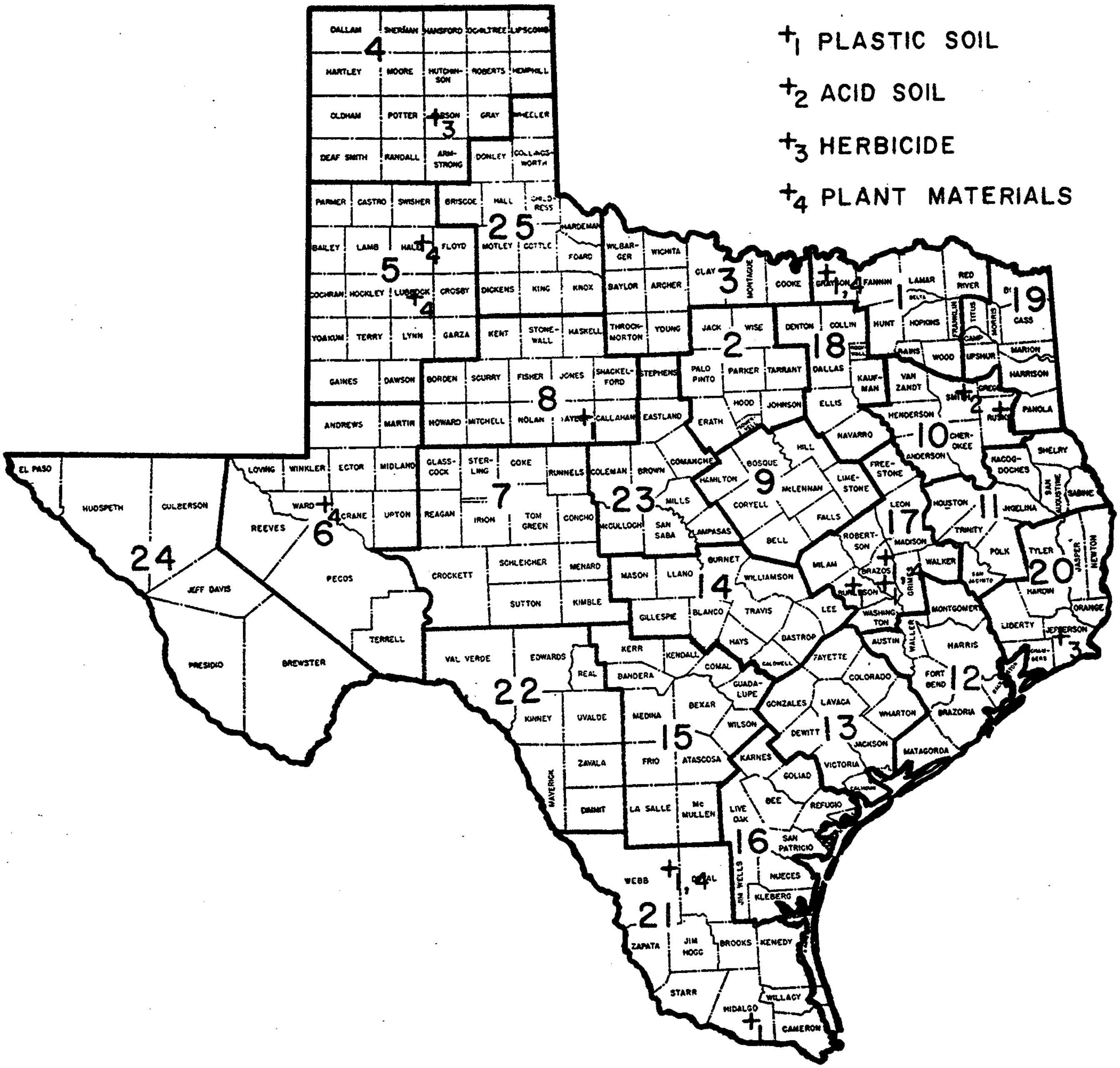

Figure 1A. The Texas Highway Department is organized into 25 districts.
Figure 1B. Location of study locations for vegetation establishment and vegetation control tests.

Table 2. Effectiveness of various soil amendments relative to the plant stand secured without treatment (+ establishment improved; 0 no advantage; - establishment depressed). If there is no entry, a particular material was not applied at that location.

