HR-155

ROADSIDE EROSION RESEARCH IN SELECTED IOWA COUNTIES[1/]

BY

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Stabilization of erosion on roadsides after construction is an essential part of highway building. Vegetation is usually the most economical and satisfactory stabilizing material. A period of not less than 6 weeks and as much as a year, however, may elapse between the time construction is completed and the time a live vegetative cover can be established. This period before the successful establishment of a living vegetative cover is a period of high erosion risk and of risk of severe damage to the environment.

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Iowa has an active roadside stabilization program along the interstate and primary road systems. Many studies have been conducted along these highways to investigate methods for soil erosion control before revegetation and to find the best seed mixtures and fertilizer rates. Roadside stabilization along secondary roads, however, is a recent development brought about, in part, by stronger Federal restrictions. Roadside stabilization along secondary roads presents special problems. These roads have smaller right-of-ways and, as a result, steeper backslopes than along the primary roads. Because of this, many practices, such as straw mulching, used to control erosion along the primary roads cannot be used on these steeper backslopes. Therefore, a research project was started to study these special problems along the county road system. Another objective of this study was to investigate various commercial soil stabilizers, as a replacement for straw mulch, to control soil erosion before revegetation.

Methods and Materials

Commercial equipment commonly owned or used by county highway departments was used in this study. Products tested had to conform to use of this equipment. Before any soil stabilizer is recommended for use, therefore, it must perform satisfactorily under these conditions. The soil stabilizer materials, seed, and fertilizer were applied with a hydroseeder. In Cedar County, a Finn Straw Mulcher was used to apply the tack along with the straw except for the 3M-XB2386 material where

the tack was applied with a hydroseeder. In Van Buren County, the tack was applied with a hydroseeder. Proven seed mixtures and fertilizer rates were used in each study area. Study areas (County sites) were selected on the basis of terrain and type of soil material. A brief description of each site is given in Table 1 and located in Figure 1.

Table 1. Description of research sites

Site location	Time established	Soil material at the site	Backslope Slope (%)	Backslope Ave. length (meters)
Hamilton County	April, 1971	Clay loam glacial till	37 (2½:1)	3
Clayton County	June, 1971	Loess over limestone residum over limestone bedrock	45 (2:1)	9
Van Buren County[a]	Sept., 1971	Leached and weathered loess over dense clay glacial till	24 (4:1)	12
Cedar County	April, 1972	Eolian sand	45 (2:1)	9
Ida County	May, 1972	Thick silt loam loess	32 (3:1)	24

[a]Topsoil vs. no topsoil replacement also studied here.

The "stake method" was used to make erosion measurements. Stakes were driven into the soil, and the amount of surface erosion was measured from marks on the stakes. Fourteen stakes were placed at equal distances from the top of the backslope in each study area, and soil loss is reported as an average of these 14 values. Percentage cover was estimated by randomly tossing a 50 cm x 50 cm quadrat and estimating the percentage cover of grasses and legumes. An average of four readings per plot is reported.

