OKLAHOMA PROJECT

No 70-01-3

ROADSIDE EROSION CONTROL

FINAL REPORT

By

Wayne W. Huffine, Project Director
Lester W. Reed, Associate Director
Fenton Gray, Professional Personnel

in cooperation with

The Oklahoma Department of Highways

and

The Federal Highway Administration

Oklahoma Agricultural Experiment Station

Oklahoma State University

Stillwater, Oklahoma

ACKNOWLEDGEMENTS

The research personnel from Oklahoma State University involved in this project express their appreciation to the personnel of the Oklahoma Department of Highways and the Federal Highway Administration for their interest and cooperation in these investigations. Special recognition is due Mr. R. T. Sutton, Mr. Gary W. Roach, Mr. J. E. Barber, and Mr. C. Dwight Hixon of the Oklahoma Department of Highways, and Mr. Jerry Emerson of the Federal Highway Administration.

Grateful acknowledgement is extended for the unlimited assistance in the furtherance of these investigations and the preparation of a documentary video-tape afforded us by Mr. Frank Fodge, Div. Engr., Division Two; Mr. C. O. Brewster, former Div. Engr., and Mr. R. L. Stringer, Div. Engr., Division Four; the I-35, Unit 3 personnel, Mr. Don G. Smith, Foreman, Mr. Roy Elder, and Mr. F. E. Goble; Mr. Joe Morgan, Div. Engr., Division Five; and Mr. Stansell Byers, former Div. Engr., and Mr. B. G. Green, Div. Engr., Division Eight; Mr. Larry Thompson, Mr. Carl Peterson, and Mr. Mitchell Smith, Oklahoma Department of Highways, Oklahoma City. We are grateful to the Division Four, Highway Maintenance District F, Logan County crew, for their help in staging some maintenance scenes for the video-tape, and the I-40 West, Maintenance District 5 personnel for their help in planting ground covers, Messrs. R. L. Maddox, W. F. Altenhofel, W. T. Baker, B. G. Bramlett, P. A. Brimer, R. G. Bruner, L. L. Carter, A. J. Dowdy, T. L. Dowdy, L. J. Hoffman, A. C. Lowry, R. L. Martin, E. J. Price, W. J. Roles, D. G. Sanders, and F. Spears.

"The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Oklahoma Department of Highways or the Federal Highway Administration."

* In order that the information in this publication may be more useful, it was sometimes necessary to use tradenames of products, rather than complicated chemical identifications. As a result it is unavoidable in some cases that similar products which are on the market under other tradenames may not be cited. No endorsement of named products is intended, nor is criticism implied of similar products which are not mentioned.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Figure Page

Figure Page

Figure Page

Figure | Page

LIST OF TABLES

Table Page

Table | Page

Table | Page

- SUMMARY -

FINDINGS WITH RECOMMENDATIONS FOR IMPLEMENTATION

Experiments along Oklahoma highways on various soil materials and in the laboratory were established to find: (a) the best methods to establish bermudagrass by vegetative means; (b) the most satisfactory means of establishing grasses from seed; (c) the effect of ecological factors on species adaptation and use for erosion control, and (d) the most desirable ground cover species for erosion control and beautification.

CHEMICAL EFFECTS ON BERMUDAGRASS SPRIGS

Water was found to be equally as effective in promoting shoot and root development of bermudagrass sprigs, soaked for four hours, as the best treatments of five growth regulators (ethrel, gibberellic acid, IBA, Shell DS 8339, and TIBA) used in laboratory investigations. No real differences in the sugar content of bermudagrass rhizomes could be detected from 27 fertilizer treatments investigated.

CULTURAL PRACTICES FOR ESTABLISHMENT OF GRASSES FROM SEED

An asphaltic emulsion (MS-2) at the recommended rate, and Coherex at doubled the recommended rate produced better results for at least 45 days in the aggregation of a Vernon-Lucien complex clayey soil than Curasol or Petroset. Curasol applied at twice the recommended rate to a Teller fine sandy loam gave the best results for a period of 45 days. Further investigation of these materials for erosion control should be made before evidescale use on the highway.

The best soil erosion control on a Vernon-Lucien soil complex was obtained from an excelsior blanket, bluestem hay, and excelsior fiber in this descending order. Aquatain appeared to provide only about 35% soil erosion control on a Vernon-Lucien soil complex. Good quality hay or straw, or excelsior blanket or fiber has provided the best erosion control of all materials investigated and should be used until something better is available. J M Fiber Tileguard mat was found to be unsuitable as a protective cover for 10 plant species used in soil erosion control, and should not be used as a protective mulch on the highway. The best stands of either weeping lovegrass, or "B" blend Asiatic bluestem can be expected on a Kirkland silt loam soil from seeding fungicide treated seeds with a drill and protected from weed competition with propazine. Wherever possible all seeds should be drilled perferably, for establishment of erosion resistant ground covers. Further investigation of herbicide applications under different conditions and on different soil types before wide scale use on the highways for establishment of erosion resistant ground covers is recommended. The use of lignon liquor for increasing the germination and growth of erosion resistant ground covers is not recommended at this time even though there is an indication of an increase in germination and growth of Interstate sericea lespedeza, wheat, common bermudagrass, and weeping lovegrass when treated with dilute solutions of lignon liquor. Further investigations are needed before it is used widely in roadside seedings.

SPECIES ADAPTATION AND USE FOR EROSION CONTROL

A more detailed investigation of a system of classification of man-made soils on Oklahoma highways is recommended for use in the establishment and maintenance of erosion resistant ground covers. The grasses that seem to be best adapted as of this time, from the standpoint of low maintenance, on the man-made soils east of U.S. 81 in Oklahoma, on Paralithic and Lithic Udarent soils with 25 to 45% slope, that are loamy, shallow, and acidic are K.R. bluestem and weeping lovegrass on south facing cut slopes followed by bermudagrass. Weeping lovegrass seems to be best on north facing cut slopes followed by K.R. bluestem. On Paralithic Ustarent soils in this area with 25 to 45% slope, but clayey, shallow to very shallow, basic in reaction, bermudagrass seems to be best for erosion control on east and west facing cut slopes, followed by K.R. bluestem and buffalo on west exposures, and weeping lovegrass and buffalo in that order on east facing cut slopes. West of U.S. 81, on Paralithic Ustarent soils, with a 25 to 45% slope, loamy, deep to shallow, and basic, switchgrass and sideoats grama seem to be best for use on north facing cut slopes followed by weeping lovegrass. On south facing cut slopes weeping love seems to be best, followed by sideoats grama and switchgrass in that order. On loamy, very shallow, basic Paralithic Ustarent soils with a 25 to 45% slope sideoats grama seems to be best on either east or west facing cut slopes followed by buffalograss and weeping lovegrass in that order. These grasses should be used in these areas under these conditions until better recommendations can be made. Weeping lovegrass, H, and J-Blend Asiatic bluestems were better adapted on an Enders-Hector soil complex for erosion control on a southeast facing backslope. In the same area, but on a northwest facing backslope Interstate sericea lespedeza produced more plants per unit area than any other species evaluated. Of the Asiatic bluestems, the thickest stands were obtained from the K, J, H, and I-Blends in this descending order. However, even the least dense, the I-Blend, had at least one seedling every nine square inches.

Honeysuckle planted in tubes 18 inches deep and four inches wide, on a 45^{o} slope, of a very highly erodible, Hector, fine sandy loam, provided greater ground cover than those in a 12 inch deep tube, and is suggested for use on these sites until a better potting size can be determined.

SLOPE PREPARATION FOR EROSION CONTROL

When precipitation is adequate to keep the soil surface moist in the early stages of germination and growth of Plains bluestem seeded with a grass drill, Conwed 2000 Fiber at 1 ton per acre, provides an equally satisfactory mulch as hay at 1 ton per acre on soils that have been chiseled or disked. Seeding on a loose (chiseled or disked) subsoil surface with a grass drill and mulched with 1 ton of good quality hay or straw is suggested as the best method at this time for the most rapid establishment of a protective ground cover on all new construction.

In western Oklahoma, weeping lovegrass, buffalograss, and the Asiatic bluestems seeded on severely to moderately compacted subsoil seedbed, with an AASHO classification of A-4(5), and a pH of 8.1, will establish a better stand when mulched with wheatstraw rather than MS-2 asphalt emulsion, or Petroset SB Emulsion. Therefore, the use of good quality wheatstraw is recommended for use as a mulch on new seedings in this area.

Propazine applied on a Brownfield-Tivoli soil, at the rate of 1 lb. active ingredient per acre, will severely suppress the germination and growth of Piper sudangrass and is not recommended for use on this crop and sand at this rate. Other triazine herbicides are available that should be investigated for this purpose on the highways.

Asiatic bluestem can be successfully established from seed, or in a more economical hay-seed combination on an eroded, clayey shale, compacted Talihina soil. This hay-seed combination method of establishment, would combine broadcast seeding and mulching into one operation thus effecting a savings in the establishment of a ground cover. This method is suggested for use on a trial basis where the Asiatic bluestems, in hay-seed combinations are available, until additional information is made available.

Southland smooth bromegrass, fertilized with 100-80-60/acre, will provide the quickest protection from soil erosion when compared to Kentucky 31 tall fescue, or crested wheatgrass seeded on a highly erodible, Bates-Collinsville complex soil that had been loosened by disking prior to seeding. Within six months after seeding the greatest protection against soil erosion would be provided by Kentucky 31 tall fescue fertilized with 100-160-60/acre. Two years after seeding the best ground cover would be provided by crested wheatgrass or Southland smooth brome fertilized with 100-80-60/acre. These grasses are suggested for use on these sites until a seeding rate of a combination of two or all three can be determined.

FERTILITY LEVELS OF ROADSIDE SOILS

Soil samples from eastern and western Oklahoma indicate a need for 300 lb. of 33.5-0-0 or equivalent nitrogen in all cases to help in the establishment of a ground cover. This should be followed with periodic applications of nitrogen, unless an adequate supply is being furnished by legumes, to help maintain the ground cover. Phosphorus should be at the rate of 100 lbs. P_2O_5/acre to most soils except those perhaps in southwest Oklahoma. Potassium, at 200 lbs. K_2O per acre should be added to those soils in northeast Oklahoma particularly.

ROADSIDE EROSION CONTROL

By

Wayne W. Huffine, Lester W. Reed, and Fenton Gray
Oklahoma Agricultural Experiment Station
Oklahoma State University
Stillwater, Oklahoma

INTRODUCTION AND RESEARCH APPROACH

This report covers research conducted during the period of 1970 to 1975. Results of the first four year's investigations were compiled in annual Interim Reports, and are included here.

The research for this project was initiated to determine the most economical and satisfactory means of controlling soil erosion on Oklahoma highways. This objective is to be achieved through research:

a) To determine the best methods to establish bermudagrass by vegetative means.

b) To determine the most satisfactory means of establishing grasses from seed.

c) To determine the effect of ecological factors on species adaptation and use for erosion control within the various land resource areas and climatic zones of the State.

d) To determine the most desirable ground cover species for erosion control and aesthetic purposes.

EXPERIMENTS WITH RESULTS, INTERPRETATION AND CONCLUSIONS

Research for this final report is presented in sections as follows:

(1) Chemical effects on bermudagrass sprigs.

(2) Cultural practices for establishment of grasses from seed.

(3) Species adaptation and use for erosion control.

(4) Slope preparation for erosion control.

(5) Fertility levels of roadside soils.

CHEMICAL EFFECTS ON BERMUDAGRASS SPRIGS

Bermudagrass (*Cynodon dactylon* (L.) Pers.) is commonly used for roadside erosion control. Because of the risk of winter kill the year of seeding, vegetative parts (sprigs or sod) are commonly planted. The cost of establishing bermudagrass from sprigs on one mile of interstate highway can exceed $50,000.

When bermudagrass is vegetatively propagated, it is not uncommon to find no more than one shoot or root per sprig. Commonly, three or four nodes containing buds are present on a sprig and potentially there would be as many as three or four shoots and roots per sprig. If sprouting potential could be realized, it is conceivable that the sprigging rates could be reduced, or a more rapid stand established, or both.

Experiments to evaluate growth regulators as a means of increasing the number and length of shoots and roots, and fertilizers as a way to increase cold hardiness were initiated in the field and in the laboratory. Data were obtained on concentrations of growth regulators and sprig exposure time to each, and the effects of various rates of fertilizer on the sugar content of the sprigs.

Experiment 1.* Effect of five growth regulators on sprouting and growth of bermudagrass sprigs.

Bermudagrass sprigs were subjected to five different growth regulators at different concentrations for varied periods of time with water used as a control as shown in Table 1. The effects on bermudagrass sprigs of these growth regulators at various concentrations and different soaking periods as measured by shoot and root numbers, and length are graphically illustrated in Figures 1, 2, 3, and 4. The Duncan's multiple range test of these data indicated that water, the control in this experiment, was equally as effective in promoting shoot and root development of bermudagrass sprigs as the best treatments of five growth regulators used in this experiment.

The length of time the sprigs were soaked in an ethrel solution resulted in significant differences in shoot and root length, and shoot numbers. However, ethrel seemed to have no significant effect on root numbers. Gibberellic acid appeared to have a significant effect on shoot length, but no significant effects on shoot or root numbers, nor root length. The concentrations of IBA showed significant effects on root numbers and lengths. However, IBA seemed to have no significant effects on shoot numbers or lengths.

Shell SD 8339 and TIBA each had a significant effect on root numbers, but their effect on shoot numbers, and shoot, or root length were not significant. Bermudagrass sprigs soaked in water for 4 hours seemed to have a higher average number of shoots per sprig than those soaked for a lesser or a greater period of time.

---

* Cargill, Lonnie M. 1975. Effect of growth regulators on sprouting of bermudagrass sprigs. Unpublished M.S. Thesis. Oklahoma State University.

TABLE 1

GROWTH REGULATORS, CONCENTRATIONS, AND SOAKING TIMES OF BERMUDAGRASS SPRIGS USED IN THIS EXPERIMENT

	Chemical	Concentration (ppm)				Soaking Time (minutes) (1)*	(2)*	(3)*	(4)*
1.	Ethrel	50	100	200	400	60	120	240	360
2.	Shell SD8339	50	100	200	400	60	120	240	360
3.	IBA	100	200	400	800	5	10	20	40
4.	TIBA	5	10	20	40	5	10	20	40
5.	GA_3	37.5	75	150	300	5	10	20	40
6.	Water	-	-	-	-	60	120	240	360

*These numbers refer to the soaking times shown in Figures 1, 2, 3, and 4.

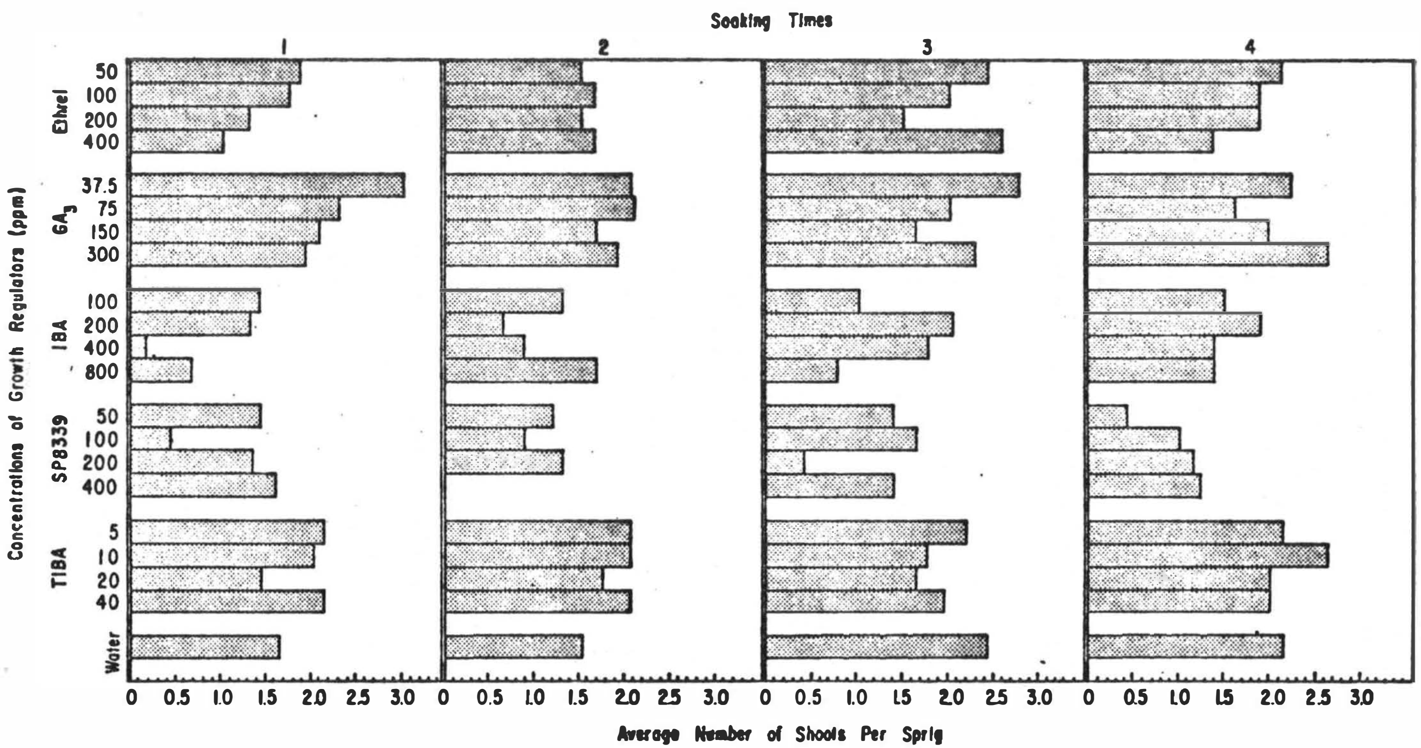


Figure 1. Effect of Growth Regulators at Various Concentrations on Shoot Numbers of Bermudagrass Sprigs Soaked for Different Periods of Time

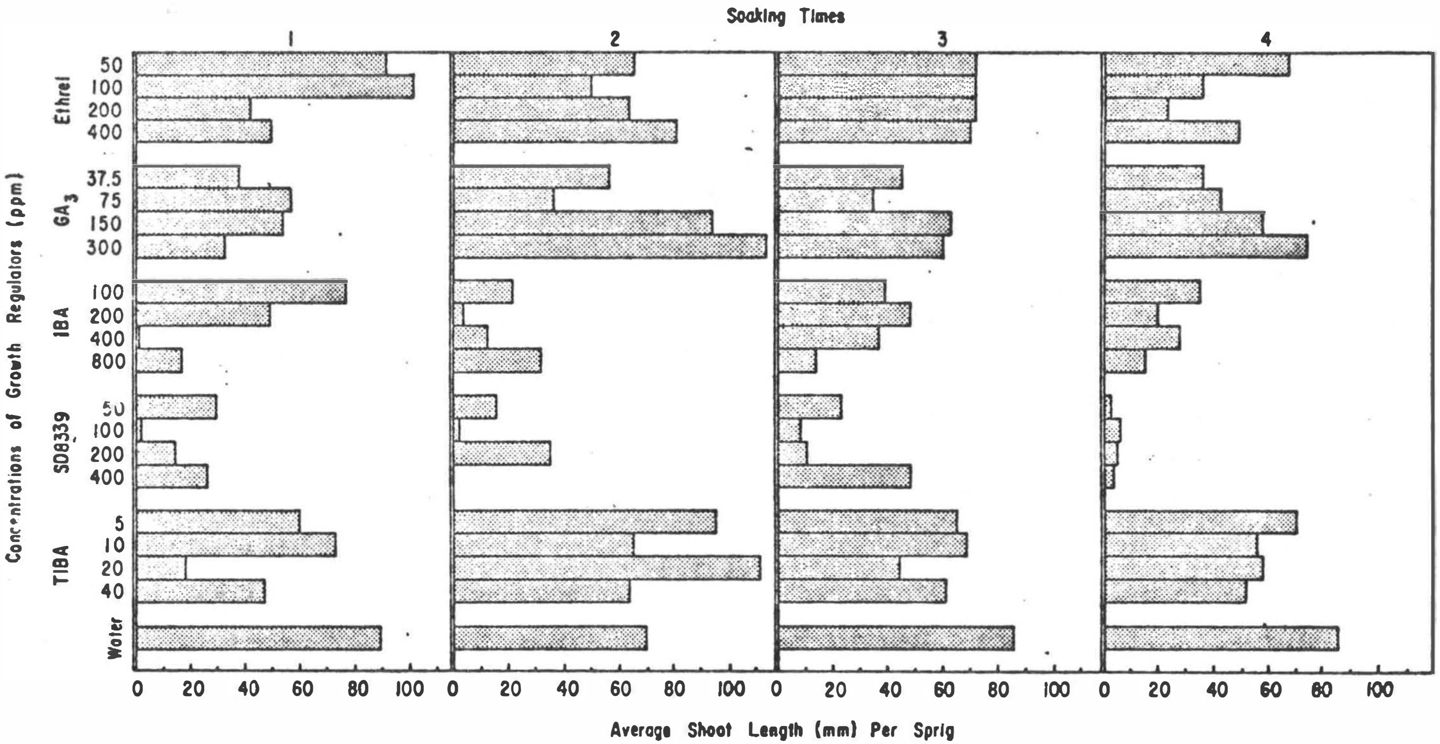


Figure 2. Effect of Growth Regulators at Various Concentrations on Shoot Elongation of Bermudagrass Sprigs Soaked for Different Periods of Time

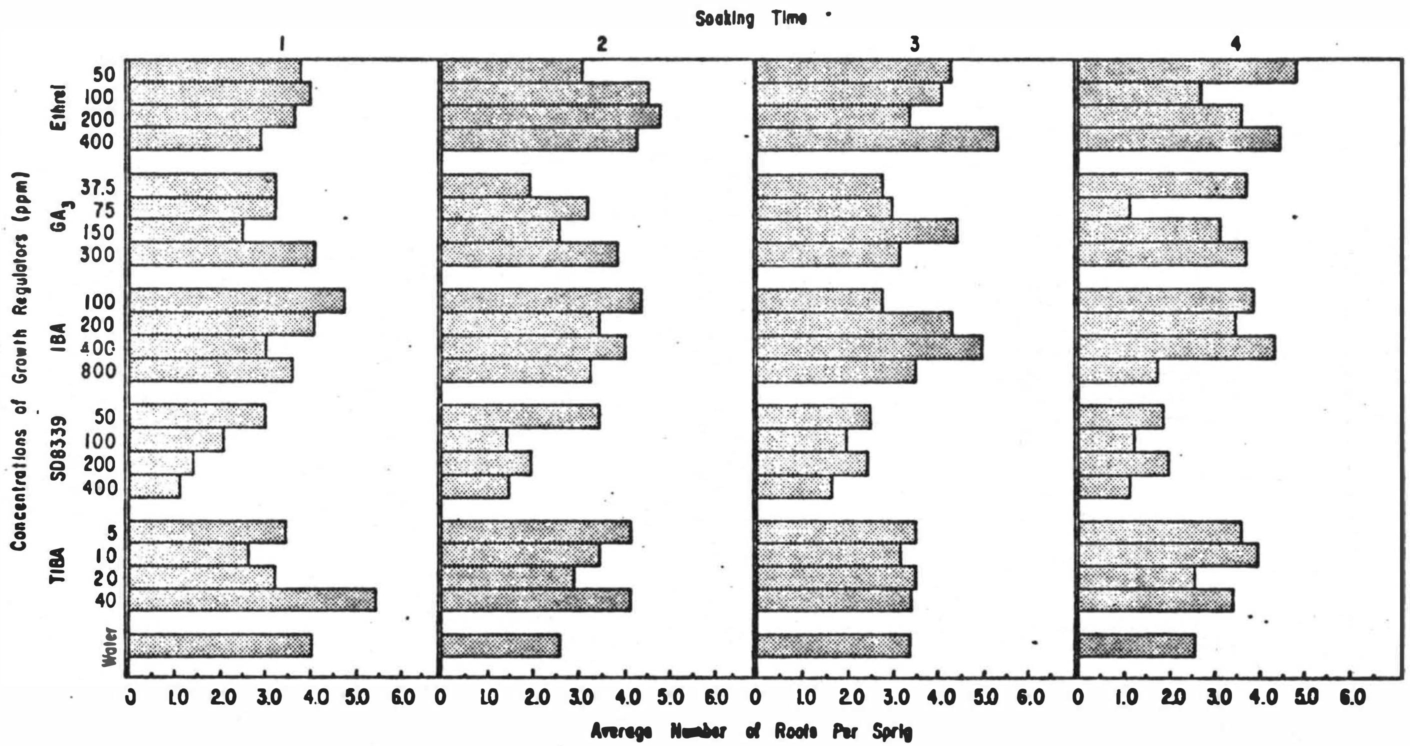


Figure 3. Effect of Growth Regulators at Various Concentrations on Root Numbers of Bermudagrass Sprigs Soaked for Different Periods of Time.

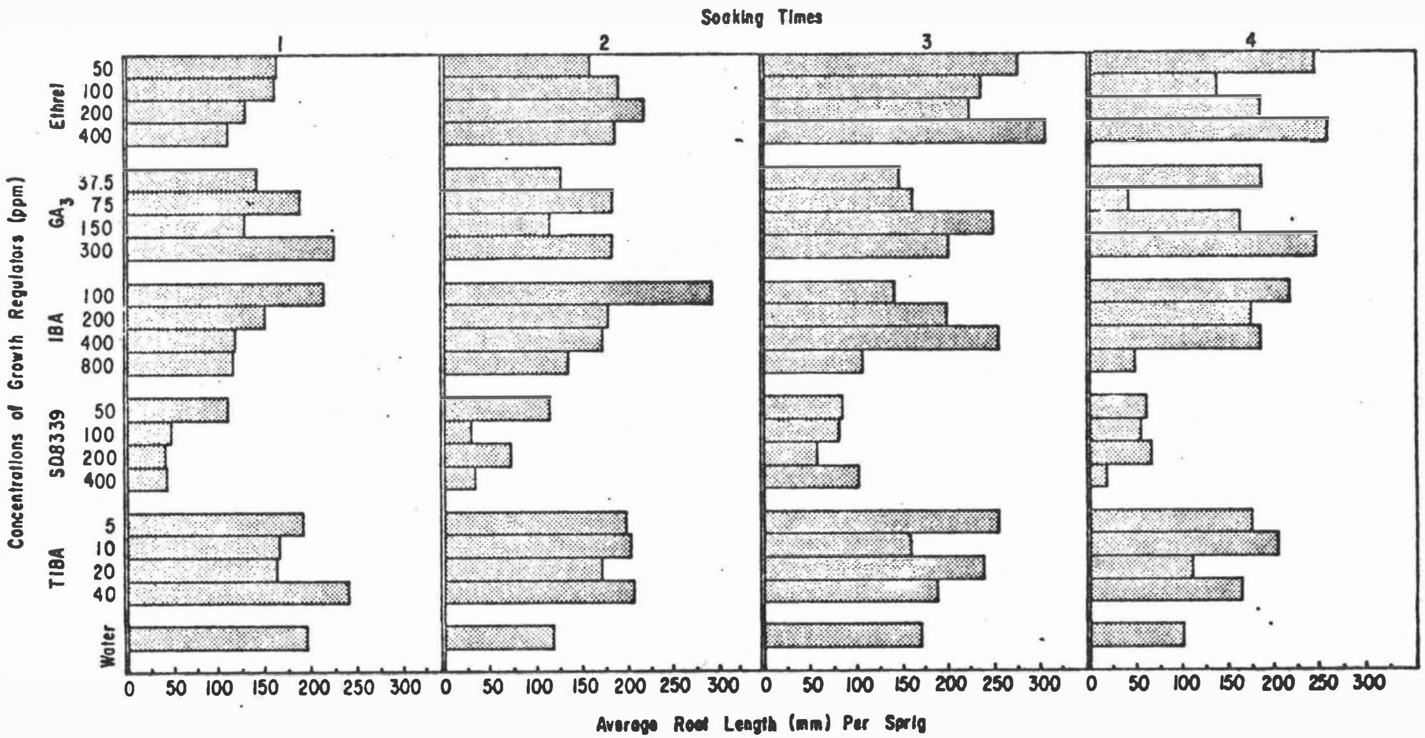


Figure 4. Effect of Growth Regulators at Various Concentrations on Root Elongation of Bermudagrass Sprigs Soaked for Different Periods of Time

Experiment 2.* Soil fertility effect on cold hardiness of bermudagrass sprigs.

Twenty-seven fertilizer treatments were applied to an old stand of common bermudagrass at the Agronomy Research Station near Perkins, Oklahoma, growing on a Eufaula loamy fine sand soil, to determine the effects of soil fertility on cold hardiness of the rhizomes. The 27 fertility treatments are shown in Table 2. These plots were abandoned in 1971 for an identical set of treatments on the Agronomy Research Station at Stillwater, on a Norge loam soil. Rhizomes were dug and sugar percentages determined during July, August, and September. No statistical differences in sugar content of the bermudagrass rhizomes could be detected from the fertilizer treatments used in this experiment. The phosphorus and potassium levels of the soil in this experiment either were adequate for maximum sugar production in all treatments, or the N:P:K ratios were below the threshold of response for influencing sugar content of the rhizomes. As a consequence, no prediction can be made as to the best fertilizer treatment to insure the greatest cold hardiness in the sprigs.

In this experiment the major factor influencing the sugar content of bermudagrass sprigs was the month in which the readings were made. The sugar percentages for the seven months in which readings were taken are shown in Figure 5. Rain during the first week of May and June prevented the collection of data for those months. The sugar content is highest during the winter months and lowest in the summer. The low October reading could possibly be accounted for by a period of unusually warm weather during the latter part of September which may have resulted in a conversion of sugars to starch just prior to the October readings.

* Fuller, William Wade. 1973. Influence of fertility levels on sugar content and coldhardiness in common bermudagrass (*Cynodon dactylon* (L.) Pers) rhizomes, and identification of some sugars. Unpublished Ph D. thesis. Oklahoma State University.

TABLE 2

AMOUNTS OF ELEMENTAL N-P-K APPLIED IN KILOGRAMS PER HECTARE (POUNDS PER ACRE)

Kg/ha	(Lb/acre)	Kg/ha	(Lb/acre)	Kg/ha	(Lb/acre)
56-0-0	(50-0-0)	112-0-0	(100-0-0)	168-0-0	(150-0-0)
56-0-45	(50-0-40)	112-0-45	(100-0-40)	168-0-45	(150-0-40)
56-0-90	(50-0-80)	112-0-90	(100-0-80)	168-0-90	(150-0-80)
56-45-0	(50-40-0)	112-45-0	(100-40-0)	168-45-0	(150-40-0)
56-90-0	(50-80-0)	112-90-0	(100-80-0)	168-90-0	(150-80-0)
56-45-45	(50-40-40)	112-45-45	(100-40-40)	168-45-45	(150-40-40)
56-90-90	(50-80-80)	112-90-90	(100-80-80)	168-90-90	(150-80-80)
56-45-90	(50-40-80)	112-45-90	(100-40-80)	168-45-90	(150-40-80)
56-90-45	(50-80-40)	112-90-45	(100-80-40)	168-90-45	(150-80-40)

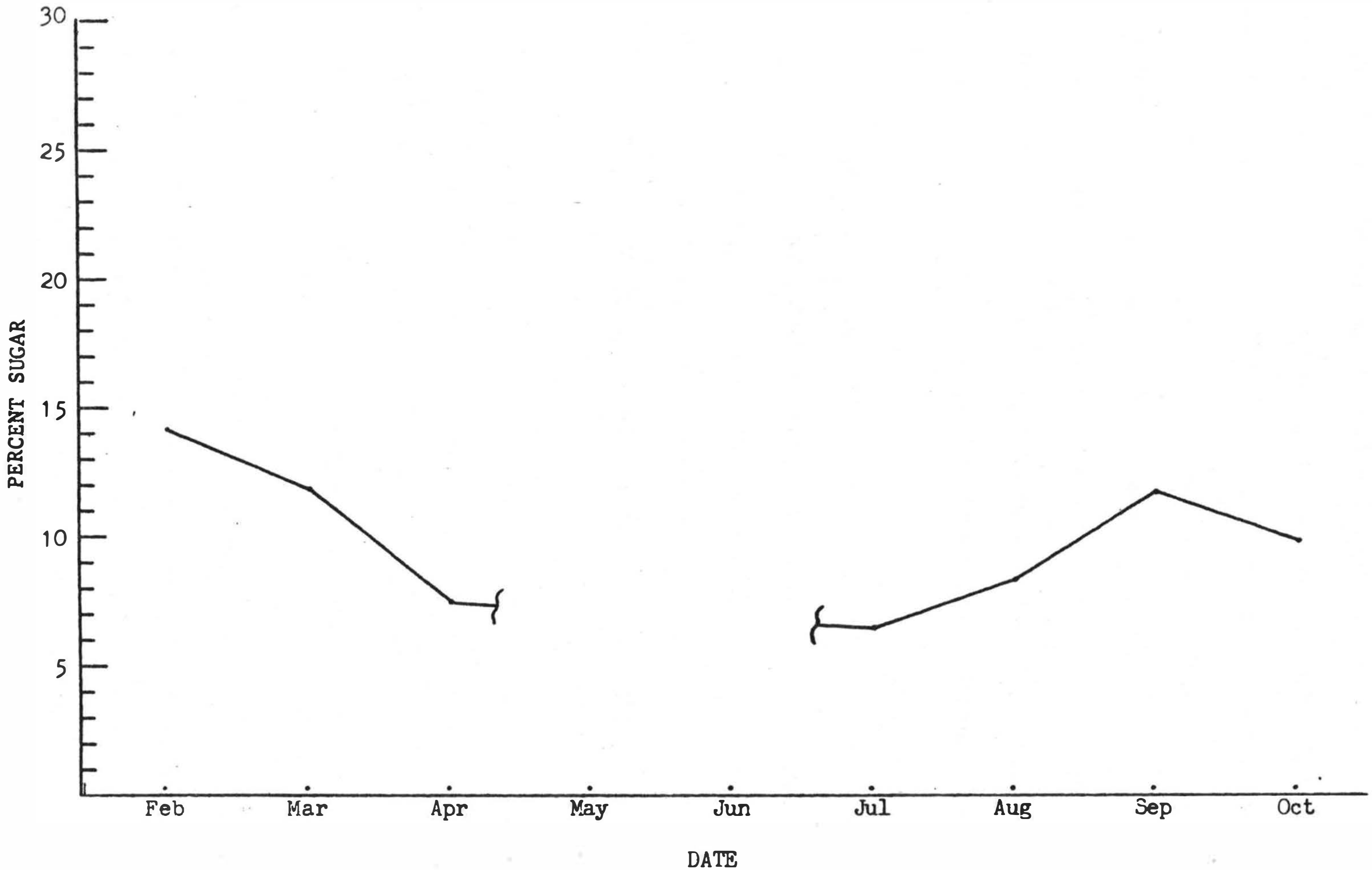


Figure 5. Percent Sugar Found in Bermudagrass Rhizomes for Seven Months of a Nine-Month Period

To evaluate the effect of different fertilizer treatments on the coldhardiness of bermudagrass sprigs (as a function of the sugar content within this tissue), a preliminary investigation of temperature and time intervals required to kill 50% of untreated bermudagrass sprigs (rhizomes, each with three nodes) indicated a temperature of - 8.9°C (16°F) for a two hour period was sufficient. This procedure was then applied to two replications of 13 representative fertility treatments. The results varied from a complete kill of sprigs in two treatments in each replication, to no damage to sprigs from one treatment in one replication, and from two treatments in the other. The treatments used and percent kill found during this preliminary investigation are shown in Table 3.

The effectiveness of this freeze treatment of bermudagrass sprigs as a measure of coldhardiness resulting from different fertilizer treatments could not be reliably determined because of excessive kill of the sprigs from most treatments. This research procedure must be modified if it is to be used as a method to predict the relative coldhardiness of bermudagrass sprigs.

The basis for cold hardiness in plants is believed by some to be directly related to the plants ability to convert starch to sugar during the cold season of the year. Sugars such as arabinose, glucose, and sucrose have been reported to be highly protective in prevention of freeze damage to plants.

A preliminary investigation of the sugars found in bermudagrass rhizomes indicated galactose, mannose, maltose, rhamnose, fucose, glucose, ribose, and xylose were present. Although fructose was not identified individually by paper chromatography, or by the Technicon auto-analyzer, it also had to be present since sucrose, of which it is a constituent, was found to be present.

TABLE 3

EFFECT OF FERTILITY TREATMENTS IN THE FIELD ON THE SURVIVAL OF BERMUDAGRASS RHIZOMES SUBJECTED TO A FREEZING TEMPERATURE OF -8.9° C FOR A TWO-HOUR PERIOD

Fertility Treatment Elemental N-P-K Kg/ha	 (Lb/acre)	Rhizomes Percent Kill Rep 1	 Rep 2	 Avg.
56-0-0	(50-0-0)	66	22	44
56-45-0	(50-40-0)	12	0	6
56-45-45	(50-40-40)	100	100	100
56-90-90	(50-80-80)	88	66	77
56-90-45	(50-80-40)	66	66	66
112-0-90	(100-0-80)	0	0	0
112-90-90	(100-80-80)	88	66	77
112-90-45	(100-80-40)	66	89	77
168-0-45	(150-0-40)	22	22	22
168-45-0	(150-40-0)	100	89	95
168-45-45	(150-40-40)	22	88	55
168-45-90	(150-40-80)	22	66	44
168-90-45	(150-80-40)	66	100	83

CULTURAL PRACTICES FOR ESTABLISHMENT OF GRASSES FROM SEED

Experiments to investigate the suitability of chemical and fiberous mulches, pesticides, and seeding methods for establishment of vegetative ground covers for roadside erosion control were established along some state and federal roads, and on the Agronomy Research Station at Stillwater, Oklahoma. All areas were seeded with species best adapted to the location, or were potentially suited for use in the area.

Experiment 3 * Aggregation ability of four soil binders on two Oklahoma soils.

Oklahoma has over 12,000 miles of federal and state highways and more than 3/4 million acres of roadside to maintain. These roadside areas are subject to erosion during and after the initial construction period. In construction, it is a common practice to remove the native vegetation along with the soil that has formed from the parent material, in order to stockpile the topsoil for replacement after this phase is completed.

The topsoil is not in the optimum condition to support good vegetative growth. It has been handled at least two times, which results in a disintegration of much of the macrostructure of the soil, leaving much smaller particles exposed to erode as soon as the soil is replaced.

To minimize soil movement from exposed sites many soil binding materials are commercially available. These materials are intended for the increase of the size of the soil aggregates, which in turn, will decrease the rate of erosion and increase the possibility of vegetative growth on roadside slopes.

---

* Ensminger, Glenn E. 1974. Evaluation of chemical and fibrous mulches for roadside erosion control. Unpublished Ph.D. thesis. Oklahoma State University.

To determine the aggregation ability of soil binders on Oklahoma soils, four soil binders, were compared at three concentrations and three lengths of time for their ability to increase the size of soil aggregates. These soil binding agents, Coherex (a resin-in-water emulsion), Curasol (a high polymer plastic emulsion), MS-2 (an asphalt emulsion), and Petroset (an elastomer emulsion), were applied to two soils, a Teller fine sandy loam(a udic argiustoll), and a clayey soil, Vernon-Lucien complex soil (a typic ustochrept and a typic haplustoll, respectively).

Thirty-six plastic containers were filled with each of the two soils and sprayed with the soil binders at concentrations 0.5 times the recommended volume after dilution, the recommended volume after dilution, and 2.0 times the recommended volume after dilution as shown in Table 4. The samples were exposed to natural weathering for designated periods of 45, 90, and 180 days, then they were analyzed for the percent aggregation of the soils at the end of their exposure period.

The MS-2 at the recommended rate and the Coherex at the highest rate produced better results in the aggregation of the Vernon-Lucien complex clayey soil than Curasol, or Petroset, as shown in Figures 6, 7, 8, and 9. The aggregation ability of the MS-2 declined after 90 days exposure, while Coherex declined in aggregation ability after 45 days exposure.

Coherex, applied at the highest rate to the Teller soil gave the best results for the 180 day exposure period as shown in Figures 10, 11, 12, and 13. For the 45 day exposure period, Curasol applied at the highest rate to the Teller fine sandy loam soil gave the best results.