Materials		Taylor County 1968	Brazos County 1968	Rusk County 1968	Burleson County 1969	Hidalgo County 1969	Webb County 1969	Brazos County 1970	Grayson County 1970
AP30	100	0	+	0					
Aqua-gro									
	100	0	+	-	-	0	0	0	+
CMC	100	0	+	0	0	0	0	0 2/	0 2/
	200	0 1/	+	0	+	+	0	0 3/	0 3/
Gelgard									
	100				0	+	0	0	0
	200				0	+	+	0	0
Gypsum									
	1 T				0	0		0	0
	2 T		+	+	0	+		0	0
Hay	4 T		0	-					
	8 T		0	0					
Lime	1 T							-	+
	2 T							0	0
Metroganic									
	2.5							0	0
	5.0							0	0
	7.5							-	0
Reten 210									
	100	0	+	-	-	0	0	0	+
	200				0	+	0	0	+
Topsoil									+
Urethane (Pre-till)									
	600				+	0	0	0	0
	1200				+	0	0		
	1800				+	0	0	0	0
Urethane (Post-till)									
	600				0	0	+		
	1200				0	0	+		
	1800				0	0	+		

1/ 150 lbs. 2/ 75 lbs. 3/ 125 lbs.

Burleson County 1969 (THD District 17).

This test was installed in late June along FM 3058 south of FM 166 and FM 60 west of SH 60 on clay subsoils of Crockett-Wilson soils. Individual treatments were applied randomly to 0.05-acre plots over 4 replications. Gypsum was applied pre-tillage at rates of 1 and 2 T/A. Urethane was applied both pre- and post-tillage at volumes of 600, 1200 and 1800 cu ft/A. Post-tillage treatments included 100 and 200 lb/A of CMC, Reten 210 and Gelgard.

A seed mixture containing 4 pounds green sprangletop, 8 pounds hulled bermudagrass and 10 pounds KR bluestem per acre was applied in a water slurr with 400 pounds of 16-8-8 fertilizer.

Hidalgo County 1969 (THD District 21).

This test was applied in mid-June on Hidalgo soils along US 83 (new location) extending from one mile west of FM 88 eastward to the Mercedes city limits. Patchy stands of bermudagrass occurred, and these were omitted from the test area.

Soil amendments and rates per acre used, included gypsum at 1 and 2 tons; urethane at 600, 1200 and 1800 cu ft/A applied both pre- and post-till; Gelgard at 100 and 200 pounds; CMC at 100 and 200 pounds; and Reten 210 at 100 and 200 pounds. These treatments were assigned at random to duplicate plots ranging in size from .02 to .20 acres. The soil amendment treatments were overseeded with 4 pounds of green sprangletop and 8 pounds of hulled bermudagrass per acre in a water slurry with 400 pounds of 16-20-0 fertilizer added.

Webb County 1969 (THD District 21).

Soil amendments were applied in mid-June to Maverick-Montell-Zapata soils along US 59 just west of the Dural County line. The treated area extended down the front slope across the ditch line and to the limits of the grading, a distance of 40 feet. Individual plots ranged in size from 0.05 to 0.20 acres. Soil amendment treatments included pre- and post-till application of urethane at 600, 1200 and 1800 cu ft/A; Reten 210 at 100 and 200 lb/A; CMC at 100 and 200 lb/A; and Gelgard at 100 and 200 lb/A distributed randomly through each of 4 replications. The pH for these soils ranged from 7.3 to 7.5. Conductivity (millimhos/cc) ranged from 11 to above 15, indicating a fairly high sodium content. A mixture containing 4 pounds of greensprangletop, 4 pounds of Rhodesgrass, 5 pounds of sideoats grama and 10 pounds of buffelgrass per acre was overseeded in a water slurry containing 400 pounds of 16-20-0 fertilizer per acre.

Brazos County 1970 (THD District 17).

A seeding test utilizing soil amendments was installed in April on SH 6 bypass (under construction) south of SH 30. Pre-tillage treatments were 1 and 2 tons of lime; 1 and 2 tons of gypsum; 600 and 1800 cu ft of urethane; and 2.5, 5.0 and 7.5 tons of composted municipal garbage (Metroganic 100) per acre. Synthetic polymers applied after tillage included 100 and 200 pounds Gelgard; 100 and 200 pounds Reten 210; and

75 and 125 pounds of CMC per acre. After the soil amendments had been applied, the test area was overseeded with a mixture of 4 pounds of green sprangletop, 8 pounds of hulled bermudagrass and 10 pounds of KR bluestem per acre.