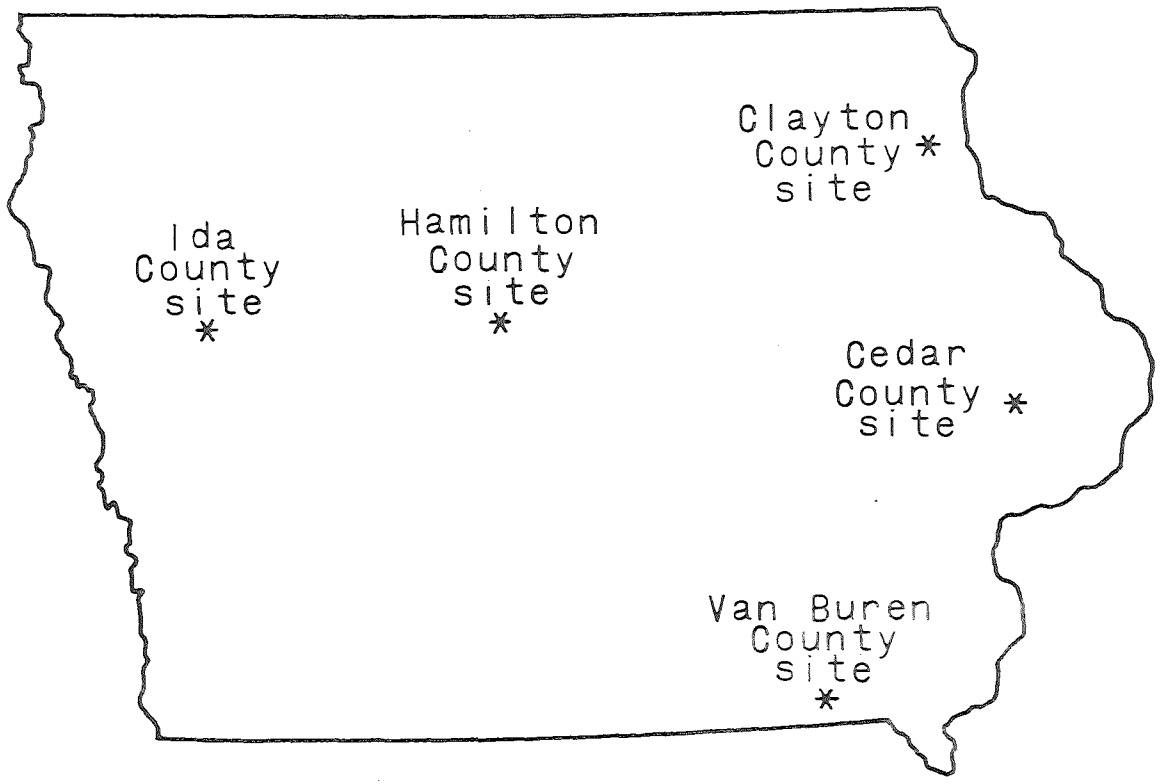

Figure 1. Location of county sites

The various materials tested include Aquatain, Curasol AE, Conwed, Petroset SB, Conwed + Curasol AH, Terra Tack, 3M-XB2386, 3M-XB2386 + Conwed, Aerospray 70, and Polyvinyl alcohol (PVA).[2/] Studies also were made on straw alone, straw mechanically tied down, and straw tacked with 3M-XB2386, Petroset, Aerospray-70, Terra Tack and Asphalt. Recommended rates for all materials were used. A brief description of the materials as well as the areas in which each material was tested, are given in Table 2.

Results

All results are for backslope areas.

Hamilton County Site. Seeding of the Hamilton Country Site was completed on April 24, 1971. Normally May is a period of frequent and abundant rain, but in 1971, rainfall in May (Figure 2) was only 7.6 cm, some 3 cm below normal, and the first large rain did not come until 2 months after seeding. As a result of drouth, all seedings on all treatments were essentially failures.

Soil loss data and percentage cover data are presented in Figures 2 and 3, respectively. These measurements were taken on July 23, 1971, 3 months after seeding.

Soil loss was greatest on the straw-treated areas and least on the Conwed treatments. The straw was not tied into the soil because of the steepness of the backslopes and was blown away within hours after application (Figure 4). Both the Conwed and straw areas had the

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[2/] Mention of a commercial product or firm does not consitute endorsement by Iowa State University or cooperating agencies, nor is criticism implied of commercial products or firms not mentioned.

Table 2. Soil stabilizer treatments and areas applied

Name	Chemical composition	Recommended amount/ hectare	Water needed /hectare (hectoliters)	Area(s) applied	Manufacturer
Aerospray-70	polyvinylacetate copolymer	470 l[a]	100	Ida County	American Cyanamid
Aquatain	sodium polypectate, glycerin & ammonia	1200 l	100	Hamilton County	Larutan
Conwed	wood fiber mulch	1700 Kg	400	Hamilton, Clayton, Van Buren, & Ida Counties	Conwed Corporation
Conwed + Curasol AH	wood fiber polyvinylacetate copolymer	1700 Kg 370 l	400	Clayton County	Conwed Corp. American Hoechst Corp.
Curasol AE	polyvinylacetate copolymer	570 l	300	Hamilton & Clayton Cos.	American Hoechst Corp.
Petroset SB	rubber emulsion	1200 l	200	Clayton County	Phillips Petroleum Co.
PVA	polyvinyl alcohol	220 Kg	100	Ida County	E.I. duPont de Nemours

[a] l = liters.

Table 2. Continued.

Name	Chemical composition	Recommended amount/ hectare	Water needed /hectare (hectoliters)	Area(s) applied	Manufacturer
Terra Tack	polysaccaride	56 Kg	200	Clayton County	Grass Growers Inc.
3M-XB2386	unknown	730 Kg	100	Ida County	Minnesota Mining & Manufacture
3M-XB2386	unknown	490 Kg	100	Ida County	Minnesota Mining & Manufacture
+					
Conwed	wood fiber	660 Kg			Conwed Corp.
The following are the chemicals used as a tack with 3.5 metric ton of straw per hectare.					
Aerospray-70	polyvinylacetate copoloymer	370 l	20	Cedar County	American Cyanamid
Asphalt	cationic emulsion	2700 l	None	Cedar County	----
Petroset SB	rubber emulsion	590 l	20	Cedar County	Phillips Petroleum Co.
Terra Tack	polysaccaride	56 Kg	200	Van Buren County	Grass Growers Inc.
Straw alone		3.5 metric tons	--	Hamilton County	
Straw mechanically tied down		3.5 metric tons	--	Van Buren County	
3M-XB2386	unknown	490 Kg	100	Cedar County	Minnesota Mining & Manufacture