TABLE 4

THE DILUTION RATIO AND THE APPLICATION

RATES OF THE SOIL BINDING AGENTS

Soil Binding Agents	Dilution Ratio Agent: Water	Rates of Application in (l/m^2) Based on the Recommended Rates		
		0.5	1.0	2.0
Coherex 1/	4:1	2.28	4.56	9.12
Curasol 2/	20:1	1.14	2.28	4.56
MS-2 3/	3:1	0.80	1.60	3.20
Petroset 4/	24:1	1.14	2.28	4.56

1/ Supplied by Golden Bear Oil Company

2/ Supplied by American Hoechst Corporation

3/ Supplied by Allied Materials Corporation

4/ Supplied by Phillips Petroleum Company

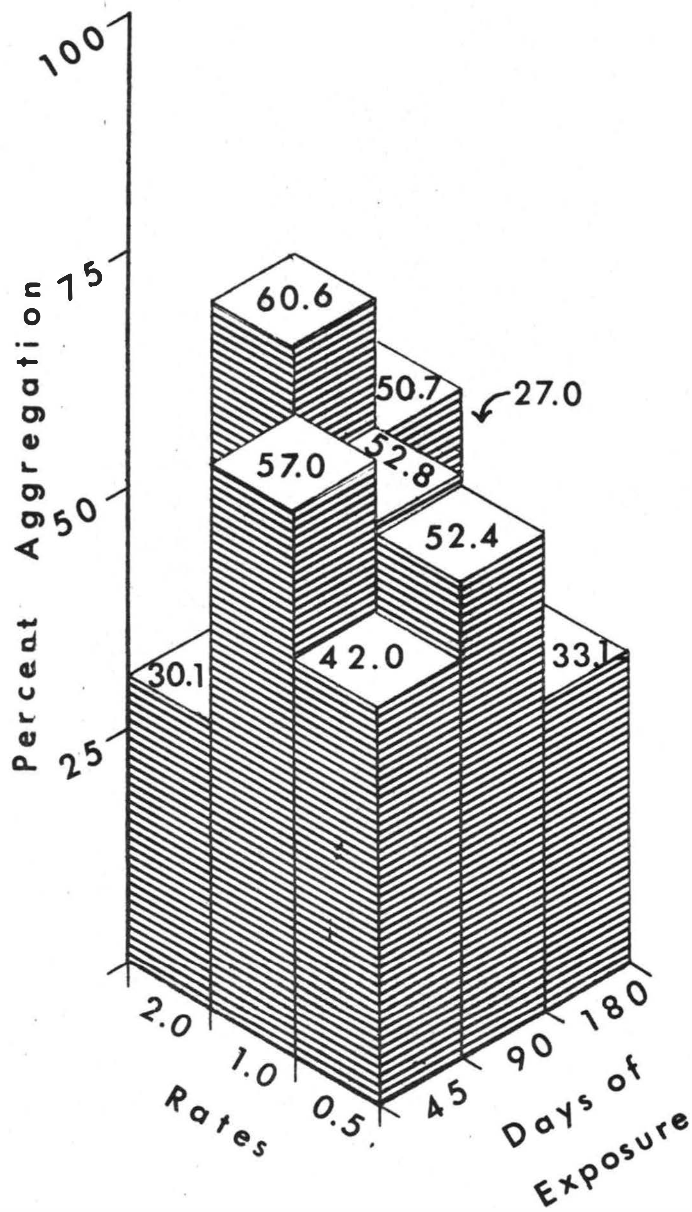


Figure 6. The Percent Aggregation of Vernon-Lucien Complex Clayey Soil Treated With MS-2

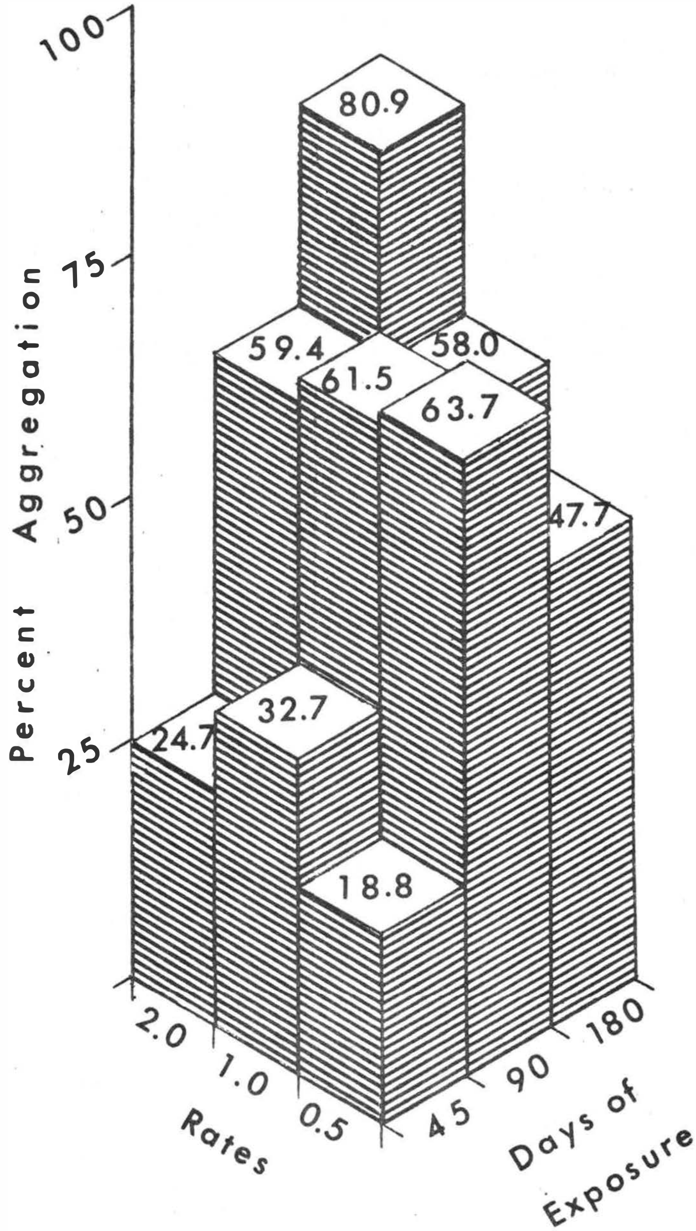


Figure 7. The Percent Aggregation of Vernon-Lucien Complex Clayey Soil Treated With Coherex

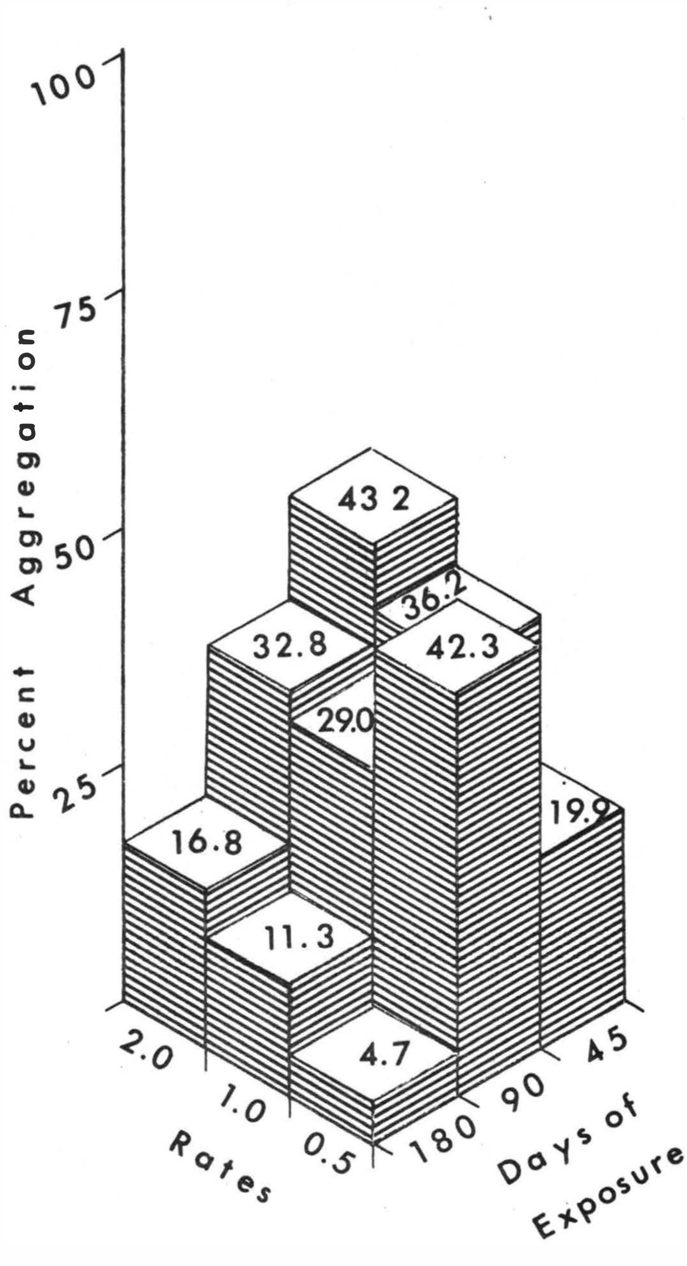


Figure 8. The Percent Aggregation of Vernon-Lucien Complex Clayey Soil Treated With Curasol

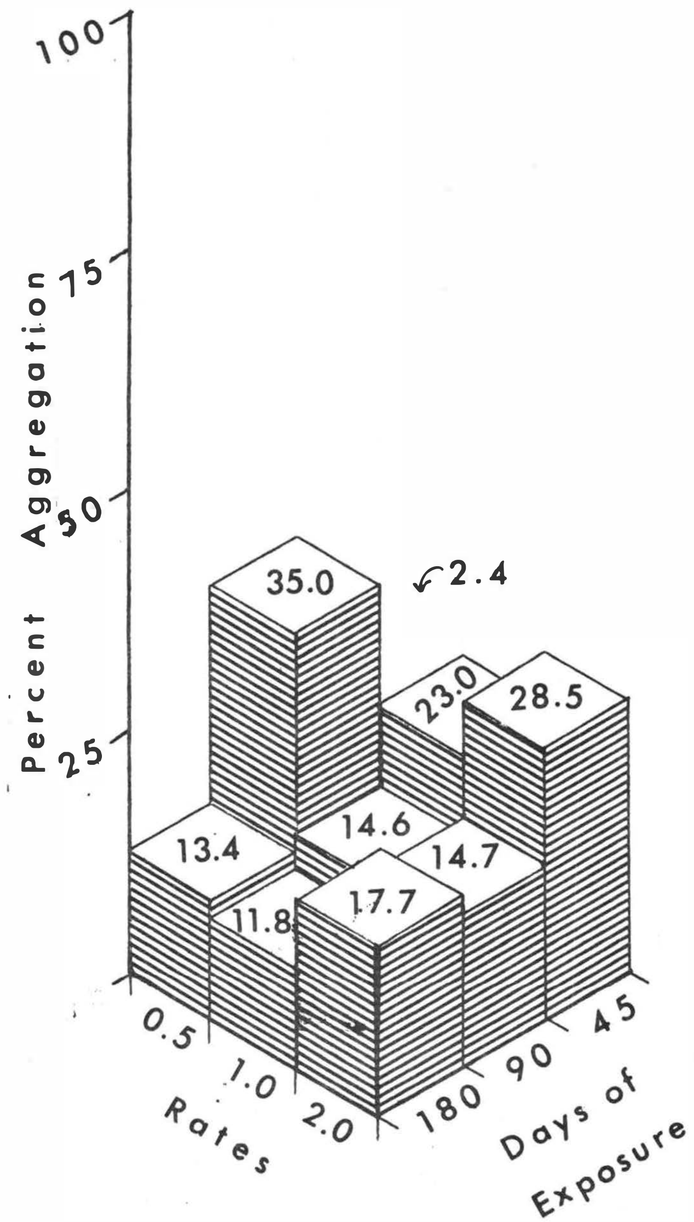


Figure 9. The Percent Aggregation of Vernon-
Lucien Complex Clayey Soil
Treated With Petroset

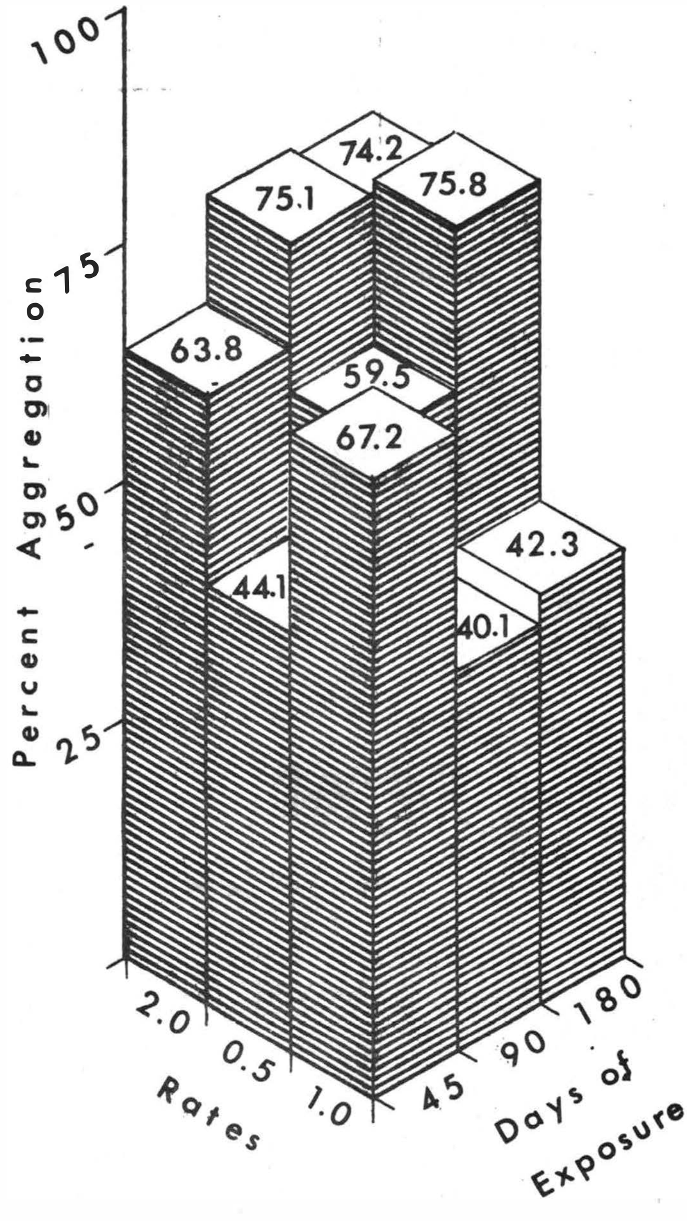


Figure 10. The Percent Aggregation of Teller Fine Sandy Loam Soil Treated With Coherex

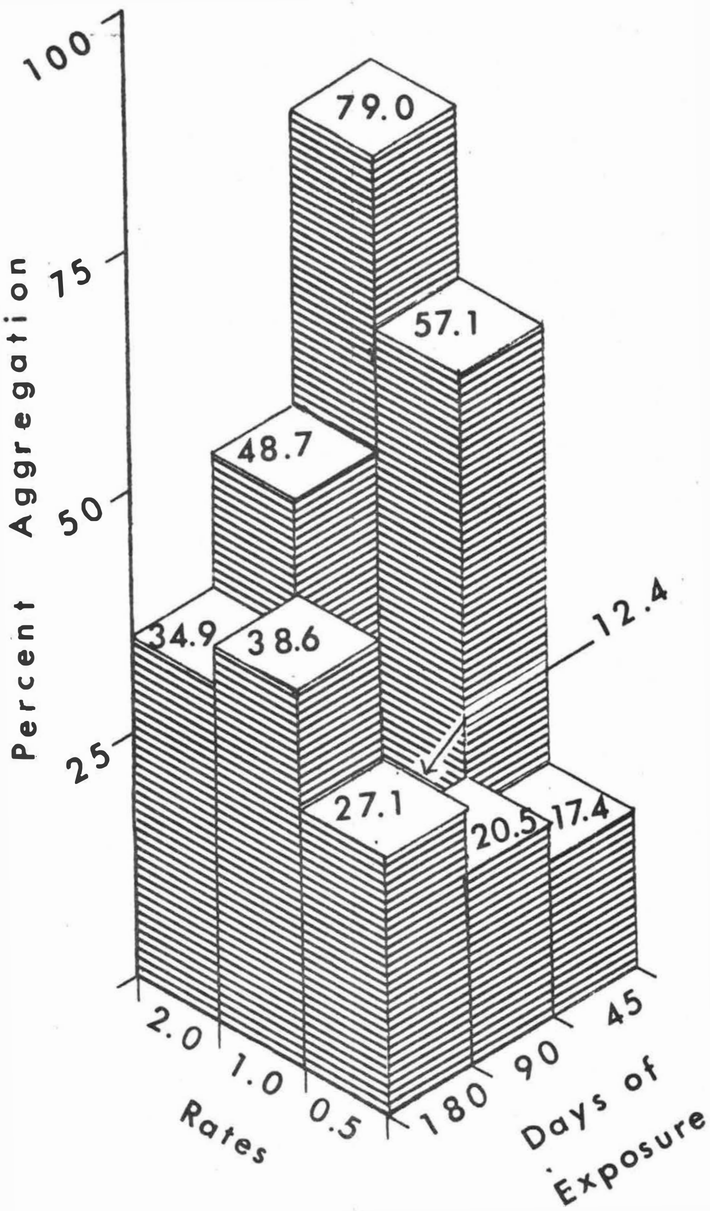


Figure 11. The Percent Aggregation of Teller Fine Sandy Loam Soil Treated With Curasol

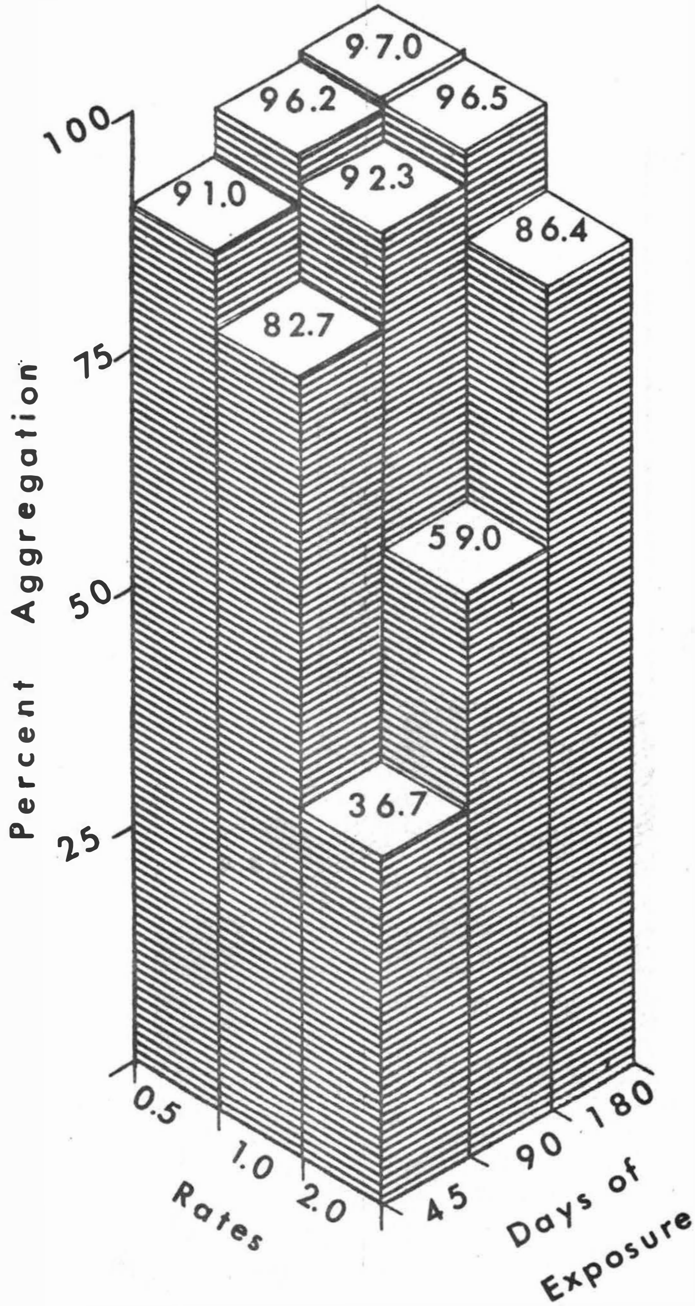


Figure 12. The Percent Aggregation of Teller Fine Sandy Loam Soil Treated With MS-2

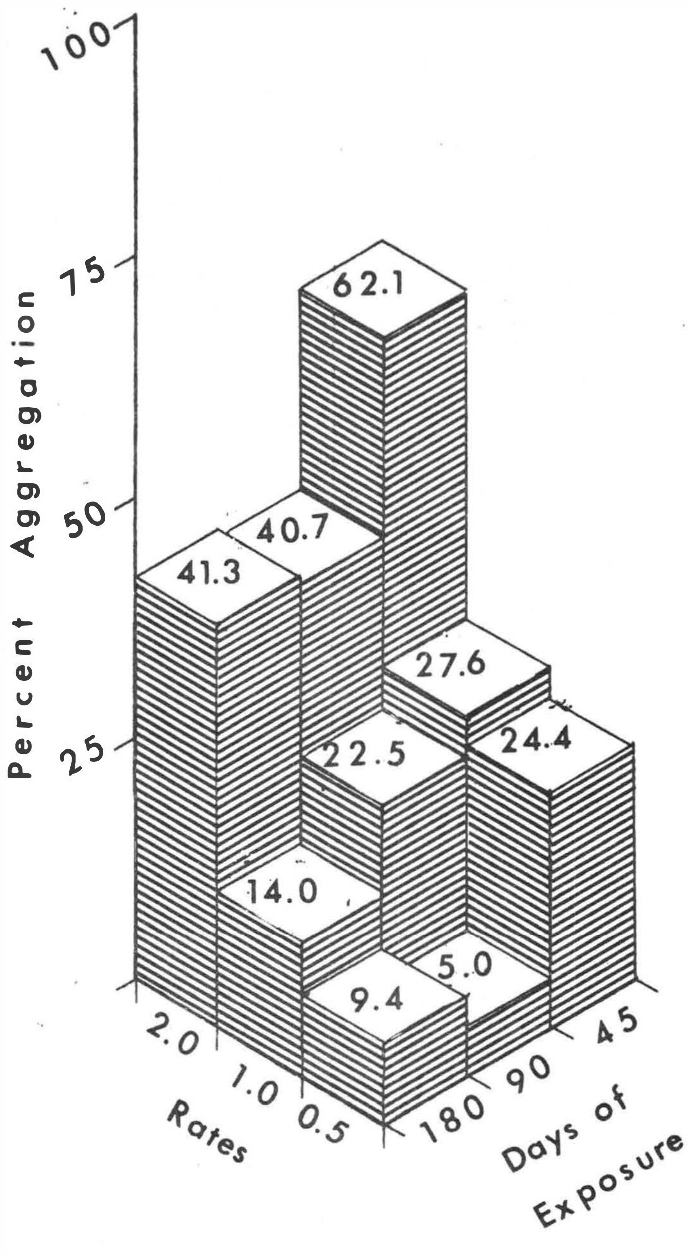


Figure 13. The Percent Aggregation of Teller Fine Sandy Loam Soil Treated With Petroset

There seems to be little advantage in applying MS-2 to the Teller soil at rates other than the lowest rate when comparing all exposure periods. Petroset exhibited the highest aggregation when applied at the highest rate to the Teller soil, and compared across all exposure periods.

Experiment 4* A comparison of 27 treatments for the germination and growth of weeping lovegrass along highway backslopes.

An investigation of the effect of 27 treatments on the germination and growth of weeping lovegrass was conducted on 4:1 backslope located on a Chickasha loam soil (a udic argiustoll) as shown in Figure 14. These treatments and their source are shown in Tables 5 and 6 respectively. The soil was fertilized with 200 pounds/acre (224 kg/ha) of 10-20-10, and disked once to a depth of 4 inches (10 cm). Weeping lovegrass (Eragrostis curvula (Schrad.) Nees) was seeded at a rate of 9 pound/acre (9.96 kg/ha). Seventy-five days after seeding 200 lb/acre (224 kg/ha) of 33.5-0-0 fertilizer was applied. Plant population counts were made 120 days after seeding. The response of weeping lovegrass to these 27 treatments is shown in Figure 15.

Applications of 2 inches (5 cm) depth of sawdust plus SS-1 asphaltic binder, woodchips, woodchips plus SS-1, and wheatstraw at 1 3/4 ton/acre (1.27 kg/3.72 m^2) plus SS-1, inhibited the growth of weeping lovegrass. This inhibition is believed to be the result of excessive rates of application of these mulches. As indicated in this investigation sawdust should not be applied without a tackifier. Much of the sawdust was eroded from the treated plots by wind action. Sawdust seemed to immobilize the soil nitrogen to the point where weeping lovegrass becomes chlorotic. An application of 200 lb/acre (224 kg/ha) of 33.5-0-0 corrected this chlorosis. Petroset and Kelgin Q seemed to inhibit the growth of weeping lovegrass. The reason for this inhibition is not known.

* Ensminger, Glenn E. 1974. Evaluation of chemical and fibrous mulches for roadside erosion control. Unpublished Ph. D. thesis Oklahoma State University.

Fig. 14. Evaluation of 27 treatments on the germination and growth of weeping lovegrass on a 4:1 backslope located on a Chickasha loam soil 2.8 miles north of Glencoe on SH-108 in Noble county.

TABLE 5

SOIL MULCH MATERIALS AND RATES USED FOR ROADSIDE EROSION CONTROL

Treatment*	Dilution ratio and rate of application/3.72m^2
Aquatain	5.5:1 (water:Aquatain) 2.95 liters of mixture
Baled excelsior	1.24 kg
Bare ground (check)	- - - - - - - - -
Coherex	4:1 (water:Coherex) 16.6 liters of mixture
Conwed Blanket	One layer thick
Conwed fiber	0.5 kg fiber applied with 6.9 liters water
Conwed fiber and emulsion	0.5 kg fiber and 14 g emulsion applied the mixture with 6.96 liters water
Conwed fiber and Kelzan	0.5 kg fiber and 15 g Kelzan applied the mixture with 6.96 liters water
Conwed fiber and Surflo	0.5 kg fiber and 1 liter Surflo applied the mixture with 6.96 liters water
Curasol	20:1 (water:Curasol) 8.32 liters of mixture
Excelsior mat	one layer thick
Gravel (<6 mm diameter)	one layer thick
Kelgin Q	14 g Kelgin Q applied with 6.96 liters water
MS-2	3:1 (water:MS-2) 5.30 liters of mixture
Petroset	25: (water:Petroset) 8.32 liters of mixture
Sawdust	5 cm thick
Sawdust and SS-1	5 cm of sawdust tackified with 7.57 liters of SS-1. Dilution ratio 6:1 (water:SS-1)
Silva fiber	0.5 kg fiber applied with 6.96 liters water
Silva fiber and Kelzan	0.5 kg fiber and 14 g Kelzan applied with 6.96 liters water
Silva fiber and Surflo	0.5 kg fiber and 1 liter Surflow applied with 6.96 liters water
SS-1	6:1 (water:SS-1) 5.30 liters of mixture
Terra mulch	0.5 kg fiber applied with 6.96 liters water
Terra mulch and Kelzan	0.5 kg fiber and 15 g Kelzan applied the mixture with 6.96 liters water
Terra mulch and Surflo	0.5 kg fiber and 1 liter Surflo applied the mixture with 6.96 liters water
Wheat straw and SS-1	1.24 kg wheat straw tackified with 7.57 liters of SS-1. Dilution ratio 6:1 (water:SS-1)
Woodchips	5 cm thick
Woodchips and SS-1	5 cm of woodchips tackified with 7.57 liters of SS-1. Dilution ratio 6:1 (water:SS-1)

*Trade names and company names are included for the benefit of the reader; they do not imply any endorsement or preferential treatment of named products by Oklahoma State University's Department of Agronomy.

Product Name	Manufacturer	Recommended Use	Product Type
Silva Fiber	Weyerhauser Co. Box B 4132 Tacoma, Washington	Erosion Inhibition	Mulch
Conwed Fiber Conwed Blanker	Conwed Corp. 332 Minnesota St. St. Paul, Minnesota	Erosion Inhibition	Mulch
Surflo	Baroid Division 1354 Skirvin Tower Oklahoma City, Oklahoma	Dust Suppresant & Soil Setting Agent	Mulch
Petroset	Phillips Petroleum Co. Chemical Dept. Bartlesville, Oklahoma	Geotechnic Emulsion to use as soil binder	Soil Binder
Aquatain	1424 South Allen St. Anaheim, California	Soil Erosion Inhibition	Mulch Binder
Curasol	American Hoechst Co. Chemicals and Plastics Division Route 202-206 Somerville, New Jersey	Soil Erosion Inhibition	Soil Binder
Woodchips	Shurplug Inc. Ada, Oklahoma		Mulch
Sawdust	Shurplug Inc.		Mulch
Gravel	Dolese Inc.		Mulch
Wheat Straw			Mulch
Excelsior Mat Excelsior (Baled)	Southwest Industries P.O. Box 237 Gallup, New Mexico		Mulch

Table 6. Soil erosion control materials and their source

Product Name	Manufacturer	Recommended Use	Product Type
Coherex	Allied Materials Corp.	Dust Controller	Soil Binder
M-S-2	Box 12340		Mulch
S-S-1	39th St. Station		Mulch
	Oklahoma City, Oklahoma		
Kelzan	Kelco Company	Mulch Binder	Mulch Binder
	75 Terminal Ave.		
Kelgin Q	Clark, New Jersey	Mulch Binder	Mulch Binder

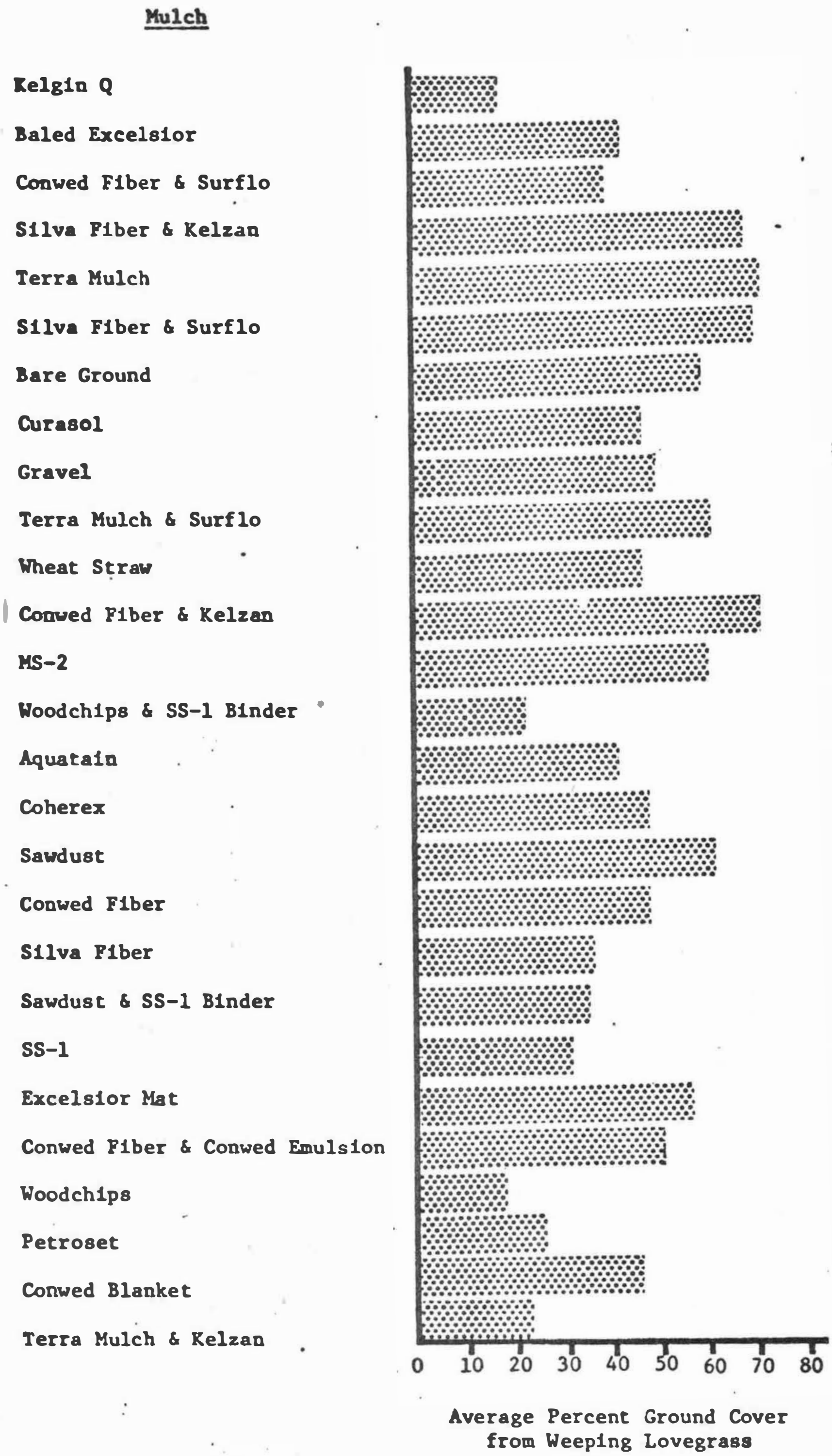


Figure 15 . Effect of 26 mulches on the germination and growth of Weeping lovegrass for roadside erosion control, seeded May 23, 1973, and mulched May 24, 1973, on a Chickasha loam soil 2.8 miles north of Glencoe on SH-108, as determined September 12, 1974.

Experiment 5. Effect of Aquatain* soil stabilizer on the germination and growth of eight seeded plant species.

Eight plant species were seeded November 6, 1971 in flats in the greenhouse on the Agronomy Research Station at Stillwater to determine the effect of Aquatain (a soil binder) on their germination and growth. As indicated in Figure 16 no definite toxicity could be detected on these plant species as determined by actual plant counts in treated and untreated flats. However, it should be noted, there were 39% fewer weeping lovegrass plants in the Aquatain treated flats when compared to the untreated. The low plant count of common bermudagrass, buffalograss, and Interstate sericea lespedeza is probably the result of poor seed as neither the treated or untreated flats contained many plants.

In another experiment, located on SH-51, one-fourth mile west of I-35, Aquatain appeared to provide only about 35% soil erosion control on a Vernon-Lucien soil complex. This ranked fourth of seven mulches evaluated for soil erosion control. In this experiment, the best erosion control was obtained from excelsior blanket, Asiatic bluestem hay, and excelsior fiber in descending order followed by Aquatain.

The day this experiment was initiated the soil moisture content was found to be 4%. Five weeks later the soil moisture content under these mulches showed 12.46% under the excelsior fiber, which was the highest, to 8.67% for Aquatain which was in fifth place. One week later, Aquatain treated plots were only slightly higher than the untreated checks in soil moisture content.

---

* Manufactured by the Larutan Corporation, 1424 South Allec Street, Anaheim, Calif. 92805. Furnished by K-P Construction Co. Inc., P.O. Drawer "O" Altus, Oklahoma 73521

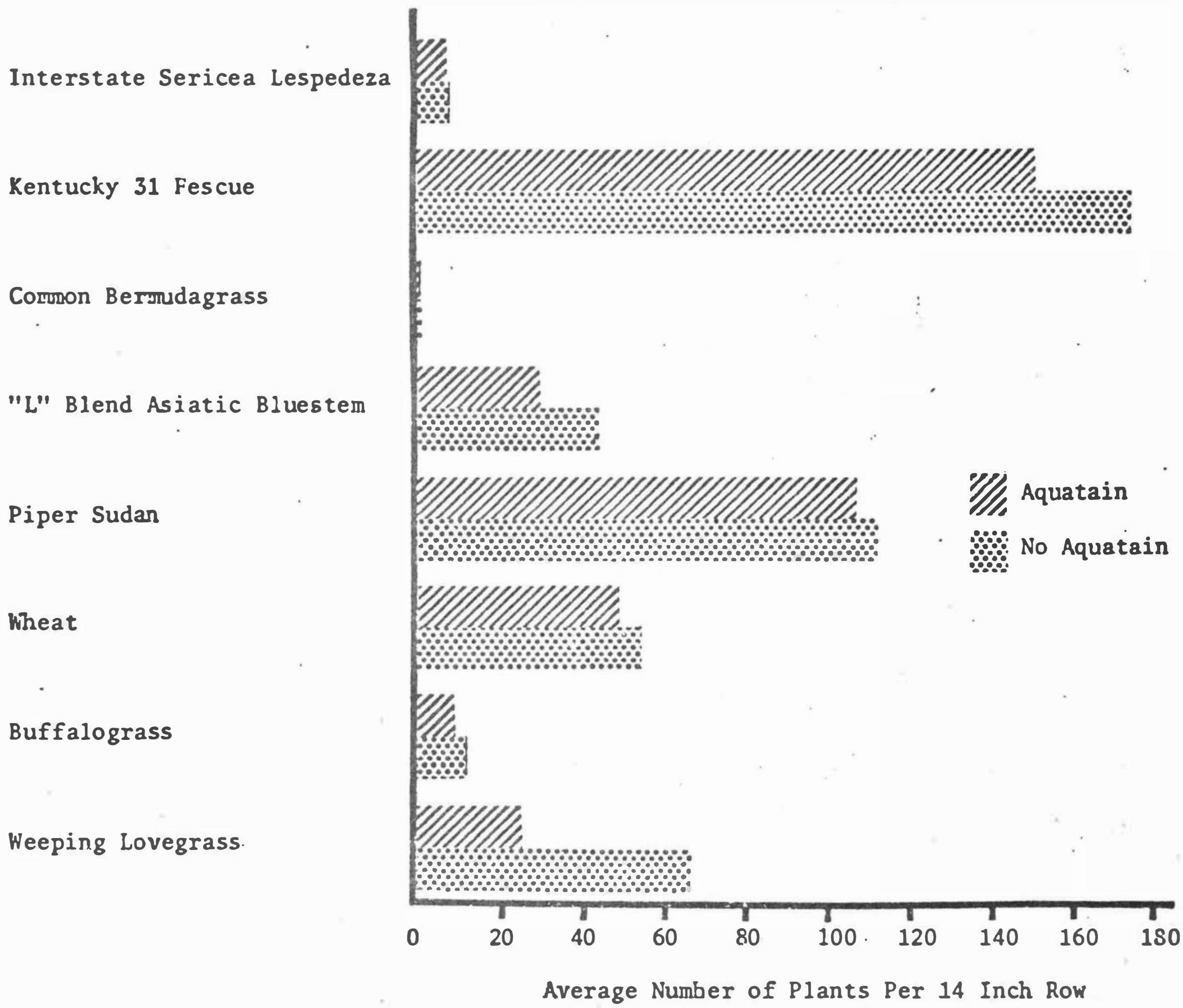


Figure 16. Effect of Aquatain soil stabilizer on the germination and growth of eight seeded plant species.

Experiment 6. Effect of six concentrations of lignon liquor* on the germination and growth of eight plant species used for roadside erosion control.

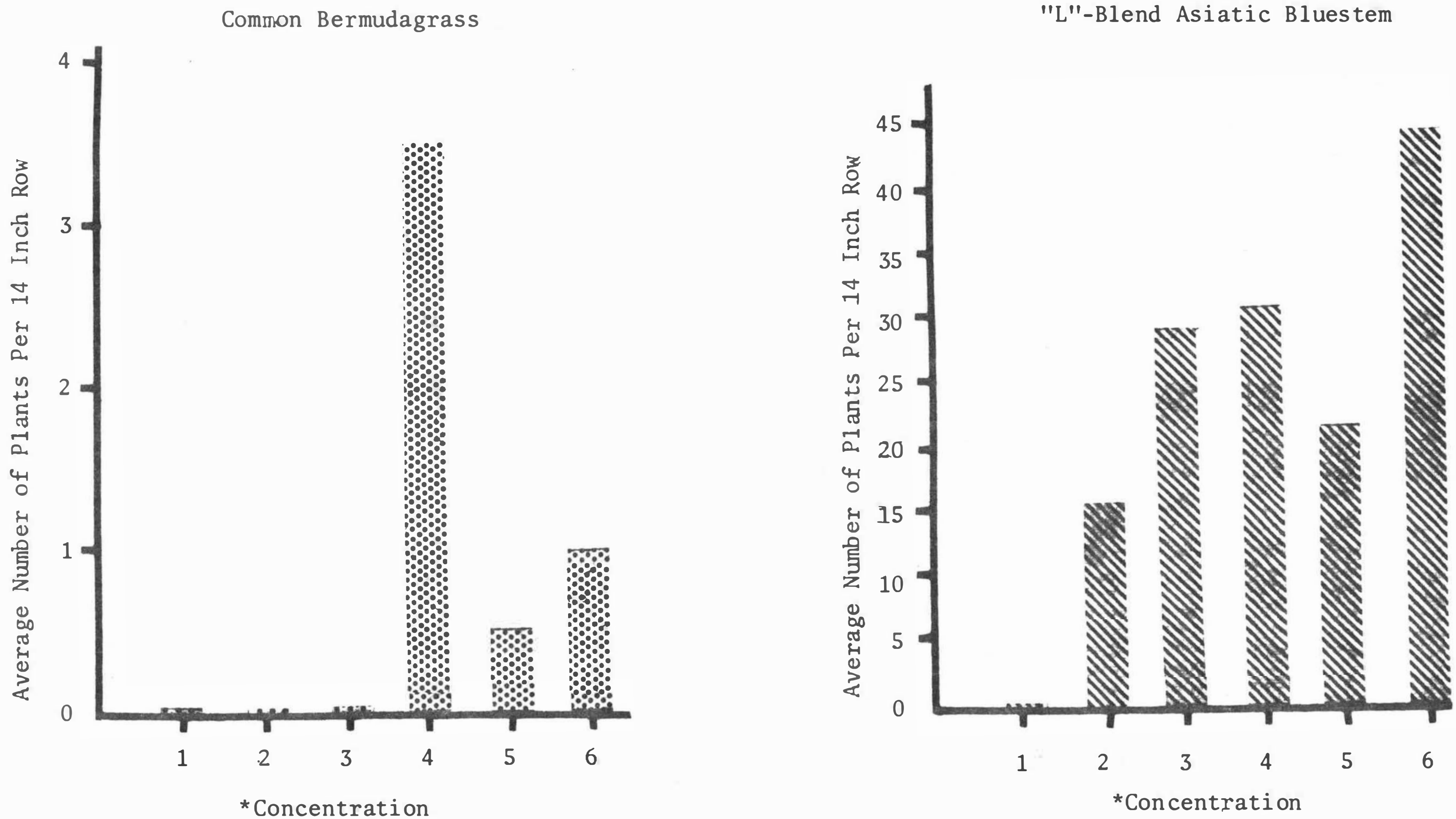
Eight plant species were seeded November 1, 1971 in flats in the greenhouse on the Agronomy Research Station at Stillwater to determine the effect of six concentrations of lignon liquor (a by-product of the wood pulp industry) on the germination and growth of these species used for roadside erosion control. As shown in Figures 17, 18, 19, and 20, a dilution of 1 part "lignon liquor" to 6 parts of water at least was necessary to minimize the highly significant injury to the germinating seedlings from probably excessive acidity. These data generally indicate an increase in germination and growth of Interstate sericea lespedeza, wheat, common bermudagrass, and weeping lovegrass when treated with diluted concentration of lignon liquor with water of 1:3, 1:6, 1:12, and 1:24 respectively.

Experiment 7. Effect of J M Fiber Tileguard Mat on the germination and emergence of 10 plant species used for roadside erosion control.

Ten plant species used for roadside soil erosion control were seeded on the Agronomy Research Station at Stillwater, October 1, 1971 with a one-row Planet Jr., seeder, and were immediately covered with J M Fiber Tileguard Mat. Four weeks later a count was made of the number of seedlings that had emerged through the mat. The results of this count are shown in Table 7. A highly significant difference in numbers of seedlings that emerged through the mat was detected. Only Kentucky 31 tall fescue had more than 3 plants emerge in 14 inches of row, and it had less than 1 plant every 2 inches of row space.

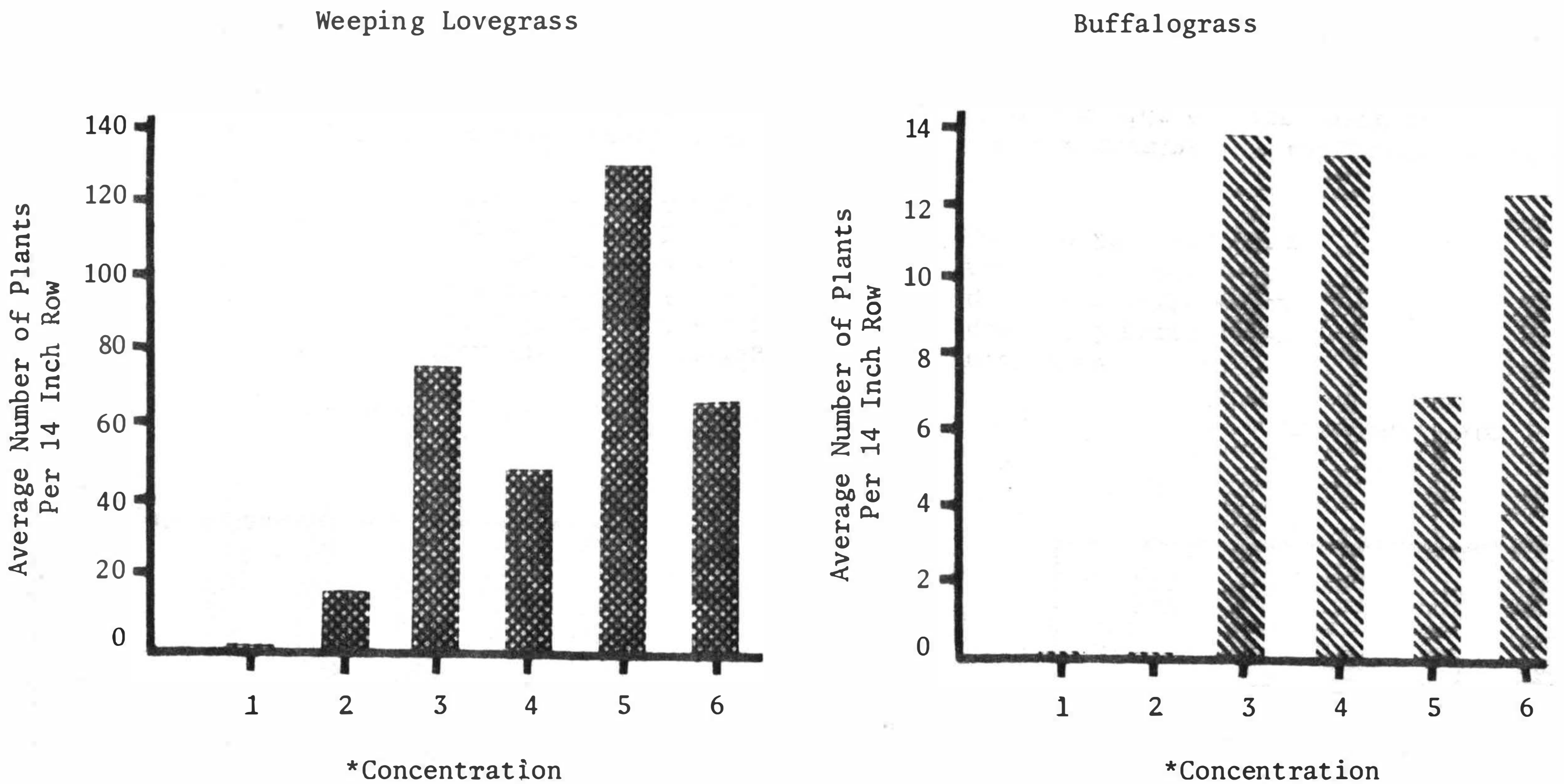
---

* Supplied by Riffe Petroleum Co., Tulsa, Oklahoma.