Each individual treatment covered .06 acres. Four replications were used as a randomized block design. The PI of the material in the slopes cut through Lufkin-Edge soils ranged from 20 to 25.

Grayson County 1970 (THD District 1).

This test installed in early May was identical with the test in Brazos County except an application of 3 inches of loose topsoil material was added as a treatment and incorporated. The test is located on SH 84 east of US 75A on slopes cut through Denton clay soils ranging in PI from 35 to 40. Individual treatments were applied to .06 acres with centerline distances ranging from 50 to 120 feet, depending upon the length of the back slope.

RESULTS AND DISCUSSION

Subsurface soil materials, especially those with a high clay content, usually are dense and massive, and lack the pore space associated with granular soils. These pores are the basis for good plant-soil-water relations and aeration so necessary for plant growth. Many subsurface materials need only to have a physical structure induced which will support and encourage plant growth.

A number of materials have been admixed with clay materials as an alternative to the expensive, but effective, practice of salvaging, storing and distributing topsoil (Table 2). None of these materials has consistently altered the soil physical properties, as expressed by plant growth. However, some generalization can be made from results of these tests.

Natural organic matter in the form of hay or composted garbage was not an effective soil amendment for roadside use. Plant growth was not favored at lower rates and suffered at higher rates of organic matter incorporation. Competition between micro-organisms and the grass plants for available nitrogen is common when an excess of organic matter is undergoing decomposition. After decomposition is complete, any advantage is rapidly lost without an additional supply of organic matter.

Gypsum favored grass establishment in some, but not all, tests. It was not detrimental at rates up to two tons per acre. Lime was applied in only two instances, and the vegetational response was quite variable.

The synthetic polymers induced a variable response, as reflected in vegetation establishment. The non-ionic polymer (Aqua-gro) favored establishment of two plantings, was detrimental in two others, and failed to induce a response in four other tests. The responses to various cationic polymers were similar in some tests (Brazos Co., 1968;

Hidalgo Co., 1969), and individual polymers were superior in others (Burleson Co., 1969; Webb Co., 1969). In several instances (Rusk Co., 1968; Burleson and Hidalgo counties, 1969) the advantage of CMC and Gelgard was measurable during the second growing season.

Polyurethane was considered for field use after laboratory tests showed that incorporation improved water conductivity in clay soil material. Water retention characteristics were unaltered. This material can be physically separated into short fibers. These urethane fibers evidently function to separate the clay mass into semi-aggregates or induce lines of weakness sufficient to enhance water movement. Considered nonbiodegradable, the material has the potential of decomposing and forming urea, a simple nitrogen compound.

The urethane material has performed better applied pre-till and incorporated than applied post-till. In individual tests (Burleson County, 1969; Webb County, 1969; Brazos County, 1970; Grayson County, 1970) the lowest rate has resulted in a better stand than higher rates.

A material "Rejuvinor" formulated by Rejuvinor, Inc., was screened according to manufacturer's recommendations. No measureable response could be seen from applications made concurrently with seedings or to thin stands of established bermudagrass on clay soils.

The variable response of clay materials to the array of amendments tested (based on vegetation establishment) means that a more critical analysis of soil characteristics is needed. Gypsum and lime are questionable as granulating agents, but they may help preserve any tendency toward granulation inherent in a clay material. Gypsum and lime, as well as cationic polymers, may sustain lines of weakness through the soil mass by their ionic attraction to the surface of the clay particle.

The association noted earlier (McCully and Bowmer, 1969) that vegetation is more difficult to establish at higher PI values also needs refining. Slopes containing soil materials with PI > 25 (Taylor County, 1968; Brazos County, 1970) produced satisfactory stands of grass without treatment, and the addition of soil amendments did not improve grass stands.

In summary, it appears from our work:

1. A more sensitive measure is needed to characterize physical properties of soils marginal in their capacity to support plant growth.

2. Modification of soil physical properties limiting plant growth can be overcome in some cases by admixture of gypsum or cationic polymers.