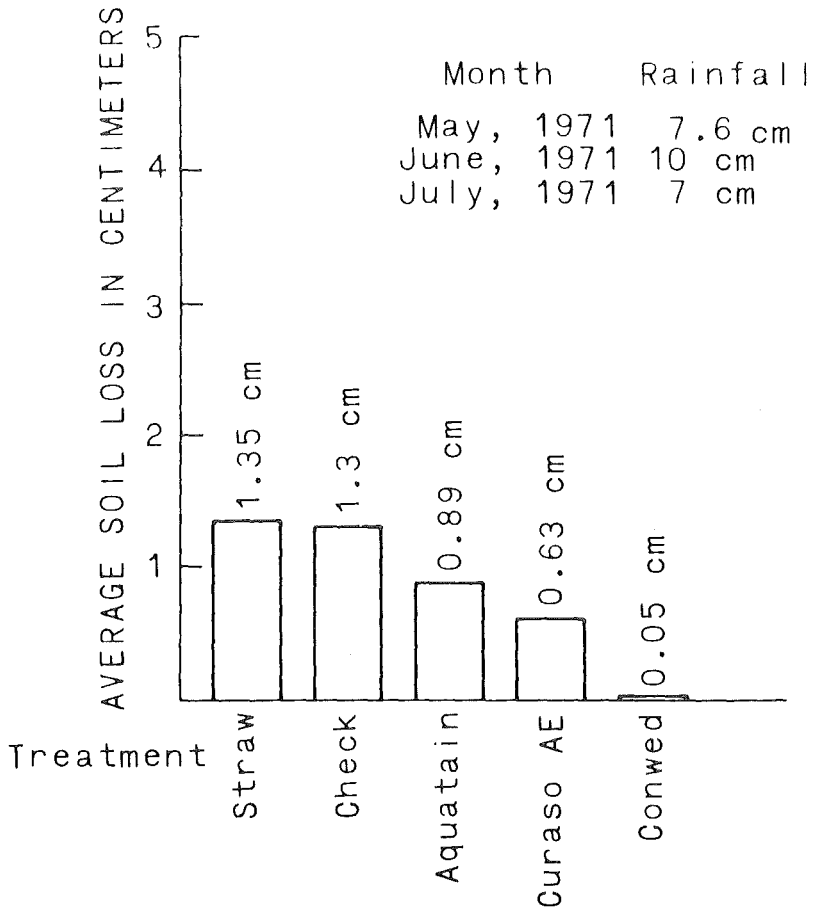

Figure 2. Soil loss and monthly rainfall at the Hamilton County site

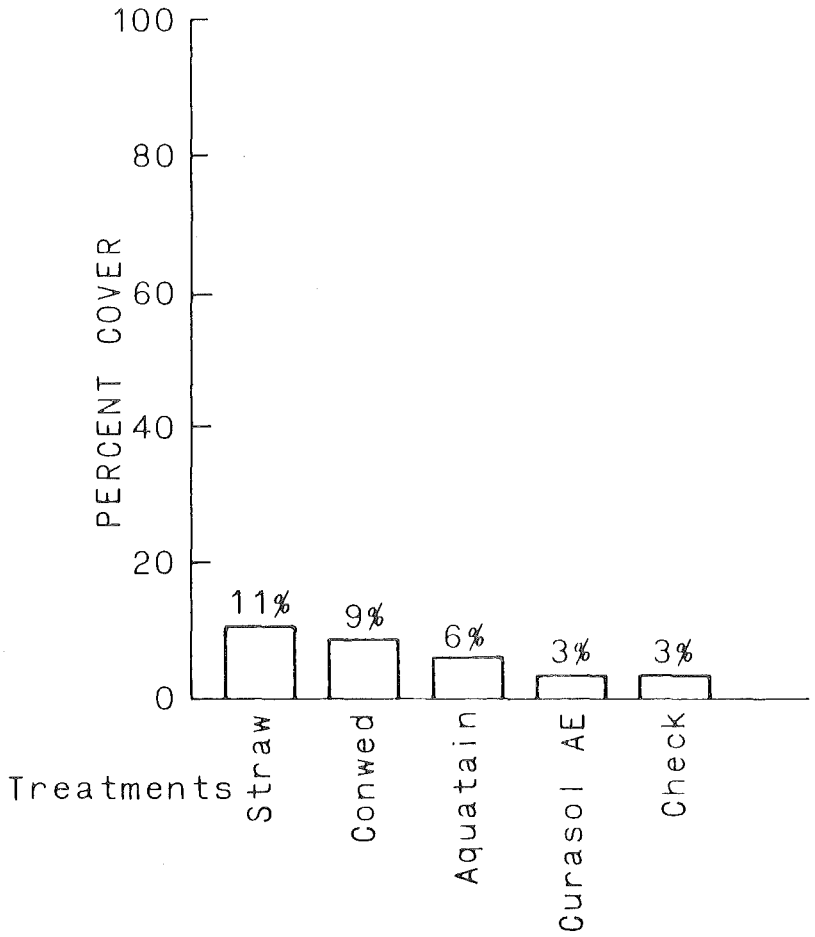