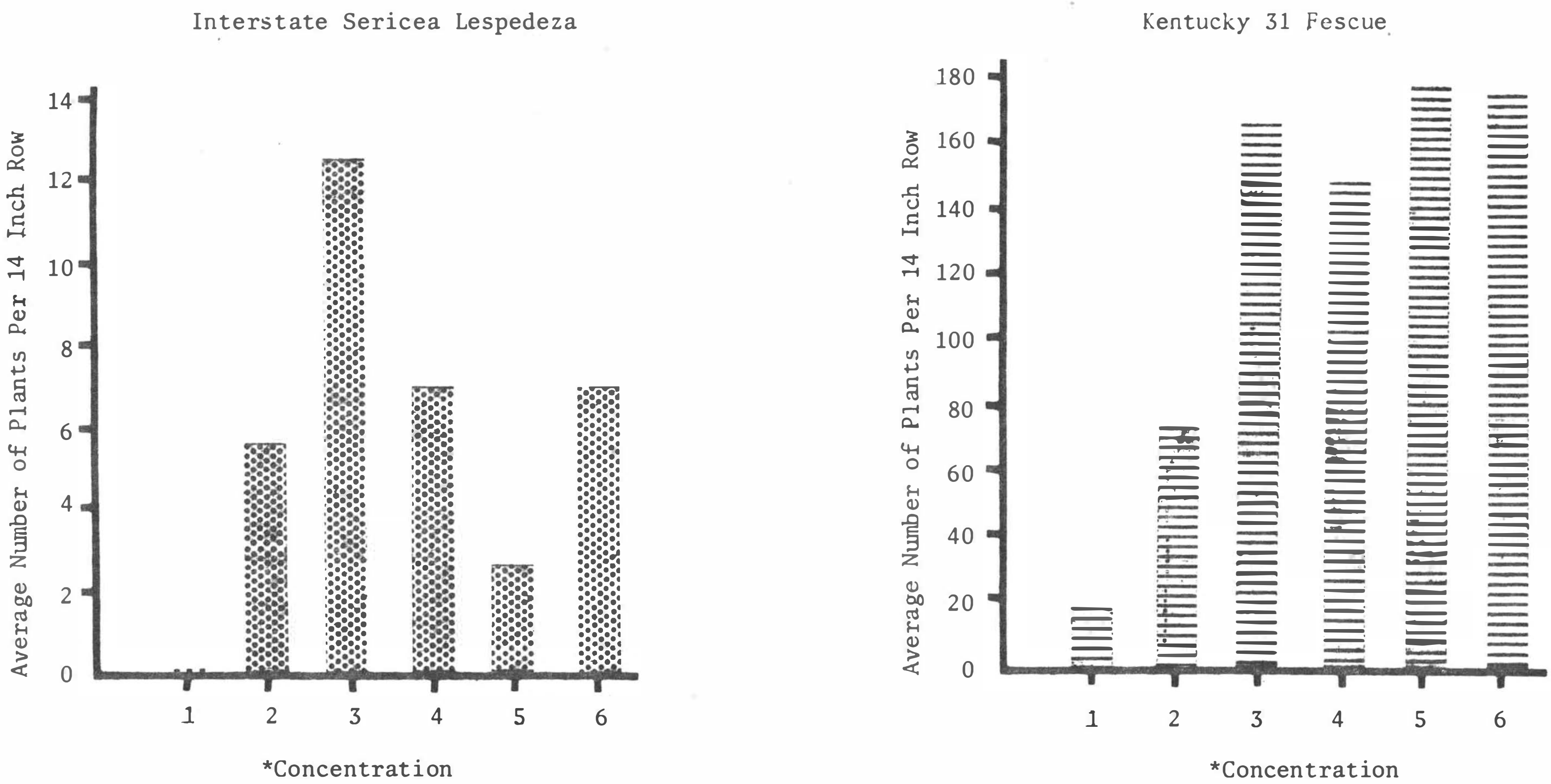
*Concentration 1 = lignin liquor Concentrate
Concentration 2 = 1 part lignin liquor to 3 parts water
Concentration 3 = 1 part lignin liquor to 6 parts water
Concentration 4 = 1 part lignin liquor to 12 parts water
Concentration 5 = 1 part lignin liquor to 24 parts water
Concentration 6 = Check (Water)

Figure 17. Effect of six concentrations of lignin liquor on the germination and growth of common bermudagrass and "L" blend Asiatic bluestem used for roadside erosion control.



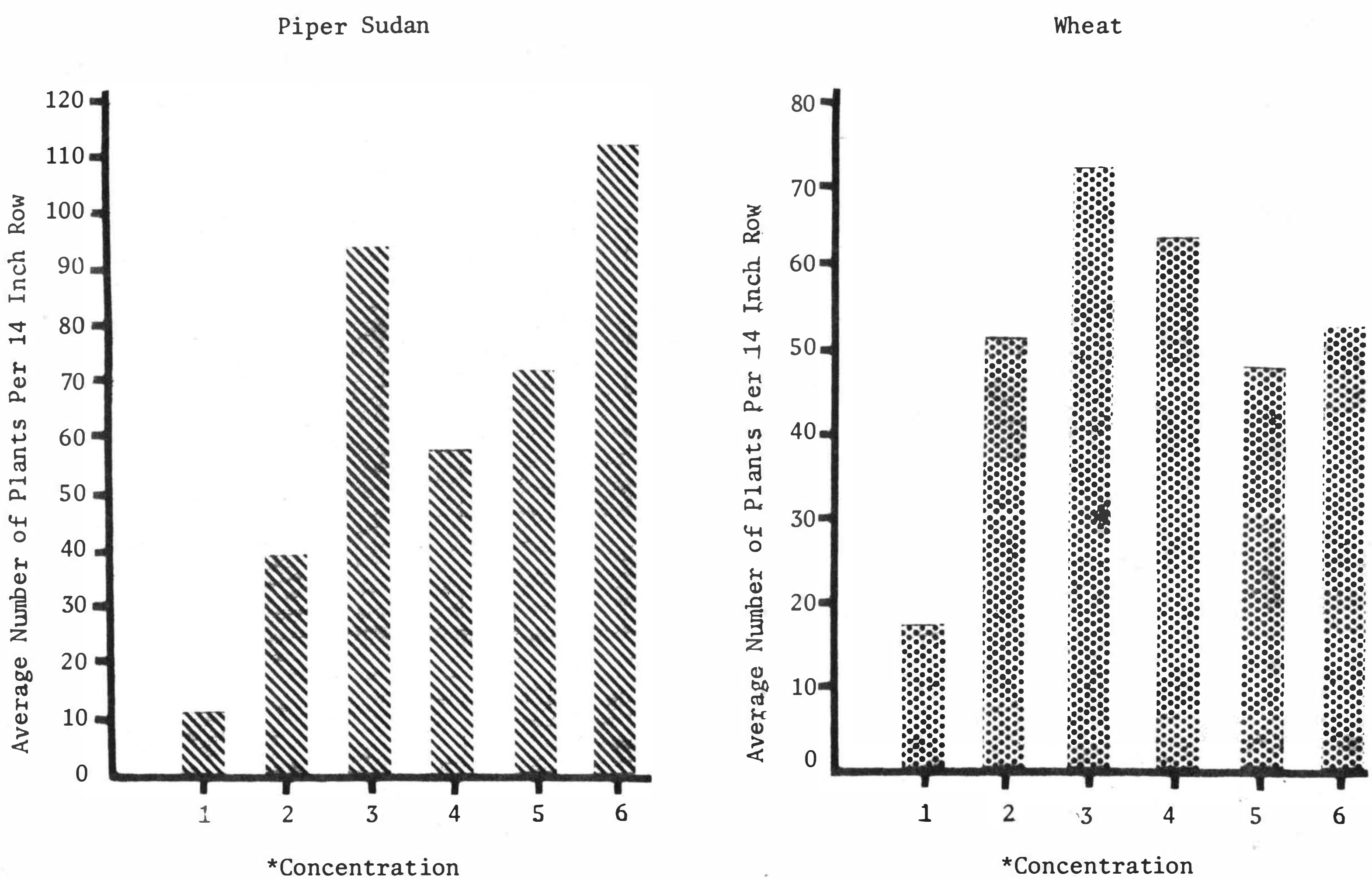
*Concentration 1 = 1 lignin liquor Concentrate
Concentration 2 = 1 part lignin liquor to 3 parts water
Concentration 3 = 1 part lignin liquor to 6 parts water
Concentration 4 = 1 part lignin liquor to 12 parts water
Concentration 5 = 1 part lignin liquor to 24 parts water
Concentration 6 = Check (Water)

Figure 18. Effect of six concentrations of lignin liquor on the germination and growth of Weeping lovegrass and buffalograss used for roadside erosion control.



*Concentration 1 = lignin liquor Concentrate
Concentration 2 = 1 part lignin liquor to 3 parts water
Concentration 3 = 1 part lignin liquor to 6 parts water
Concentration 4 = 1 part lignin liquor to 12 parts water
Concentration 5 = 1 part lignin liquor to 24 parts water
Concentration 6 = Check (Water)

Figure 19. Effect of six concentrations of lignin liquor on the germination and growth of Interstate Sericea Lespedeza and Kentucky 31 fescue used for roadside erosion control.



*Concentration 1 = lignin liquor concentrate
Concentration 2 = 1 part lignin liquor to 3 parts water
Concentration 3 = 1 part lignin liquor to 6 parts water
Concentration 4 = 1 part lignin liquor to 12 parts water
Concentration 5 = 1 part lignin liquor to 24 parts water
Concentration 6 = Check (Water)

Figure 20. Effect of six concentrations of lignin liquor on the germination and growth of Piper sudan and wheat used for roadside erosion control.

Table 7. The Effect of JM Fiber Tileguard Mat on Emergence of 10 Plant Species Used for Roadside Erosion Control, Seeded October 1, 1971, at the Agronomy Research Station, Stillwater, Oklahoma as Determined October 28, 1971.

Plant Species	Average Number of Plants Per 14" Row
Interstate Sericea Lespedeza	0.0
Kentucky 31 Fescue	6.6
Common Bermudagrass	0.0
Western Indiangrass	0.0
"L" Blend Asiatic Bluestem	0.2
Piper Sudan	1.8
Wheat	2.0
Buffalograss	2.2
Weeping Lovegrass	0.2
Sideoats Grama	0.0
Statistical Difference	**

These data indicate the J M Fiber Tileguard Mat would not be a suitable protective cover for these 10 plant species that are used for roadside erosion control.

Experiment 8. Effect of a fungicide, herbicide, and seeding methods on stand establishment of two grasses used for soil erosion control.*

An investigation of several seeding methods for the establishment of an erosion resistant ground cover was initiated in June, 1970, on the Agronomy Research Station at Stillwater, on a Kirkland silt loam soil that had been tilled earlier with a disk plow. A John Deere drill, a Brillion seeder, a Nisbet grass seeder, and a brush-drag method were evaluated for their effectiveness in stand establishment of seeded weeping lovegrass (*Eragrostis curvula* (Schrad.) Nees.), and an unnamed Asiatic bluestem (*Bothriochloa intermedia* var. *indica* (R. Br.) A. Camus), referred to locally as "B" blend. The effects of a preemergence herbicide, propazine (Ciba-Geigy product), and a fungicide Tersan, (Du Pont product) on stand establishment were also investigated. The John Deere drill and the Nisbet grass seeder were set at a planting depth of 1/2 inch.

The pre-emergence herbicide, propazine, was applied at the rate of 1 lb active ingredient (ai) per acre on the treated plots. Weeping lovegrass was seeded at the rate of 5 lb pure live seed/acre. The "B" blend Asiatic bluestem was seeded at the rate of 2 lb pure live seed/acre. The fungicide Tersan, which is 75% thiram was used in excess on the treated seed, with 76.8 grams of Tersan added to 10 pounds of bulk "B" blend Asiatic bluestem seed, and 38.4 grams added to 10 pounds of bulk weeping lovegrass seed.

---

* Cornforth, Lawrence Arthur. 1971. The effect of a fungicide, a herbicide, and seeding methods on stand establishment of two grasses for soil erosion control. Unpublished M.S. Thesis. Oklahoma State University.

Planting began June 19 when the two grasses were seeded with the Brillion seeder and the brush-drag method. A 0.23 inch rain fell that night so seeding with the John Deere drill and the Nisbet grass seeder was not finished until June 22. Since the Brillion seeder had no agitators, the "B" blend Asiatic bluestem was sown by hand, and then the Brillion seeder was run across the plot. A grass seedbox attachment with an agitator was not available for the John Deere drill so constant seed agitation by hand was necessary when "B" blend Asiatic bluestem was seeded. Hand-seeding was used in the brush-drag method, and a tree limb was drug across the plots to cover the seed. The preemergence herbicide, propazine, was applied June 22 after all seeding had been completed, and then approximately one-quarter inch of water was applied by sprinkler irrigation.

Although there were no significant differences among the four planting methods in the establishment of an erosion resistant grass stand, there were highly significant differences in grass population from the use of the preemergence herbicide, propazine, as can be seen in Figure 21. It was noted that by mid-summer seedlings in the weedy plots were smaller, less vigorous, and thinner than the seedlings in the plots where the weeds were controlled.

A possible explanation for no differences being found between planting methods is that the seedbed was well prepared and adequate moisture was available during the establishment period. A total of 4.78 inches of precipitation was received in July compared to a 30 year average of 3.69 inches for the month.

The addition of a seed treatment with the fungicide Tersan, with or without the herbicide propazine, showed little effect on the grass population as shown in Figure 22. The lack of any benefit from the fungicide treatment in this experiment perhaps can be explained by quick germination and growth of these grasses in a very favorable environment.

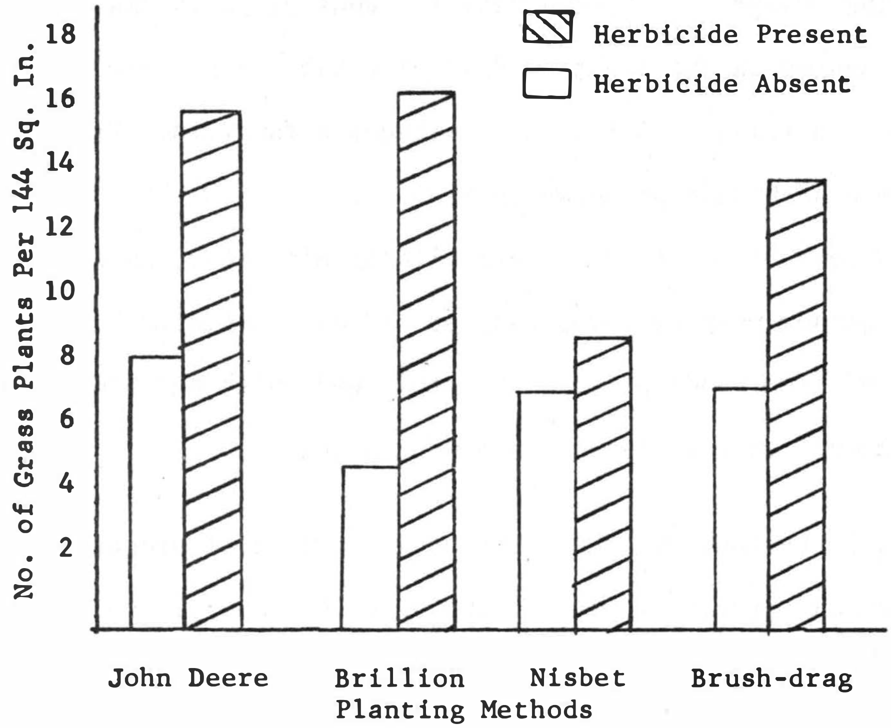


Figure 21 The Effect of Planting Methods and Herbicide Treatments on Stand Establishment

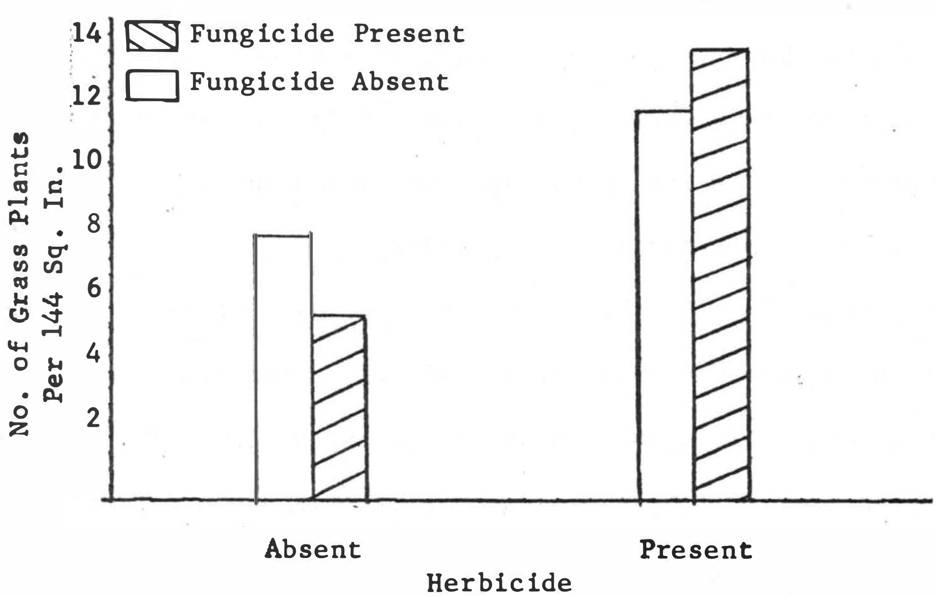


Figure 22. The Effect of Fungicide and Herbicide Treatments on Stand Establishment

Weeping lovegrass produced better stands of grass than "B" blend Asiatic bluestem in the first 60 days of establishment regardless of seeding method (Figure 23), with or without a fungicide (Figure 24), and with or without a herbicide as shown in Figure 25.

These data, although not statistically different, indicate the best stands of either weeping lovegrass, or "B" blend Asiatic bluestem, was obtained from seeding Tersan treated seeds with the John Deere drill, and protected from weed competition with propazine.

Experiment 9 Evaluation of the phytotoxic effect of propazine on the germination and growth of seven plant species used for roadside erosion control.

One of the most common causes for failures in stand establishment of roadside seedings is the competition from weeds. In an attempt to eliminate this problem an investigation was started July 21, 1971 to determine the effect of propazine on germination and growth of seven plant species used for roadside erosion control.

The grasses were seeded on a Kirkland silt loam soil on the Agronomy Research Station at Stillwater, Oklahoma. Propazine at the rate of 1 lb active ingredient (ai) / acre was applied in the equivalent of 40 gallons of water per acre immediately after seeding.

On September 9, 1971 the treatments were evaluated and the results are shown in Figure 26. These data indicate propazine at 1 lb ai/acre has no phytotoxic effect on weeping lovegrass, M-Blend Asiatic bluestem, sand lovegrass, or switchgrass. Further evaluations under different conditions and on different soil types should be made before these results are put to wide scale use.

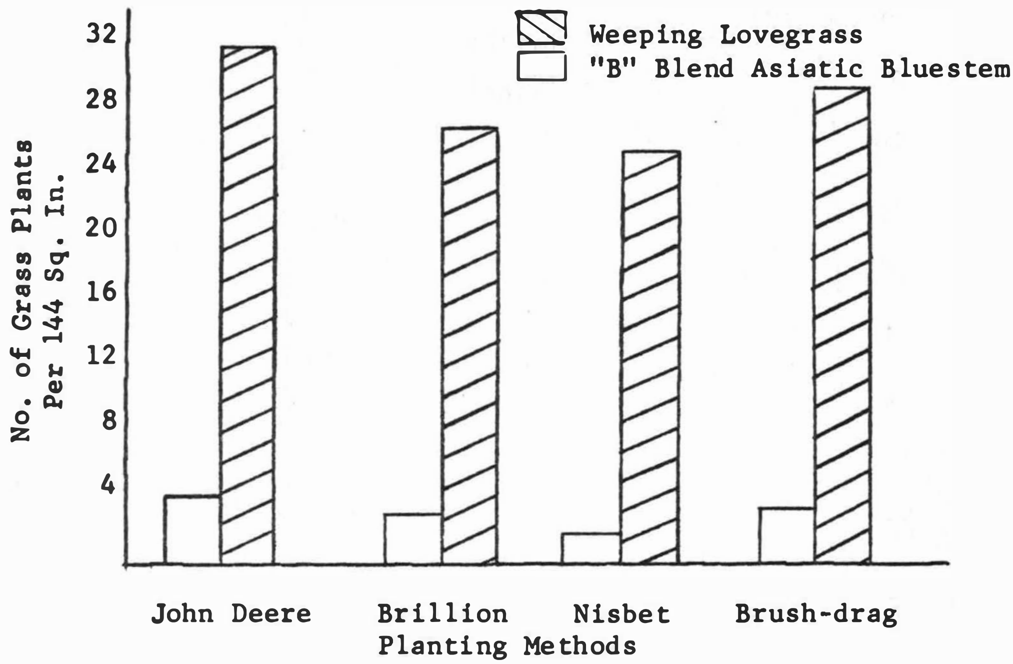


Figure 23. The Effect of Planting Methods and Kind of Grass on Stand Establishment

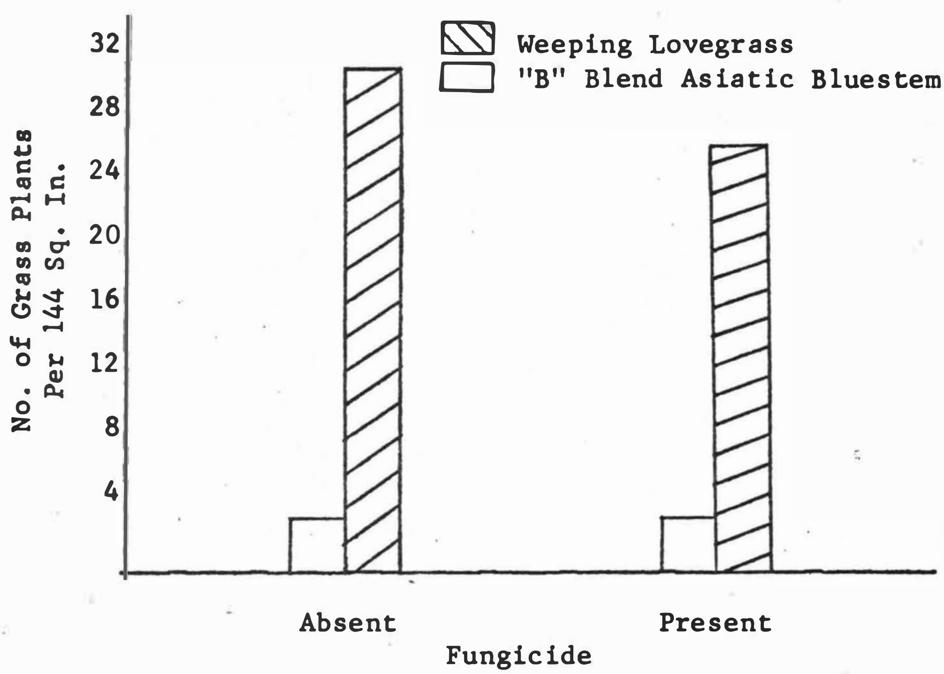


Figure 24. The Effect of Fungicide Treatments and Kind of Grass on Stand Establishment

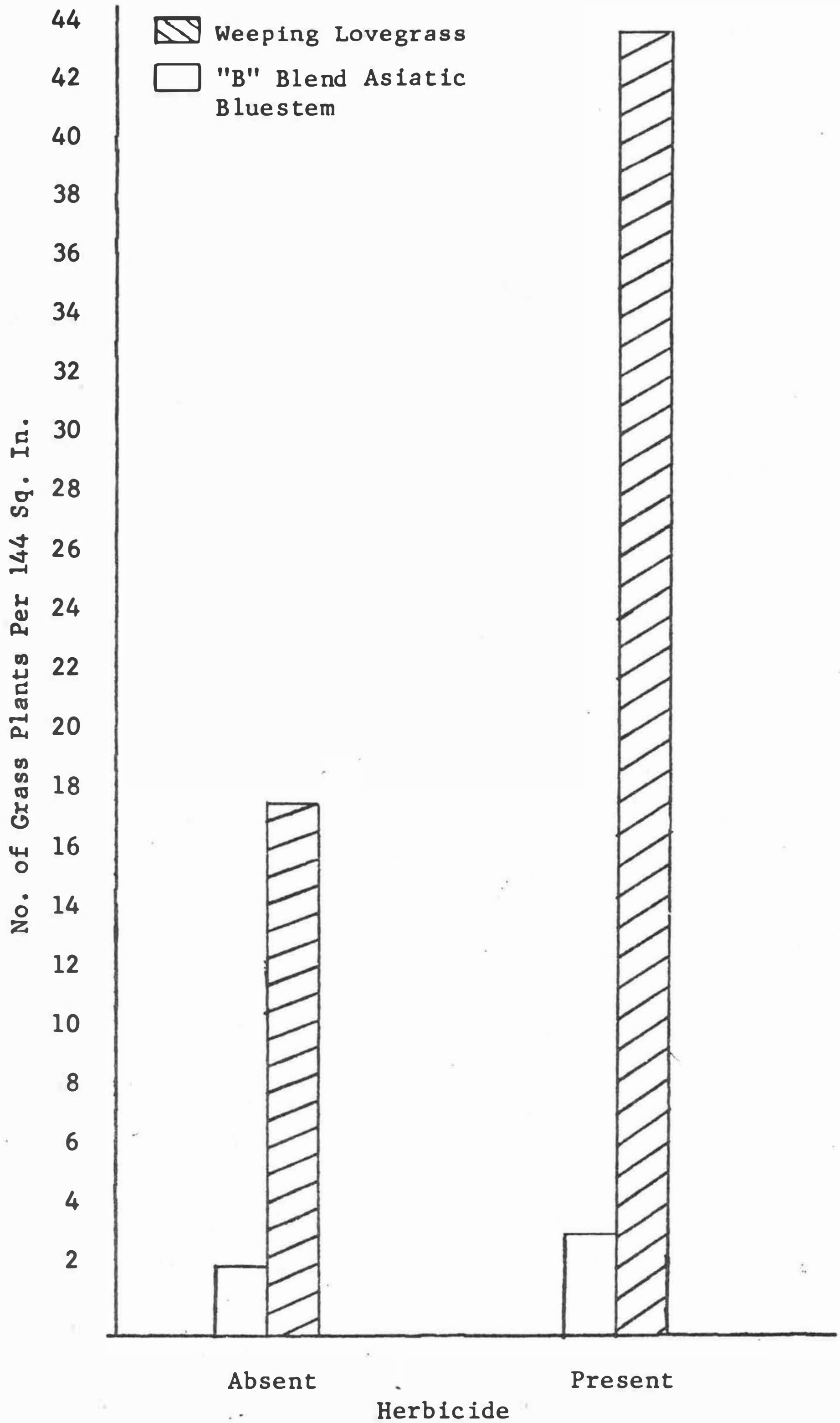


Figure 25. The Effect of Herbicide Treatments and Kind of Grass on Stand Establishment

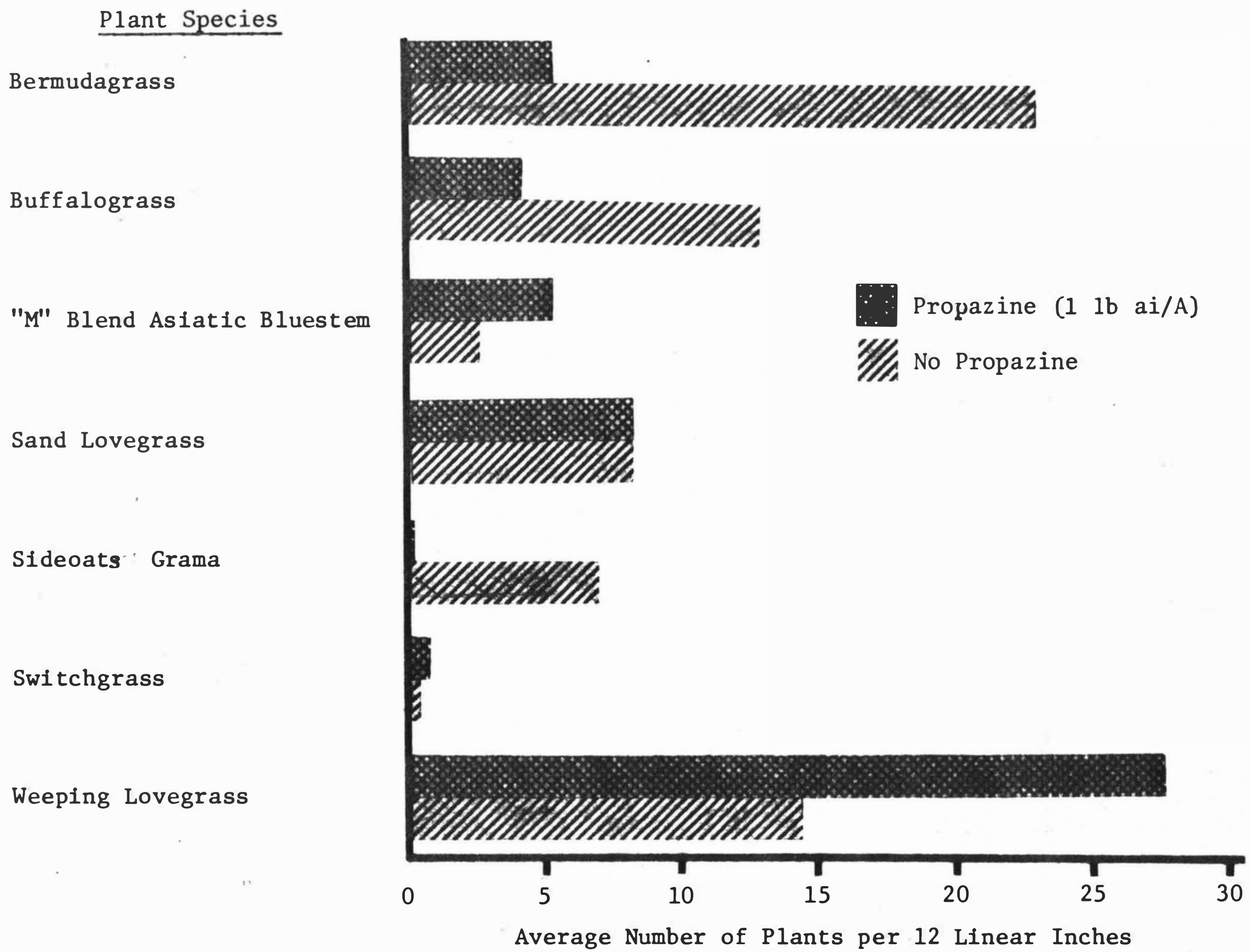


Figure 26. Effect of two levels of propazine on the germination and growth of seven soil erosion resistant grasses, seeded and treated July 21, 1971, on a Kirkland silt loam soil, on the Agronomy Research Station at Stillwater, Oklahoma, as determined September 9, 1971.

Experiment 10 Effect of three pre-emergence herbicides on germination and growth of 24 erosion resistant plant materials for possible use on roadside erosion control*.

In May, 1972, an investigation was initiated to determine the phytotoxicity of three pre-emergence herbicides (propazine, a product of Ciba-Geigy Corp; siduron, a DuPont product; and A-820, an Amchem product at two rates on the germination and growth of 24 seeded, erosion resistant plant materials for possible use on highway rights-of-way for the control of soil erosion. The plant species shown in Table 8 were seeded on a firm seedbed prepared on a Kirkland silt loam soil on the Agronomy Research Station at Stillwater, Oklahoma. The experiment was seeded on May 15, 1972, with a one-row Planet Junior. The herbicides, chemical names, formulations, and rates of application are shown in Table 9.

All herbicides were applied immediately after planting. The herbicides used were sprayed on each treated plot in an equivalent rate of 40 gallons water per acre. After seeding, all plots were kept moist by sprinkler irrigation for a period of three weeks to aid germination.

The effect of these herbicides on germination and growth of these plant species was determined by making an actual plant count from a random six inch section of of row in each plot, 30 and 90 days after seeding. Counts were made on June 15, and August 15, 1972.

As shown in Table 10, at the first count 30 days after treatment, propazine at either rate was not different from its check in seedling number of weeping lovegrass, switchgrass, caucasian bluestem, "H" Blend, "K" Blend and plains bluestem.

There were differences however in the high rate of propazine and the check on sideoats grama and crested wheatgrass.

---

*McCall, Donald A. 1973. The effect of three pre-emergence herbicides on germination and growth of 24 erosion resistant plant materials for possible use on roadside erosion control. Unpublished M.S. Thesis, Oklahoma State University.

TABLE 8

NAMES AND RATE OF PLANTING FOR 24 SEEDED MATERIALS USED IN THIS INVESTIGATION

Common Name	Scientific Name	Bulk Planting Rate Lbs/Acre
Weeping lovegrass	Eragrostis curvula	6
Bermudagrass	Cynodon dactylon	18
Buffalograss	Buchloe dactyloides	36
Serecia lespedeza	Lespedeza cuneata	40
Sideoats grama	Bouteloua curtipendula	33
Switchgrass	Panicum virgatum	16
Indiangrass	Sorghastrum nutans	32
Crested wheatgrass	Agropyron cristatum	17
Smooth bromegrass	Bromus inermis	39
Kentucky 31 fescue	Festuca arundinacea	33
Caucasian bluestem	Andropogon caucasicus	38
KR bluestem	*Bothriochloa ischaemum var. songarica	38
Blue grama	Bouteloua gracilis	25
L-Blend Asiatic bluestem	*Bothriochloa intermedia var. indica	38
T-Blend Asiatic bluestem	*Bothriochloa intermedia var. indica	38
H-Blend Asiatic bluestem	*Bothriochloa intermedia var. indica	38
S-Blend Asiatic bluestem	*Bothriochloa ischaemum var. ischaemum	38
J-Blend Asiatic bluestem	*Bothriochloa intermedia var. montana	38
K-Blend Asiatic bluestem	*Bothriochloa intermedia var. montana	38
B-Blend Asiatic bluestem	*Bothriochloa intermedia var. indica	38
Plains bluestem (M-Blend)	*Bothriochloa ischaemum var. ischaemum	38
Sudangrass	Sorghum vulgare var. sudanensis	28
Wheat	Triticum aestivum	120
Rye	Secale cereale	112

* Blends

** H-Blend was a semi-processed seed when planted while the other blends were combine run, rough, chaffy seeds.

TABLE 9

HERBICIDES, CHEMICAL NAMES, FORMULATIONS, AND RATES USED TO DETERMINE PHYTOTOXICITY ON 24 SEEDED PLANT MATERIALS

			Application Rates	
Herbicide	Chemical Name	Formulation*	Kg. a.i./ha	lb. a.i./a
Siduron	1-(2-methylcyclohexyl)-3-phenylurea	WP	0.56, 1.12	0.5, 1.0
Propazine	2-chloro-4, 6-bis (isopropylamino)-5-triazine	WP	0.56, 1.12	0.5, 1.0
**A-820	(Not Available)	EC	1.12, 2.24	1.0, 2.0
Check	- - -	--	-- --	-- --

*WP-wettable powder EC-Emulsifiable concentrate

**An experimental formulation of a dinitroanaline identified by Amchem as A-820.

TABLE 10

EFFECT OF THREE PRE-EMERGENCE HERBICIDES ON GERMINATION AND GROWTH OF 13 PLANT MATERIALS THAT SHOWED STATISTICAL DIFFERENCES AT COUNT ONE, THIRTY DAYS AFTER PLANTING

	Treatments						
Plant Material	Siduron ½ lb ai/a	Siduron 1 lb ai/a	Propazine ½ lb ai/a	Propazine 1 lb ai/a	A-820 1 lb ai/a	A-820 2 lb ai/a	Check*
Weeping lovegrass			78.3 a	74.3 a			81.3 a
Bermuda							47.6 a
Serecia lespedeza	36.6 a						29.6 a
Sideoats grama	24.6 a	18.3 a	7.6 a		7.0 a		22.6 a
Switchgrass	40.6 a		47.3 a	38.3 a			48.3 a
Crested wheatgrass	31.6 a	22.6 a	13.3 a		18.0 a	16.0 a	30.3 a
Smooth brome	32.3 a	37.6 a			32.3 a	24.3 a	38.0 a
Ky 31 fescue	39.6 a	22.6 a			21.3 a		33.6 a
Caucasian bluestem			42.0 a	25.3 a			37.3 a
H-Blend			50.6 a	35.0 a			39.3 a
K-Blend	14.0 a	10.3 a	10.0 a	12.3 a	6.0 a		23.6 a
Plains bluestem			27.3 a	15.0 a			23.3 a
Wheat	24.0 a	22.3 a			27.0 a	19.6 a	39.0 a

Standard Error of the Mean = 116.37

*Only those means which were equal to the check plot means are shown.

The high rate affected the germination and growth of these two grasses resulting in a reduced stand just as it did at either rate on bermuda, buffalo, indian, smooth brome, Kentucky 31 fescue, KR bluestem, blue grama, L,T,S,J, and B-Blend Asiatic bluestem, sudangrass, wheat, and rye.

Siduron at either rate caused no significant reduction from the check plots in seedling number for sideoats grama, crested wheatgrass, smooth brome, Kentucky 31 fescue, K-Blend Asiatic bluestem, and wheat. Siduron at 1/2 lb active ingredient (ai)/acre was no different than the check on sericea lespedeza. A significant reduction in plant numbers resulted from either rate of siduron applied on plots seeded with weeping lovegrass, bermuda, caucasian bluestem, H-Blend Asiatic bluestem, and Plains bluestem.

The experimental herbicide A-820 (now registered as Amex 820) applied up to 2 lb ai/acre caused no significant reduction in seedling number when compared to the untreated check of crested wheatgrass, smooth bromegrass, and wheat. The high rate however, did affect sideoats grama, Kentucky 31 fescue, and K-Blend Asiatic bluestem.

Ninety days after planting propazine treated plots at either rate when compared to their untreated check plots, showed no significant reduction in seedling number of weeping lovegrass, switchgrass, L,H,J, and K-Blend Asiatic bluestems as shown in Table 11. The high rate caused a significant reduction in plant numbers, after the first count, of caucasian and Plains bluestem.

There were no changes in treatment effects from siduron 90 days after treatment, when compared to the count made 30 days after planting except for Kentucky 31 fescue which was seriously affected, as well as bermuda and J-Blend Asiatic bluestem which showed a noticeable decline in plant numbers at the low rate of application. Wheat had matured during this period which accounts for its absence at this count. Seedling numbers in siduron treated plots of sideoats grama, crested wheatgrass, smooth brome, blue grama, and K-Blend bluestem were not significantly different when compared to the untreated checks.

TABLE 11

EFFECT OF THREE PRE-EMERGENCE HERBICIDES ON GERMINATION AND GROWTH OF 14 PLANT MATERIALS THAT SHOWED STATISTICAL DIFFERENCES AT COUNT THREE, NINETY DAYS AFTER PLANTING

	Treatments						
Plant Material	Siduron ½ lb ai/a	Siduron 1 lb ai/a	Propazine ½ lb ai/a	Propazine 1 lb ai/a	A-820 1 lb ai/a	A-820 2 lb ai/a	Check*
Weeping lovegrass			67.0 a	60.0 a			61.6 a
Bermuda	27.3 a						28.0 a
Serecia lespedeza	36.3 a						24.3 a
Sideoats grama	24.3 a	11.6 a					23.3 a
Switchgrass	39.3 a		43.0 a	37.3 a			37.0 a
Crested wheatgrass	27.0 a	16.3 a				12.0 a	16.3 a
Smooth brome	27.0 a	33.3 a			26.0 a	19.0 a	33.0 a
Caucasian bluestem			43.3 a				31.3 a
Blue grama	11.0 a	10.3 a					17.3 a
L-Blend	6.6 a		19.3 a	9.0 a			5.3 a
H-Blend			46.3 a	32.3 a			35.3 a
J-Blend	10.6 a		20.3 a	16.0 a	17.0 a		7.0 a
K-Blend	12.3 a	4.3 a	8.6 a	12.0 a			20.6 a
Plains bluestem			34.6 a				20.0 a

Standard Error of the Mean = 84.04

*Only those means which were equal to the check plot means are shown.

A-820 (Amex 820) at either rate produced no noticeable damage to the seedlings of smooth brome and crested wheatgrass during this 90 day period. During this period, propazine gave the best control of both grassy and broadleaf weeds of the three herbicides evaluated.

SPECIES ADAPTATION AND USE FOR EROSION CONTROL

Grasses are generally recognized for most situations to be the most practical roadside cover, as they combine good erosion control with an attractive appearance. Although easier to establish than most plants used for erosion control, grasses vary in their speed of germination and growth.

For the most satisfactory and economical means of roadside erosion control it is imperative that we evaluate numerous plant species under varied conditions. The complete evaluation of species, cultural practices, and ecological effects can only be made with time. The plant, soil, and weather complex interact differently from one year to the next, but over a period of time, a trend or pattern evolves upon which recommendations can be made with greater confidence and reliability.

Experiment 11 Tentative classification of man-made soils* and list of dominant grasses.

In 1971 a tentative classification of man-made soils on Oklahoma highways was made on former roadside development and erosion control research sites, and a list prepared of the dominant grasses as shown in Table 12.

Although the grasses listed here reflect the performance of those presumed to have been seeded originally as shown in Table 13, they are perhaps good indicators of species that can be used for roadside erosion control on those slopes, exposures, and weather conditions in Oklahoma, until something better can be found.

---

*Dr. Fenton Gray, Tentative classification of man made soils. See 1971 Interim Report, Project 70-01-3, HPR-1 (6), Roadside Erosion Control, Table 1, pages 5 and 6.

Table 12. The grasses that seem to be best adapted to the man-made soils listed in the new tentative classification are as follows:

East of US 81

New Classification of Man-Made Soils	Dominant Grasses
Paralithic and Lithic Udarent, 25-45% slope, loamy, shallow, acidic	K.R. bluestem and weeping lovegrass appear to be best suited on south facing cut slopes followed by bermuda with a trace of switchgrass being found. Weeping lovegrass seems to be best on north facing cut slopes followed by K.R. bluestem with a small amount of bermuda being found and an occassional switch-grass plant.
Paralithic Ustarent, 25-45% slope, clayey, shallow-very shallow, basic.	Bermudagrass seems to be best for erosion control on both east and west facing cut slopes followed by K. R. bluestem and buffalo on west exposures and weeping love and buffalo in that order on east facing cut slopes.

West of US 81

New Classification of Man-Made Soils	Dominant Grasses
Paralithic Ustarent, 25-45% slope, loamy, deep-shallow, basic	Switchgrass and sideoats grama seem to be best for use on north facing cut slopes followed by weeping lovegrass. On south facing cut slopes weeping love seems to be best followed by sideoats grama and switch in that order.
Paralithic Ustarent, 25-45% slope, loamy, very shallow, basic.	Sideoats grama seems to be best on either east or west facing cut slopes followed by buffalograss and weeping love in that order.

Table 13. Dominant Grasses Observed. Approximately Five Years or More After Seeding on Different Soils and Slope Exposures on Oklahoma Highways.

Slope Cut or Fill	%	Exposure	Soil Assn.	Soil Unit	AASHO No.	Dominant Grass &	%Ground Cover
			East of US 81				
Excavation	5%	NW	Dougherty	Dougherty	A2-3	Bermuda	42%
			Konowa &	Konowa	A4	Weeping Love	35%
			Eufaula			Buffalo	27%
Cut	38%	South	Parsons	Talihina	A6	K.R. Bluestem	68%
			Dennis	Collinville	A7	Weeping Love	53%
			Bates			Bermuda	53%
						Switch	nil
Cut	33%	North	Parsons	Talihina	A6	Weeping Love	72%
			Dennis	Collinsville	A7	K. R. Bluestem	35%
			Bates			Bermuda	5%
						Switch	nil
Cut	33%	South	Parsons	Collinsville	A4	Weeping Love	53%
			Dennis			Bermuda	18%
			Bates			Switch	nil
						K. R. Bluestem	nil
Cut	33%	North	Parsons	Collinsville	A4	Weeping Love	65%
			Dennis			Bermuda	2%
			Bates			K. R. Bluestem	nil
						Switch	nil
Cut	33%	East	Dougherty	Konowa	A4	Bermuda	68%
			Teller				
			Yahola				

* Percent ground cover in best fertility treatment for that grass.

Table 13. (cont'd)

Slope Cut or Fill	%	Exposure	Soil Assn.	Soil Unit	AASHO No.	Dominant Grass	% Ground Cover
Level Subsoil	--	None	Vanoss	Konowa	A4	Bermuda	58%
			Minco				
			Yahola				
Cut	42%	East	Renfrow	Vernon	A6	Bermuda	54%
			Zaneis			K. R. Bluestem	40%
			Vernon				
Cut	42%	West	Renfrow	Vernon	A6	Bermuda	83%
			Zaneis			K. R. Bluestem	12%
			Vernon			Buffalo	12%
			West of US 81				
Cut	35%	North	Vanoss	Vanoss	A4	Switch	35%
			Minco			Sideoats Grama	30%
			Yahola			Weeping Love	23%
Fill	32%	North	Vanoss	Vanoss	A4	Bermuda	52%
Cut	43%	North	Vanoss	Vanoss	A4	Sideoats Grama	31%
			Minco		A6	Switch	27%
			Yahola			Weeping Love	22%
Cut	35%	South	Vanoss	Vanoss	A4	Weeping Love	40%
			Minco		A6	Sideoats Grama	29%
			Yahola			Switch	6%
Cut	32%	West	Vernon	Vernon	A-7-6	Sideoats Grama	25%
						Buffalo	18%
						Weeping Love	6%

Table 13. (Cont'd)

Slope Cut or Fill	%	Exposure	Soil Assn.	Soil Unit	AASHO No.	Dominant Grass	% Ground Cover
Cut	33%	East	Vernon Break	Vernon	A-7-6	Sideoats Grama	23%
						Buffalo	14%
						Weeping Love	13%
Fill	41%	East	Vernon breaks	Vernon	A-7-6	Bermuda	62%
Fill	40%	West	Vernon breaks	Vernon	A-7-6	Bermuda	77%

Experiment 12. Evaluation of five grasses and one legume for roadside erosion control on a southeast facing backslope..

On June 22, 1971 an investigation of five grasses and one legume for use in roadside erosion control was initiated on US 271, approximately 0.6 miles northeast of Wister, in LeFlore county. The seedbed, with a moderately compacted shale surface, contained 534 pounds of available P_2O_5 per acre, 785 pounds of available K_2O per acre, and had a pH reading of 6.7, as determined by a water-paste method.

The species were hand seeded on June 22, 1971 and were mulched the following day with 2 tons/acre of wheat straw. They were evaluated approximately five months later as shown in Figure 27.