2. Modification of soil chemical conditions. Individual plants vary in their response to soil reaction (pH), but most plants seem to grow best at pH ranges bordering the arbitrary neutral value of 7.0. Plants having a high calcium requirement commonly are found on soils having a pH above 7.0, while plants having a high requirement for iron and other elements

more available under acid conditions are found on soils having pH values lower than 7.0. All plant growth stops when soil acidity reaches the threshold pH 4.0. The restraints on plant growth at low pH values are not clear, but a very acid soil contains an abundance of H+ ions (Coleman and Thomas, 1966), low exchangeable calcium and magnesium, possible organic plant toxins, and soluble aluminum, iron and manganese (Kamprath, 1967). Acid soil also lacks available phosphorous and perhaps nitrogen.

Total rather than active acidity was used to estimate lime requirement (Miller, et al., 1968). Total acidity was established by potentiometric titration with a standard base (chemical) (Kamprath, 1967), while exchange acidity represents the amount of acidity which is not active and subject to pH measurement (Table 3).

Table 3. Some comparison of pH, and total and exchangeable acidity in sediments exposed by construction along IH 20.

Site No.	Depth in.	pH	Exchange-able acidity	Total acidity
A-1	0-10*	5.9	0.0	0.1
	24-30	2.9	10.0	21.0
	54-60	2.5	17.8	28.8
A-2	0-6	2.5	16.1	27.4
	12-18	2.5	26.6	44.0
	48-54	3.7	2.5	23.8
A-4	0-6	2.9	21.1	47.8
	12-18	2.6	18.2	40.0
	36-42	4.0	1.2	14.4
A-5	0-6	2.9	26.1	46.8
	12-18	4.6	1.0	18.8
	24-30	2.8	16.6	40.0
	48-54	4.9	0.5	13.4
A-6	0-6	2.6	23.8	37.2
	18-24	2.6	4.7	8.8
	30-36	2.6	6.1	12.0
A-7	0-6	2.4	7.5	18.4
	12-18	2.8	3.5	6.4
	48-54	2.7	3.3	6.1

*Brown sandy loam topsoil from previous mulch sod.

Samples taken from 26 cut slopes along IH 20 for 100 miles westward from the Texas-Louisiana border disclosed that most slopes lacking vegetation or with thin stands would benefit from lime application. Estimated lime requirements ranged from 0.6 to 22.8 tons per acre, and pH values varied from 2.7 to 5.9. Sediments high in pyrite making up the Weches and Queen City geologic formations become exceedingly acid (pH 1.8 to 3.5) when exposed by construction.

Calcitic lime rates of 5, 25 and 50 tons per acre based on potentiometric titration were incorporated approximately 8 inches deep on a selected backslope along IH 20 approximately 2 miles east of US 69 in April 1968. Following the lime application, 6 inches of (loose) bermudagrass mulch sod was applied and covered with hay mulch. Three replications were designated for portions of the slope separated by diversion terraces. Individual plots varied from 0.6 to 0.25 acres.

One year later pH readings in the surface soil layer treated with 50 tons of lime were high enough to support bermudagrass (Table 4).

Table 4. pH of samples from the different calcitic lime rates approximately 12 months after the treatment.

Portion of Slope	Site No.	Sample** No.	Calcitic lime rates (tons/acre) 50	30	25	5	0
			pH				
Upper	L-1	1	6.1		6.2	5.2	5.0
		2	7.5		6.6	6.1	4.2
		3	4.0		3.6	3.6	3.3
Middle	L-2	1	6.4		5.6	5.0	4.7
		2	7.4		*6.4	5.7	4.1
		3	3.6		3.4	5.3	3.3
	L-3	1	6.1		5.4	4.5	4.7
		2	6.0		6.3	4.2	3.8
		3	3.2		3.3	3.3	3.2
Lower	L-4	1	5.8	4.7	5.0		4.2
		2	*5.5	*4.3	3.4		3.3
		3	3.3	2.9	2.8		2.6
	L-5	1	6.1	4.9	5.2		3.8
		2	*4.2	*4.0	4.2		3.1
		3	2.8	2.5	2.8		2.6
	L-6	1	6.5	6.2	3.9		3.7
		2	*5.4	*5.0	*2.7		3.3
		3	2.7	2.9	2.7		3.3

**At sites L-1 through L-6, samples 1, 2 and 3 represent bermudagrass sod topsoil, incorporated calcitic lime layer, and undisturbed backslope soil material, respectively.