Figure 3. Cover at the Hamilton County site

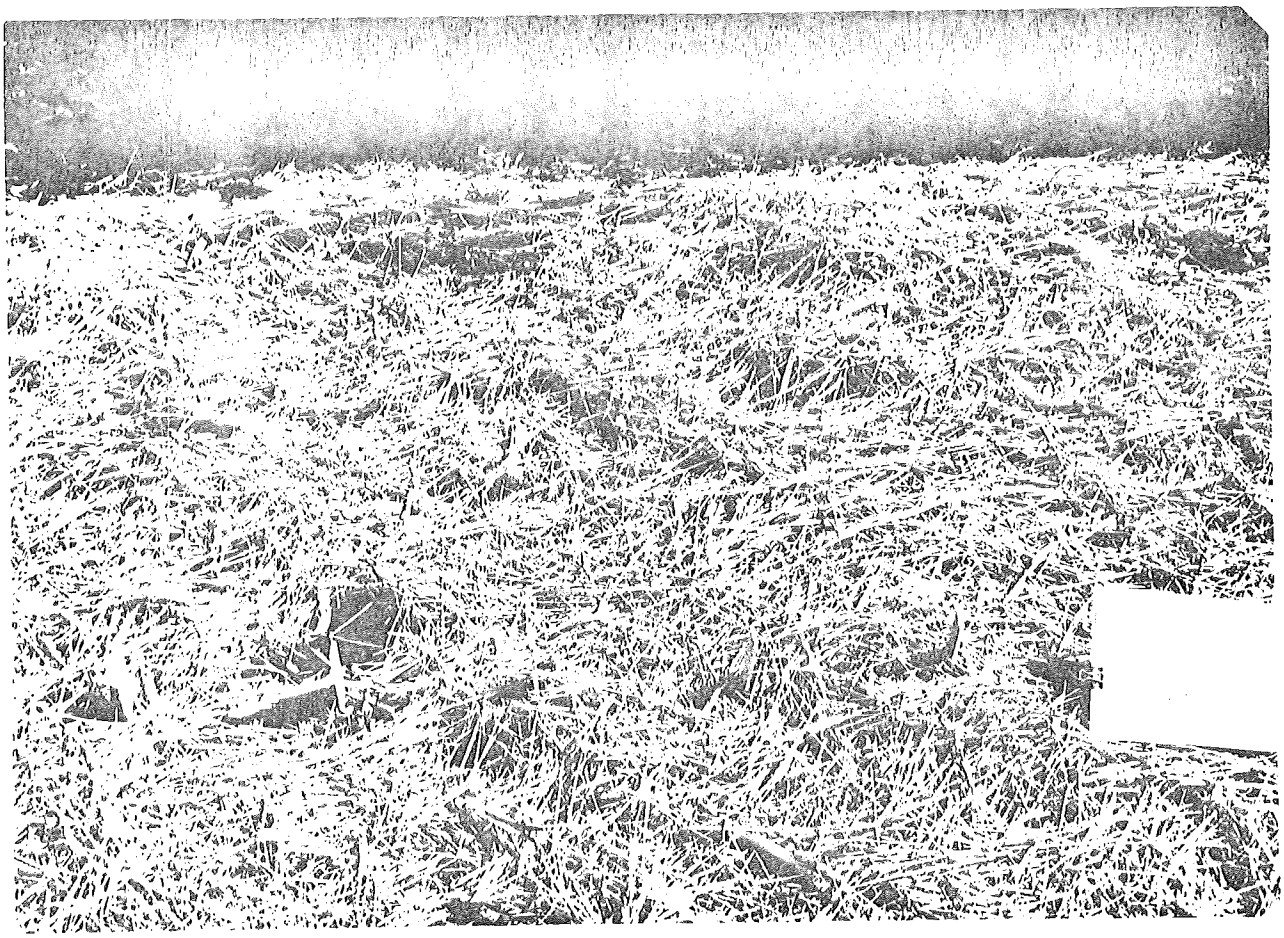

Figure 4a. Effect of wind on straw not anchored in Hamilton County at time of application