Although there were no statistical differences, weeping lovegrass, H, and J-Blends Asiatic bluestem in that order, provided two or more times more plants per square yard than the other species tested. Interstate sericea lespedeza was fourth in plant population with approximately half as many plants per unit area as the third highest H-Blend Asiatic bluestem.

Experiment 13. Evaluation of five grasses and one legume for roadside erosion control on a northwest facing backslope.

On the opposite side of US 271 from experiment #12, an identical experiment was started the same day, and mulched one day later. The pH, available P_2O_5, and available K_2O were the same as that across the road. The only difference being a northwest exposure.

Although there were no significant differences in plant count within the experiment, as many as 40 to 250 times more plants per unit area were counted here than in the experiment across the road. Interstate sericea lespedeza as shown in Figure 28, produced more plants per unit area than any other species in the experiment. Seeded at the rate of 30 pounds/acre, there were approximately 300 plants per square yard.

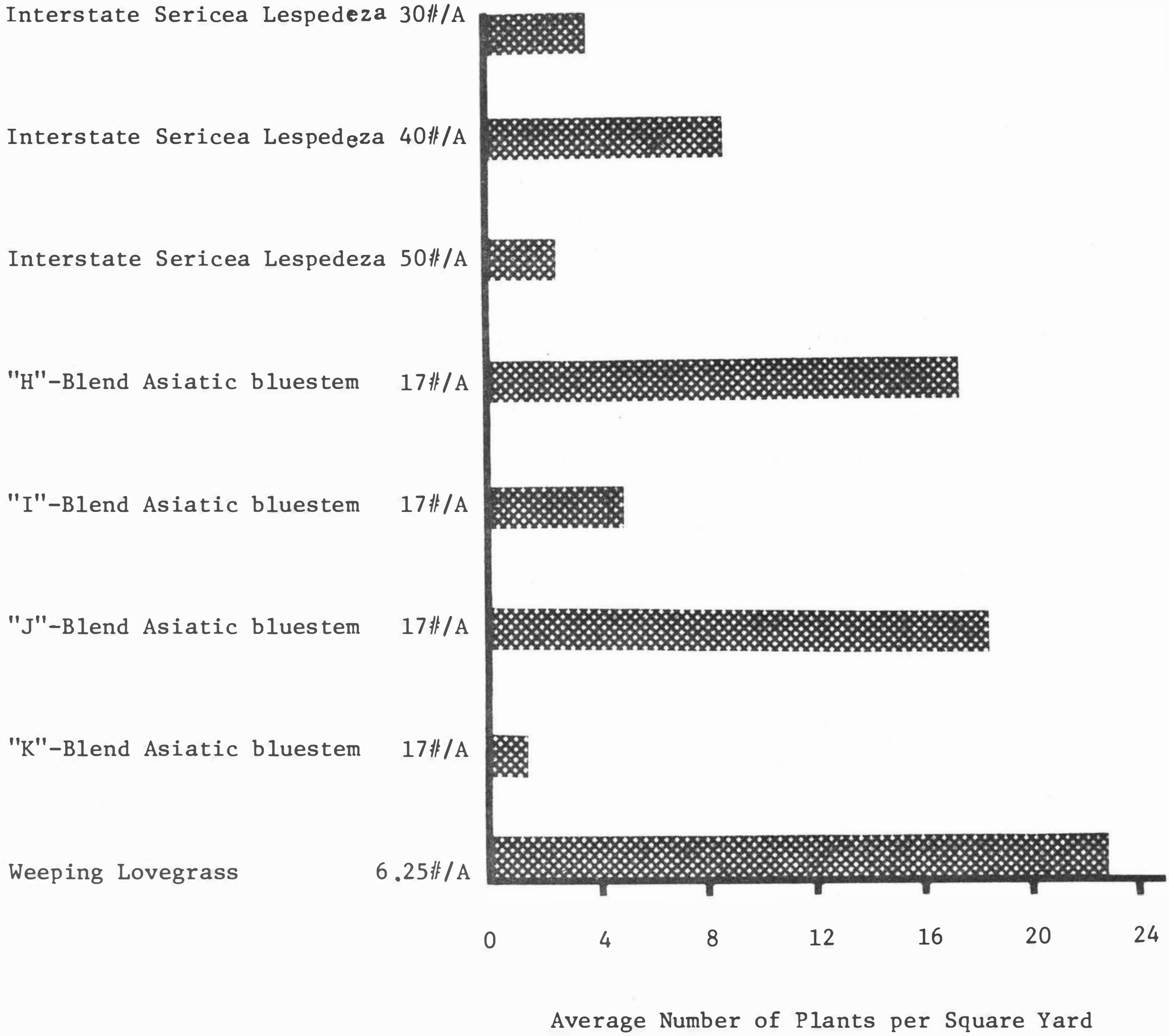


Figure 27 . Evaluation of five grasses and one legume seeded June 22, 1971, on an Enders-Hector soil complex on US-271, 0.6 miles northeast of Wister in LeFlore County on a southeast-facing backslope, as determined November 13, 1971.

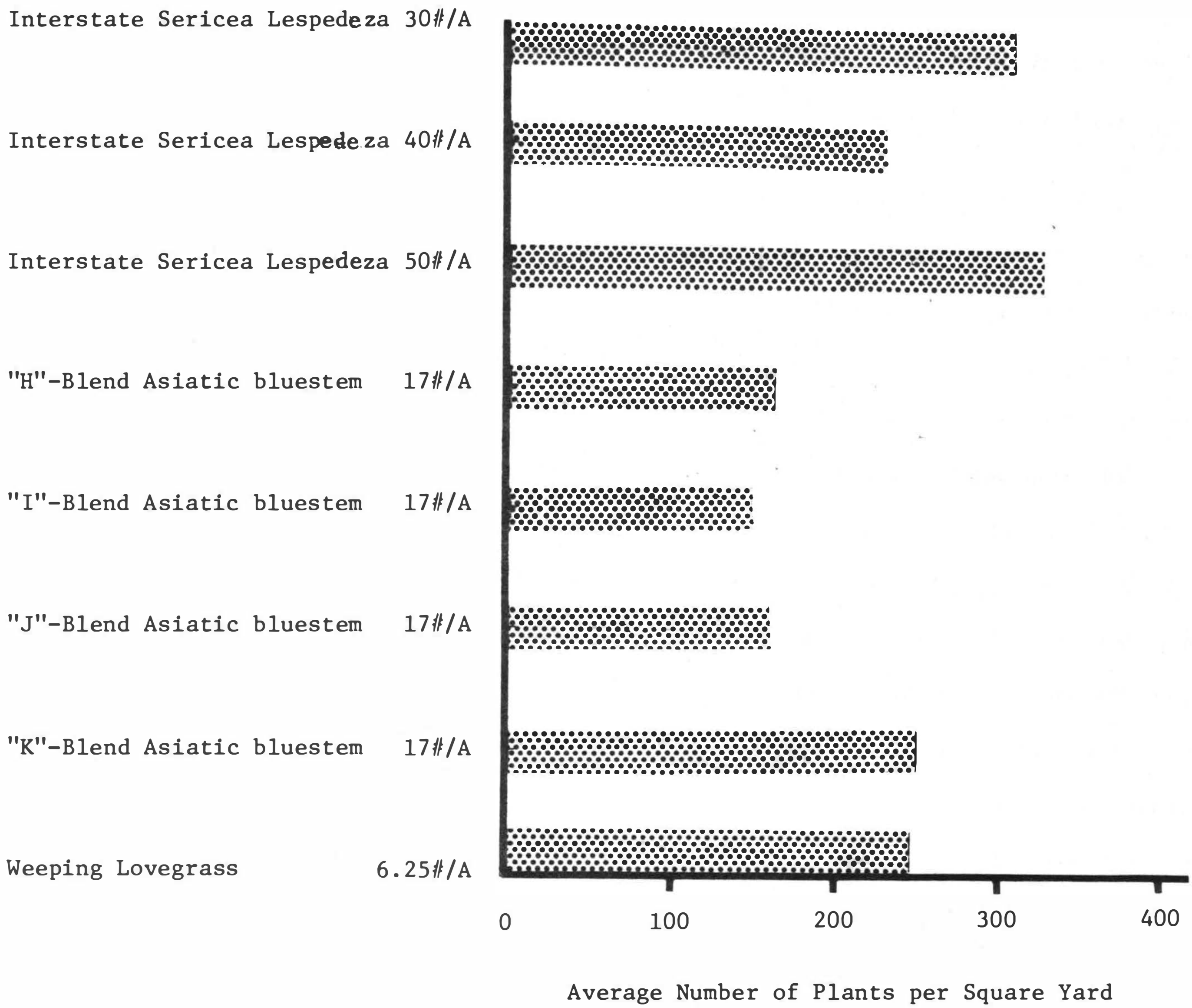


Figure 28. Evaluation of five grasses and one legume seeded June 22, 1971, on an Enders-Hector soil complex on US-271, 0.6 miles northeast of Wister in LeFlore County on a northwest-facing backslope, as determined November 13, 1971.

Of the Asiatic bluestems, the thickest stands were obtained from K, J, H, and I-Blends in this descending order. However, even the least dense, the I-Blend, had at least one seedling every nine square inches.

Experiment 14. Effect of a 12 and 18 inch deep tube of rooted honeysuckle on the growth and establishment of erosion resistant ground cover.

In May 1972, honeysuckle (*Lonicera japonica*), planted in 12 and 18 inch deep tubes as shown in Figure 29, was planted on a 45^{o} slope, of a very highly erodible, Hector fine sandy loam, nine miles east of US 271, on SH-1, in Le Flore county. The slope, (Figure 30), with a north exposure, was characterized by a rocky and stoney, very shallow soil, and where some soil did occur it was very acid.

The honeysuckle was planted on four foot centers (Figure 31), and overseeded on subplots with weeping lovegrass at 6.25 lb/acre 7 kg/ha, and Interstate sericea lespedeza (*Lespedeza cuneata*) at 40 lb/acre (45 kg/ha). At the time of planting approximately one-half gallon of water, and about 3 ounces of Milorganite (6-3-0) was applied per plant (Figure 32).

The runner length of the honeysuckle plants was determined in each of the years 1972 to 1974 as shown in Figure 33. Although there were no statistical differences in runner length for either of these three years, the runners of the plants in the 18 inch potting cylinder averaged 20 inches in length five months after planting compared to 14 inches for those from the 12 inch planters. In mid-summer of 1973, the runners from the plants in 12 inch tubes averaged a little over 24 inches, whereas the runners from those plants in 18 inch tubes were 2½ to 3 feet in length. In 1974 plants in the 12 inch tubes has runners that averaged 35 inches in length, whereas the length of the runners from plants in the 18 inch tubes were slightly shorter, averaging about 33 inches.

In 1974 and 1975, the honeysuckle plants that were potted in 18 inch tubes showed a significantly greater percent ground cover thant that obtained from those plants potted in the 12 inch cylinders as shown in Figure 34.

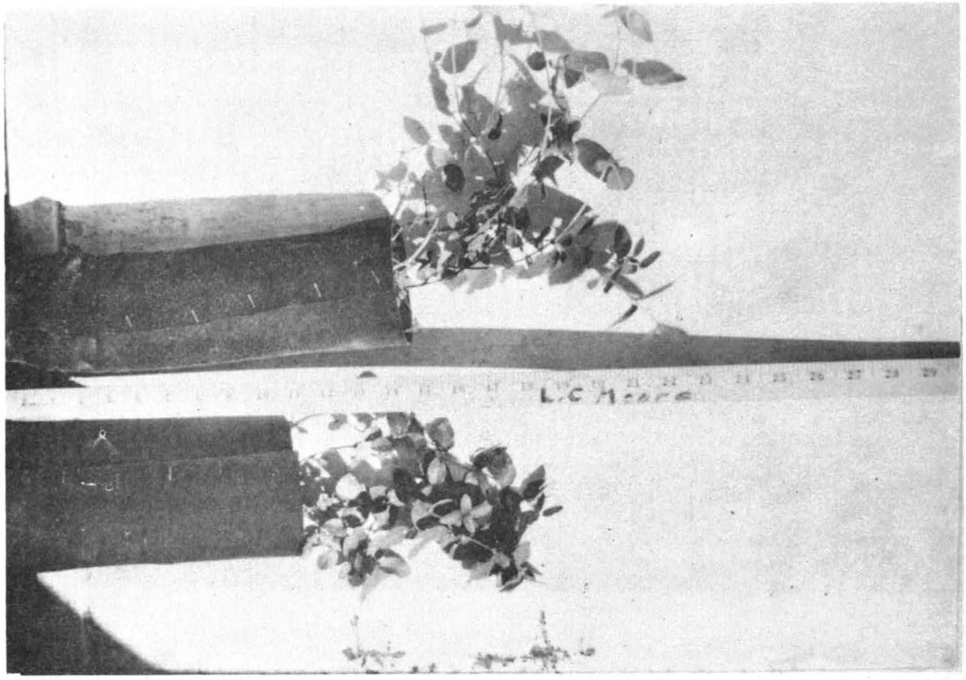


Fig. 29. Honeysuckle plants potted in 12 and 18 inch tubes for evaluation on roadside erosion control.

Fig. 30. A 45^{o}, very highly erodible slope of Hector fine sandy loam on SH-1, in Le Flore county.

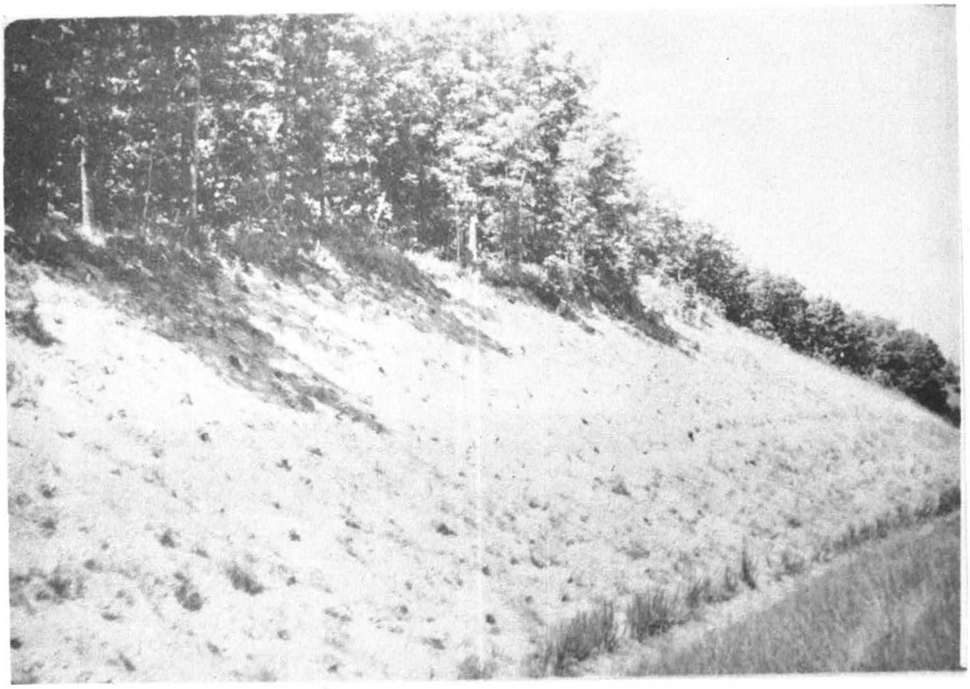


Fig. 31. Twelve and 18 inch honeysuckle plants placed on 4 foot center for evaluation of growth rate and roadside erosion control.

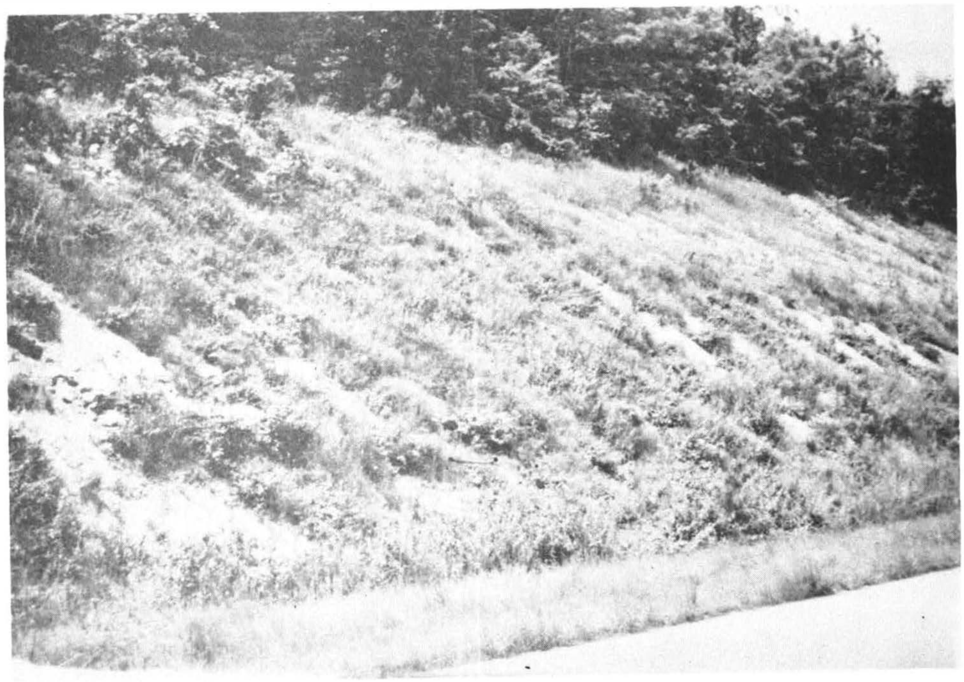


Fig. 32. Slope appearance in May 1975, three years after planting honeysuckle, weeping lovegrass and Interstate sericea lespedeza.

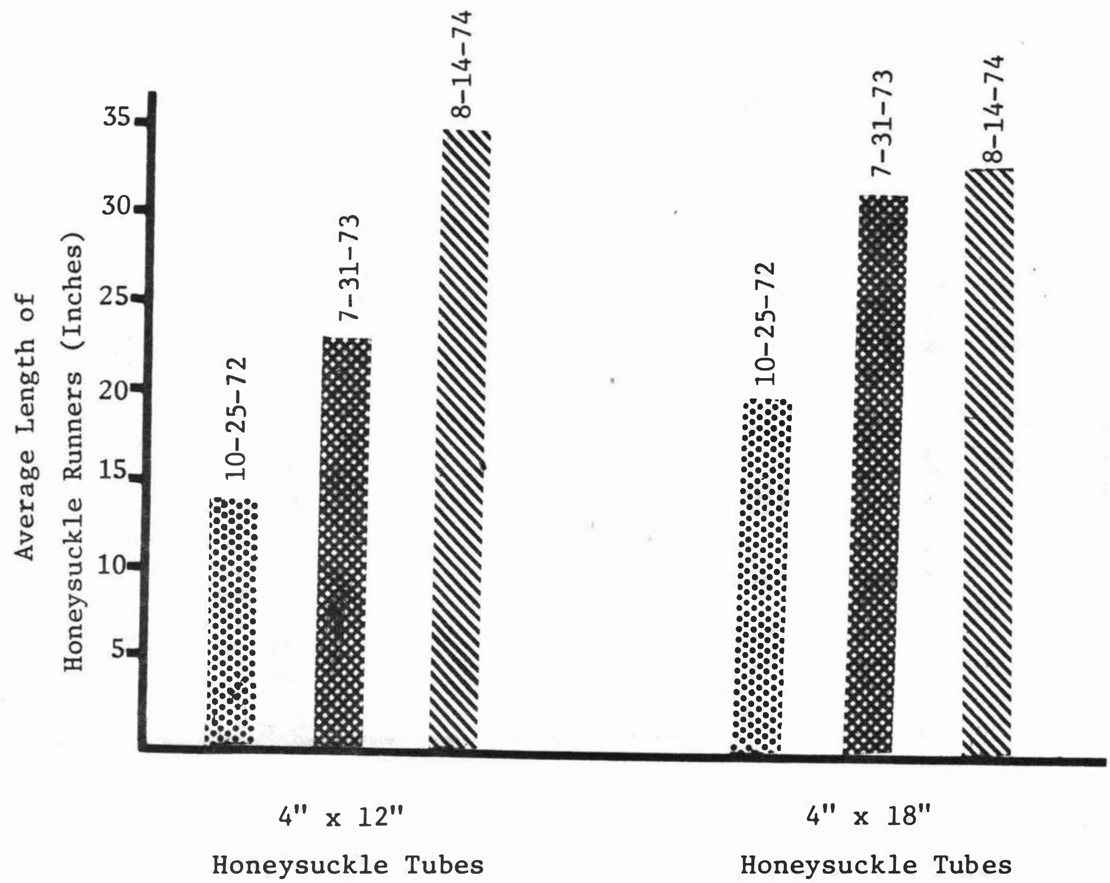


Figure 33. Evaluation of 12 and 18 inch deep tube-potted plants of honeysuckle (Lonicera japonica cv.) planted May 23 and 24, 1972, on a Hector fine sandy loam soil on SH-1, 9.0 miles east of US-271 on a north-facing backslope, as determined by the average length of honeysuckle runners.

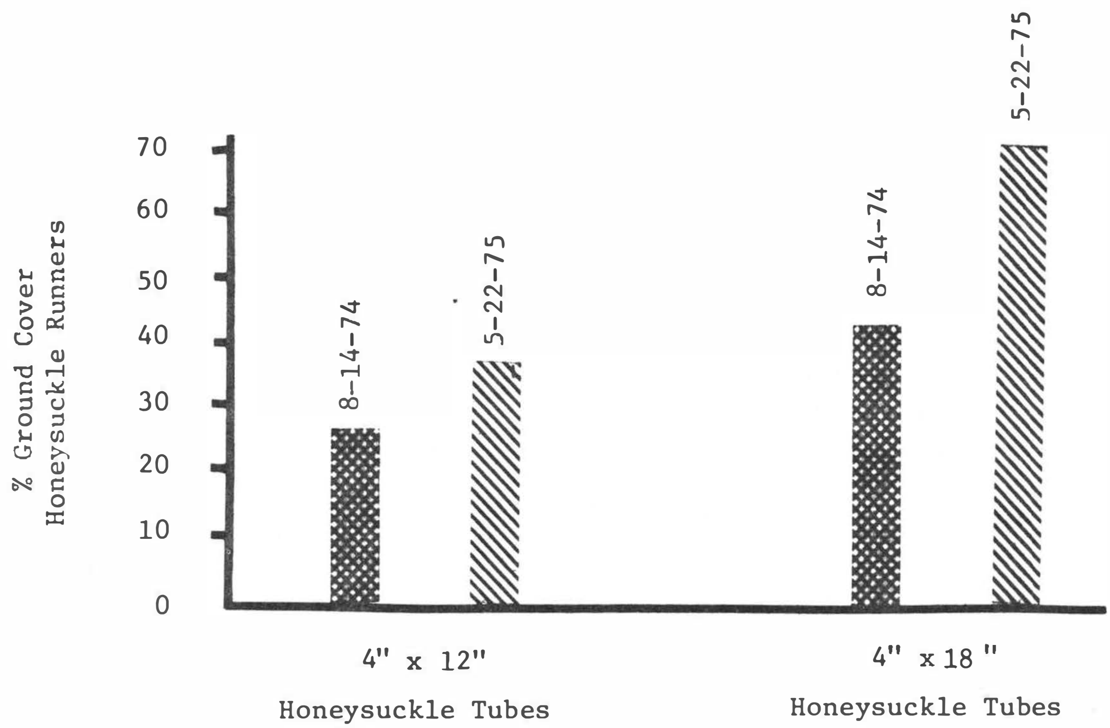


Figure 34. Evaluation of 12 and 18 inch deep tube-potted plants of honeysuckle (<u>Lonicera japonica</u> cv.) planted May 23 and 24, 1972, on a Hector fine sandy loam soil on SH-1, 9.0 miles east of U.S. 271 on a north-facing backslope, as determined by the average percent of ground cover by the honeysuckle runners.

These data would tend to indicate that even though the average runner length of honeysuckle plants potted in 18 inch tubes is not significantly different from those potted in 12 inch tubes, there are evidently, significantly more runners from those plants potted in 18 inch tubes as compared to 12 inch tubes as indicated by a significantly greater ground cover when evaluated in both years 1974 and 1975. Based upon these results we would suggest potting honeysuckle in 4 inch by 18 inch tubes for use on a Hector fine sandy loam soil for roadside erosion control.

Experiment 15. Evaluation of seven mulches for retention of soil moisture and their effect along with the pre-emergence herbicide propazine on the germination and growth of weeping lovegrass seeded for roadside erosion control.

Seven mulches were applied to a very highly erodible Vernon-Lucien soil complex on SH-51 one-fourth mile west of I-35 in Payne county July 21, 1972. This 8.6%, north-facing backslope, was characterized as being a very shallow soil on soft calcareous clayey materials, and very droughty. The seedbed was slightly to moderately compacted prior to being disked to a depth of 4 inches.

The treatments included:

1. Asiatic bluestem hay @ 2 tons/acre
2. Excelsior fiber @ 2 tons/acre
3. Excelsion blanket @ 60½ rolls/acre
4. MS-2(3:1) @ 1513 gallons mixture/acre
5. Aquatain(5½:1) @ 845 gallons/acre
6. Petroset(24:1) @ 2420 gallons/acre, and
7. Conwed fiber @ 1,000 pounds/acre

A pre-emergence herbicide "propazine" was applied to one-half of each plot at the rate of ½ pound active ingredient (ai)/acre immediately after seeding and prior to the application of the mulches.

At the time of seeding the soil moisture content averaged about 4%. Germination and growth of the weeping lovegrass was first evident in those plots mulched with Asiatic bluestem hay, Excelsior fiber, and Excelsior blanket. This corresponds closely with the soil moisture content under these mulches throughout the remainder of the summer as shown in Figure 35. One month after seeding the soil moisture measured 11-12% under these three mulches and only about one-half this amount under the other materials.

On November 17, 1972 four months after seeding, in all cases except one (the Aquatain treatment), more weeping lovegrass plants were found in those plots not treated with propazine than in those that were treated as shown in Figure 36. These data would tend to indicate that propazine at ½lb ai/acre (0.7 kg/ha) is detrimental to the germination and growth of weeping lovegrass on a Vernon-Lucien soil complex.

On March 23, 1973 an ocular estimate was made on the effectiveness of these mulches on soil erosion control. Based upon these estimates as shown in Figure 37, the most effective protection from erosion was provided by the Excelsior blanket followed in order by Asiatic bluestem hay, Excelsior fiber, Aquatain, MS-2 asphalt emulsion, Petroset, with the least provided by Conwed Fiber.

SLOPE PREPARATION FOR EROSION CONTROL

Experiment 16. Effect of three tillage practices and three mulches on the stand establishment of Plains bluestem (*Bothriochloa ischaemum* var. *ischaemum*) on a north facing backslope on SH-51 in Payne county.

An investigation of the effects of disking, and chiseling compared to no tillage, and mulching with one-half ton, or one ton of hay, or one ton of Conwed Fiber 2000 on the stand establishment of Plains bluestem was initiated in April 1975, on SH-51 one-half mile west of SH-51C in Payne county. The soil type is a Zaneis, that had been fertilized the month before with 200 pounds of 10-20-10, and 150 pounds of 0-46-0 per acre. The pH was determined to be 6.5, with 16 pounds of available P_2O_5 and 290 pounds of available K_2O per acre at the time of seeding.

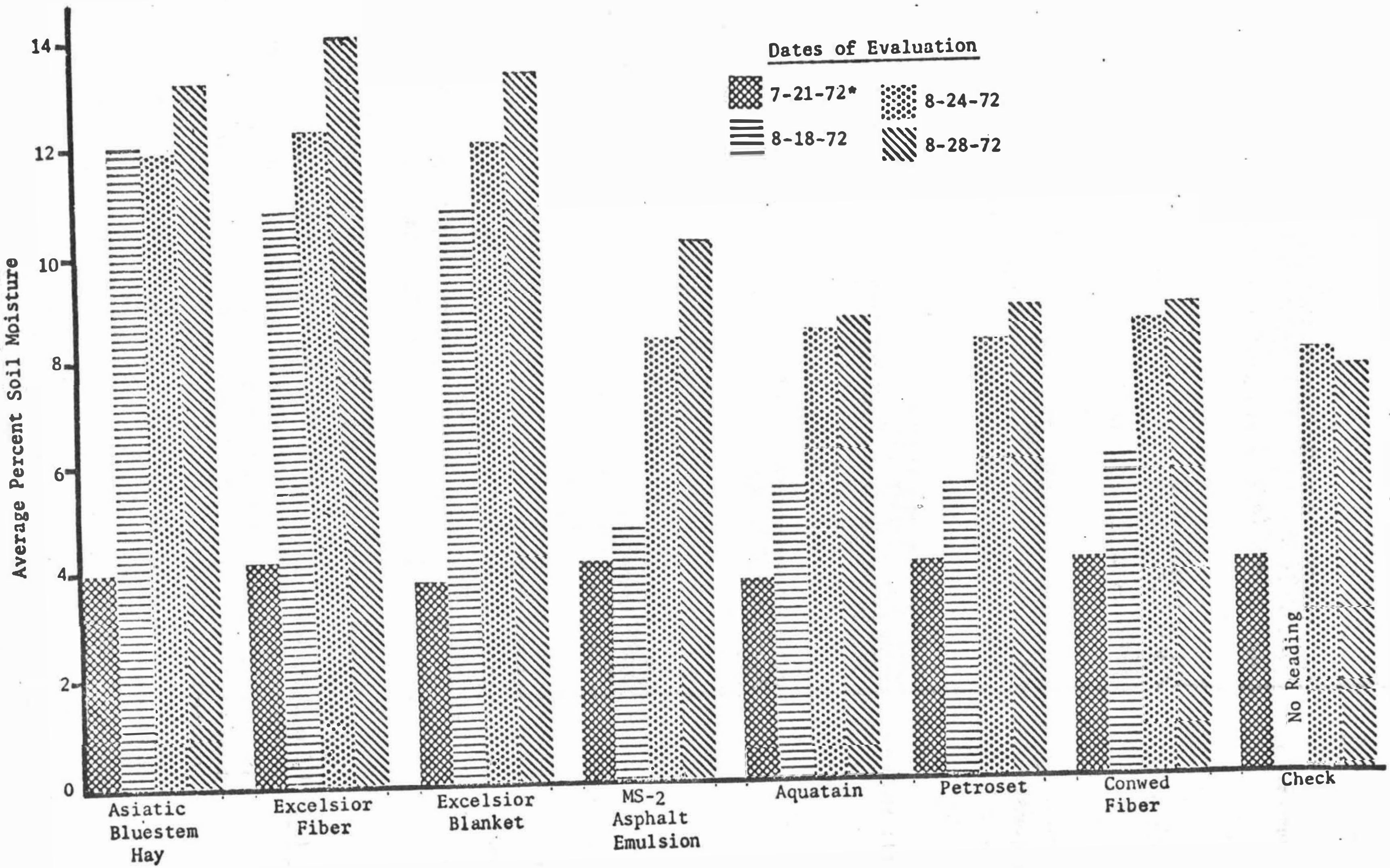


Figure 35. Effect of seven mulches applied on July 21, 1972, on the average percent soil moisture on a Vernon-Lucien soil complex located on SH-51, one-fourth mile west of I-35 on a north-facing backslope.

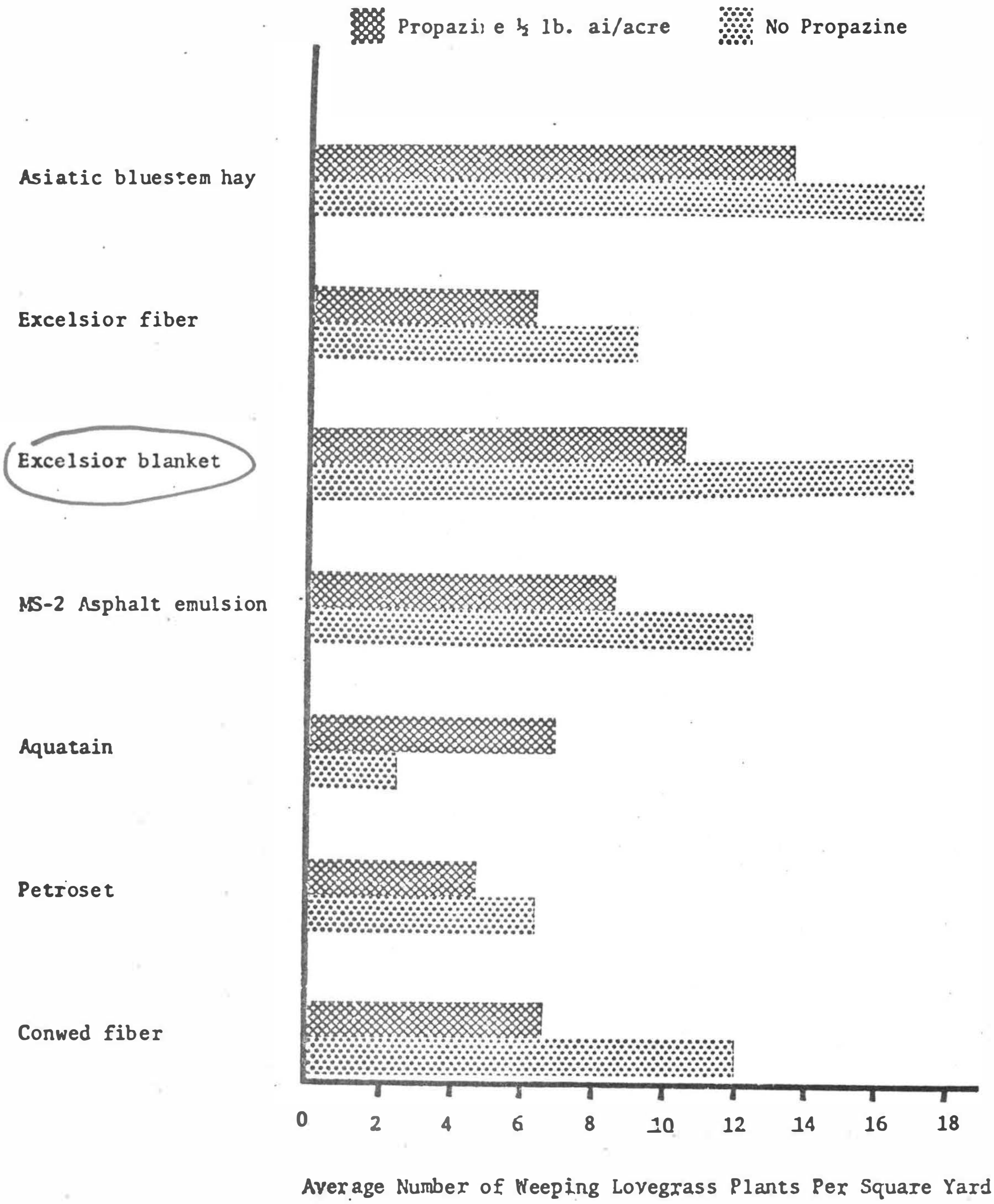


Figure 36 . Effect of seven mulches and two levels of propazine on the germination and growth of Weeping lovegrass seeded July 20, 1972, on a Vernon-Lucien soil complex on SH-51, one-fourth mile west of I-35 on a north-facing backslope as determined November 17, 1972.

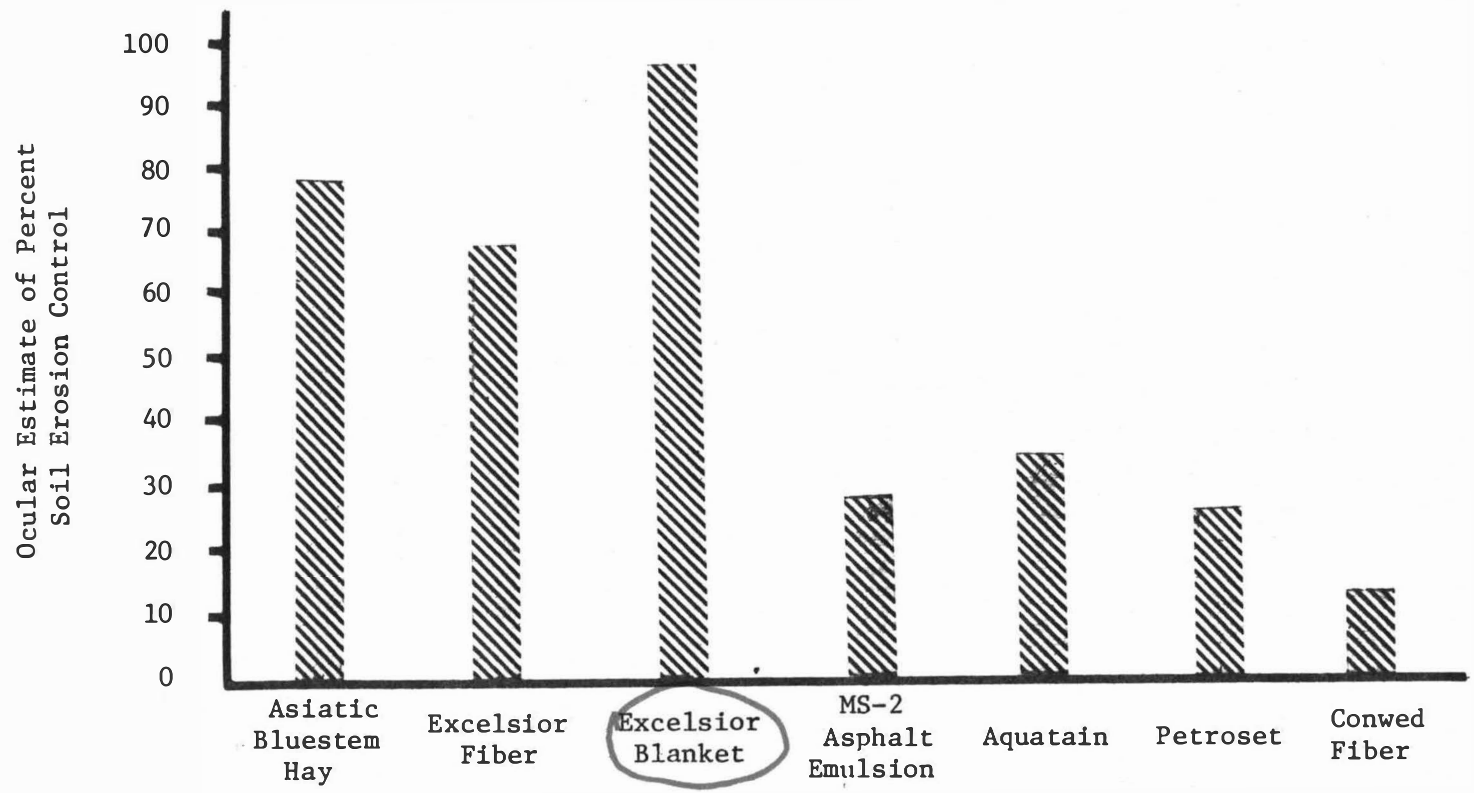


Figure 37. Evaluation of seven mulches for roadside erosion control, mulched July 21, 1972, on a Vernon-Lucien soil complex on SH-51, one-fourth mile west of I-35 on a north-facing backslope as determined May 23, 1973.

The grass was planted with a Nesbit grass seeder (Figures 38 and 39) on opposing backslopes, and mulched with either hay, or Conwed Fiber 2000* (Figure 40), after the soil was roughened by tilling either with a disk, or chisel, for comparison with the usual smooth, compacted backslopes (Figure 41) for establishment of an erosion resistant ground cover.

Although there were no statistical differences in plant density, and a good stand was obtained in all plots, there were slightly better stands in those plots mulched with 1 ton of hay that were not tilled, or in those that were chiseled and mulched with ½ ton of hay, or 1 ton of Conwed Fiber 2000, or in those plots that were disked and mulched with 1 ton of Conwed 2000 per acre as shown in Figure 42.

Significant differences in plant height were found 70 days after seeding the Plains bluestem on this north facing slope. Where no tillage of the slope occurred those plots mulched with hay either at 1/2 or 1 ton per acre had slightly taller plants than in the Conwed 2000 mulched plots, as shown in Figure 43. Where the soil was chiseled slightly taller plants were observed in those plots mulched with 1 ton of hay per acre or 1 ton of Conwed 2000 Fiber. In the plots that were disked those plants mulched with Conwed 2000 were 1/2 to 1 inch taller than those in the plots mulched with hay.

Experiment 17. Effect of three tillage practices and three mulches on the stand establishment of Plains bluestem (*Bothriochloa ischaemum* var. *ischaemum*) on a south facing backslope on SH-51 in Payne County.

The treatments in this experiment, (soil fertility, tillage, date of seeding, and mulching) are the same as those in Experiment 16, the only difference being the backslope in this experiment faces south.

---

*Provided by Conwed Corporation, 3510 Whitehall Drive, Dallas, Texas 75229

Figure 38. Nesbit grass seeder planting Plains bluestem on SH-51 west of Stillwater, April 25, 1975.

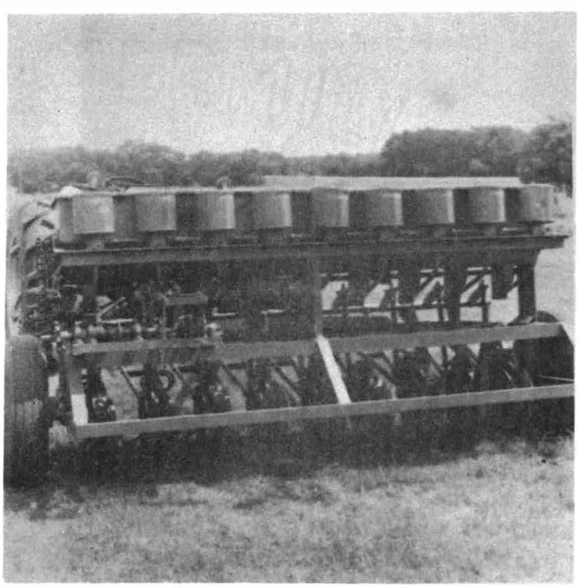


Figure 39. Close-up of Nesbit grass seeder showing planter boxes (left), and furrow opener disks with flanges (right) to prevent planting at excessive depths.

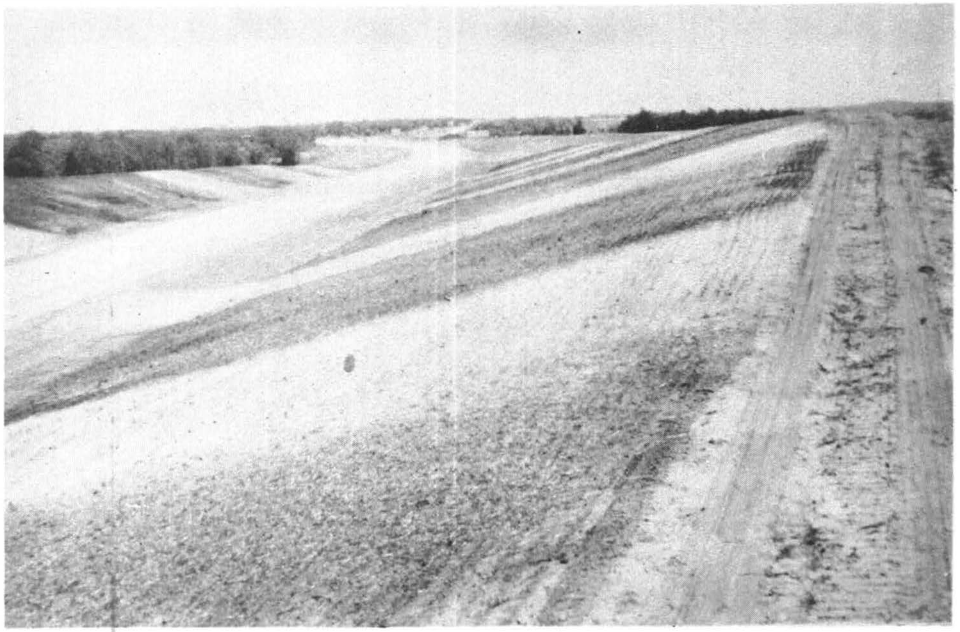


Figure 40. Hay and Conwed Fiber 2000 mulches in place of opposing backslopes on SH-51, 7.4 miles west of Stillwater, Oklahoma.