* Calcitic lime incorporated with backslope soil material; otherwise, calcitic lime incorporated with topsoil.

Soils treated with 25 tons of lime were borderline pH, and plant stands were thin. An application of 5 tons of lime was insufficient to neutralize the acidity and permit plant growth (Figure 2). Close examination revealed that grass roots turned away from acidic sediments much like roots avoid a compacted soil layer. The same reaction was noted in Mississippi (Bieber, 1968).

Soil samples taken in late summer 1970 (2 years after treatment) showed a pH value of 3.2 where 5 tons of lime had been applied and which is now bare of vegetation. Even with an application of 50 tons of lime the bermudagrass stand was spotty. Soil samples taken within a colony of bermudagrass showed pH values of 6.4 for the surface 6 inches and 5.8 for original material at a depth of 6 to 9 inches. On areas bare of bermudagrass, pH values of 5.2 were recorded for soil material in the surface 6 inches, while original soil material had a pH value of 2.7.

The acidity reserve in sediments under the limed soil layer indicates that additional maintenance lime applications should be tested to maintain and encourage vegetative growth.

Similar tests in Louisiana (Beavers, et al., 1965; Grafton, 1968) and in Mississippi (Bieber, 1968) showed that lime rates lower than 20 tons per acre were insufficient for grass establishment. In the successful test (Grafton, 1968), the need for periodic surface applications of lime was projected.

3. Plant materials for roadside use.

Seeding for dry climates. The risks involved in obtaining a stand of grass sod for erosion control increases as one proceeds westward across Texas. Seeding agricultural lands is not done where less than 15 inches of rainfall is received. The 15-inch isohyet lies along the western boundary of the Texas Panhandle, and turns slightly eastward as it proceeds south. One seeding was made at Monahans to obtain an estimate on the western limits of seeding grasses in Texas. Also, grasses assembled at the U. S. Soil Conservation Service Plant and Materials Center, Knox City, Texas and buffalograss treated to improve germination were seeded at various locations.

Western limits of seeding. An experimental seeding was installed on each of 7 interchanges along IH 20 at Monahans extending approximately 15 miles from the east U. S. 80 interchange to the SH 115 interchange. The fill material was obtained from local borrow sources, and was extremely sandy in nature with rock and caliche included. The pH of these materials ranged from 7.6 to 8.0, and the conductivity varied from 0.6 to 7.0 millimhos per cubic centimeter. Because of the sandy nature of the material tillage was not done. A seed mixture consisting of 1 pound Lehman lovegrass, 4 pounds sideoats grama, 10 pounds blue grama, 3 pounds green sprangletop, 1 pound sand dropseed and 1 pound of alkali sacaton per acre was applied directly to the surface and covered with a mulch of grain straw.

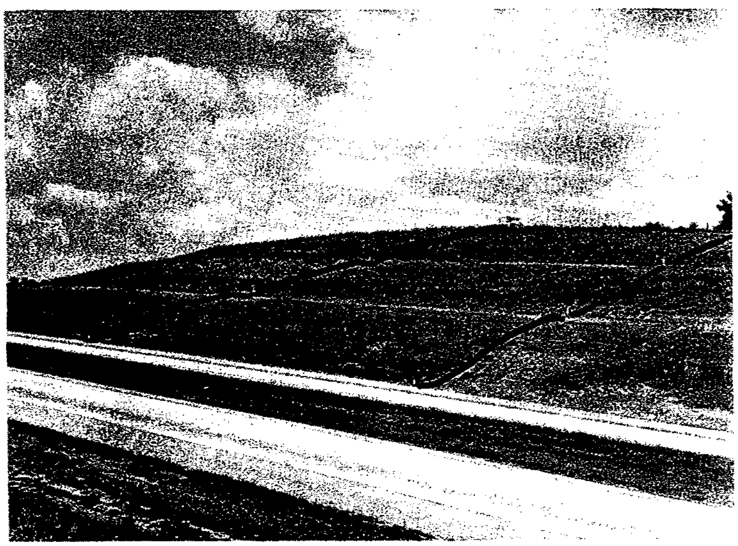

Figure 2. Lime applications (right to left) of 5, 25 and 50 tons per acre on extremely acid soils in Smith County. The most acid materials are in the segment of the backslope adjacent to the ditchline.