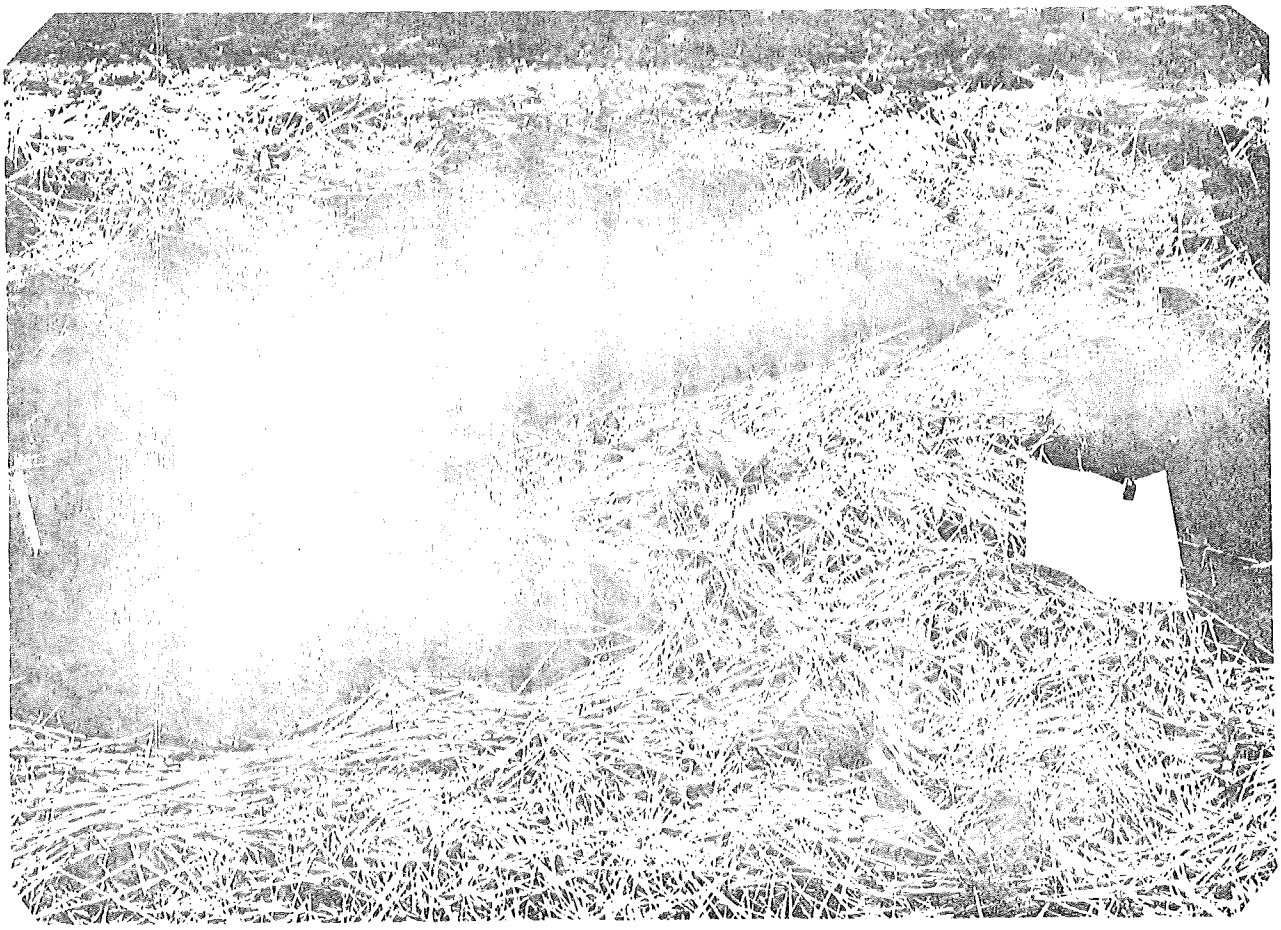

Figure 4b. Effect of wind on straw not anchored in Hamilton county 24 hours after application

greatest amount of cover, about 10%, which is extremely low for 3 months after seeding. The estimation of cover on the straw-treated plots is biased upward because measurements were made on the few areas on which some straw remained on the plots, and the areas from which straw had blown away were essentially bare of vegetation.

Because of abnormally dry conditions at this site during the seeding year, the results obtained are of limited predictive value. The study indicates that high rates of erosion occur on these soil materials when there is appreciable rainfall or when the backslopes are incompletely vegetated or inadequately mulched.

In 1972, a year of about normal rainfall, a satisfactory stand was obtained over all treatments with an additional overseeding in the spring of 1972 but without further treatments.

Clayton County Site. Seeding was completed June 10, 1971. Rain fell soon after seeding; moisture was adequate for rapid germination, and seedlings started to emerge within about 10 days.

As is shown in Figure 5, there were large differences in erosion between treatments. Erosion, however, was excessive on all plots. The lowest rate was 147 metric tons per hectare on the Curasol AE treatment. As is shown in Figure 6, the Conwed, Curasol AE, and Conwed + Curasol AH treatments had better vegetative cover and more uniform growth than the other treatments. This cover difference was more pronounced in July than it was in late summer. The Petroset SB treatment seemed to inhibit