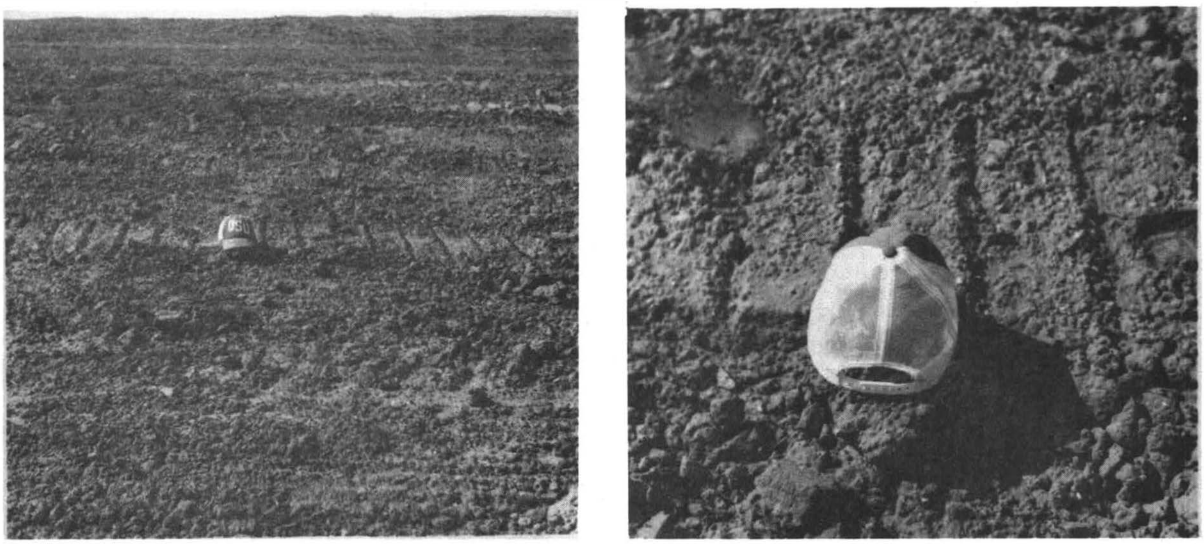


Figure 41. The usual smooth, compacted backslopes soil where an erosion resistant ground cover is to be established. (Note lug marks from a crawler tractor).

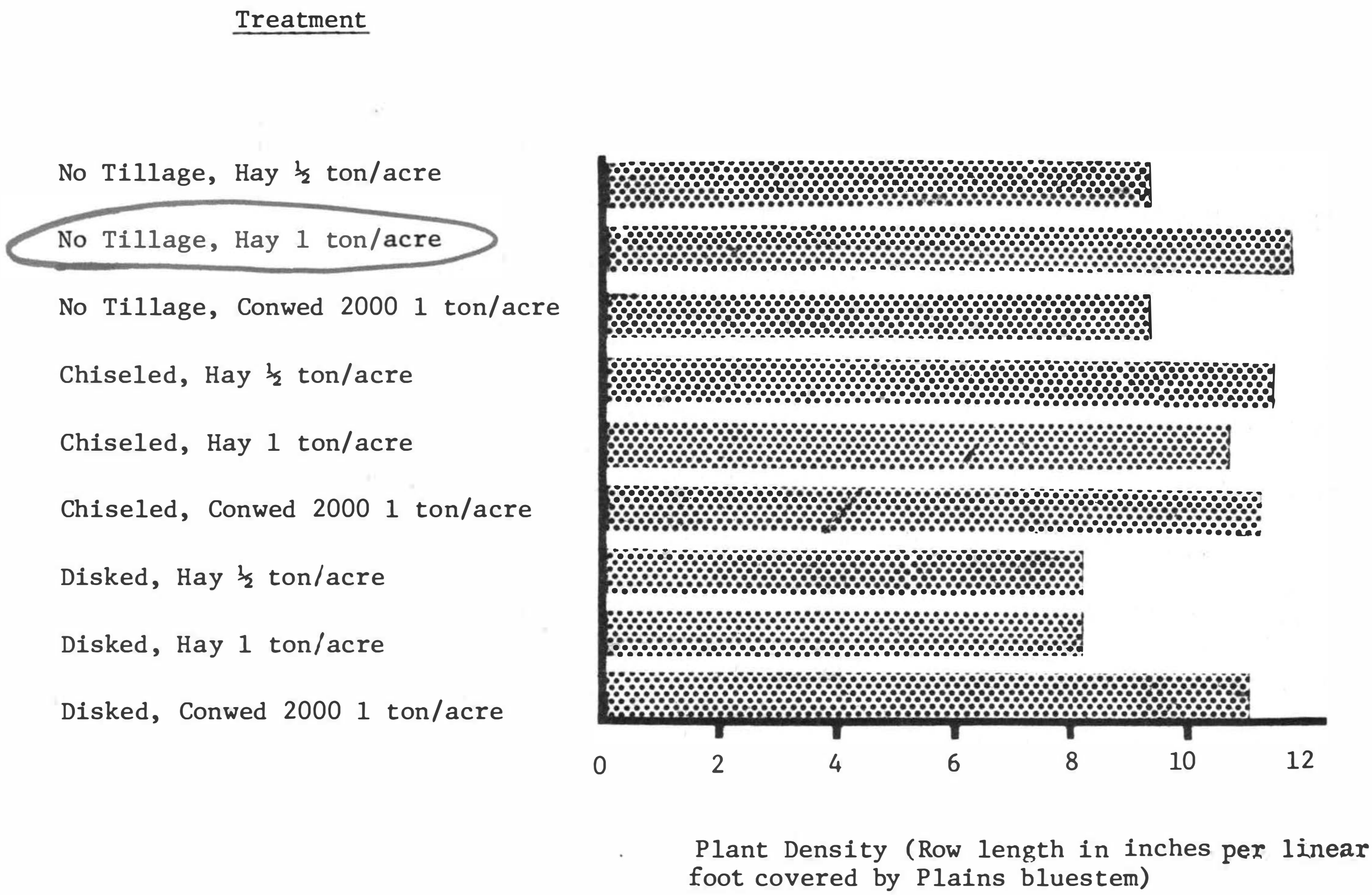


Figure 42. Effect of three tillage practices and three mulches on the stand establishment of Plains bluestem, tilled April 23, 1975, mulched April 25, 1975 and seeded May 1, 1975 on a Zaneis soil on SH-51, 7.4 miles west of Stillwater on a north-facing backslope, as determined by plant density on July 9, 1975.

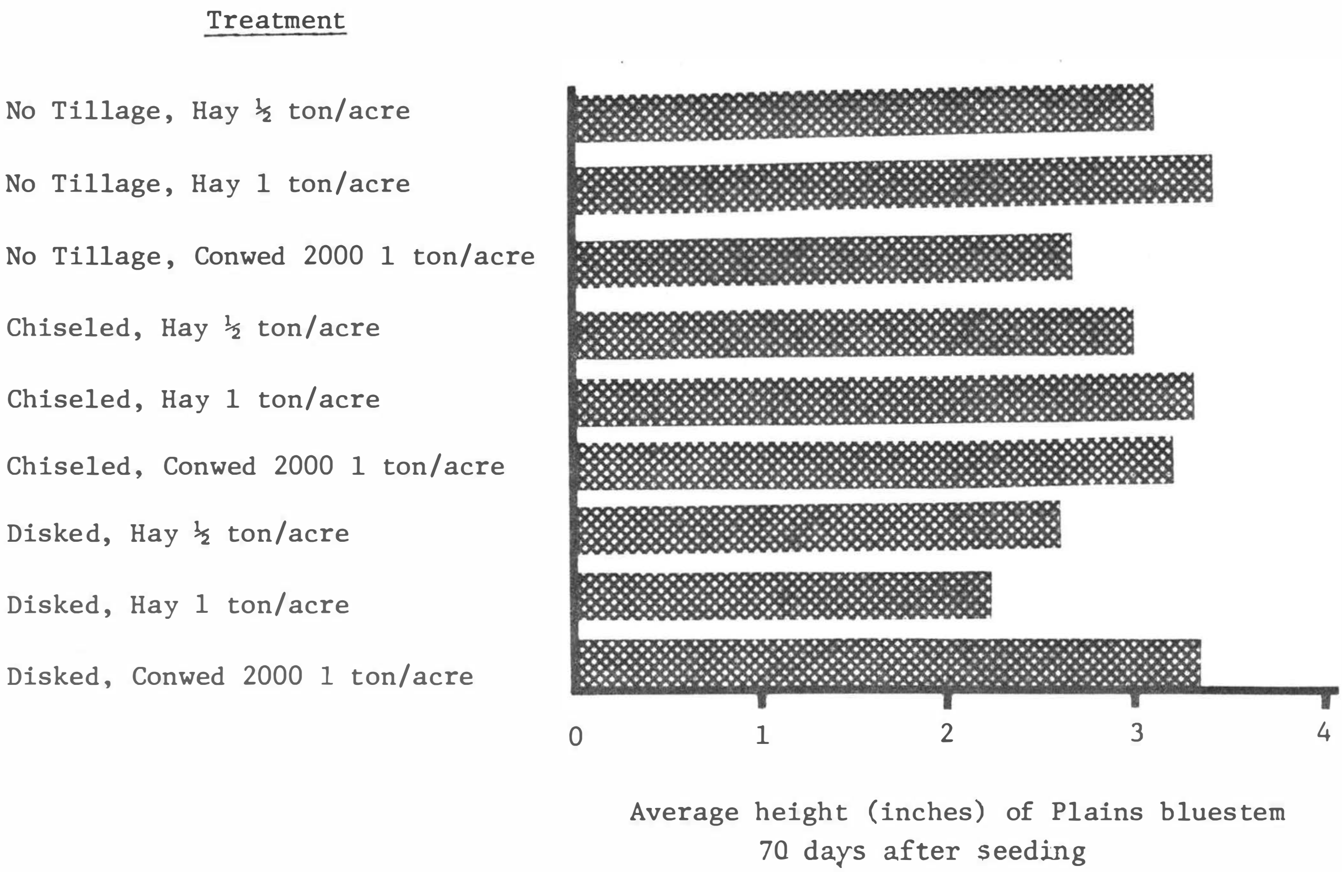


Figure 43. . Effect of three tillage practices and three mulches on the stand establishment of Plains bluestem, tilled April 23, 1975, mulched April 25, 1975, and seeded May 1, 1975, on a Zaneis soil on SH-51, 7.4 miles west of Stillwater on a north-facing backslope, as determined July 9, 1975.

When these treatments were evaluated 70 days after seeding, no significant differences in plant density could be detected slightly better stands were observed however in those plots that had been either chiseled, or disked, and mulched either with hay or Conwed 2000 Fiber as shown in Figure 44. For some unexplained reason the plant density on this south facing slope was not as great as that found across the highway on the north facing slope. The greatest plant density in this experiment on the south facing slope was not as good as the poorest one across the road.

Just as in Experiment 16 significant differences in plant height were found here. Although the plant density was not as great as that found on the north facing slope, the average plant height in this experiment is up to twice that found across the road (Figure 45). The shortest average plant height here is greater than the tallest in those plots on a north facing slope.

Even though the plant density was not as great on this south facing slope, there seemed to be some compensation for this in greater plant height.

Experiment 18. Investigation of soil-air temperature relationships*, and the effect of slope orientation on vegetative composition on opposing backslopes on SH-51 in Payne County.

Temperature measurements were made on two opposing north and south facing backslopes located approximately 15 miles east of Stillwater on SH-51. Temperatures were recorded continuously with a Wilh. Lambrecht Kg., recording thermograph. Each thermograph recorded three temperatures simultaneously. One measurement, referred to here as air temperature, is from three inches

---

*Ensminger, Glenn E. 1972. Studies in Soil-Air Temperature Relationships. Unpublished research problem. Oklahoma State University.

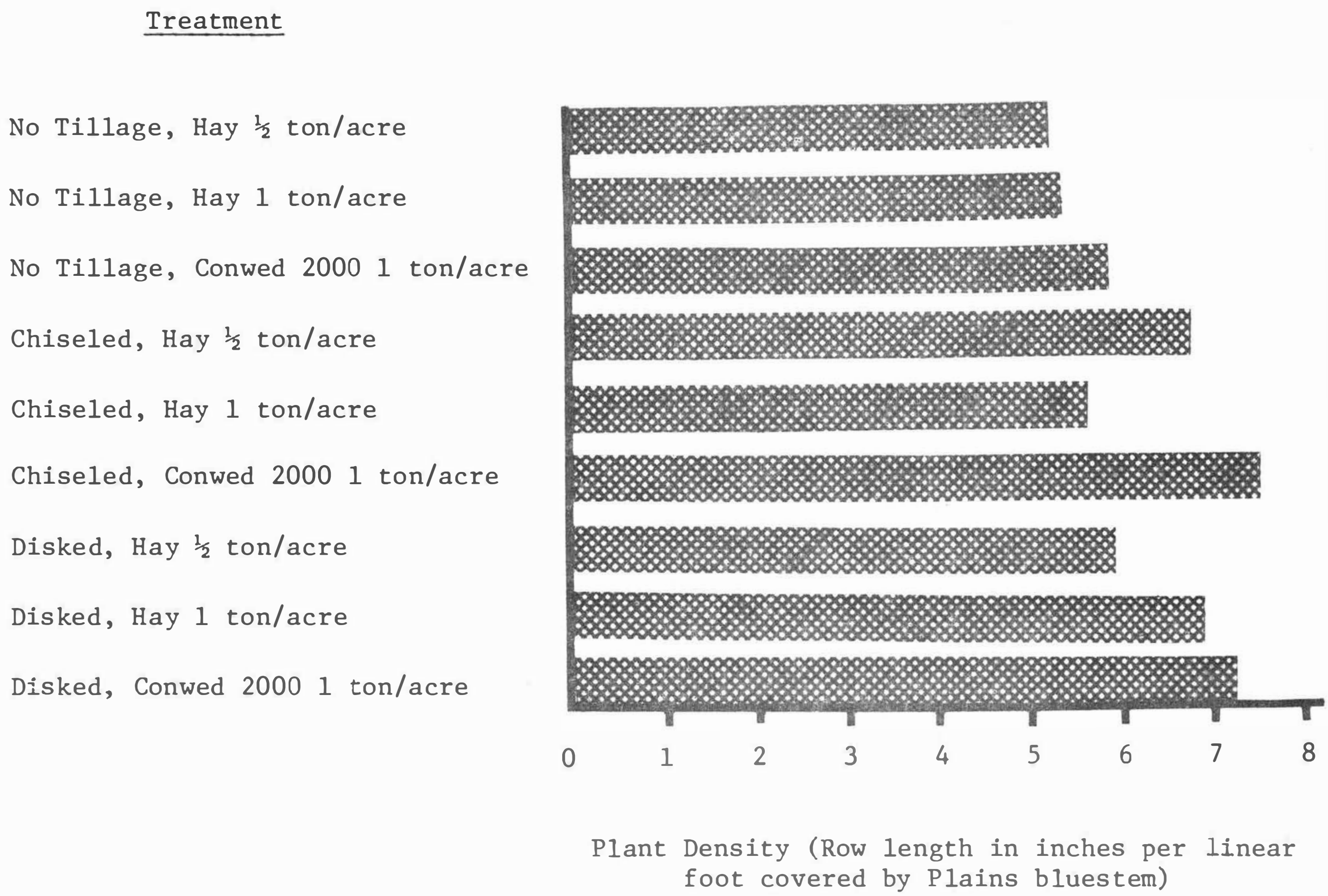


Figure 44. . Effect of three tillage practices and three mulches on the stand establishment of Plains bluestem, tilled April 23, 1975, mulched April 25, 1975, and seeded May 1, 1975, on a Zaneis soil on SH-51, 7.4 miles west of Stillwater on a south-facing backslope, as determined by plant density on July 9, 1975.

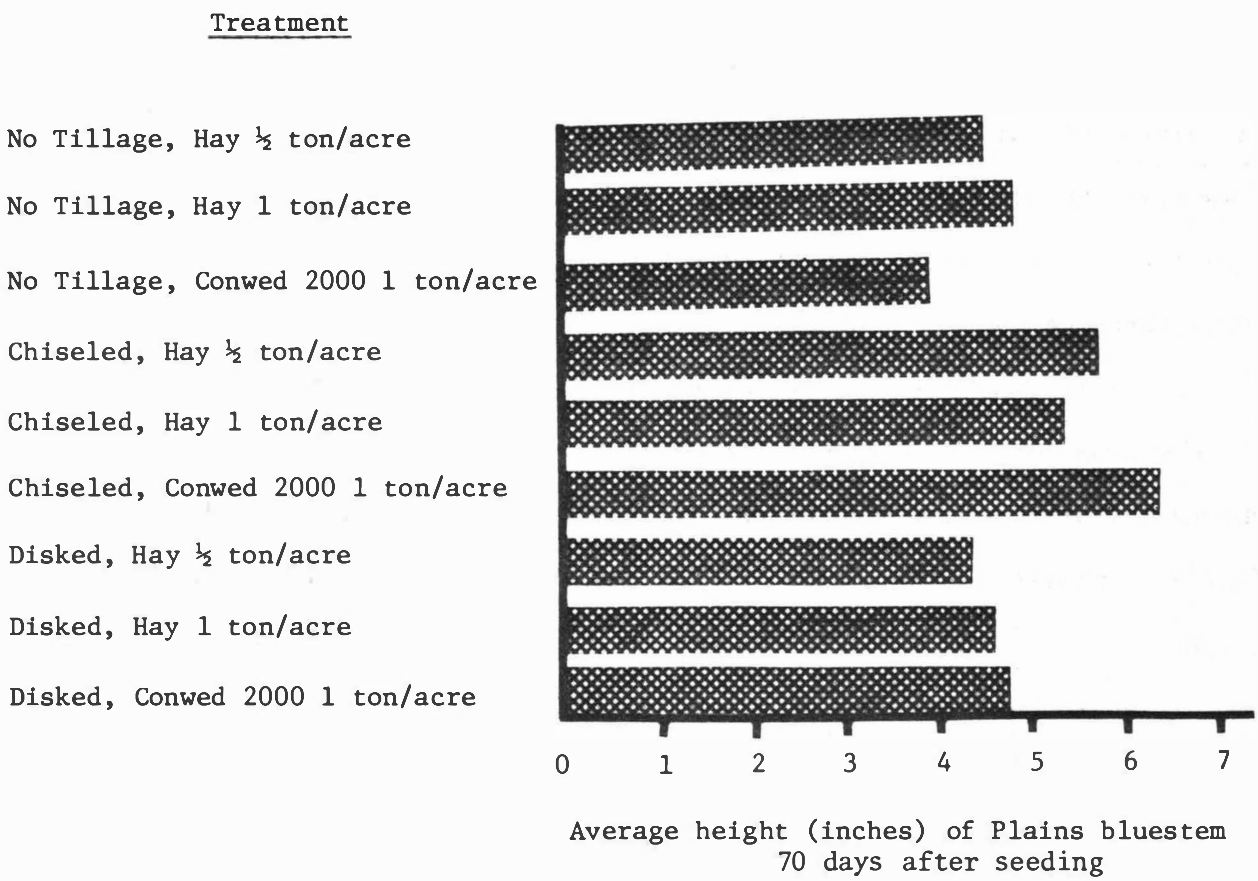


Figure 45. . Effect of three tillage practices and three mulches on the stand establishment of Plains bluestem, tilled April 23, 1975, mulched April 25, 1975, and seeded May 1, 1975, on a Zaneis soil on SH-51, 7.4 miles west of Stillwater on a south-facing backslope, as determined July 9, 1975.

above the soil surface, the second measurement is on the soil surface, and the third measurement referred to here as sub-surface, is taken three inches below the soil surface. The data was collected and assembled for the 290 day period of July 12, 1971 to May 7, 1972. The weekly average high and low temperature for each of the three locations on each slope is shown graphically in Figures 46, 47, and 48.

These data reveal, as would be expected, that the south facing backslope has warmer air and sub-surface temperatures throughout the recording period, however at the soil surface as indicated here, the north facing slopes had a higher average maximum temperature for the first 50 days (July 12 to Sept. 1, 1971) than the south facing slope.

If these data are correct, it would be different than was expected. Too, the magnitude of temperature differences for the first week of the experiment showed the average maximum temperature on the north facing slope was 86°C (187°F) compared to 71.4°C (161°F) for the soil surface on the south facing slope.

If we assume these two slopes were seeded initially with the same species, we can characterize the slope effect on these plants as shown in Table 14. The north facing slope showed almost 20% more Japanese bromegrass (*Bromus japonicus*) than was found on the south facing slope. Too, the north facing slope had almost 15% more bare ground than the south facing slope. The differences in plant composition for the other species varied from 0.5 to 9.5% on the two opposing slopes which is of a rather low order of magnitude. It was somewhat surprising to note no silver bluestem (*Andropogon saccharoides*), wild rye (*Elymus* spp.) dropseed (*Sporobolus* spp.), blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), sagewort (*Artemisia*

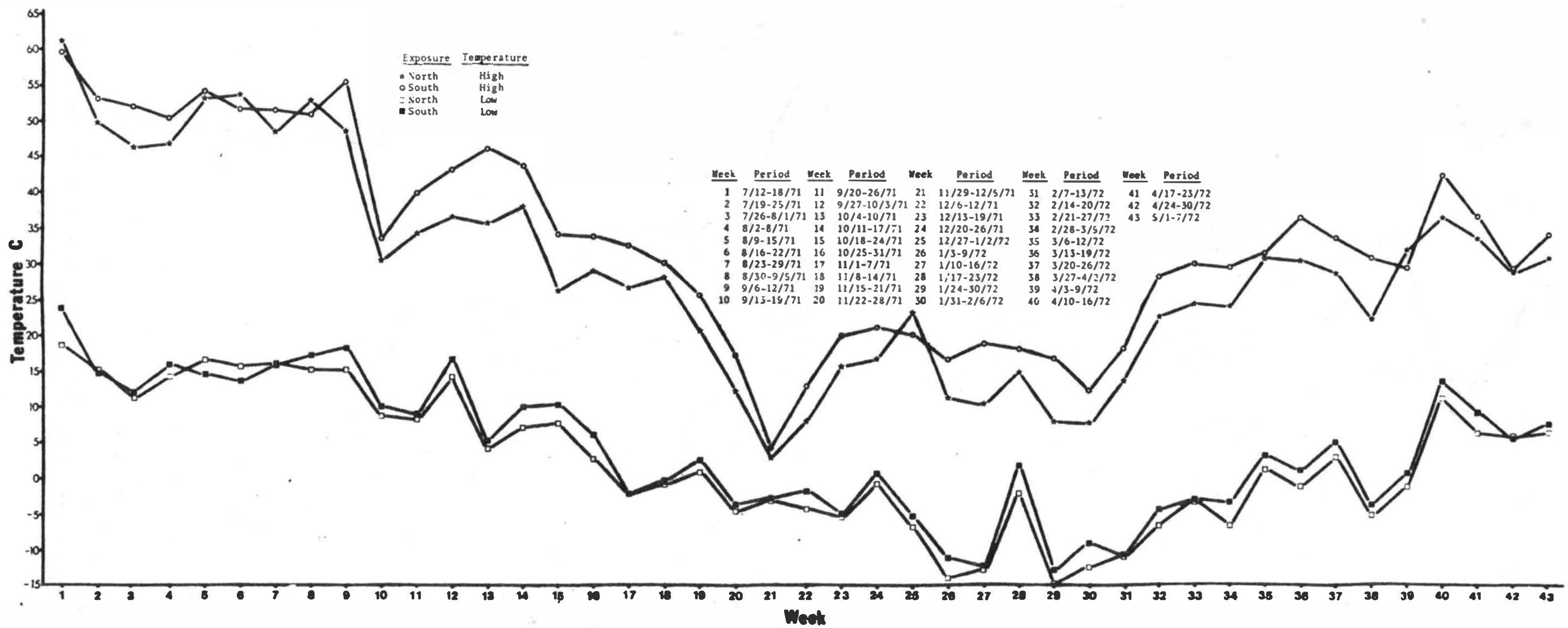


Figure 46. Variation of air temperatures three inches above the soil surface on two opposing backslopes on SH-51 in Payne County, 15 miles east of Stillwater.

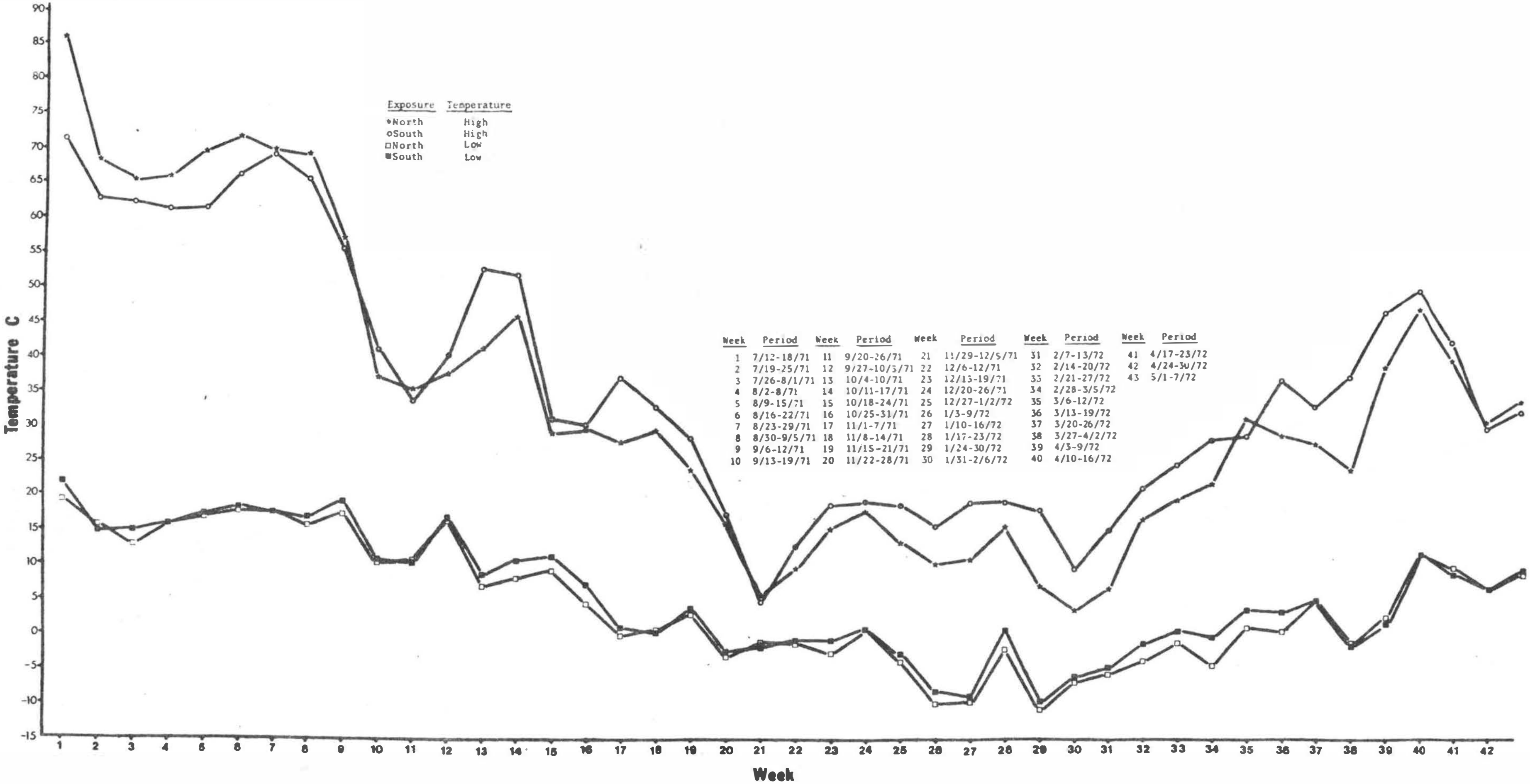


Figure 47. Variation of soil surface temperatures on two opposing backslopes on SH-51 in Payne County, 15 miles east of Stillwater.

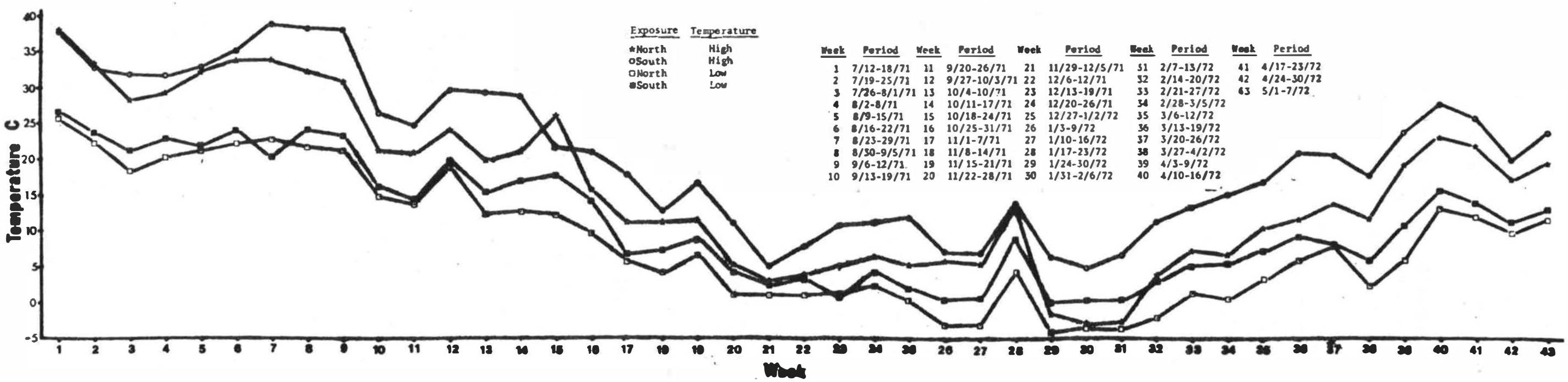


Figure 48. Variation of sub-surface soil temperatures three inches below the soil surface on two opposing backslopes on SH-51 in Payne County, 15 miles east of Stillwater.

Table 14. Plant Composition of Two Opposing Backslopes, 14 Miles East of Stillwater on SH-51, Established in 1966, as Determined Five Years Later on September 23, 1971.

Plant Species	North Exposure		South Exposure		Exposure Effect
	Count	% of Total	Count	% of Total	Difference in %
Japanese Brome	84	42.0	46	23.0	19.0
Silver Bluestem	0	0.0	19	9.5	9.5
Little Bluestem	17	8.5	4	2.0	6.5
Big Bluestem	16	8.0	8	4.0	4.0
Switchgrass	10	5.0	14	7.0	2.0
Splitbeard Bluestem	12	6.0	8	4.0	2.0
Johnsongrass	7	3.5	0	0.0	3.5
Wild Rye	0	0.0	7	3.5	3.5
Panicum	6	3.0	2	1.0	2.0
Sagewort	0	0.0	4	2.0	2.0
Dropseed	0	0.0	6	3.0	3.0
Blue Grama	0	0.0	3	1.5	1.5
Sideoats Grama	0	0.0	2	1.0	1.0
Western Ragweed	0	0.0	2	1.0	1.0
Illinois Bundleflower	1	0.5	0	0.0	0.5
Bare Ground	47	23.5	75	37.5	14.0

ludoviciana), or western ragweed (Ambrosia psilostachya), was found on the north facing slope, even though only a few plants of each were found on the south facing slope, with the exception of silver bluestem which was somewhat more abundant.

Experiments 19 & 20. Evaluation of three mulches and seven grasses for roadside erosion control on an east and west facing backslope, southeast of Sayre, on I-40, in Beckham County.

On February 13, 1971 seven grasses were seeded on a severely, to moderately compacted seedbed, just north of the C.R.I. and P.R.R. overpass on I-40, on the west side of the highway. The soil had a pH of 8.1, as determined by the water-paste method. The AASHO classification of this soil is A-4(5).

The grasses used, and their seeding rates are as follows:

Grasses	Seeding Rate lbs/acre Bulk	PLS
Weeping Lovegrass	6.3	5
Buffalograss	27.2	20
S-Blend Asiatic bluestem	8.3	2
T-Blend Asiatic bluestem	8.6	2
H-Blend Asiatic bluestem	8.6	2
L-Blend Asiatic bluestem	6.8	2
B-Blend Asiatic bluestem	9.0	2

These grasses were mulched with the following materials and rates of application.

Mulch	Application Rate Sq. Yd.	Acre
MS-2 Asphalt Emulsion (Mixture: 1 gal MS-2 to 3 gal water)	1¼ gal mix	6050 gal
Petroset SB Emulsion (Mixture: 1 gal Petroset SB to 24 gal water)	½ gal mix	2420 gal
Straw (Wheat)	0.83 lb	2T

The MS-2 asphalt emulsion and the Petroset SB mulches were applied on February 16, and the wheatstraw was not put on until one month later, on March 16, 1971.

When the treatments were evaluated on September 16, 1971 there were no statistical differences in plant numbers* as a result of either of the three mulches on either side of the road as shown in Tables 15 and 16. But when the treatments were evaluated November 1, 1974 those plots that had been mulched with wheat straw had significantly more grass than those plots mulched with either of the other two materials as shown in Figures 49 and 50.

These data indicates a difinite superiority in stand establishment with these seven grasses under these conditions in Western Oklahoma, exists when they are mulched with wheatstraw when compared to MS-2 Asphalt Emulsion, or Petroset SB Emulsion.

Experiments 21 & 22. Determination of the effect of propazine on the germination and growth of Piper sudangrass, and evaluation of sudan stubble and MS-2 asphalt emulsion for the establishment of weeping lovegrass in I-40, in Beckham County.

Piper sudangrass (*Sorghum sudanense* cv. Piper) was seeded August 10, 1971 in a Brownfield-Tivoli soil, 4 miles west of SH-283, near Sayre, on a north and south facing fill slope. This soil has a very high wind erosion susceptibility.

These deep, loose, dry sands and loamy sands have an AASHO classification of A-2-4(0). At the time of seeding the soil analyses showed 68 lb/acre of available P_2O_5, 480 lb/acre of available K_2O, and a pH of 7.3 as determined by the water-paste method.

---

*Plants counted: Lovegrass, johnsongrass, russian thistle, sweet clover, dropseed, western ragweed, curlycup gumweed, sunflower, lambsquarter, puncture vine, ground cherry, stinkgrass, yellow foxtail, bluestems, prostrate spurge, sandbur, tripleawn, and nightshade.

Table 15. Mulch Effect on Plant Population for Roadside Erosion Control on I-40 Southeast of Sayre on an East-facing Backslope as Determined September 16, 1971.

Mulch	Application Date	Average Number of Plants Per Square Yard
A. MS-2 Asphalt Emulsion	Feb. 16-17, 1971	46.5
B. Petroset SB Emulsion	Feb. 16-17, 1971	50.9
C. Wheat Straw	March 16, 1971	49.0
Statistical Differences		NS

Table 16. Mulch Effect on Plant Population for Roadside Erosion Control on I-40 Southeast of Sayre on a West-facing Backslope as Determined September 16, 1971.

Mulch	Application Date	Average Number of Plants Per Square Yard
A. MS-2 Asphalt Emulsion	Feb. 16-17, 1971	70.6
B. Petroset SB Emulsion	Feb. 16-17, 1971	78.7
C. Wheat Straw	March 16, 1971	76.9
Statistical Differences		NS

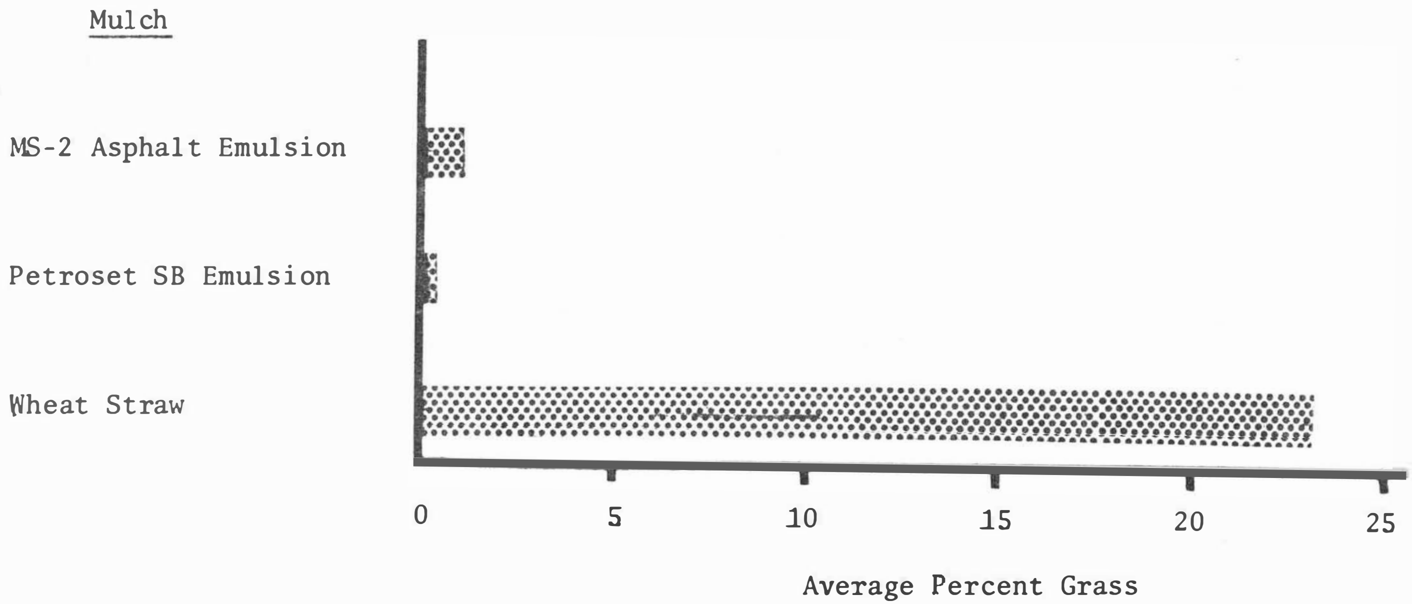


Figure 49. Mulch effect on germination and growth of grasses used for roadside erosion control on I-40 southeast of Sayre on an east-facing backslope as determined November 1, 1974.

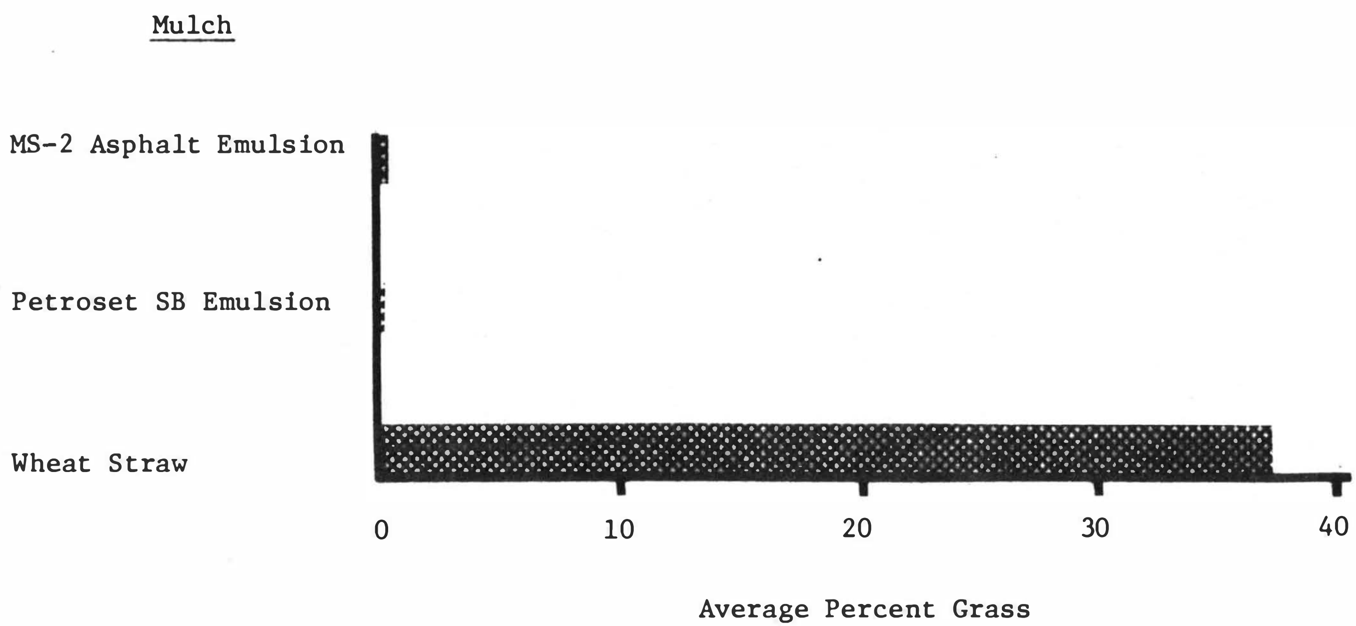


Figure 50 . Mulch effect on germination and growth of grasses used for roadside erosion control on I-40 southeast of Sayre on a west-facing backslope as determined November 1, 1974.

A heavy stand of weeds had to be mowed prior to disking, just before planting the sudangrass. The plots that were to be mulched with MS-2 asphalt emulsion, or that were not to be mulched at all, were not disked until June 15, 1972 just prior to seeding weeping lovegrass.

Immediately after seeding the Piper sudangrass, one-half of each plot was sprayed with the herbicide propazine at the rate of 1 lb ai/acre.

On October 16, 1971 the plots were evaluated to determine the effect propazine had on the stand establishment of Piper sudangrass. The results of these evaluations are shown in Tables 17 and 18. In all cases, this rate of propazine suppressed the germination and growth of Piper sudangrass.

In 1972, weeping lovegrass was seeded into these experimental plots with a Nisbet Grass Seeder on June 15. The MS-2 asphalt emulsion was applied the following day.

On August 2, 1972 the effects were determined of the sudan stubble, and MS-2 Asphalt Emulsion on the stand establishment of weeping lovegrass, when compared to no mulch. The results of these evaluations are shown in Tables 19 and 20. In all cases, more weeping lovegrass plants were found in those plots that were not mulched. We believe these results however, will be found to be the exception rather than the rule as more research is conducted in this area.

Experiments 23 & 24. Evaluation of three grasses and four cultural practices for the establishment of erosion resistant ground covers on US-62, south of Snyder, in Kiowa County.

An investigation was begun on March 26, 1971 to determine the best method to establish an erosion resistant ground cover, on opposing back-slopes of US-62, on a highly erodible Lawton silt loam soil. The soil was characterized as deep, clayey, very hard and dry with 25 to 45% slopes.

Table 17. Effect of Two Levels of Propazine on the Germination and Growth of Piper Sudangrass Seeded August 10, 1971, on a Brownfield and Tivoli Soil on I-40, 4.0 Miles Southwest of SH-283 Near Sayre on a North-facing Fill Slope as Determined October 16, 1971.

Treatments	Average Height (Inches)	Sudan Plants	
		Number Per Sq. Ft.	Number Per Sq. Yd.
1. Propazine 1 lb. ai/acre	25.0	3.1	27.9
2. No - Propazine	41.5	4.3	38.7

Table 18. Effect of Two Levels of Propazine on the Germination and Growth of Piper Sudangrass Seeded August 10, 1971, on a Brownfield and Tivoli Soil on I-40, 4.0 Miles Southwest of SH-283 Near Sayre on a South-facing Fill Slope as Determined October 16, 1971.

Treatments	Average Height (Inches)	Sudan Plants	
		Number Per Sq. Ft.	Number Per Sq. Yd.
1. Propazine 1 lb. ai/acre	5.3	.97	8.7
2. No - Propazine	14.2	3.40	30.6

Table 19. Effect of Sudan Stubble and MS-2 Asphalt Emulsion on the Germination and Growth of Weeping Lovegrass for Roadside Erosion Control, on a Brownfield and Tivoli Soil on I-40, 4.0 Miles Southwest of SH-283 Near Sayre on a North-facing Fill Slope as Determined August 2, 1972.

Mulch	Average Number of Weeping Lovegrass Plants	
	Per Square Meter	Per Square Yard
Piper Sudan	3.99	3.28
MS-2 Asphalt Emulsion	7.01	5.76
None	19.24	15.82

Table 20. Effect of Sudan Stubble and MS-2 Asphalt Emulsion on the Germination and Growth of Weeping Lovegrass for Roadside Erosion Control, on a Brownfield and Tivoli Soil on I-40, 4.0 Miles Southwest of SH-283 Near Sayre on a South-facing Fill Slope as Determined August 2, 1972.

Mulch	Average Number of Weeping Lovegrass Plants	
	Per Square Meter	Per Square Yard
Piper Sudan	3.15	2.59
MS-2 Asphalt Emulsion	19.84	16.31
None	31.67	26.03

At the time of seeding the soil analyses indicated a pH of 7.3 (by the water-paste method), 62 lb/acre of available P_2O_5 and 1027 lb/acre of available K_2O. The AASHO classification is A-7.

The grasses, seeding rates, and cultural practices are as follows:

Grasses	Seeding rate, lb bulk see/acre
Weeping lovegrass	6.3
Buffalograss	27.0
S-Blend Asiatic Bluestem	8.3
H-Blend Asiatic Bluestem	8.6

Cultural Practices

Rotary Hoe
Water only
Rotary Hoe, water, plus propazine @ 1 lb ai/acre
Water, plus propazine @ 1 lb ai/acre

The slopes became covered with a variety of plant as shown in Figure 51. When evaluated on October 16, 1971 little difference in grasses or cultural treatments could be detected as shown in Figures 21 and 22.

The season was extremely dry and only a few of the seeded grasses had germinated and become established. No recommendations for the establishment of an erosion resistant ground cover, either as to kind of grass, or cultural practice to use, can be made from these data because of poor response due to the dry weather. An observation made in 1975 did show buffalograss becoming rather widespread in some of the areas.