The seed mixtures were applied April 30, 1969. At that time the fill materials were damp for just below the surface for a considerable depth, and light showers totaling less than 0.25 inches fell on May 2 and 5. A good stand of seedlings was secured, but only the seedlings on the two eastern interchanges showed any appreciable establishment. Seedlings on the other interchanges failed to survive a dry summer complicated by competition from annual weeds and volunteer grain from the mulch material.

Experimental plant materials. Plant materials furnished by Soil Conservation Service were scheduled for planting in Ward and Webb counties in 1969 and in Brazos and Grayson counties in 1970. Materials seeded in Ward County were Lehman lovegrass, sideoats grama, Old World bluestem, green sprangletop and silky bluestem. In Webb County, the materials were Old World bluestem, whiplash pappusgrass and pinhole bluestem. Plant stands in Ward County were too variable to permit systematic evaluation. In Webb County, equipment failure prevented proper application of these materials.

The 1970 seedings in Brazos County utilized Brunswickgrass, Wilmington bahiagrass, Old World bluestem and silky bluestem. Pinhole bluestem was added to this mixture for planting in Grayson County. At each location, Old World and Kleberg bluestems came up to scattered stands. Very little, if any, of the other materials emerged.

Buffalograss. Buffalograss is a component of the natural vegetation for northwestern Texas. It forms a low sod, and has been projected for solid planting to minimize mowing. Treatment of buffalograss seed with potassium nitrate during cold storage (stratification) was found to improve stands (Wenges, 1943).

Experimental seedings were established in 1970 on US 70 just east of Plainview city limits and on cut slopes of a borrow pit at the intersection of US 82 and Loop 289 in Lubbock. In these tests 20 and 40 pounds per acre of stratified buffalograss seed were compared with a standard mixture containing 4 pounds of green sprangletop, 5 pounds of sideoats grama, 5 pounds of buffalograss (stratified) and 15 pounds of blue grama per acre. The assigned seeding treatment at each location was placed on 0.25 acres and covered with a straw mulch. The Lubbock seeding was on Amarillo soils and on Pullman soil at Plainview.

The seeded grasses emerged at each location, but the lack of moisture at Plainview prevented critical comparison. Preliminary evaluation of the Lubbock planting and inspection of various field seedings in the vicinity of Lubbock and Amarillo suggest that buffalograss should be planted as part of a seeding mixture in that region. Seeding with buffalograss alone is not recommended at this time.

PART B. VEGETATION CONTROL

This series of chemical tests was concerned with post-surface treatment of perennial grasses and weeds infesting shoulder pavements in the Texas Panhandle, and with evaluation of selective materials for maintaining landscape plantings.

1. Perennial grasses and weeds in shoulder pavements. Sixteen chemical treatments, involving materials, individually or in mixtures, were applied to inside shoulders along US 60 extending from the Panhandle city limits westward to the Carson County line. The treated area varied from 0.28 to 13.00 foot-miles, depending upon the density of weed infestation. The treatments shown in Table 5 were applied in a spray volume of 24 gallons per foot-mile. The designated area was completely sprayed initially on July 30-31, 1969. Two thirds of the area treated originally was resprayed on October 8, 1969 with the same treatment, and each plot was completely treated again May 18-19, 1970 using the original mixture.

Table 5. Schedule of herbicidal materials applied in a single treatment to shoulder pavements in Carson County for controlling a mixture of annual and perennial plants.

Material	lbs/A (active ingredient)
Fenac/TCA	20/200
Tritac/TCA	20/200
Prometone	12
Bromacil	5
Dicamba/fenac	10/30
Erbon/fenac/dicamba	40/5/10
Prometone/fenac/dicamba	6/5/10
Bromanil/fenac/dicamba	0.5/5/10

An inventory was made of the plants present in the pavement before each application and in October 1970 at the end of the growing season.

From these treatments, the most effective treatment program is one which schedules two applications, one at the beginning followed by another at the end of the growing season during a single year. The most effective chemicals were the mixtures of prometone/fenac/dicamba or bromanil/fenac/dicamba. Plants resistant to treatment included bindweed, Kochia and various bunchgrasses, but these are considerably reduced in stand density. Prostrate milkweed is an early invader of treated pavements.