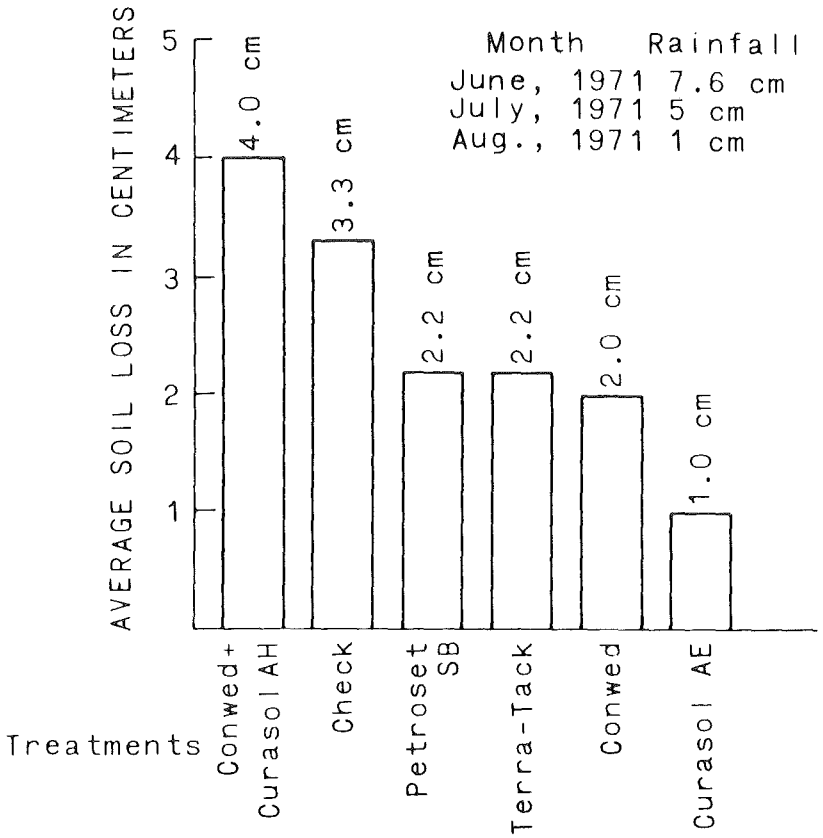

Figure 5. Soil loss and monthly rainfall at the Clayton County site

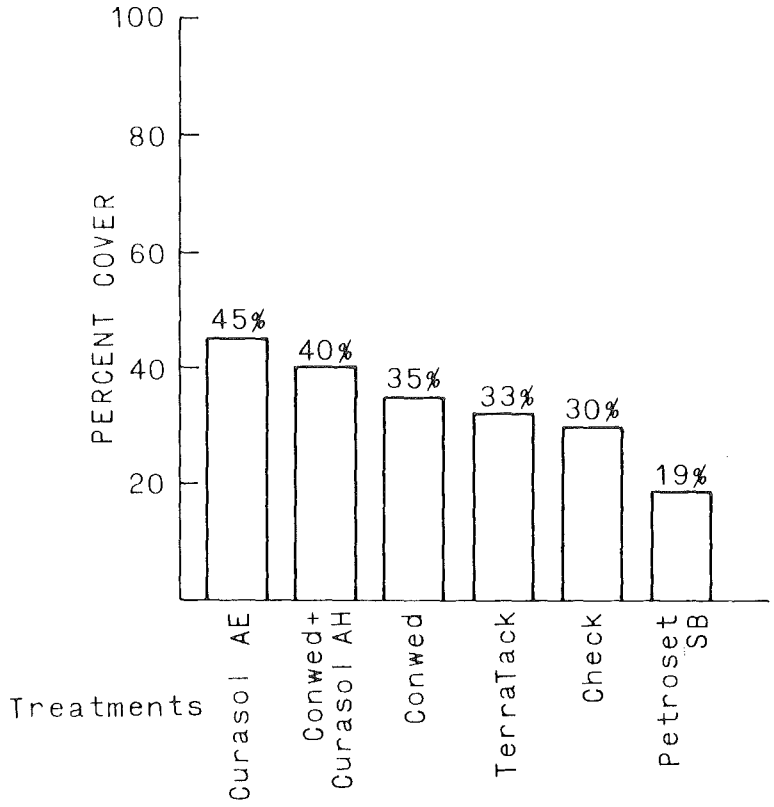

Figure 6. Cover at the Clayton County site

growth or germination of seeds when sprayed along with the seeds (Figure 7).[3/] This project was overseeded in the spring of 1972, and satisfactory cover was obtained on all plots.

This study indicated that several of the materials studied had an effect on soil losses and on seedling establishment but none could furnish adequate protection from high intensity rain before seed germination.

Van Buren County Site. This experiment was established during the first week of September, 1971. Weather at time of seeding was dry, and the subsoil, which is a very dense clay, was very hard and cloddy.

Soon after seeding several light rains fell that were adequate for germination but did not produce much runoff. By late November, when the ground froze, a vigorous plant growth was established on all plots.

Soil-erosion measurements, made on May 5, 1972, and percentage of cover, measured on June 2, 1972, are presented in Figures 8 and 9, respectively. Soil loss for each treatment is an average over both the topsoil and no-topsoil areas. Erosion was much less than at other sites, but as is shown in Figure 8, it was influenced by treatment. The untreated plots and the Conwed-treated plots had approximately 3 times as much erosion as the straw-mulched plots. Backslopes at this site are on a 4 to 1 slope, and the mulch for the straw treatment was disced into the soil.