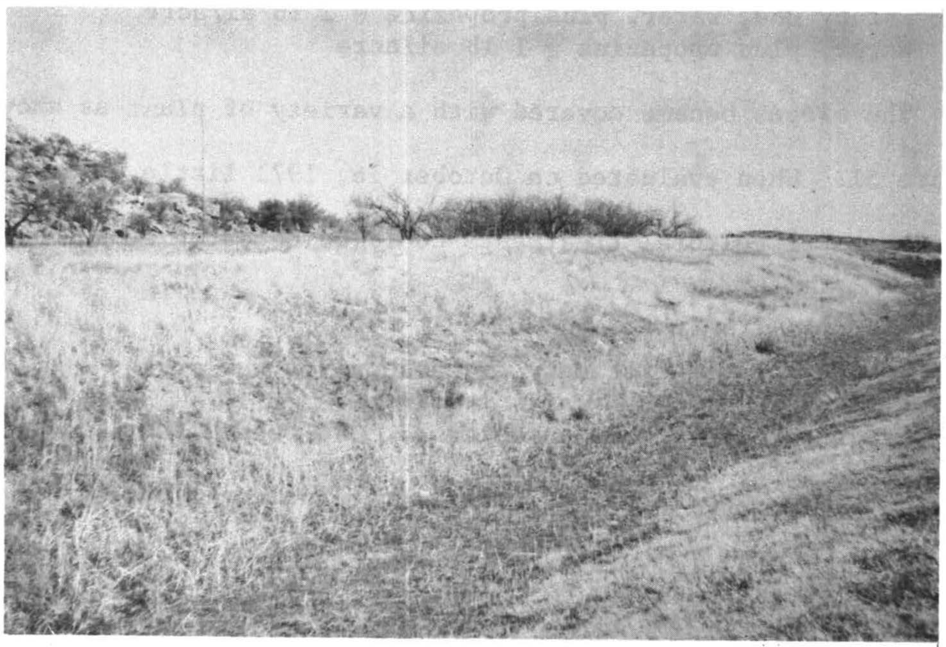


Figure 51. Vegetative cover of a south facing backslope on US-62, south of Snyder, in Kiowa County.

Table 21 Effect of four cultural practices on plant establishment* for roadside erosion control on a Lawton silt loam soil on US-62 south of Snyder on a north-facing backslope as determined October 16, 1971.

Treatments	Average Number of Plants Per Square Foot	Average Number of Plants Per Square Yard
Rotary Hoe	1.39	12.5
Water Only	1.62	14.6
Rotary Hoe, Water, plus Propazine 1 lb ai/acre	1.09	9.8
Water Plus Propazine 1 lb ai/acre	1.29	11.6

* Plants present were: Weeping lovegrass, lambsquarter, dropseed, Coloradograss, Russian thistle, stinkgrass, johnsongrass, pigweed, windmillgrass, sweetclover, western ragweed, milk purslane, buffalograss, yellow wood sorrel, gumweed, prostrate spurge, threeawn, goosegrass, broomweed, green foxtail, and sunflower.

Table 22 Effect of four cultural practices on plant establishment* for roadside erosion control on a Lawton silt loam soil on US-62 south of Snyder on a south-facing backslope as determined October 16, 1971

Treatments	Average Number of Plants Per Square Foot	Average Number of Plants Per Square Yard
Rotary Hoe	1.87	16.8
Water Only	1.97	17.7
Rotary Hoe, Water, Plus Propazine 1 lb ai/acre	1.62	14.6
Water Plus Propazine 1 lb ai/acre	1.53	13.8

* Plants present were: Weeping lovegrass, lambsquarter, dropseed, Coloradograss, Russian thistle, stinkgrass, johnsongrass, pigweed, windmillgrass, sweetclover, western ragweed, milk puslane, buffalograss, yellow wood sorrel, gumweed, prostrate spurge, threeawn, goosegrass, broomweed, green foxtail, and sunflower.

Experiments 25 &26. Evaluation of four mulches for the establishment of of buffalograss on SH-19, near Cooperton, in Kiowa County.

On July 15, 1971 buffalograss* was seeded at the rate of 20 lb PLS/acre, on a Tillman-Foard soil, three miles east SH-54, on SH-19 near Cooperton. The soil is highly erodible, and is characterized as a deep, clayey, very hard dry soil. The AASHO classification is A-7-6 (20). At the time of seeding, soil analyses indicated the soil to have a pH of 8.2 (as determined by water-paste method), 21 lb/acre of available P_2O_5, and 864 lb/acre of available K_2O. The seedbed was moderately compacted. The mulches were applied on July 16, 1971.

On August 1, 1972 the experiments were evaluated and the results are shown in Tables 23 and 24. As indicated in the Tables the largest number of buffalograss plants (although low because of extremely dry conditions) were to be found in those plots mulched by Excelsior Fiber.

In January 1975, the plots were again evaluated and the results are presented in Figures 52 and 53. As can be noted, the north facing backslope had the largest percentage of buffalograss when compared to the opposing south facing backslope. On the north facing backslope (Figure 52) Excelsior Fiber although not significantly different, had the greatest percentage of buffalograss followed by Conwed Fiber,* and wheat straw in that order. Across the highway, on the south facing slope the greatest precentage of buffalograss again, not significantly different was observed in those plots mulched with either Excelsior Fiber, or wheat straw (Figure 53). This probably reflects a better soil moisture level under these two mulches on this hotter, south facing slope.

* Supplied by the Bowie Industries, Inc. P.O. Box 931, Bowie, Texas 76230

Table 21 Effect of four cultural practices on plant establishment* for roadside erosion control on a Lawton silt loam soil on US-62 south of Snyder on a north-facing backslope as determined October 16, 1971.

Treatments	Average Number of Plants Per Square Foot	Per Square Yard
Rotary Hoe	1.39	12.5
Water Only	1.62	14.6
Rotary Hoe, Water, plus Propazine 1 lb ai/acre	1.09	9.8
Water Plus Propazine 1 lb ai/acre	1.29	11.6

* Plants present were: Weeping lovegrass, lambsquarter, dropseed, Coloradograss, Russian thistle, stinkgrass, johnsongrass, pigweed, windmillgrass, sweetclover, western ragweed, milk purslane, buffalograss, yellow wood sorrel, gumweed, prostrate spurge, threeawn, goosegrass, broomweed, green foxtail, and sunflower.

Table 22 Effect of four cultural practices on plant establishment* for roadside erosion control on a Lawton silt loam soil on US-62 south of Snyder on a south-facing backslope as determined October 16, 1971

Treatments	Average Number of Plants Per Square Foot	Per Square Yard
Rotary Hoe	1.87	16.8
Water Only	1.97	17.7
Rotary Hoe, Water, Plus Propazine 1 lb ai/acre	1.62	14.6
Water Plus Propazine 1 lb ai/acre	1.53	13.8

* Plants present were: Weeping lovegrass, lambsquarter, dropseed, Coloradograss, Russian thistle, stinkgrass, johnsongrass, pigweed, windmillgrass, sweetclover, western ragweed, milk puslane, buffalograss, yellow wood sorrel, gumweed, prostrate spurge, threeawn, goosegrass, broomweed, green foxtail, and sunflower.

Experiments 25 &26. Evaluation of four mulches for the establishment of of buffalograss on SH-19, near Cooperton, in Kiowa County.

On July 15, 1971 buffalograss* was seeded at the rate of 20 lb PLS/acre, on a Tillman-Foard soil, three miles east SH-54, on SH-19 near Cooperton. The soil is highly erodible, and is characterized as a deep, clayey, very hard dry soil. The AASHO classification is A-7-6 (20). At the time of seeding, soil analyses indicated the soil to have a pH of 8.2 (as determined by water-paste method), 21 lb/acre of available P_2O_5, and 864 lb/acre of available K_2O. The seedbed was moderately compacted. The mulches were applied on July 16, 1971.

On August 1, 1972 the experiments were evaluated and the results are shown in Tables 23 and 24. As indicated in the Tables the largest number of buffalograss plants (although low because of extremely dry conditions) were to be found in those plots mulched by Excelsior Fiber.

In January 1975, the plots were again evaluated and the results are presented in Figures 52 and 53. As can be noted, the north facing back-slope had the largest percentage of buffalograss when compared to the opposing south facing backslope. On the north facing backslope (Figure 52) Excelsior Fiber although not significantly different, had the greatest percentage of buffalograss followed by Conwed Fiber,* and wheat straw in that order. Across the highway, on the south facing slope the greatest precentage of buffalograss again, not significantly different was observed in those plots mulched with either Excelsior Fiber, or wheat straw (Figure 53). This probably reflects a better soil moisture level under these two mulches on this hotter, south facing slope.

---

* Supplied by the Bowie Industries, Inc. P.O. Box 931, Bowie, Texas 76230

Table 23. Effect of Four Mulches on the Germination and Growth of Buffalograss Seeded July 15, 1971, for Roadside Erosion Control, on a Tillman-Foard Soil on SH-19 Three Miles East of SH-54 Near Cooperton in Kiowa County on a North-facing Backslope, as Determined August 1, 1972.

Mulch	Application Rate	Average Number of Buffalograss Plants	
		Per Square Meter	Per Square Yard
1. Excelsior Fiber	2 ton/acre	5.64	4.64
2. Conwed Fiber	½ ton/acre	2.72	2.24
3. Wheat Straw	2 ton/acre	1.62	1.33
4. Conwed Fiber (Plus 1% Petroset SB)	½ ton/acre	1.89	1.55

Table 24. Effect of Four Mulches on the Germination and Growth of Buffalograss Seeded July 15, 1971, for Roadside Erosion Control, on a Tillman-Foard Soil on SH-19 Three Miles East of SH-54 Near Cooperton in Kiowa County on a South-facing Backslope, as Determined August 1, 1972.

Mulch	Application Rate	Average Number of Buffalograss Plants	
		Per Square Meter	Per Square Yard
1. Excelsior Fiber	2 ton/acre	13.87	11.40
2. Conwed Fiber	½ ton/acre	1.63	1.34
3. Wheat Straw	2 ton/acre	5.06	4.16
4. Conwed Fiber (Plus 1% Petroset SB)	½ ton/acre	3.09	2.54

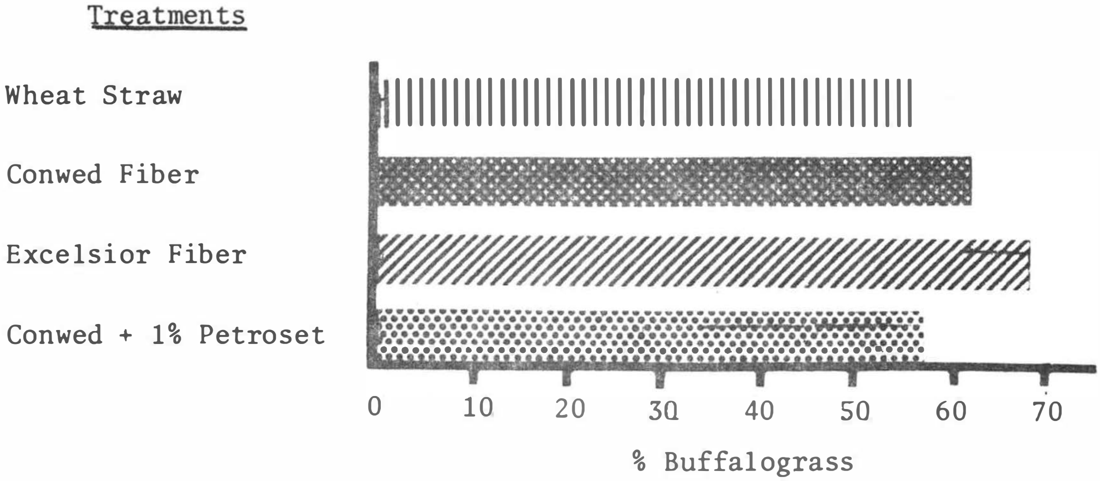


Figure 52. . Effect of four mulches on the germination and growth of buffalograss seeded July 15, 1971, on a Tillman-Foard soil on SH-19, three miles east of SH-54 near Cooperton in Kiowa county on a north-facing backslope as determined January 7, 1975.

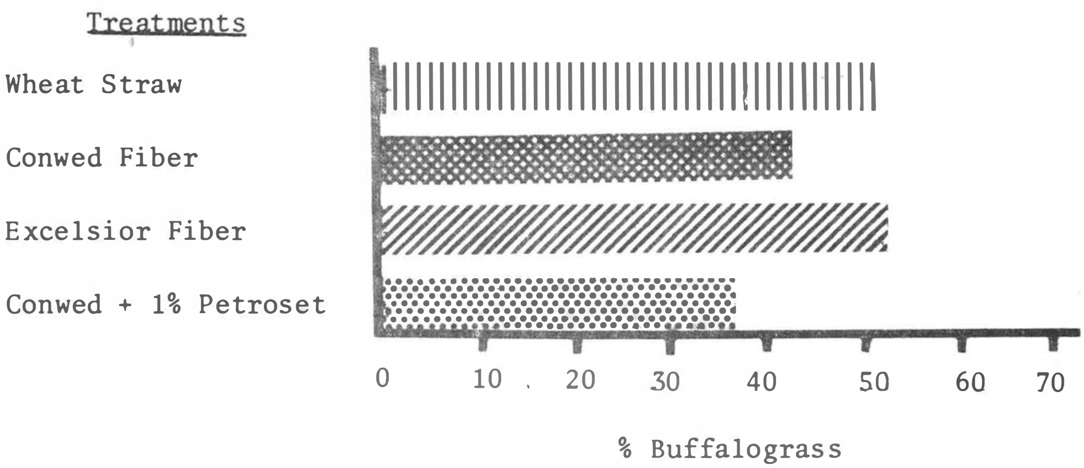


Figure 53 . Effect of four mulches on the germination and growth of buffalograss seeded July 15, 1971, on a Tillman-Foard soil on SH-19, three miles east of SH-54 near Cooperton in Kiowa county on a south-facing backslope, as determined January 7, 1975.

Experiments 27 & 28. Evaluation of six Asiatic bluestems seeded conventionally, or in a hay-seed combination and weeping lovegrass for roadside erosion control on I-244, in Tulsa.

An investigation of two methods of seeding Asiatic bluestems for the most satisfactory and economical means of stand establishment for roadside erosion control was started March 22, 1972, east of the Utica street overpass, on I-244, in Tulsa. The soil, classified as a Talihina, with a high erodibility, can be characterized as eroded, clayey shales. The AASHO classification is an A-7-6.

At the time of seeding the soil analyses of the south facing slope indicated a pH of 7.8 (as determined by the water-paste method), 32 lb/acre of available P_2O_5, and 58 lb/acre of available K_2O. The plots were disked twice to prepare a suitable seedbed on the usual compacted backslopes, as shown in Figure 54. Prior to disking, 530 lb of 10-20-20 was applied per acre.

The grasses and rates used are as follows:

Grasses	Seeding rate, lb PLS/acre
*Caucasian bluestem	10
*I-Blend Asiatic bluestem	10
*T-Blend Asiatic bluestem	10
*L-Blend Asiatic bluestem	10
**H- Blend Asiatic bluestem (Hay-seed combination)	10
** 1359-Blend Asiatic bluestem (Hay-seed combination)	10

All plots were overseeded with weeping lovegrass, at the rate of 2 lb PLS/acre with a Brillion seeder, just prior to mulching.

The north facing slope was seeded the same as the opposing slope across the road. Some slight differences in the soil could be detected

---

*Mulched with 2 ton/acre of wheat straw.

**Added enough Asiatic Bluestem hay to equal 2 ton/acre.

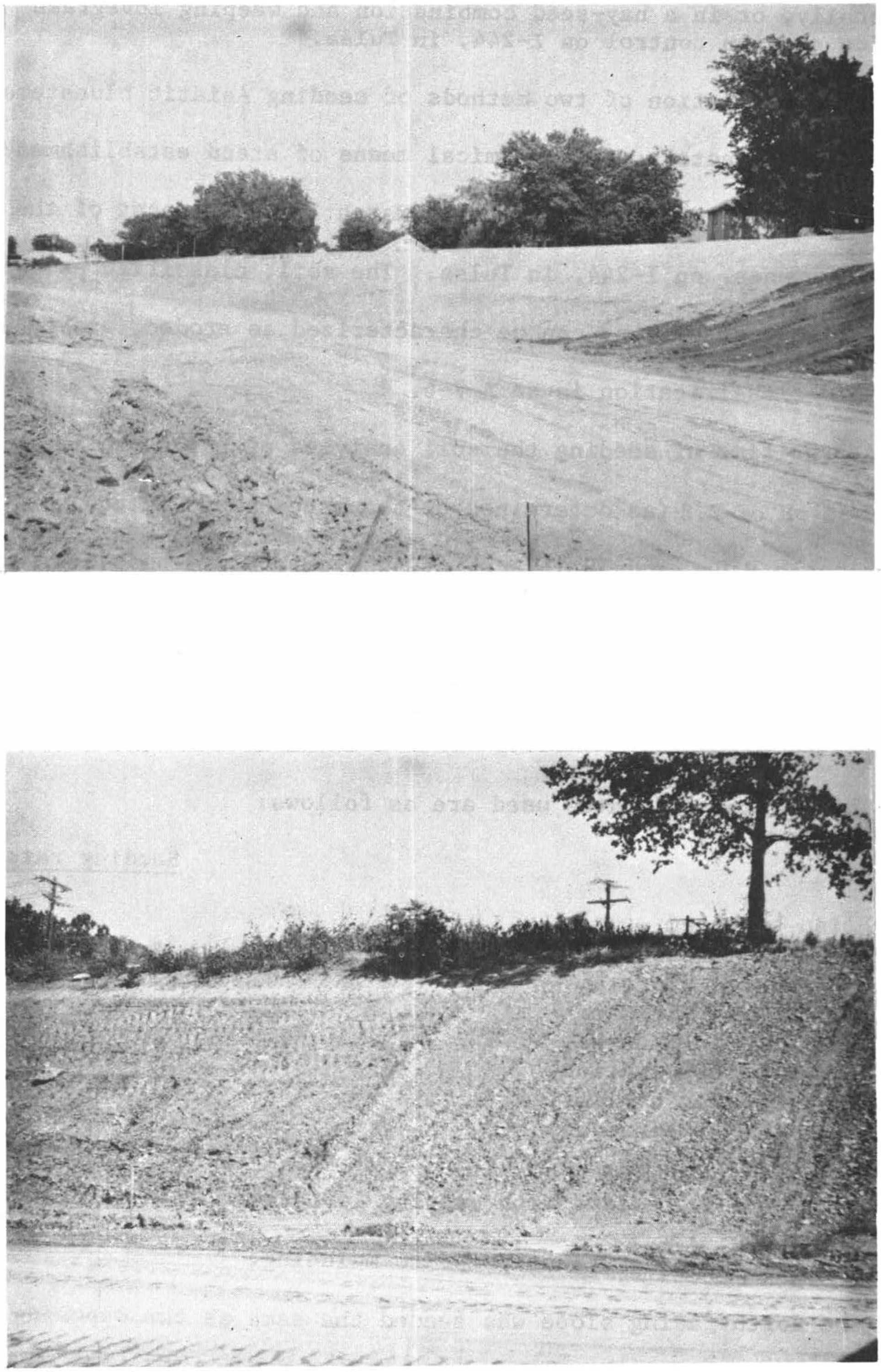


Figure 54. The usual compacted soil on opposing backslope (Top-south facing; Bottom-north facing) prior to disking for the establishment of roadside erosion control on I-244, in Tulsa.

on this slope compared to the south facing slope. The pH was 7.8 (as determined by the water-paste method), there were 40 lb/acre of available P_2O_5 and 52 lb/acre of available K_2O.

The mulches were applied on March 22, 1972, and appeared as shown in Figure 55. Four months later (July 26, 1972) the plots were evaluated and the results are shown in Tables 25 and 26. As can be noted more grasses generally were found on the south facing slope when compared to the opposing north facing slope.

More Caucasian bluestem, T, and L-Blend Asiatic bluestem was found on the north facing slope than on the slope facing south. Just the opposite was true for the I, H, and 1359-Blend Asiatic bluestem where more plants were found on the south facing slope than on the one facing north.

In 1973, there were no statistical differences in plant population on the south facing slope as shown in Table 27. However, on the south side of the highway there were highly significant differences in the plant population of bluestems as shown in Table 28. On this north facing slope, the greatest plant population was in the L-Blend Asiatic bluestem, with the least being found in those plots seeded with the I-Blend. This would tend to indicate on these north facing slopes of Talihina soil, the L-Blend Asiatic bluestem would be the better one to use for roadside erosion control.

When the plots were evaluated in November 1974, the Caucasian bluestem presented the greatest population on both the north and south facing slopes as shown in Figures 56 and 57. This was closely followed by the I-Blend on both slopes. Somewhat of a surprise was the small percentage of L-Blend found on this north facing slope, only one year after it had been found to be in greatest abundance.

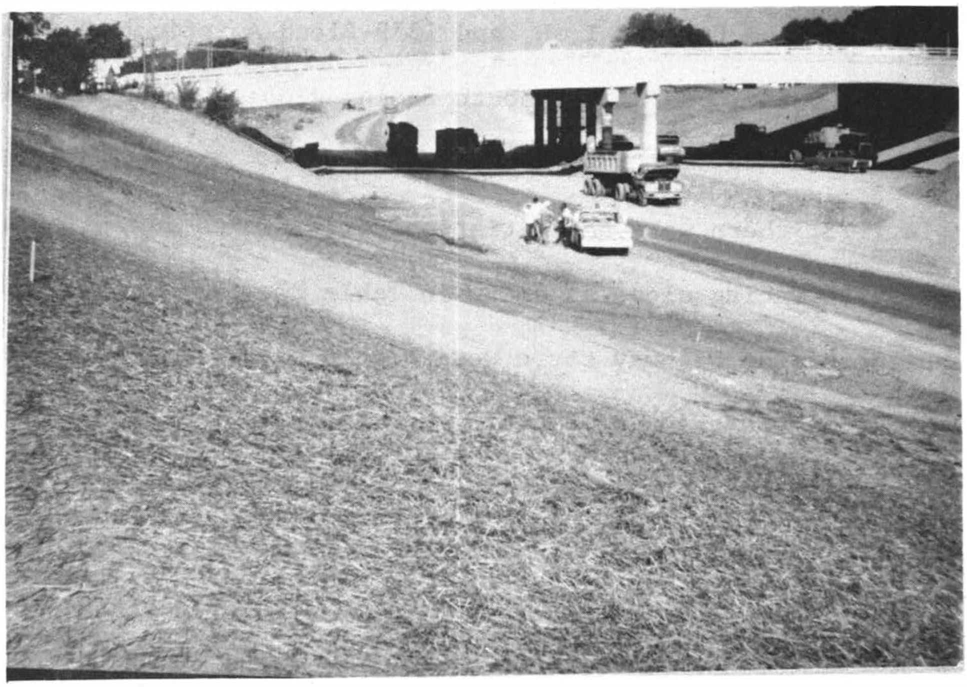


Figure 55. Appearance of the north facing backslope on I-244, in Tulsa immediately after mulching.

Table ,25. Average Plant Population of Weeping Lovegrass and Asiatic Bluestems Established from Seed and Hay-seed Combination March 22, 1972, for Roadside Erosion Control on a Talihina Soil in Tulsa on I-244 East of the Utica Overpass on a South-facing Backslope as Evaluated July 26, 1972.

Treatments	Average No. of Plants/sq. meter		Total No. of Plants	
	Bluestem	Weeping Love	Sq. Meter	Sq. yd.
Caucasian Bluestem	90.35	90.35	180.7	148.5
"I" Blend Asiatic Bluestem	125.55	41.85	167.4	137.6
"T" Blend Asiatic Bluestem	77.14	35.76	112.9	92.8
"L" Blend Asiatic Bluestem	85.60	23.10	108.7	89.4
"H" Blend (Hay-seed comb.)	141.74	69.56	211.3	173.7
"1359" Blend (Hay-seed comb.)	87.20	78.80	166.1	136.5

Table 26. Average Plant Population of Weeping Lovegrass and Asiatic Bluestems Established from Seed and Hay-seed Combination March 22, 1972, for Roadside Erosion Control on a Talihina Soil in Tulsa on I-244 East of the Utica Overpass on a North-facing Backslope as Evaluated July 26, 1972.

Treatments	Average No. of Plants/sq. meter		Total No. of Plants	
	Bluestem	Weeping Love	Sq. Meter	Sq. yd.
Caucasian Bluestem	144.10	34.20	178.3	146.6
"I" Blend Asiatic Bluestem	95.22	36.88	132.1	108.6
"T" Blend Asiatic Bluestem	148.70	28.60	177.3	145.7
"L" Blend Asiatic Bluestem	150.20	52.30	202.5	166.4
"H" Blend (Hay-seed comb.)	23.80	26.30	50.1	41.2
"1359" Blend (Hay-seed comb.)	48.09	101.74	149.8	123.1

Table 27. Plant Population in Percent of Erosion Resistant Grasses and Broadleaved Weeds from a Seeding March 22, 1972, of Asiatic Bluestems and Weeping Lovegrass on a Talihina Soil in Tulsa on I-244 East of the Utica Overpass on a South-facing Backslope as Determined July 27, 1973.

Treatment	Plant Population in Percent (Average of Three Reps)				
	Bluestem	Weeping Lovegrass	Broad Leaves	Other Grasses	Bare Ground
Caucasian Bluestem	25.3	2.7	14.7	15.3	42.0
"I" Blend Asiatic Bluestem	23.3	5.3	28.0	20.7	22.7
"T" Blend Asiatic Bluestem	18.0	2.0	6.0	20.7	53.3
"L" Blend Asiatic Bluestem	34.0	1.3	23.3	12.0	28.7
"H" Blend Asiatic Bluestem (hay-seed comb.)	30.7	6.7	33.3	12.0	18.0
"1359" Blend Asiatic Bluestem (hay-seed comb.)	16.0	9.3	12.0	39.3	23.3
Average	24.5	4.6	19.6	20.0	31.3
Statistical Differences	NS	NS	NS	NS	NS
CV	56%	119%	82%	50%	53%

Table 28. Plant Population in Percent of Erosion Resistant Grasses and Broadleaved Weeds from a Seeding March 22, 1972 of Asiatic Bluestems and Weeping Lovegrass on a Talihina Soil in Tulsa on I-244 East of the Utica Overpass on a North-facing Backslope as Determined July 27, 1973.

Treatment	Plant Population in Percent (Average of Three Reps)				
	Bluestem	Weeping Lovegrass	Broad Leaves	Other Grasses	Bare Ground
Caucasian Bluestem	12.7	0.7	18.7	14.7	53.3
"I" Blend Asiatic Bluestem	9.3	6.7	26.0	5.3	52.7
"T" Blend Asiatic Bluestem	12.7	4.7	33.3	18.0	32.7
"L" Blend Asiatic Bluestem	42.7	1.3	35.3	3.3	17.3
"H" Blend Asiatic Bluestem (hay-seed comb.)	22.0	7.3	32.0	4.7	34.0
"1359" Blend Asiatic Bluestem (hay-seed comb.)	18.0	12.0	34.7	11.3	24.0
Average	19.6	5.5	30.0	9.6	35.7
Statistical Differences	**	NS	NS	NS	NS
CV	32%	127%	56%	100%	53%

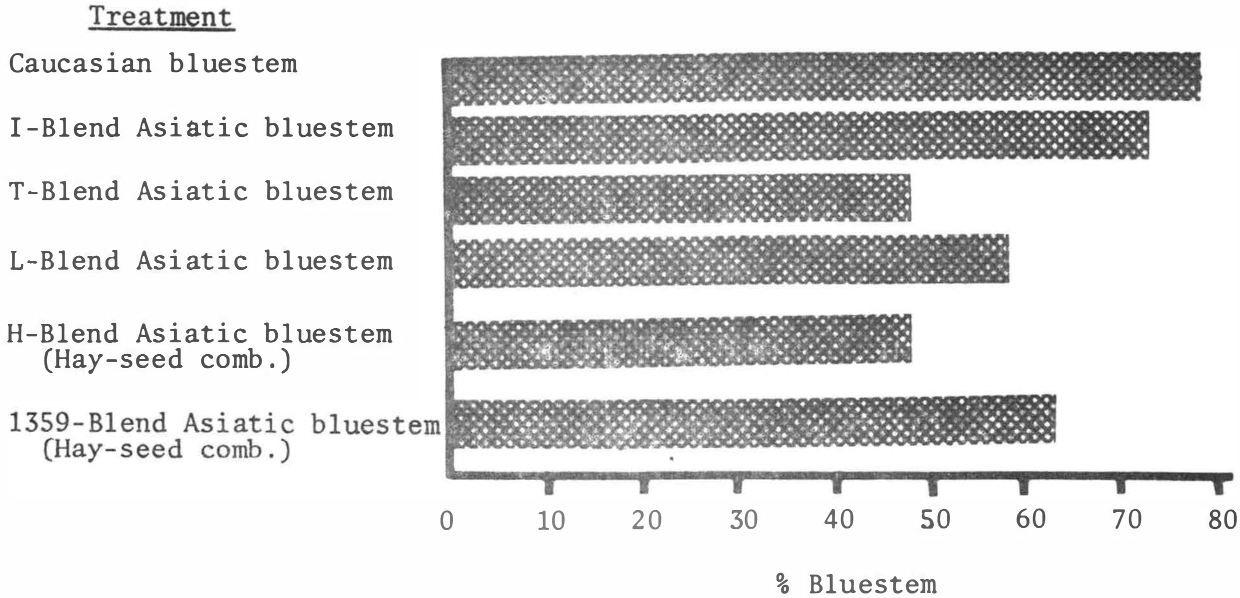


Figure 56. Percent plant population of Asiatic bluestem established from seed and hay-seed combination March 22, 1972, for roadside erosion control on a Talihina soil in Tulsa on I-244 east of the Utica overpass on a south-facing backslope as evaluated November 20, 1974.

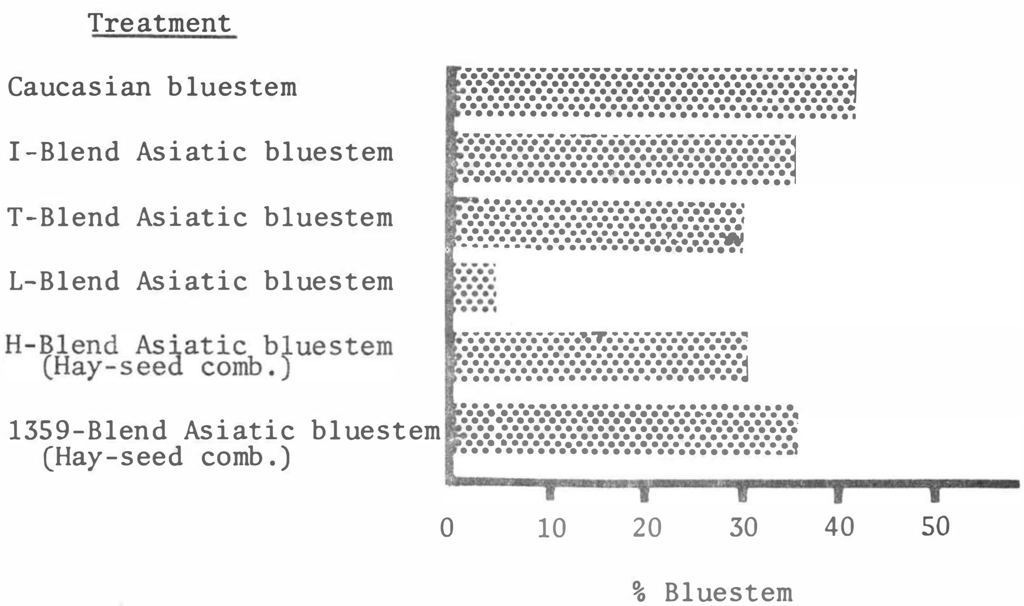


Figure 57. Percent plant population of Asiatic bluestems established from seed and hay-seed combination March 22, 1972, for roadside erosion control on a Talihina soil in Tulsa on I-244 east of the Utica overpass on a north-facing backslope as evaluated November 20, 1974.

A greater percentage of all grasses were noted on the south facing slope than on the north. This might be explained in part by the fact some topsoil was replaced on this south facing slope, but none on the north facing slope, just prior to the time of seeding these grasses.

In 1975 the slopes fertilized with 360 lb/acre of 14-14-14, were beginning to demonstrate the aggressiveness of these grasses (Figure 58) as evidenced by the data in Figures 59, and 60. On the south facing slope all species exhibited a 70% or better ground cover in 1975, compared on only one in 1974.

These data tend to indicate that although not statistically different, Caucasian and I-Blend Asiatic bluestem will provide the most ground cover on a south facing backslope on a Talihina soil, closely followed by T, H, and 1359 Asiatic Blend bluestems. The least cover (which is over 70%) was provided by the L-Blend Asiatic bluestem.

On a north facing backslope, even though not statistically different, the H-Blend provided the most ground cover (a little over 70%), closely followed by 1359 and T-Blend Asiatic bluestems. These were followed by L-Blend, Caucasian, and I-Blend Asiatic bluestem in this descending order.

Either the H-Blend, or the 1359-Blend Asiatic bluestems, applied to a north facing backslope in the economical form of a hay-seed combination tion would provide the most ground cover on a Talihina soil three years after planting. The T-Blend Asiatic bluestem would be the third choice, followed by Caucasian and I-Blend in that order.

Figure 58. The appearance of a north facing backslope three years after seeding with Asiatic bluestem on a Talihina soil, on I-244, in Tulsa.

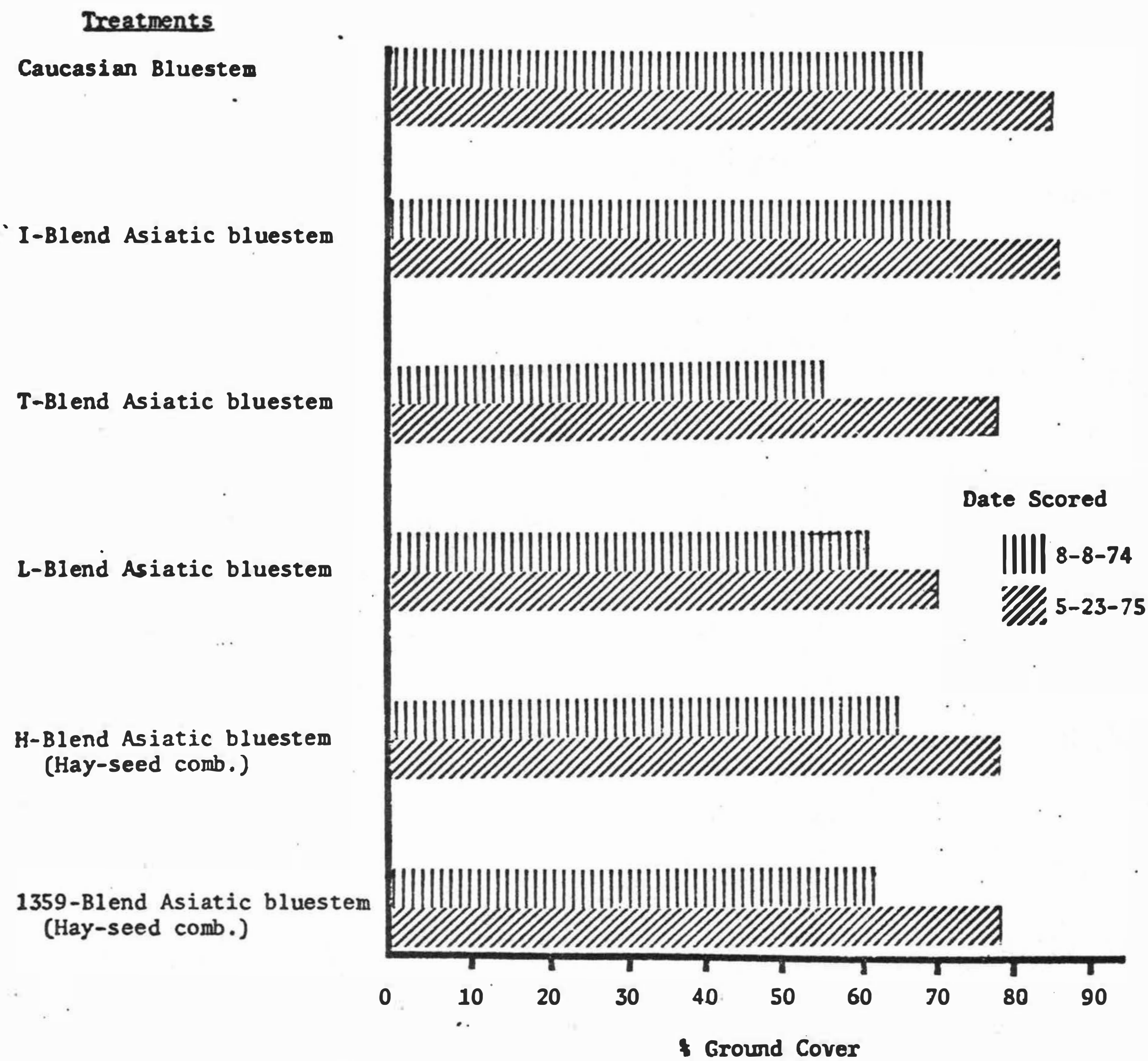


Figure 59. Percent ground cover of Asiatic bluestems established from seed and hay-seed combination for erosion control, seeded and mulched March 22, 1972, on a Talihina soil in Tulsa on I-244 east of the Utica overpass on a south-facing backslope.

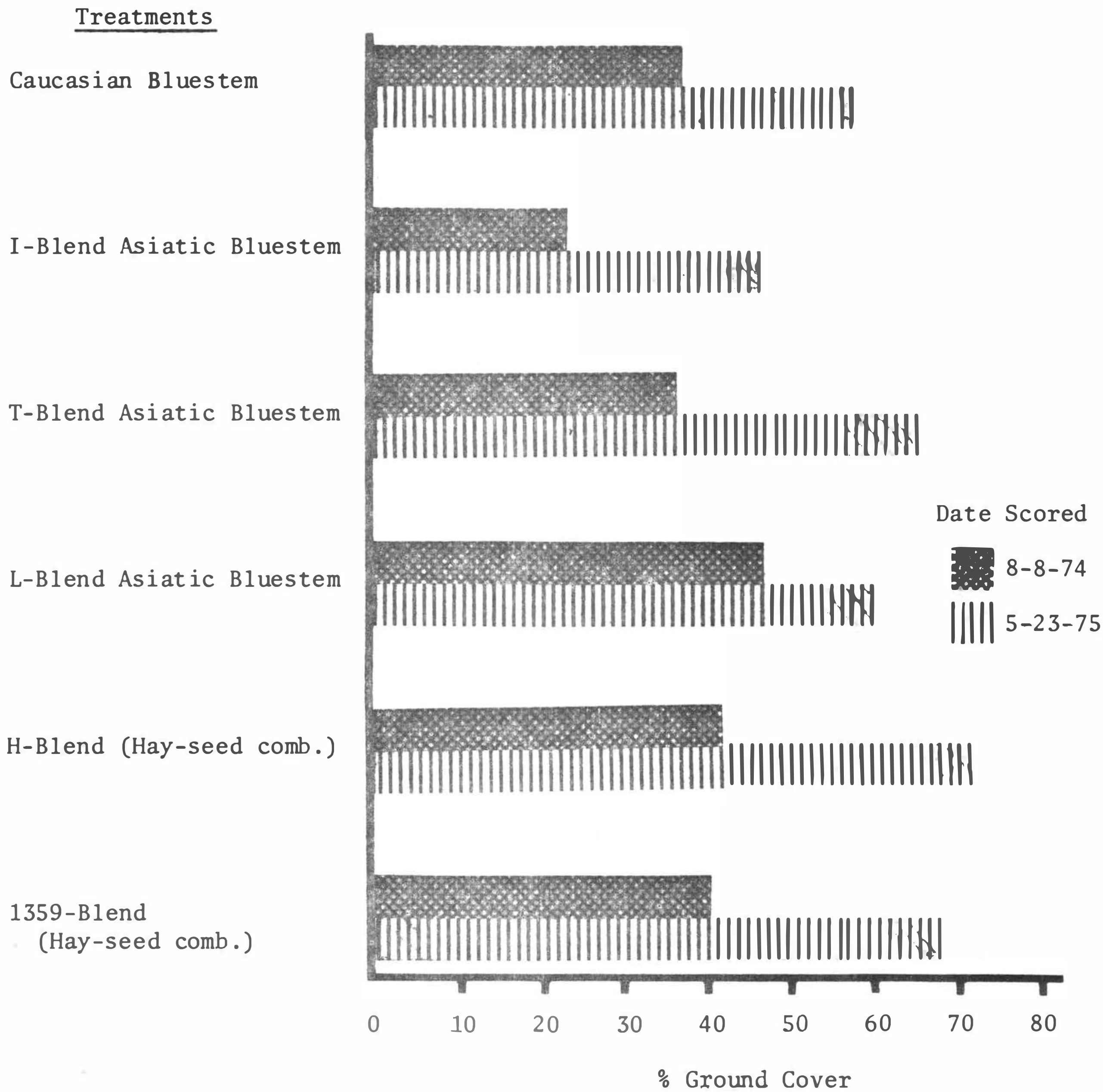


Figure 60. Percent ground cover of Asiatic bluestems established from seed and hay-seed combination for erosion control, seeded and mulched March 22, 1972, on a Talihina soil in Tulsa on I-244 east of the Utica overpass on a north-facing backslope.

Experiments 29 & 30. Determination of the fertilizer effect on the germination and growth of three erosion resistant grasses on US-75, two miles south of Copan, in Washington County.

On October 20, 1972, an east and west facing backslope on US-75, south of Copan, Washington County covered with natural vegetation was disked to prepare a suitable seedbed for the establishment of an erosion resistant ground cover. After the first disking the following fertilizer treatments were applied.

100-0-60 per acre

100-80-60 per acre

100-160-60 per acre

Immediately after fertilization with an Easy-Flo Spreader, the soil was disked again. The seed of the following grasses were seeded by hand at the rates shown as follows:

Grass	Seeding rate, lb bulk seed/acre
Southland Smooth Bromegrass	46
Crested Wheatgrass	17
Kentucky 31 Tall Fescue	33

The soil is classified as a highly erodible, Bates, Collinsville complex characterized as a shallow, strong loam on 25 to 45% slopes with some clayey spots. The slope angle on the east facing slope was 22% and 24% on the west facing slope. The AASHO classification is as follows: Bates = A-4, A-6, A-7; Collinsville= A-2, A-4; and Talihina= A-7. Prior to seeding the soil analyses on both slopes showed a pH of 7.1 (as determined by a water-paste method), 12 lb/acre of available P_2O_5, and 58 lb/acre of available K_2O.

The treatments were evaluated in 1972, 1973, and 1974, as shown in Tables 29 and 30. A highly significant difference in the average rating of plant population and average number of plants/square yard was found in 1972 and 1973.

Table 29. Fertilizer Effect on Germination and Growth of Three Erosion Resistant Grasses Fertilized and Seeded October 20, 1972, on a Bates-Collinsville Soil Complex on US-75, 2 Miles South of Copan on an East-facing Backslope as Determined on December 20, 1972, March 20, 1973, and August 13, 1974.

Treatments Grass	Ferti- lizer	12-20-72 Average Rating* Plant Population	3-20-73 Average Number of Plants/sq.yd.	8-13-74 Average % Ground Cover
1A Southland Smooth Bromegrass	100- 0 -60	7.66	276	70
1B Southland Smooth Bromegrass	100- 80 -60	7.33	381	60
1C Southland Smooth Bromegrass	100-160-60	8.33	585	65
2A Crested Wheatgrass	100- 0 -60	2.66	76	85
2B Crested Wheatgrass	100- 80 -60	2.66	92	65
2C Crested Wheatgrass	100-160-60	2.66	221	65
3A Kentucky 31 Tall Fescue	100- 0 -60	5.66	204	75
3B Kentucky 31 Tall Fescue	100- 80 -60	5.00	462	60
3C Kentucky 31 Tall Fescue	100-160-60	6.33	801	60
Statistical Differences		**	**	N.S.
CV		20%	13%	10%

* Ocular Estimate of Plant Population (10 = best, 1 = none)

Table 3a **Fertilizer Effect on Germination** and Growth of Three Erosion Resistant Grasses Fertilized and Seeded October 20, 1972, on a Bates-Collinsville Soil Complex on US-75, 2 Miles South of Copan on a West-facing Backslope as Determined on December 20, 1972, March 20, 1973, and August 13, 1974.

Treatments Grass	Fertilizer	12-20-72 Average Rating* Plant Population	3-20-73 Average Number of Plants/sq.yd.	8-13-74 Average % Ground Cover
1A Southland Smooth Bromegrass	100- 0 -60	7.00	351	85
1B Southland Smooth Bromegrass	100- 80 -60	7.33	473	87
1C Southland Smooth Bromegrass	100-160-60	7.33	670	82
2A Crested Wheatgrass	100- 0 -60	2.66	317	83
2B Crested Wheatgrass	100- 80 -60	4.00	330	88
2C Crested Wheatgrass	100-160-60	2.66	464	88
3A Kentucky 31 Tall Fescue	100- 0 -60	2.68	334	75
3B Kentucky 31 Tall Fescue	100- 80 -60	2.66	458	83
3C Kentucky 31 Tall Fescue	100-160-60	3.33	772	78
Statistical Differences		**	Not	**
CV		24%	Computed	4%

* Ocular Estimate of Plant Population (10 = best, 1 = none)

However, in 1974, there were no differences in the average percent ground cover.