Any further experimental consideration of this problem should include treatment of bindweed growing in open soil adjacent to the shoulder pavements (Figure 3). This persistent perennial invades pavements primarily by vegetative shoots from underground rootstocks. Scheduling the treatment in early May or at a time when many of the annual weeds are germinating will help maintain cleaner pavements.

2. Landscape Plantings, 1970. A multiflora rose hedge planted in the median along IH 10 eastward from Winnie (THD District 20) has become unslightly from invasion by other plants. The invading plants included a variety of grasses and broadleaf weeds common to the area as well as baccharis, a woody shrub.

Individual plots containing 0.05 acres were treated in early June with one gallon of cacodylic acid per acre, in combination with dichlobenil granules at 4, 5 and 6 pounds per acre; trifluralin granules at 4, 6 and 8 pounds per acre; simazine in granules or spray at 2, 4 and 6 pounds per acre; dymid at 5 and 10 pounds per acre; norea at 4, 6 and 8 pounds per acre; sesone spray at 4, 6 and 8 pounds per acre; and 2 experimental chemicals.

Two months following treatment none of the rose plants showed any ill effects from the chemicals applied. Simazine granules were the most effective pre-emergence material following the contact action by cacodylic acid.

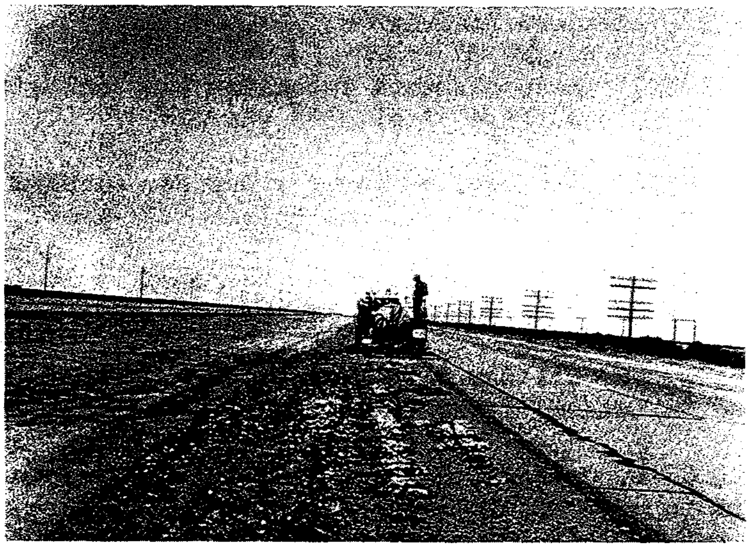

Figure 3. Bindweed is an aggressive invader of shoulder pavements from adjacent open soil. Associated plants, particularly annuals, grow from seed lodged in cracks and joints.

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APPENDIX A. COMMON AND SCIENTIFID NAMES OF PLANTS*

Alkali sacaton	Sporobolus airoides (Torr.) Torr.
Baccharis	Baccharis halimifolia L.
Bermudagrass	Cynodon dactylon (L.) Pers.
Bindweed	Convolvulus arvensis L.
Blue grama	Bouteloua gracilis (Willd. ex H.B.K.) Lag.
Brunswickgrass	Paspalum nicorae Parodi
Buffalograss	Buchloe dactyloides (Nutt.) Engelm.
Buffelgrass	Cenchrus ciliaris L.
Green sprangletop	Leptochloa dubia (H.B.K.) Nees
Kleberg bluestem	Dicanthium annulatum Stapf.
KR bluestem	Andropogon ischaemum L.
Lehmann lovegrass	Eragrostis lehmanniana Nees
Old World bluestem	Andropogon spp.
Pinhole bluestem	Andropogon spp.
Rhodesgrass	Chloris gayana Kunth
Sand dropseed	Sporobolus cryptandrus (Torr.) Gray
Sideoats grama	Bouteloua curtipendula (Michx.) Torr.
Silky bluestem	Andropogon sericeus
Switchgrass	Panicum virgatum L.
Whiplash pappusgrass	Pappophorum mucronulatum Nees
Wilmington bahiagrass	Paspalum notatum Flugge

*Plant nomenclature following Gould, F. W. (1969).