[3/] The toxicity of Petroset SB applied directly to the seeds was confirmed in a greenhouse study.

Figure 7. Comparison of Petroset SB in the foreground with Conwed + Curasol AH in background (Clayton Co. site)

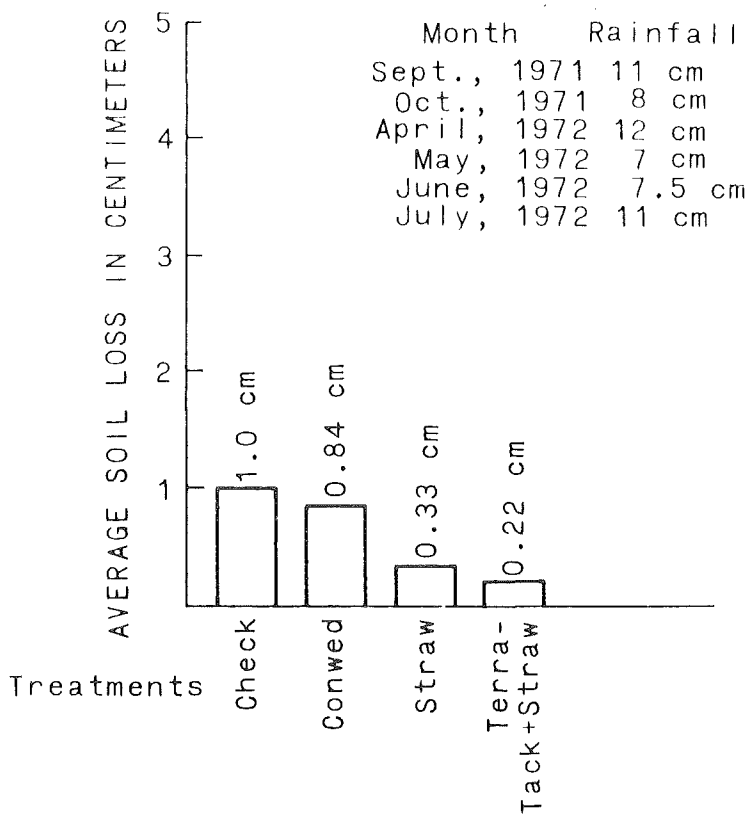

Figure 8. Soil loss and monthly rainfall at the Van Buren County site

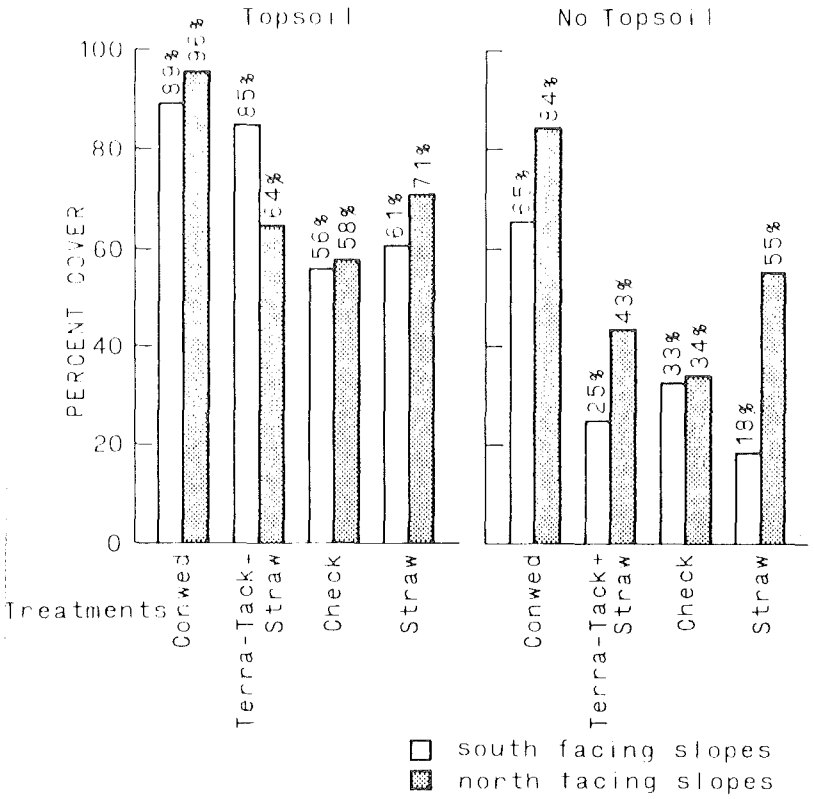

Figure 9. Cover at the Van Buren County site

The Terra Tack treatment, which was to be applied to the straw mulch, was a failure because the hydroseeder could not pump the Terra Tack solution. In this test, the Terra Tack solution was supposed to hold the straw in place so that straw could be used in areas where it could not be tilled into the soil. Because of gentle backslopes, abundant gentle rains, and lack of strong winds during the germination period, the straw, even though not disced in, remained in place, and the treatment had very little erosion. This study indicates that straw is effective in controlling erosion if it can be kept in place, even though not anchored into the soil.