In 1972, on this east facing backslope, Southland bromegrass at all three fertility levels provided the best plant population of the three grasses evaluated. Kentucky 31 tall fescue, at all fertility levels was second, followed rather distantly by crested wheatgrass.

In 1973, Kentucky 31 tall fescue fertilized with 100-160-60/acre provided the greatest number of plants (sq. yd.,) followed by Southland smooth bromegrass fertilized wtih 100-160-60/acre. In third place, with approximately half as many plants as the best treatment, was Kentucky 31 tall fescue fertilized with only half as much phosphorus, but the same amount of nitrogen and potassium. Only the highest fertilizer rate on crested wheatgrass produced more plants/sq. yd., than the lowest fertilizer rate on Kentucky 31 tall fescue.

When the plots were evaluated in 1974, there were no significant differences in percent ground cover among grasses, or fertilizer treatments. All grasses, at all fertility levels provided 60% or more ground cover.

On the east side of the highway highly significant differences in plant population were noted in 1972. Just as on the opposite side of the highway, Southland smooth bromegrass at all fertility levels provided the best plant population of the three grasses evaluated. Little differences in plant population could be detected between crested wheatgrass and Kentucky 31 tall fescue at this time.

In 1973, again as on the opposing slope, Kentucky 31 tall fescue fertilized with 100-160-60/acre provided the greatest number of plants per sq. yd., on this west facing backslope.

Southland smooth bromegrass fertilized with 100-160-60/acre was second. In third place with approximately 61% as many plants per sq. yd., as the best treatment was Southland smooth bromegrass fertilized with 100-80-60/acre.

When the plots were evaluated in 1974, there were highly significant differences in the percent ground cover on this west facing backslope, in contrast to the finding of no significant differences on the east facing slope. Here the best ground cover was provided by crested wheatgrass fertilized with either 100-80-60, or 100-160-60/acre, followed closely by Southland smooth bromegrass fertilized with 100-80-60, and 100-0-60/acre.

These data tend to indicate for the quickest protection from soil erosion, Southland smooth bromegrass fertilized with 100-80-60/acre would be best. Five months after seeding the greatest number of plants for protection against soil erosion would be provided by Kentucky 31 tall fescue fertilized with 100-160-60-/acre. In second place would be Southland smooth bromegrass fertilized with 100-160-60, with 73% or more as many plants /sq. yd., as the best treatment.

Almost two years after seeding the best ground cover would be provided by crested wheatgrass or Southland smooth bromegrass fertilized with 100-80-60/acre.

FERTILITY LEVELS OF ROADSIDE SOILS

Soil fertility levels of seven newly constructed roadsides were determined to characterize the kinds and amounts of fertilizers that would be needed to supply the minimum amount of nutrients necessary for desirable plant growth to control erosion on highway backslopes and fillslopes*. All soil samples taken to a five inch depth, were analyzed for pH-H_2O, pH-Kcl, phosphorus, potassium, sodium, calcium, and magnesium.

---

*Ensminger, Glenn E. 1972. Fertility levels of Oklahoma Roadsides. Unpublished M.S. Thesis. Oklahoma State University.

Soil erosion on Oklahoma highways causes much damage each year. Therefore, if this erosion can be stopped, or reduced to a minimum, many dollars would be saved on maintenance. One method of minimizing the soil erosion is by mulching these slopes with some vegetative (either living or dead), or commercial material. Mulch on the surface of the soil can intercept the rainfall and dissipate the the energy of the falling raindrops. A readily established, dense, vegetative ground cover (preferably perennial), established on newly constructed roadsides would result in a negligible amount of soil erosion along these highways. Soils with adequate fertility levels to support rapid growth and establishment of these erosion resistant ground covers are a necessity if we affect the greatest savings in roadside maintenance costs.

Experiments 31 & 32. In 1971 soil samples were taken from two opposing backslopes on U.S. 217, approximately 0.5 mile northeast of Wister, in LeFlore County, on a highly erodible, Enders-Hector complex soil type. The southeast facing backslope had a slope angle of 34%, as did the opposing northwest facing backslope.

The slopes approximately 130 feet high, were arbitrarily divided in half from top to bottom. They were further subdivided into 24 plots of equal size (3069 sq. ft.), that covered the entire length of the area, one sample was taken from each subplot giving a total of 48 samples from each experimental slope.

The soil analyses from the northwest facing backslope showed highly significant differences in the pH-H_2O, pH-Kcl, and phosphorus. The pH-H_2O is quite acidic on the east end and decreases as you move to the west end as shown in Figure 61. The same pattern but of a different magnitude is exhibited by the pH-Kcl data. The potassium content of the soil on the northwest facing backslope is higher on the east end than on the west end of the experimental area. An average of 430 ppm is found on the east end and decreases to a minimum of 300 on the west as shown in Figure 62. The pH-H_2O and pH-Kcl values on this

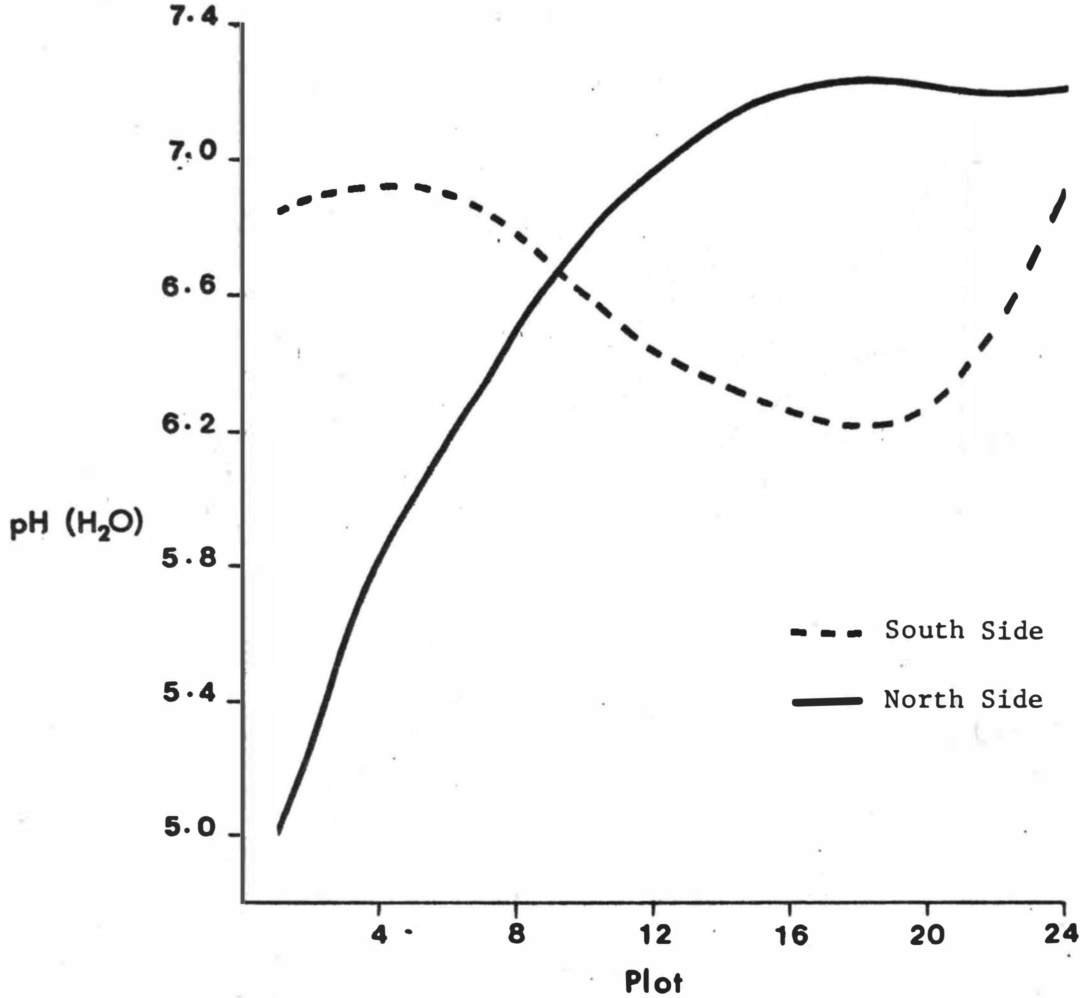


Figure 61. The pH-H_2O levels of an Enders-Hector complex soil type on opposing backslopes of U. S. 271, 0.6 miles northeast of Wister, Oklahoma in LeFlore County.

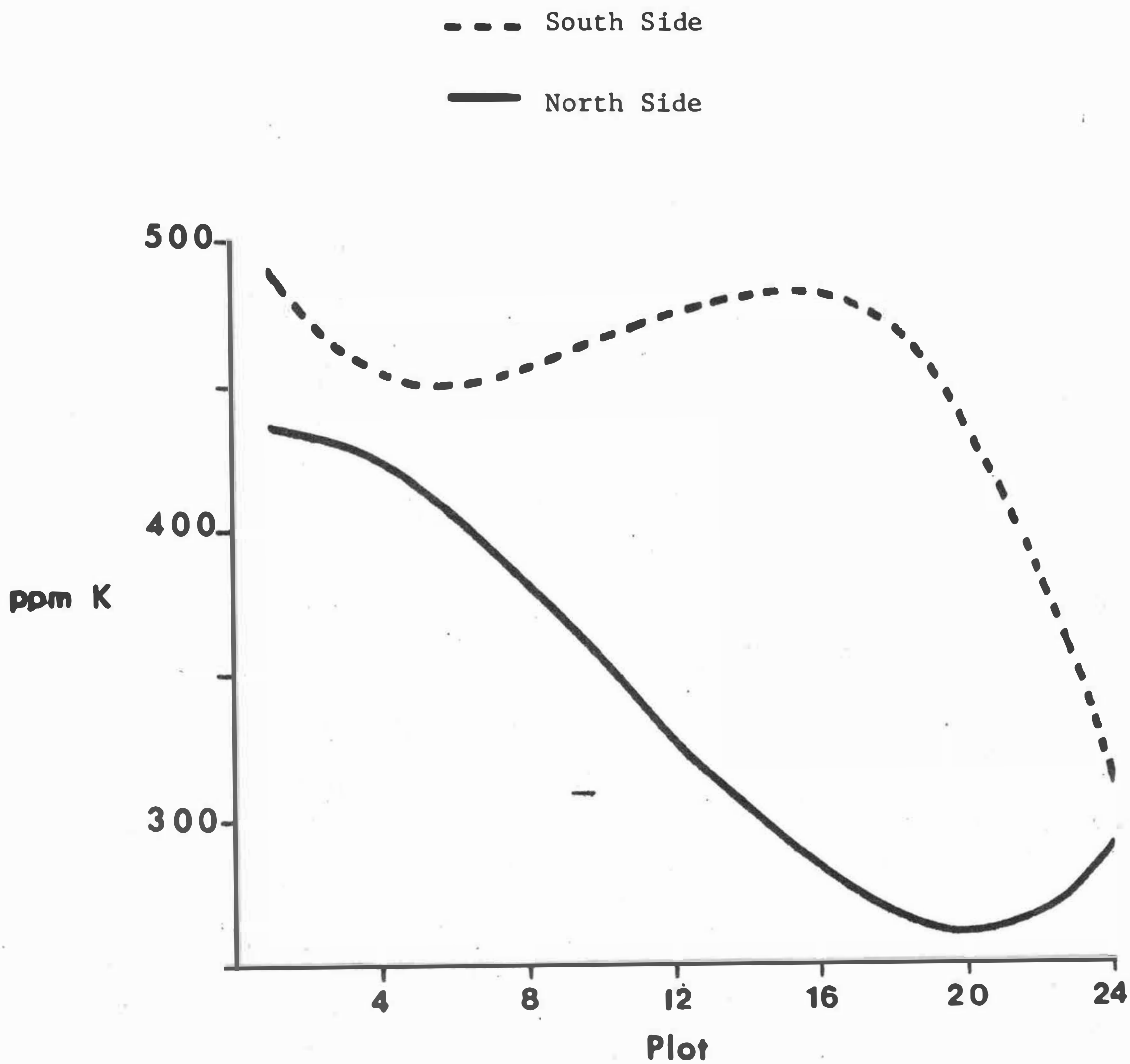


Figure 62. The potassium levels of an Enders-Hector Complex soil type on opposing backslopes of U.S. 271, 0.6 miles northeast of Wister, Oklahoma in LeFlore County.

northwest exposure are higher on the lower half of the slope than on the upper as shown in Figures 63 and 64. A highly significant difference in pH-Kcl levels was found, with the higher readings coming from the soil at either end of the experimental area than in the middle of this northwest facing backslope as shown in Figure 65. However, there is not enough difference to be of a practical matter in a soil fertility program. The fertility level of these soils is uniformly low. These analyses indicate there are no practical differences between these opposing backslope soils in any of the components tested.

Experiments 33 & 34. Two opposing backslopes on I-40, east of Sayre in Beckham County were selected for analyses in 1971. The AASHO classification is an A04(5), with a slope angle of 33% on the south, decreasing to 26% on the north.

Significant differences among plots were found in levels of pH-H_2O, pH-Kcl, phosphorus, and potassium in the backslope soils on the west side of the highway with an east exposure. The phosphorus level at the south end of this experimental area (nearest the North Fork of the Red River) is very low as shown in Figure 66, but the fertility gradient increases from south to north possibly due to the decreasing depth of the cut. These differences are highly significant. However, as far as the soil fertility is concerned, the phosphorus level is not adequate for good plant growth on this east facing backslope. On the east side of the highway highly significant differences in pH-Kcl, phosphorus, and potassium were detected from top to bottom of the backslope. The pH-Kcl increases slightly as we go from the bottom to the center third and top of this west facing backslope as shown in Figure 67. However, on the west side of the highway the pH-Kcl decreases as we go up the slope, but increases slightly from the middle to the top. The phosphorus content increases in both backslopes as we go from the bottom to the middle, but decreases significantly as we move to the top as shown in Figure 68. The decrease in phosphorus content on top of the slope could be

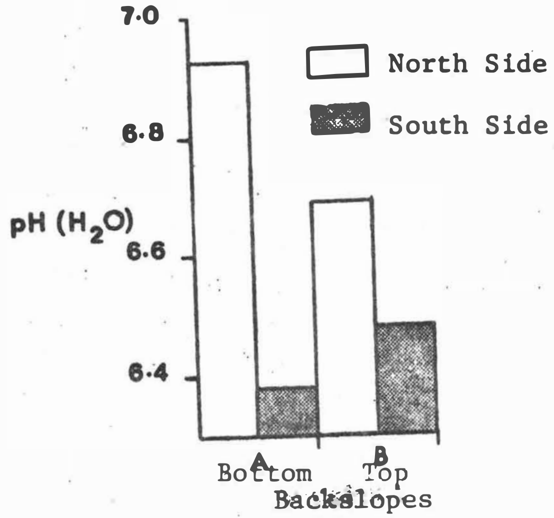


Figure 63. The average pH-H_2O levels of the top and bottom halves of opposing backslopes on an Enders-Hector complex soil type on U.S. 271, 0.6 miles northeast of Wister, Oklahoma in LeFlore County.

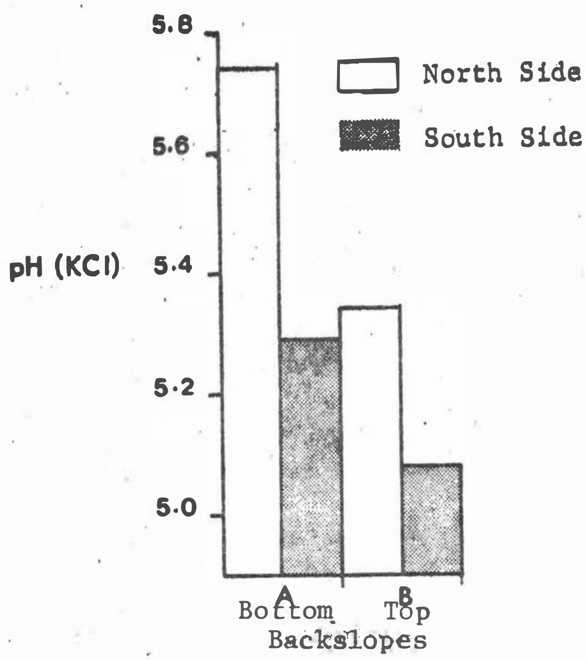


Figure 64. The average pH-Kcl levels of the top and bottom halves of opposing backslopes on an Enders-Hector complex soil type on U.S. 271, 0.6 miles northeast of Wister, Oklahoma in LeFlore County.

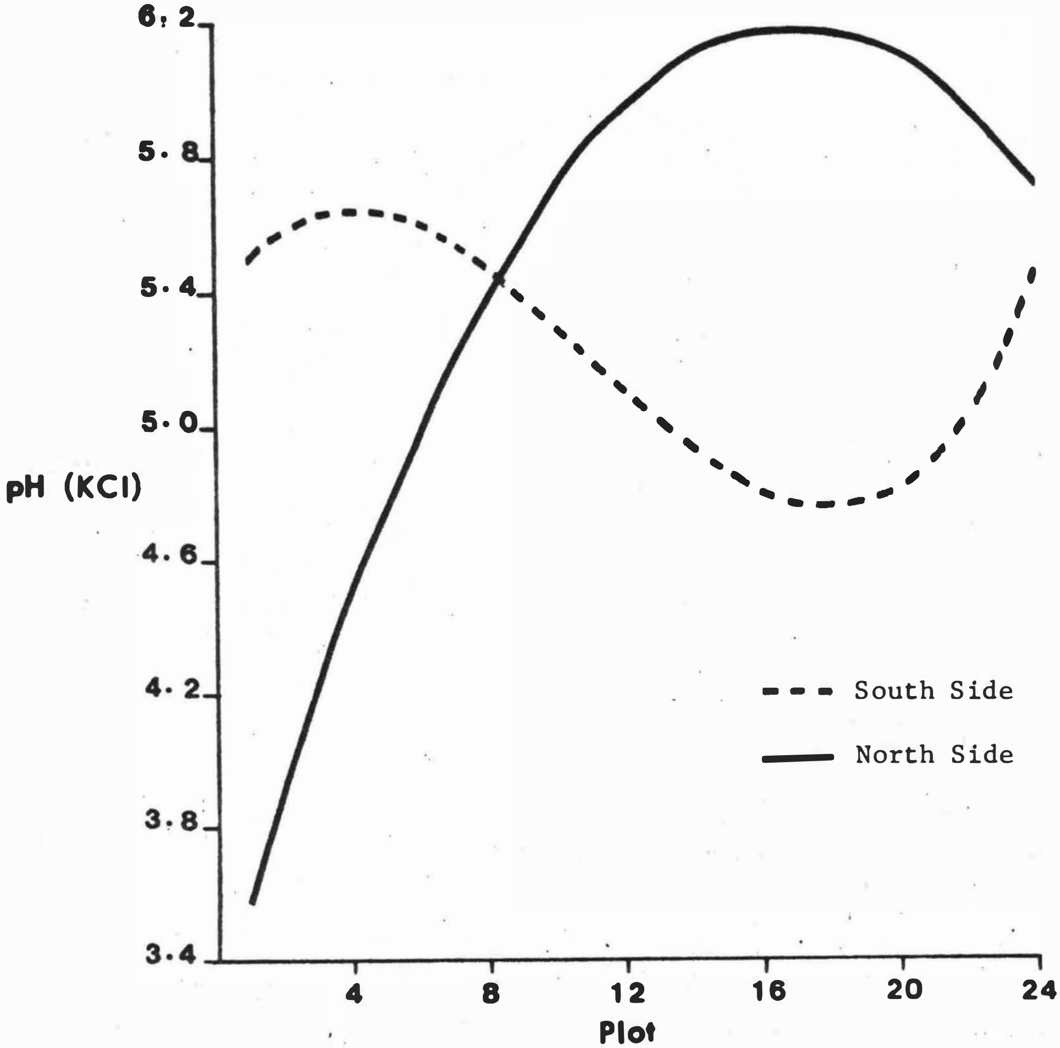


Figure 65. The pH-Kcl levels of an Enders-Hector complex soil type on opposing back-slopes of U.S. 271, 0.6 miles north-east of Wister, Oklahoma in LeFlore County.

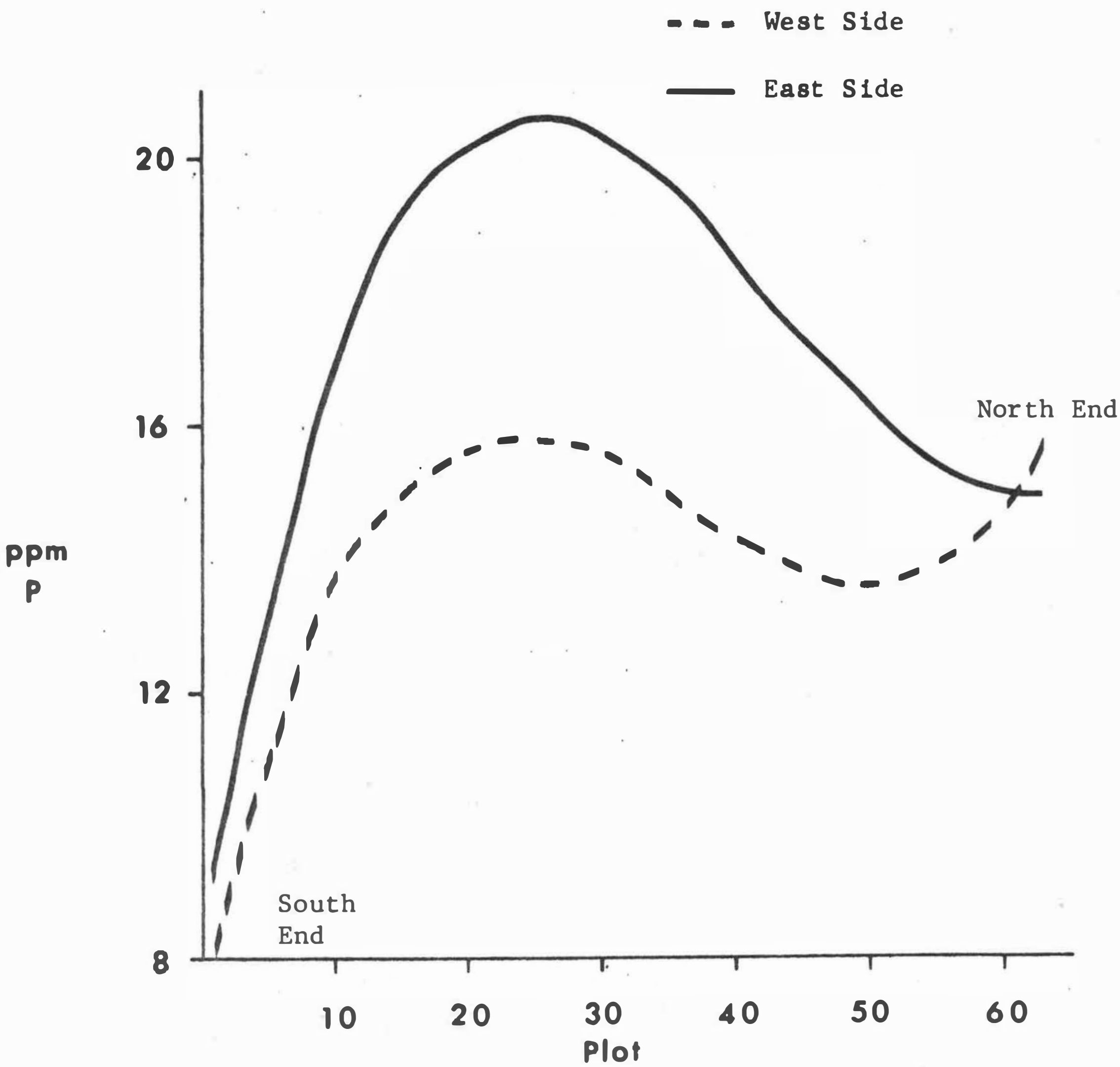


Figure 66. Average phosphorus levels of the backslope soils on I-40, north of C.R.I. and P.R.R. overpass east of Sayre, Oklahoma in Beckham County.

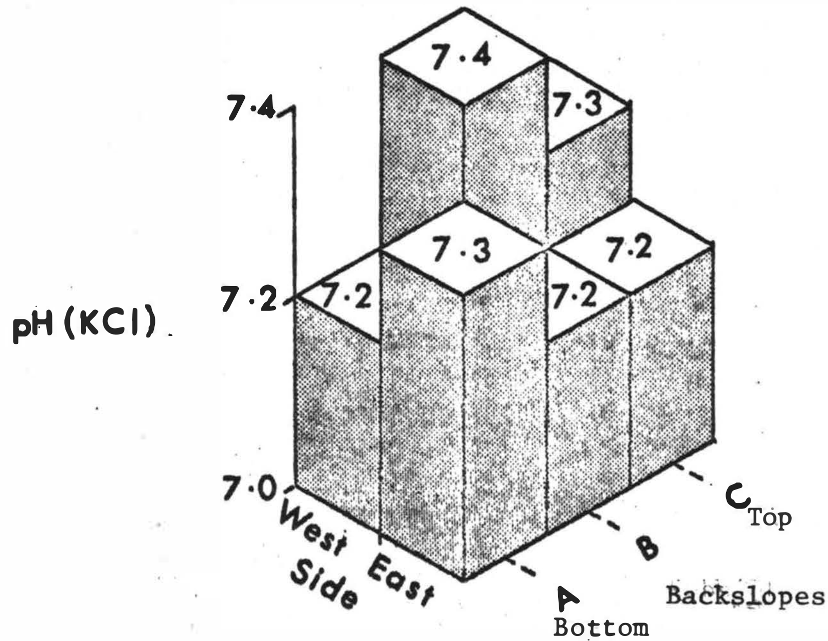


Figure 67. The average pH-Kcl levels of two opposing backslope soils on I-40 immediately north of the C.R.I. and P.R.R. overpass east of Sayre, Oklahoma in Beckham County.

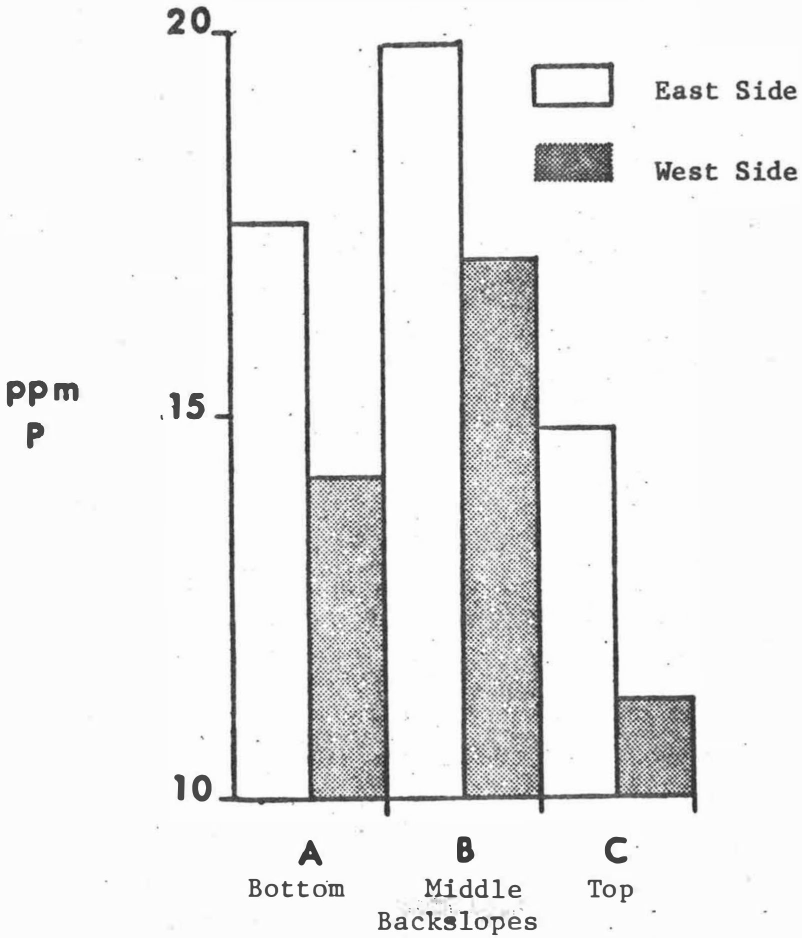


Figure 68. The average phosphorus levels of two opposing backslope soils on I-40 immediately north of the C.R.I. and P.R.R. overpass east of Sayre, Oklahoma in Beckham County.

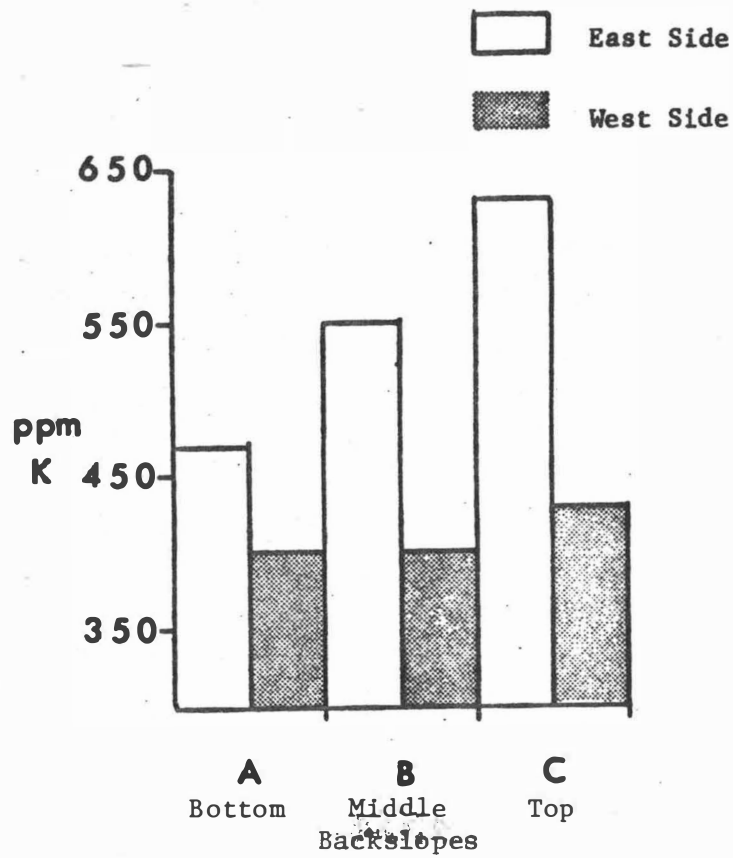


Figure 69. The average potassium levels of two opposing backslope soils on I-40 immediately north of the C.R.I. and P.R.R. overpass east of Sayre, Oklahoma in Beckham County.

due to increased surface erosion. Potassium shows a steady increase up the slope as shown in Figure 69, possibly caused by more severe weathering of the potassium bearing minerals.

When comparing the two exposures, we find the pH-Kcl for the east backslope has a slightly higher average (7.30) than does the west backslope (7.23) as shown in Figure 67.

Experiments 35 & 36. Soil analyses of two fill slopes on I-40, four miles southwest of SH-283 near Sayre in Beckham County, were made on Brownfield and Tivoli soils that have an AASHO classification of A-2-4(0). These soils are deep, loose, dry, and loamy sands, with a very high wind erosion susceptibility. The only significant differences in the soil analyses of these two backslopes appeared only in the pH-H_2O, and potassium levels as shown in Figures 70 and 71.

Experiments 37 & 38. Two opposing backslopes on U.S. 62 south of Snyder in Kiowa County were sampled and analyzed on a Lawton Silt Loam soil with an AASHO classification of A-7. These highly erodible north and south facing backslopes have deep, clayey soils, neutral in reaction, very hard, and dry slopes of 25 to 45%.

No significant differences in fertility levels could be detected in the north facing backslope, but highly significant differences were found in the opposing south facing backslope in pH-H_2O, pH-Kcl and phosphorus, as shown in Figures 72, 73, 74, and 75 respectively. The pH-H_2O and pH-Kcl levels as shown in Figures 75 and 76 respectively, have their maximum values at the bottom of the slope and decline as you move to the top. The potassium levels varied significantly from east to west in this north facing backslope as shown in Figure 77. The phosphorus levels were found to be significantly different in these slopes, they are at a minimum (26 ppm) at the bottom and increase to a maximum (53 ppm) at the top as shown in Figure 78.

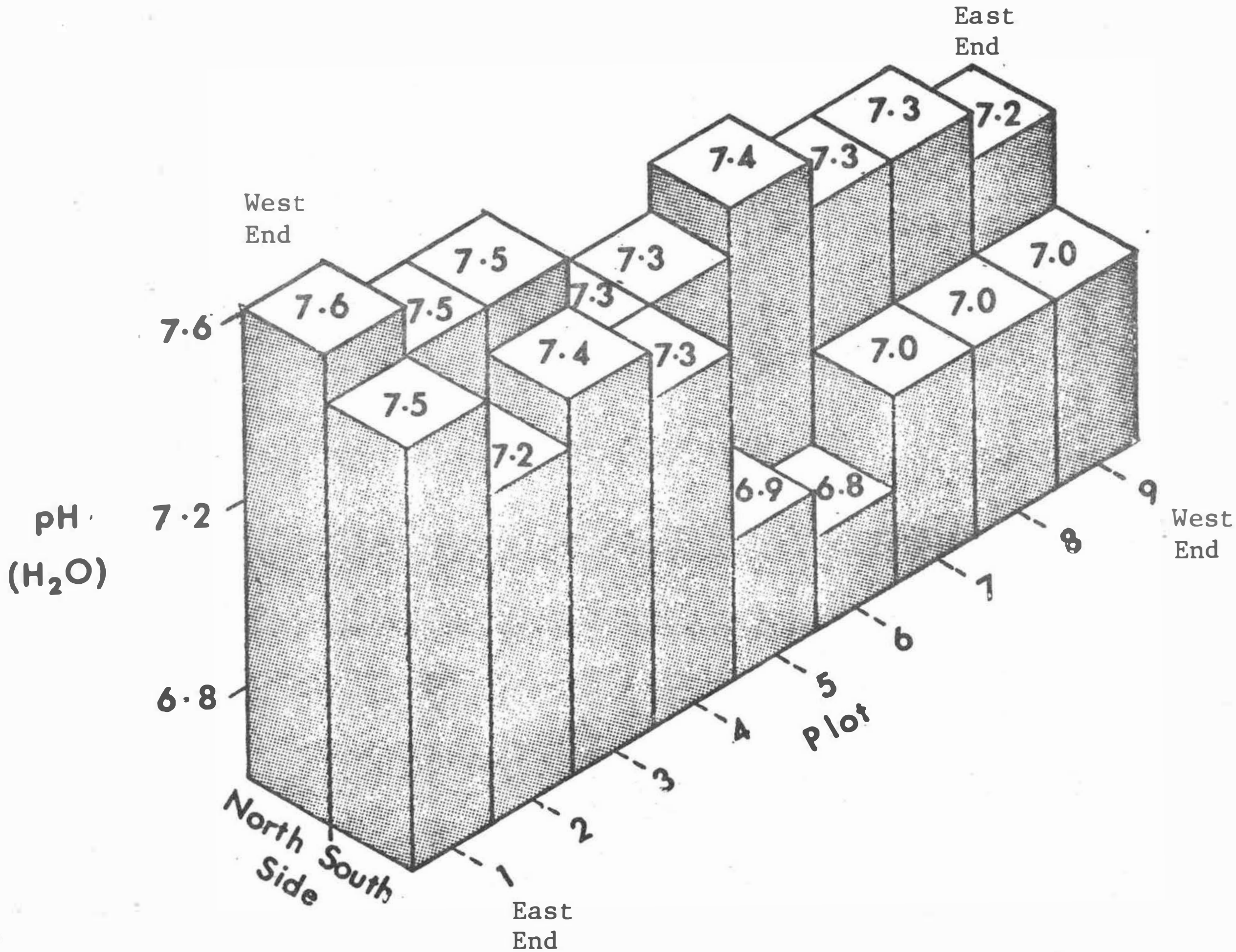


Figure 70. The pH-H_2O levels of two opposing Brownfield and Tivoli fillslope soils on I-40, four miles southwest of SH-283 near Sayre, Oklahoma, in Beckham County.

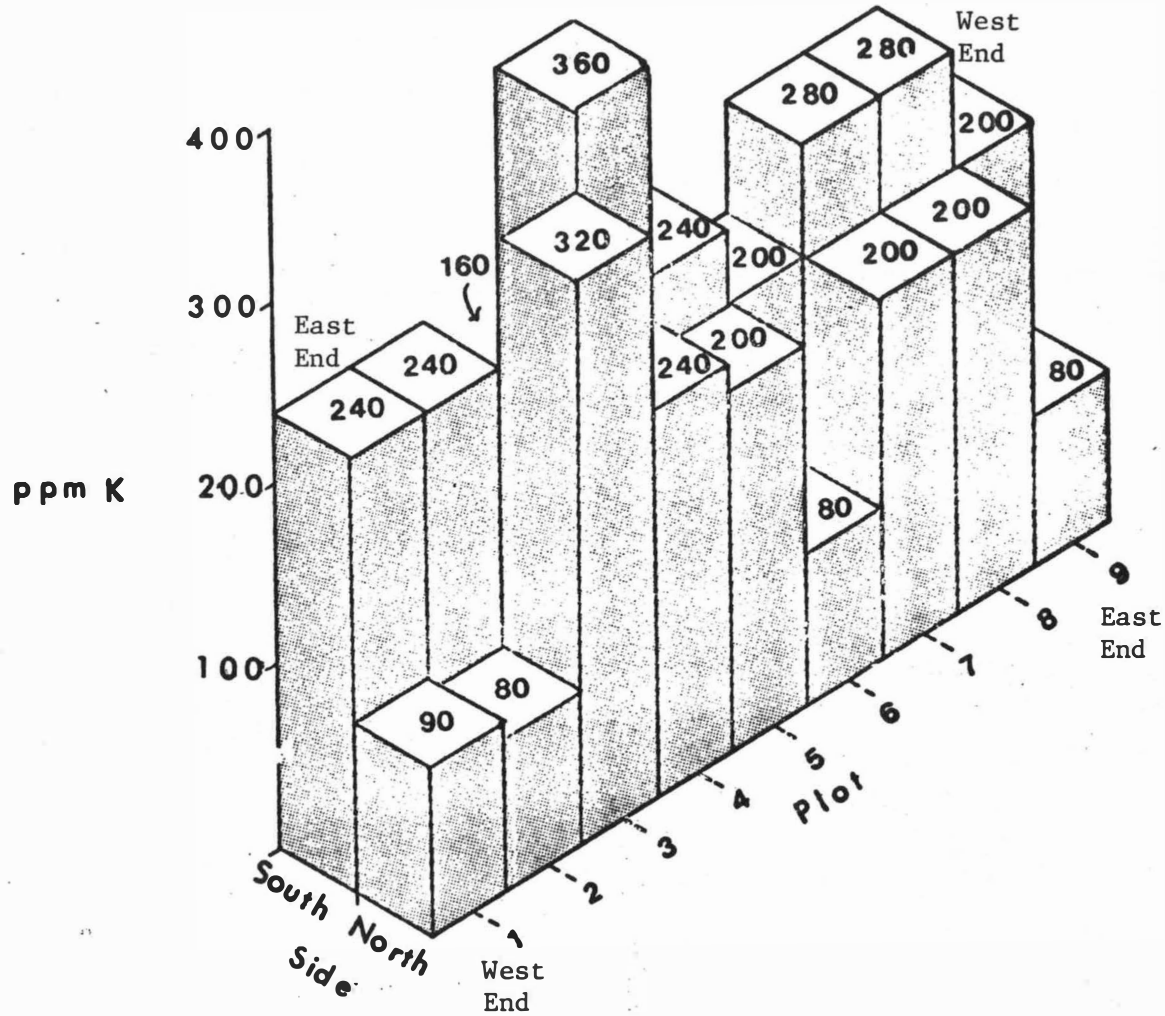


Figure 71. The available potassium levels of two opposing Brownfield and Tivoli fill-slope soils on I-40, four miles south-west of SH-283 near Sayre, Oklahoma in Beckham County.

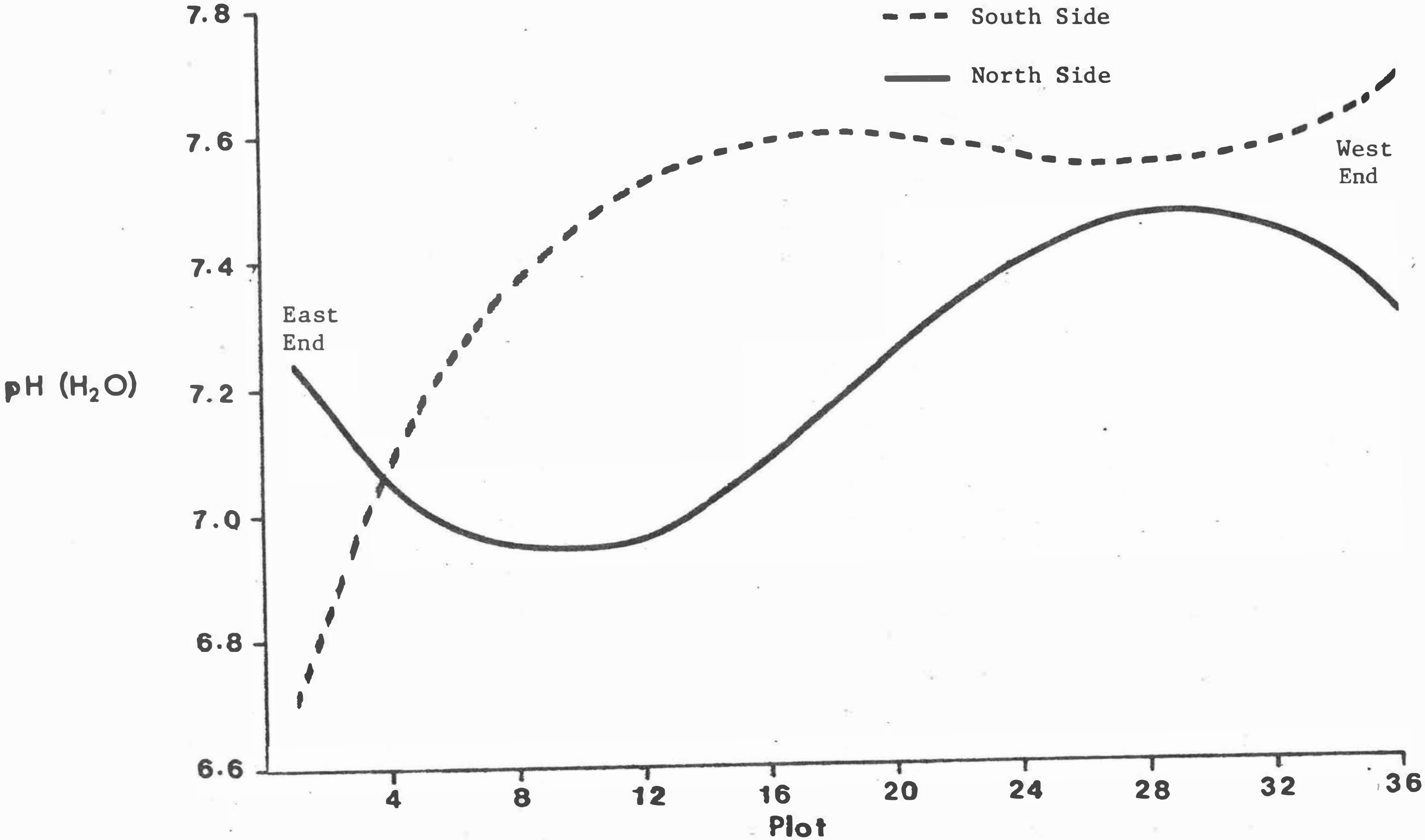


Figure 72. The pH-H_2O levels of two opposing Lawton silt loam backslope soils on U.S. 62, south of Snyder, Oklahoma in Kiowa County.

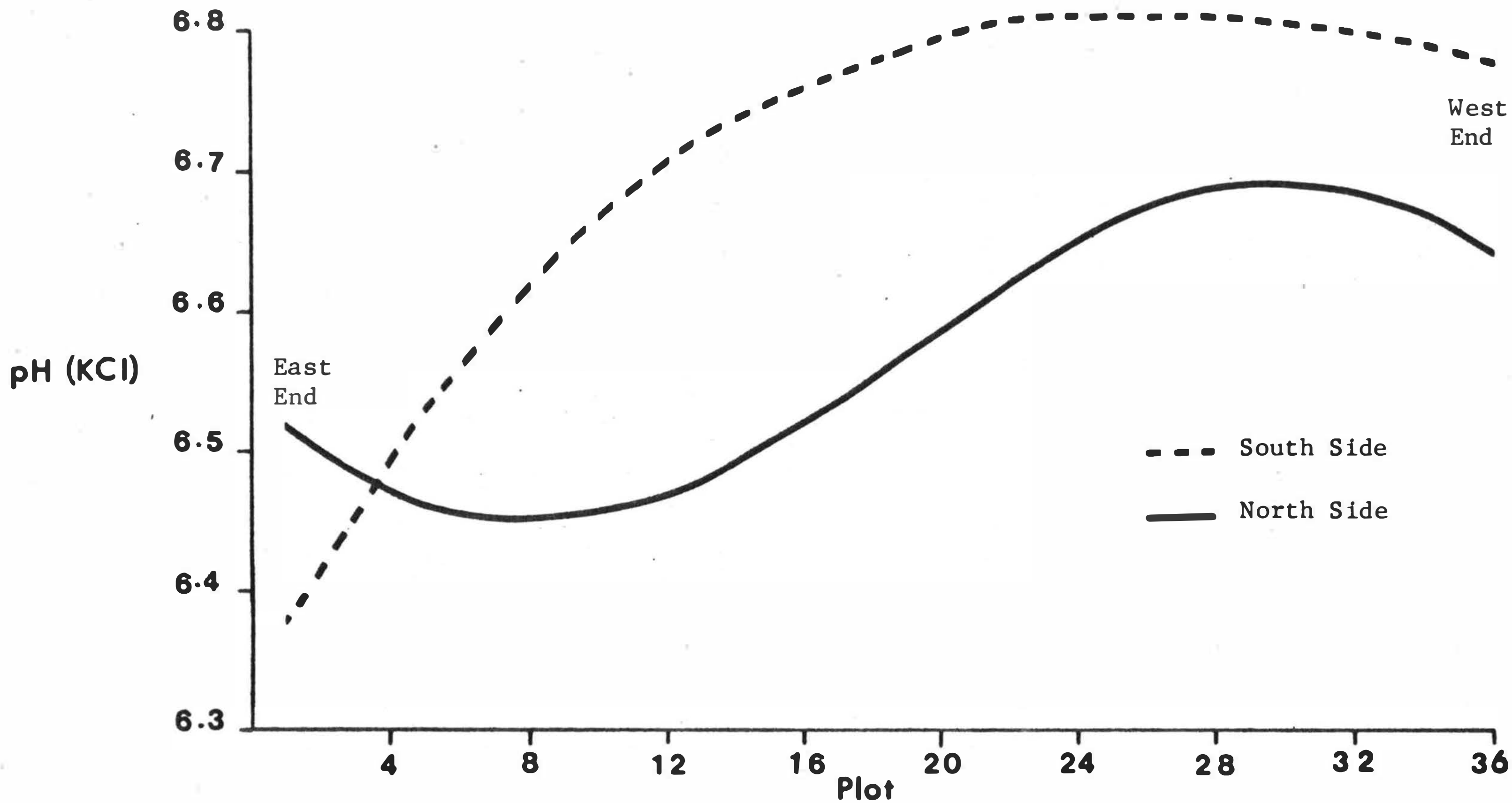


Figure 73. The pH-Kcl levels of two opposing Lawton silt loam backslope soils on U.S. 62, south of Snyder, Oklahoma in Kiowa County.

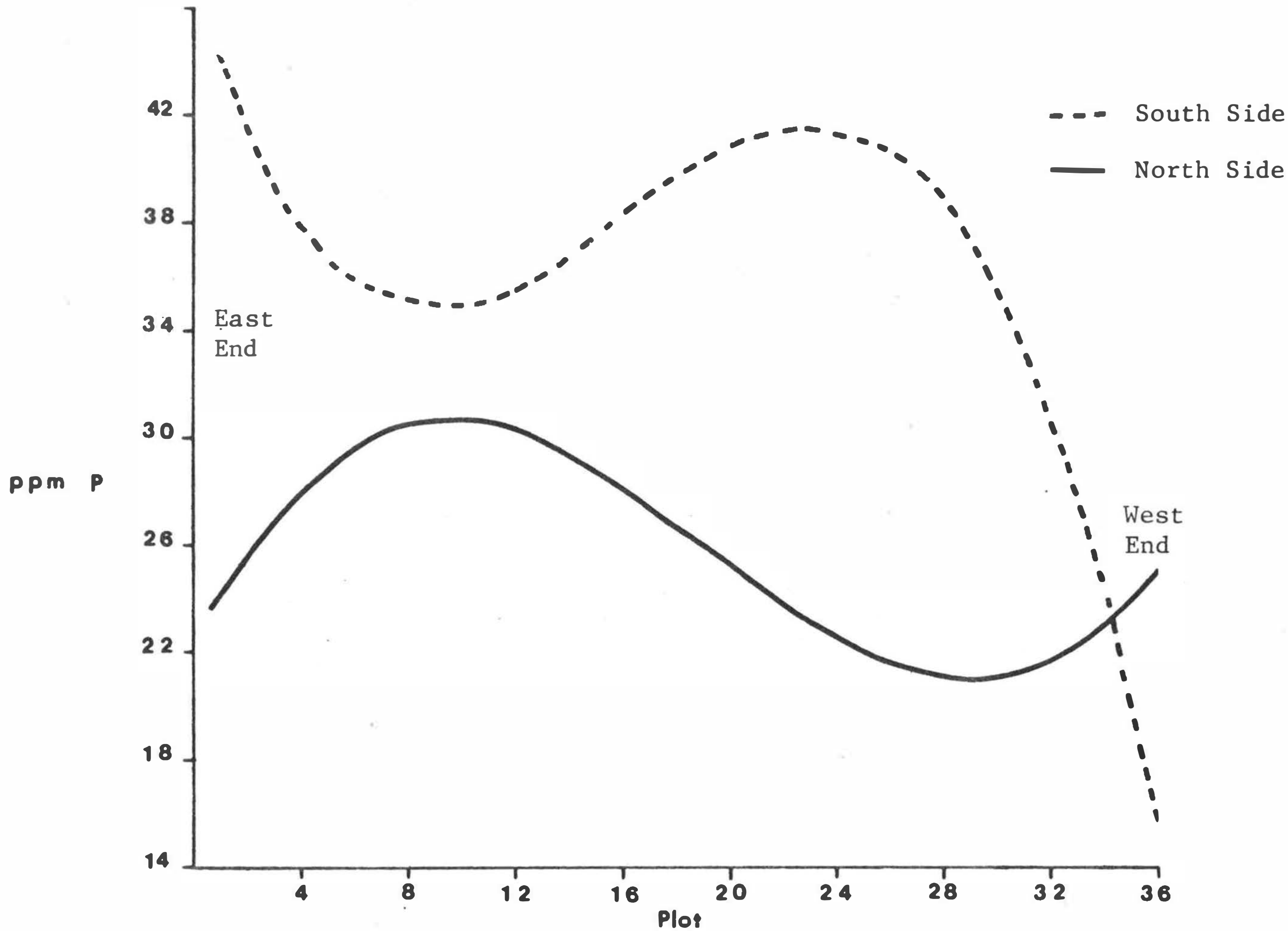


Figure 74. The phosphorus levels of two opposing Lawton silt loam backslope soils on U.S. 62, south of Snyder, Oklahoma in Kiowa County.

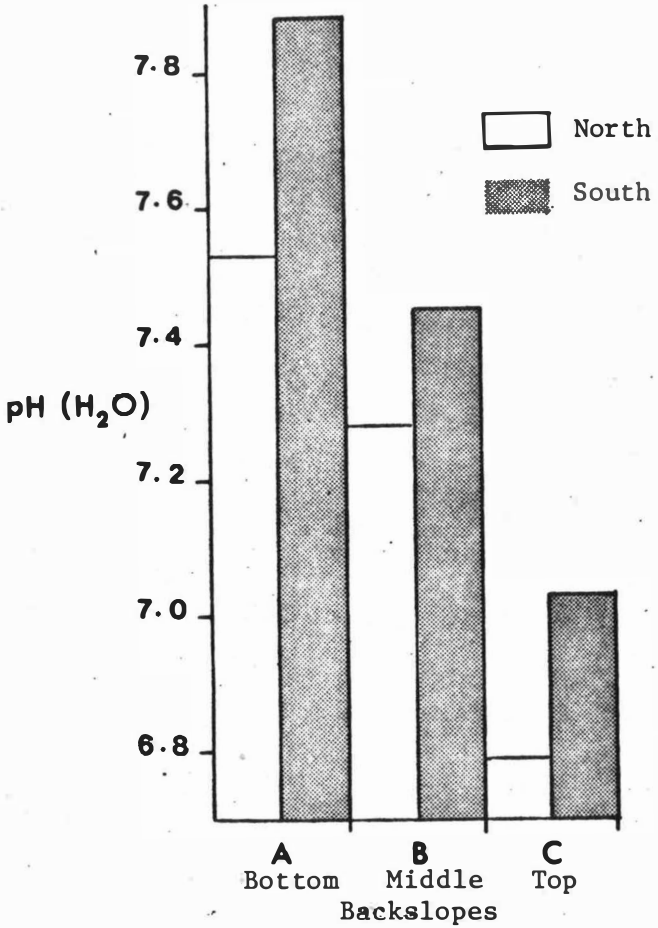


Figure 75. The average pH-H_2O levels of two opposing Lawton silt loam backslope soils on U.S. 62, south of Snyder, Oklahoma in Kiowa County.

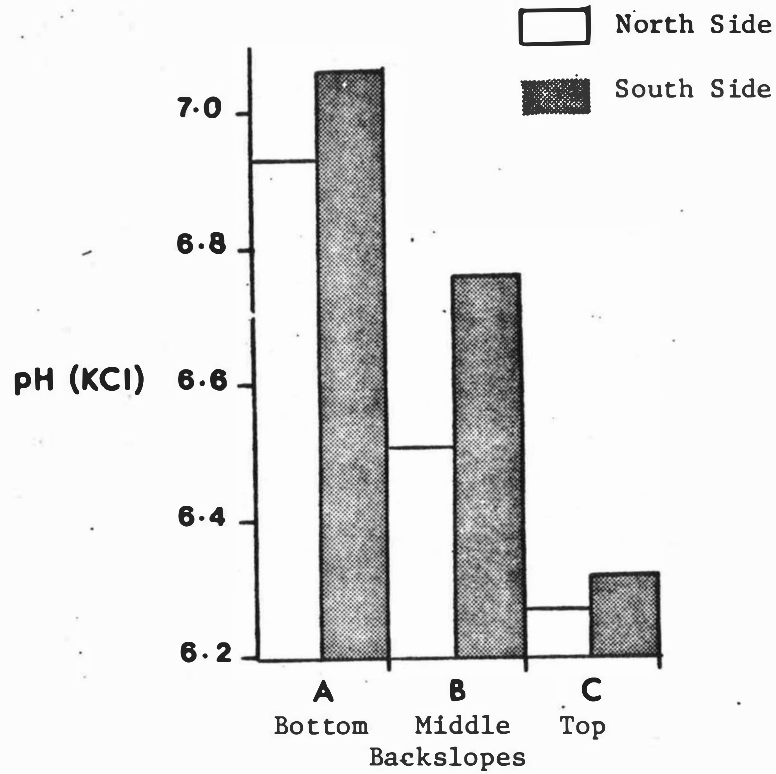


Figure 76. The average ph-Kcl levels of two opposing Lawton silt loam backslope soils on U.S. 62, south of Snyder, Oklahoma in Kiowa County.

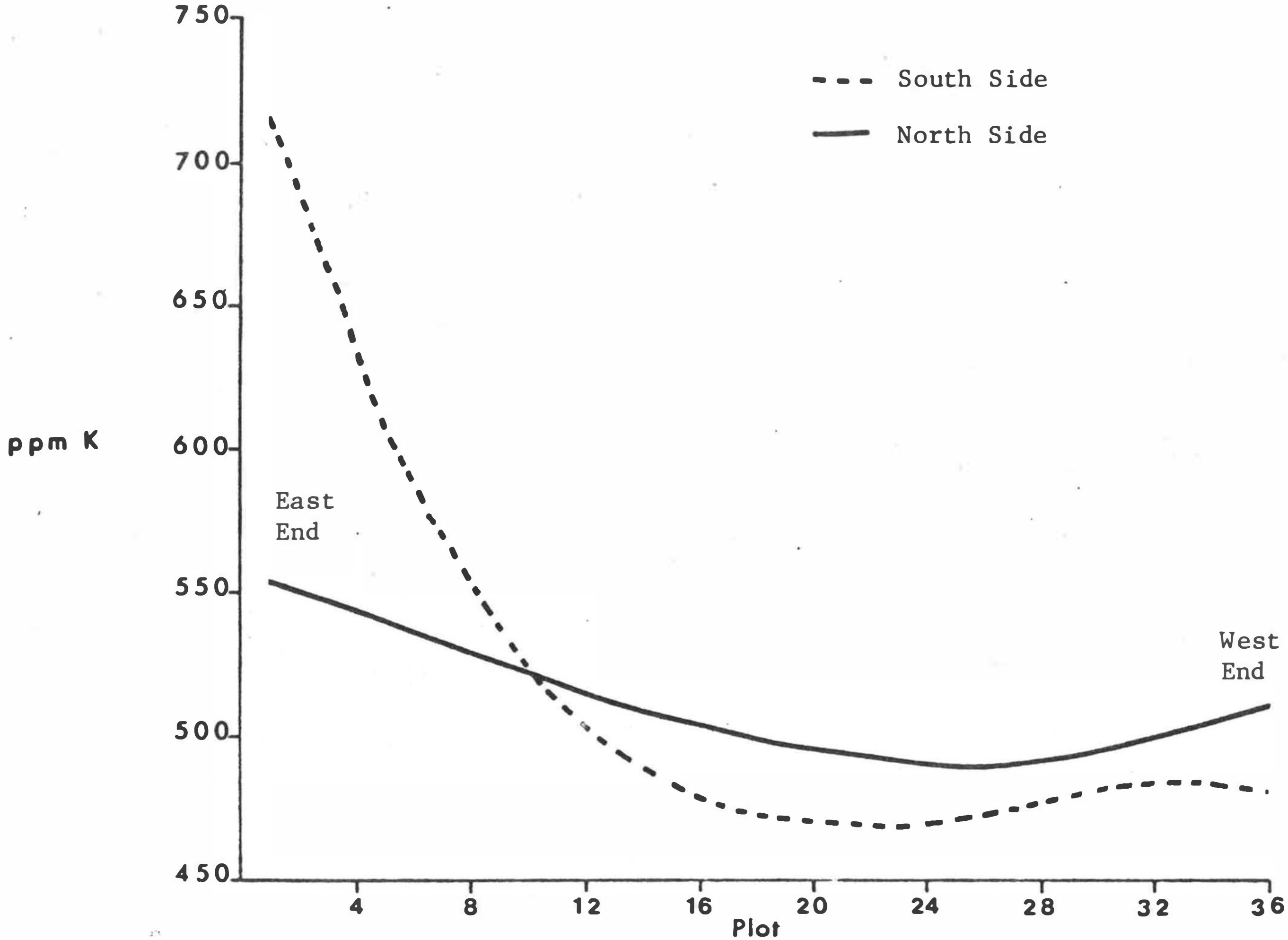


Figure 77. The potassium levels of two opposing Lawton silt loam backslope soils on U.S. 62, south of Snyder, Oklahoma in Kiowa County.

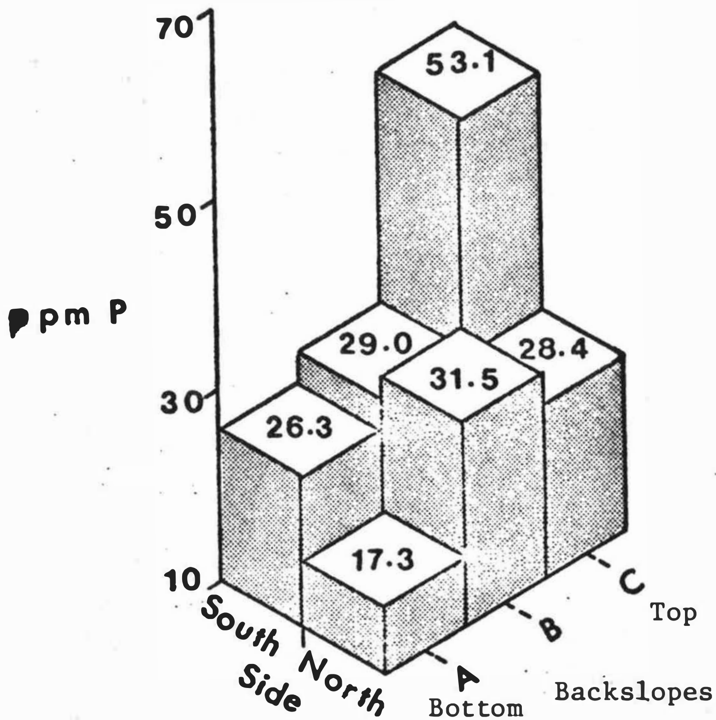


Figure 78. The average phosphorus levels of two opposing Lawton silt loam backslope soils on U.S. 62, south of Snyder, Oklahoma in Kiowa County.

Experiments 39 & 40. Investigation of two opposing backslopes on SH-19, three miles east of SH-54 near Cooperton in Kiowa County showed significant differences only in the amount of potassium in the north facing backslope as you go from east to west as shown in Figure 79. The potassium level in the south facing backslope was not significantly different from east to west.

Experiments 41 & 42. Two eroded clayey shale backslopes on I-244 just east of the Utica overpass in Tulsa, Oklahoma were analyzed and found to have significant differences in pH-H_2O among plots on the south side of the highway, and highly significant differences in pH-Kcl and phosphorus on the northside. The pH-H_2O values are higher at both ends of the north facing backslope than in the middle as shown in Figure 80. This difference is of no consequence in the practical fertility requirement of this soil. The pH-Kcl is at its maximum at the base of the slope but declines to its minimum at the top as shown in Figure 81. The phosphorus level, Figure 82, is at its minimum on the south side near the base of the slope and reaches its maximum about one-fourth the way from the top. However, the backslope on the north side of the highway has the minimum phosphorus level at the bottom and the maximum one-fourth of the way higher up the slope. This may have been caused by surface erosion from soils higher up on the slope depositing the phosphorus laden soils farther down.

On the north side of the highway there are highly significant differences in the values of pH-H_2O and phosphorus. In addition there are highly significant differences in the pH-Kcl from one end of the backslope to the other. A gradient in the value of pH-H_2O is found with a high on the west end and declining to a low on the east as shown in Figure 80. The phosphorus gradient shows a reverse trend as shown in Figure 83. The phosphorus level is significantly lower on the north facing backslope (7 ppm) than the average phosphorus level of the south facing backslope (9 pmm).

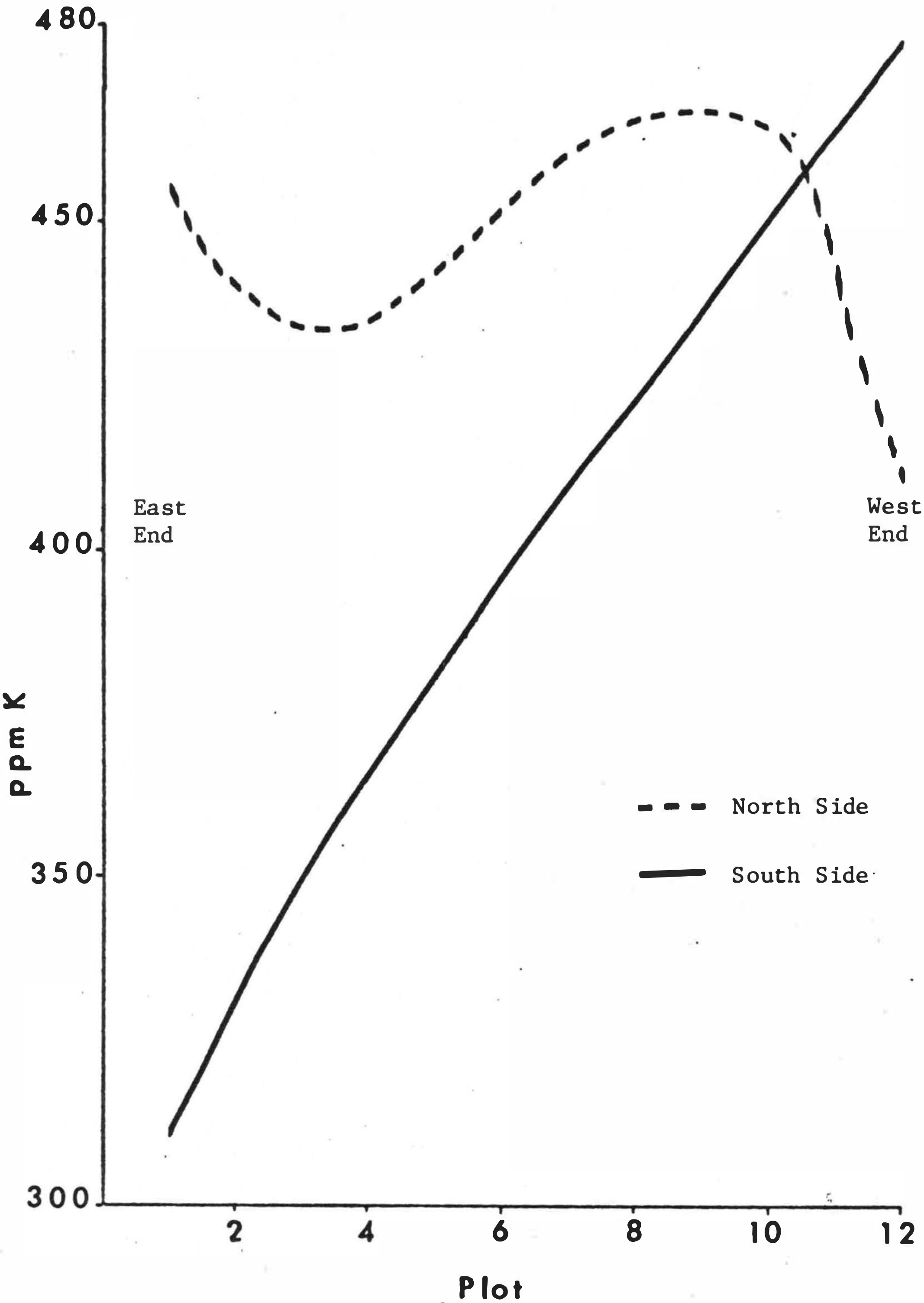


Figure 79. The average available potassium levels of two opposing Tillman-Foard backslope soils on SH-54 near Cooperton, Oklahoma in Kiowa County.

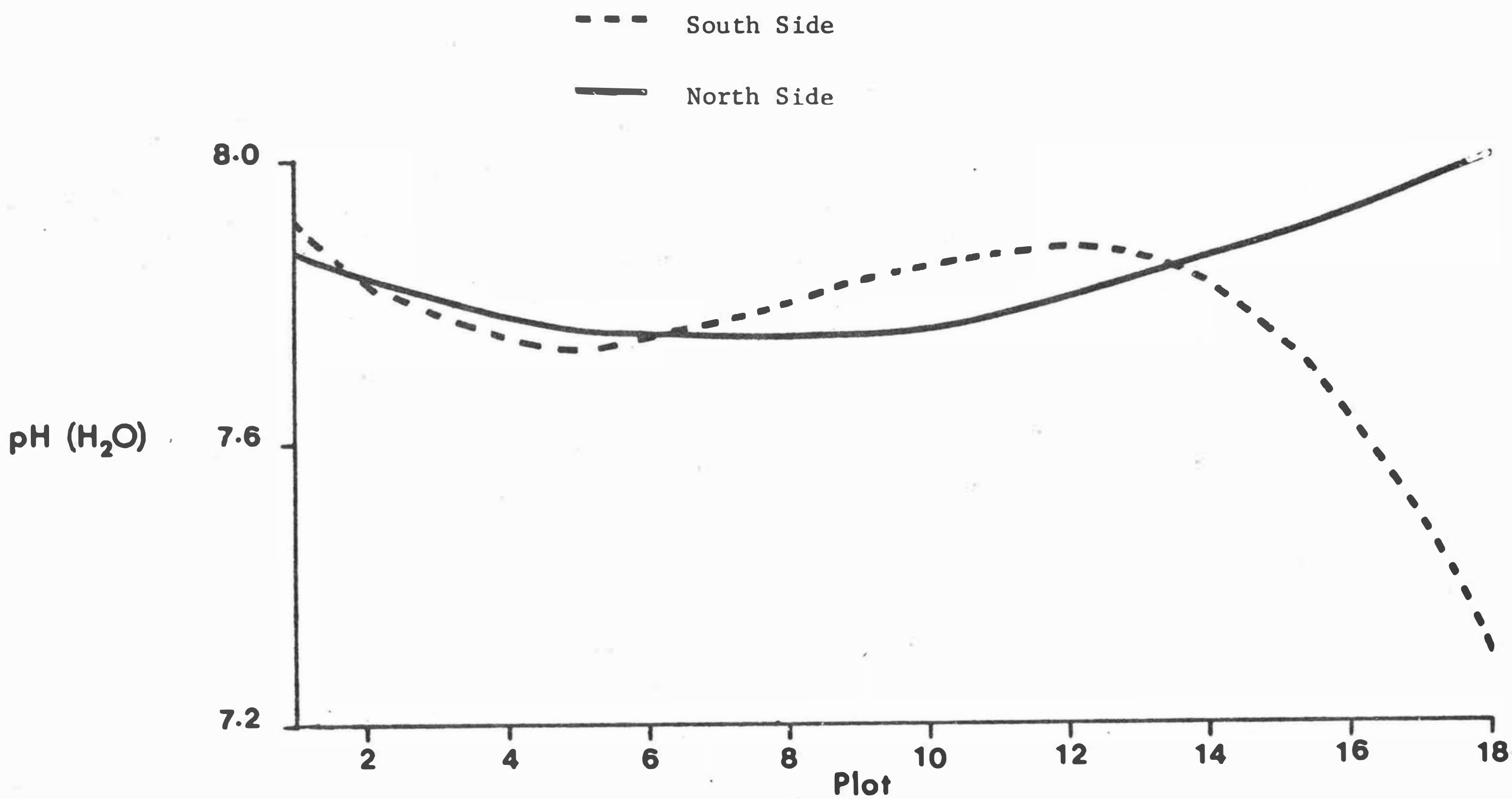


Figure 80. The pH-H_2O levels of two opposing Talihina backslope soils on I-244, immediately east of the Utica Street overpass in Tulsa, Oklahoma.

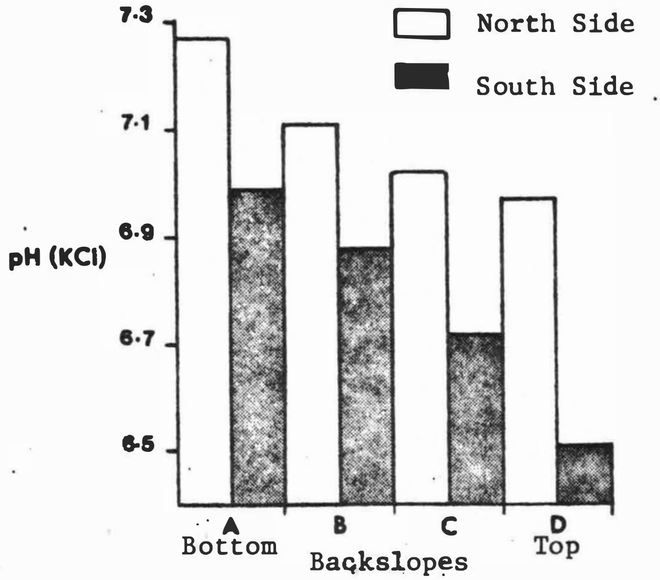


Figure 81. The average pH-Kcl levels of two opposing Talihina backslope soils on I-244, immediately east of the Utica Street overpass in Tulsa, Oklahoma.

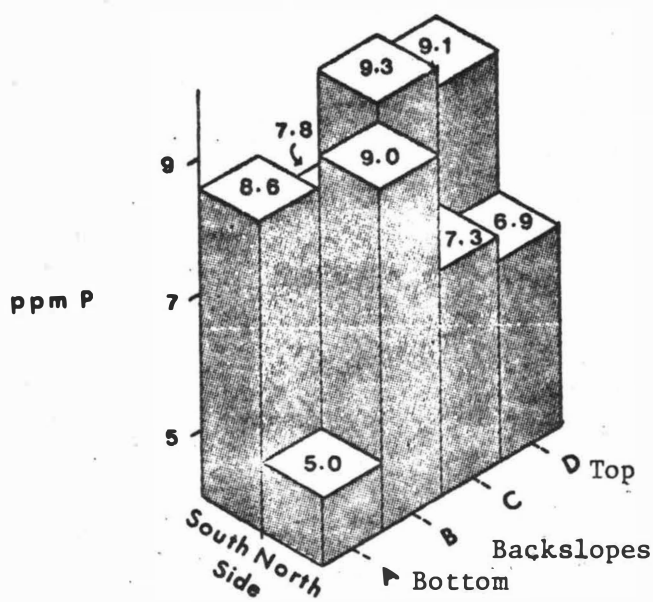


Figure 82. The phosphorus interaction of two opposing Talihina backslope soils on I-244 immediately east of the Utica Street overpass in Tulsa, Oklahoma.

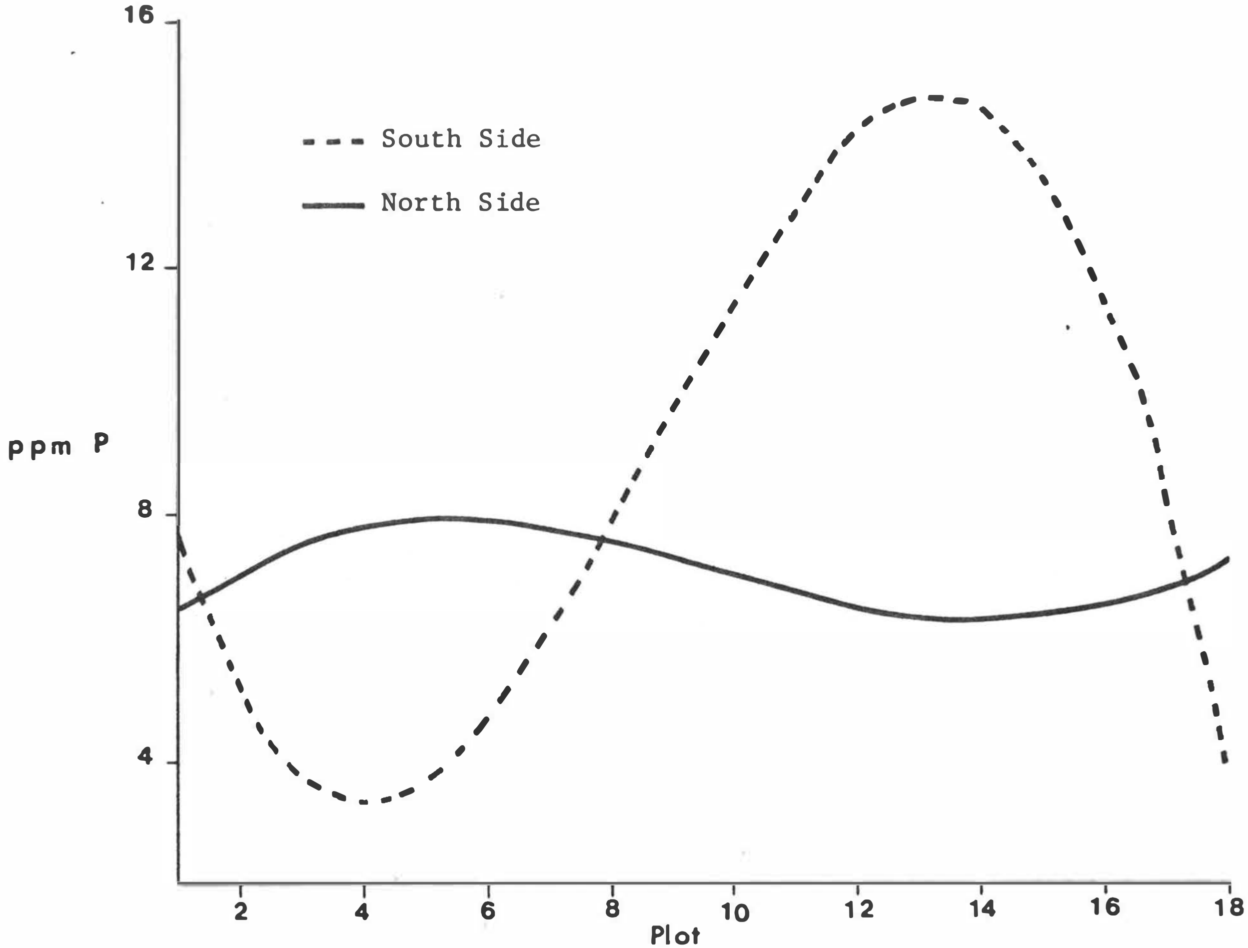


Figure 83. The phosphorus levels of two opposing Talihina backslope soils on I-244, immediately east of the Utica Street overpass in Tulsa, Oklahoma.

Experiments 43 & 44. Two opposing backslopes on U.S. 75, two miles south of Copan in Washington County, showed many significant differences in the analyses of a highly erodible Bates-Collinsville complex soil, having a 22% slope. On the east side of the highway there is a significant difference in the value of pH-Kcl from one end of the slope to the other as shown in Figure 84. Highly significant differences in the values of pH-Kcl, as well as significant differences in the value of pH-H_2O exists from the bottom to the top of these backslopes as shown in Figures 85 and 86 respectively. The pH-H_2O decreases, or it becomes more acidic, as one proceeds from the bottom to the top of the slope as shown in Figure 86. The same results but of a different magnitude, are found in the pH-Kcl data as shown in Figure 85.

On the west side of the highway there are no fertility gradients from one end of the backslope to the other, however, there are fertility gradients on this backslope from the bottom to the top. These fertility gradient differences are highly significant with pH-H_2O and pH-Kcl. Significant differences in fertility gradients also occur with phosphorus and potassium levels. The pH-Kcl and pH-H_2O levels are shown in Figures 85 and 86. The pH tends to decrease as one proceeds up the slope except when the pH-H_2O is considered at the top, where there is a slight increase. There is a sharp increase (significantly so) in potassium from the bottom of the slope up three-fourths the way on the slope, and then it decreases as shown in Figure 87. The available phosphorus decreases up the slope as shown in Figure 88. The available phosphorus is quite low on the west side. One explanation may be that surface erosion has carried the phosphorus rich soil from the top of the slope toward the bottom.

When comparing the two backslopes at Copan there are significant differences among the levels of pH-H_2O and pH-Kcl. The west facing backslope has the higher average of pH-H_2O (7.15 for the west exposure and 7.10 for the east exposure) as

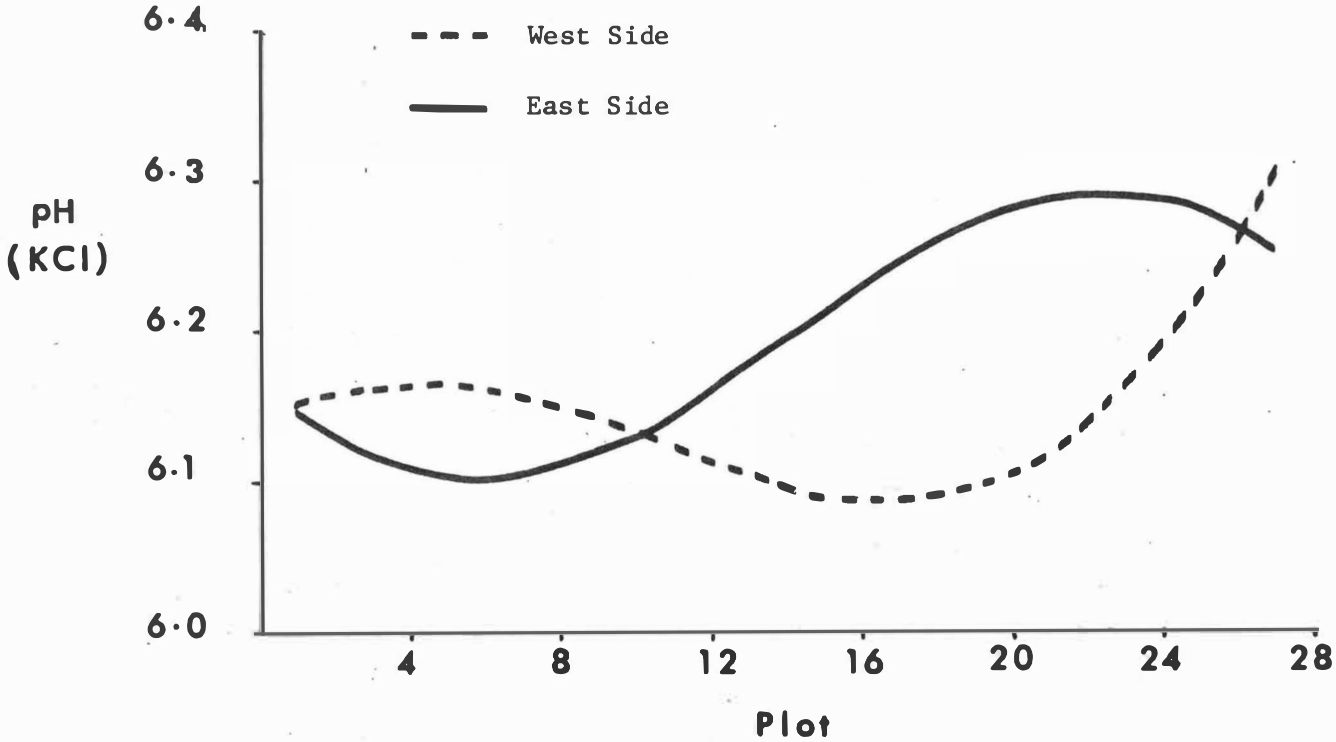


Figure 84. The average pH-Kcl levels of two opposing Bates-Collinsville complex backslope soils on U.S. 75, two miles south of Copan, Oklahoma in Washington County.

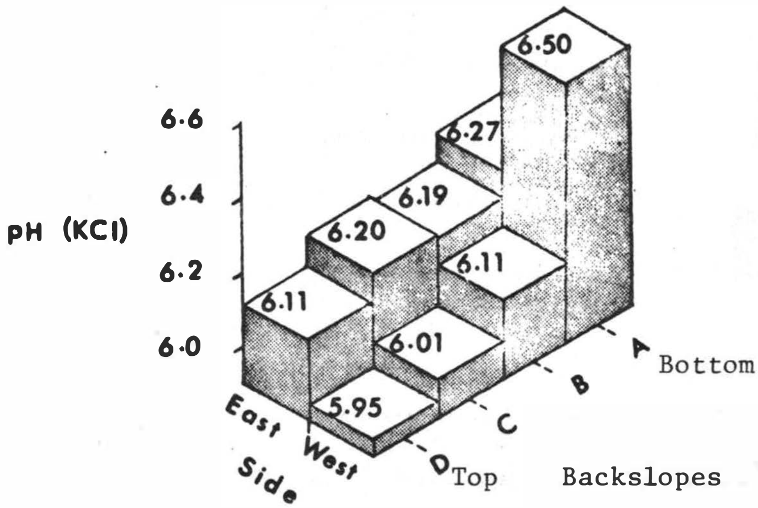


Figure 85. The average pH-Kcl levels of two opposing Bates-Collinsville complex backslope soils on U.S. 75, two miles south of Copan, Oklahoma in Washington County.

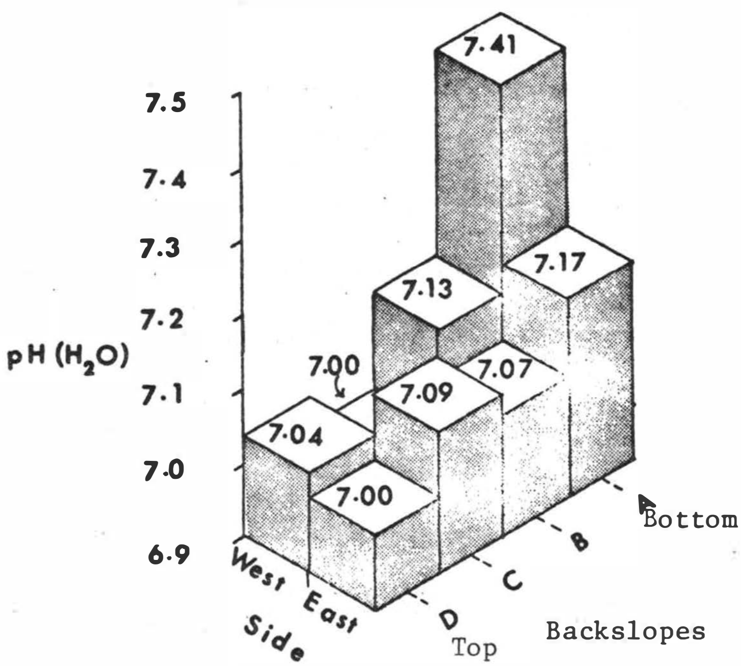


Figure 86. The average pH-H_2O levels of two opposing Bates-Collinsville complex backslope soils on U.S. 75, two miles south of Copan, Oklahoma in Washington County.

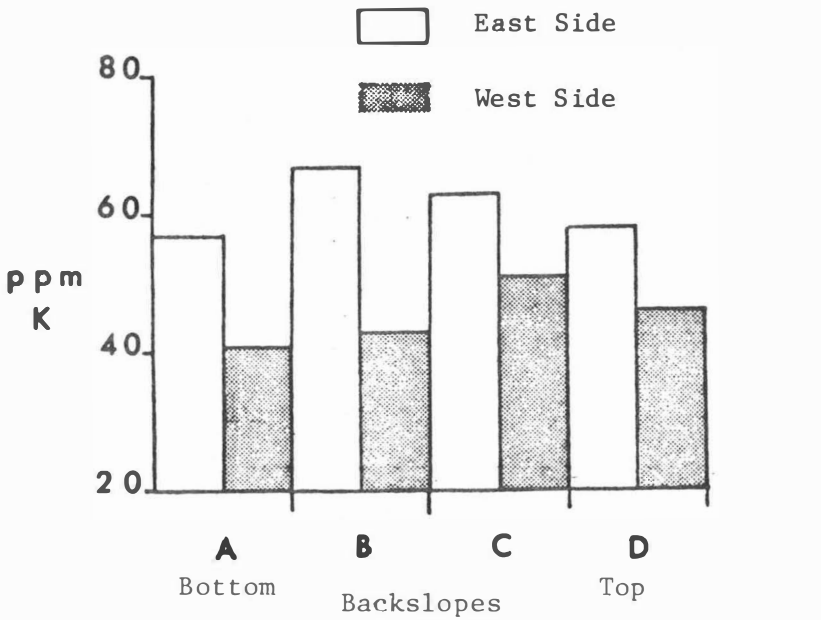


Figure 87. The average available potassium levels of two opposing Bates-Collinsville complex backslope soils on U.S. 75, two miles south of Copan, Oklahoma in Washington County.

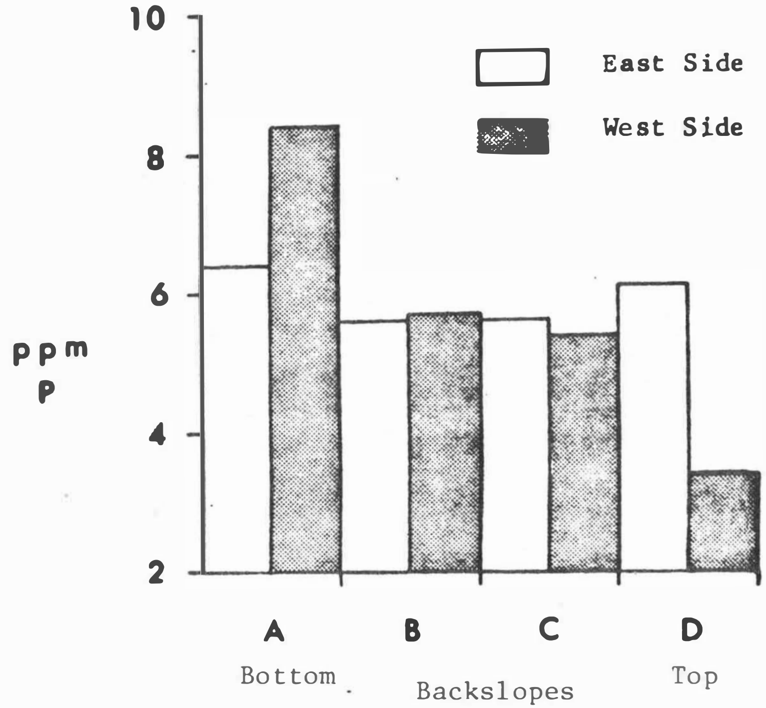


Figure 88. The average available phosphorus levels of two opposing Bates-Collinsville complex backslope soils on U.S. 75, two miles south of Copan, Oklahoma in Washington County.

shown in Figure 86. The east facing backslope has the higher average pH-Kcl (6.20 for the east exposure and 6.15 for the west exposure) as shown in Figure 85.