The Conwed mulch did not control erosion, but its use resulted in the greatest and most uniform cover on both the topsoil and no-topsoil areas. Within the topsoil and no-topsoil areas, there were two replications, one on the south-facing backslope and one on the north-facing backslope. The slope aspect did not affect cover on the topsoil areas as much as on the no-topsoil areas (Figure 9). The Conwed treatment was the only one that resulted in an effective vegetative cover on the south-facing no-topsoil area early in the spring. Note in Figure 9 that cover values for the no-topsoil Conwed treatment compare favorably with cover values for all treatments on the topsoil areas. The south-facing straw areas with initially sparse cover are now, approximately 9 months after seeding, completely covered with the legumes seeded.

To summarize, the straw treatments controlled erosion, and the Conwed treatments gave the best cover. Averaging over-all treatments,

the topsoil areas had better cover than the no-topsoil areas. This difference is more pronounced on the south-facing slopes and on the straw-treated areas.

Cedar County Site. Percentage of cover data measured Aug. 18, 1972, are presented in Figure 10. Although rainfall was plentiful after seeding (Figure 10), it was gentle and not erosive. Therefore, little soil erosion was detected. Cover is sparse for all treatments except the straw + Petroset treatment at this site. The 3M-XB2386 treatment areas have very little cover, which indicates that the product might restrict germination. The seed was sprayed on the surface and not covered with soil because of the steepness of the backslope. The 3M-XB2386 product seems to create a less dense layer, approximately 1 cm thick, which may hinder germination by creating a drier environment for the seeds.

Ida County Site. Soil loss measured June 23, 1972, and percentage of cover measurements from Aug. 1, 1972 are presented in Figures 11 and 12, respectively. Rainfall again was plentiful at this site after seeding (Figure 12), with the area receiving a high intensity 9 cm rain approximately 2 weeks after seeding. Soil erosion, therefore, was great for all treatments. There are apparent differences between treatments, but no treatment effectively controlled erosion. The largest difference is in cover measurements with only the PVA-treated area adequately covered. The PVA treatment seemed to prevent surface seal and allowed a good environment for germination of the seeds (Figure 13). The Conwed treatment was next in cover, with all the other treated areas very low in cover. Further studies with PVA are in process at this site.

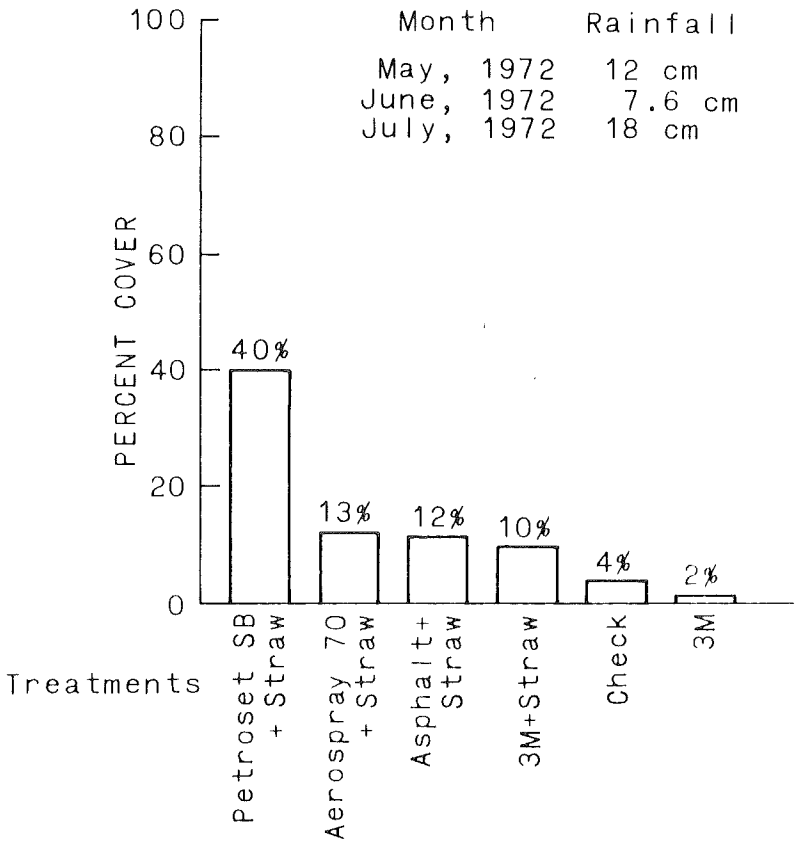

Figure 10. Cover and monthly rainfall at the Cedar County site

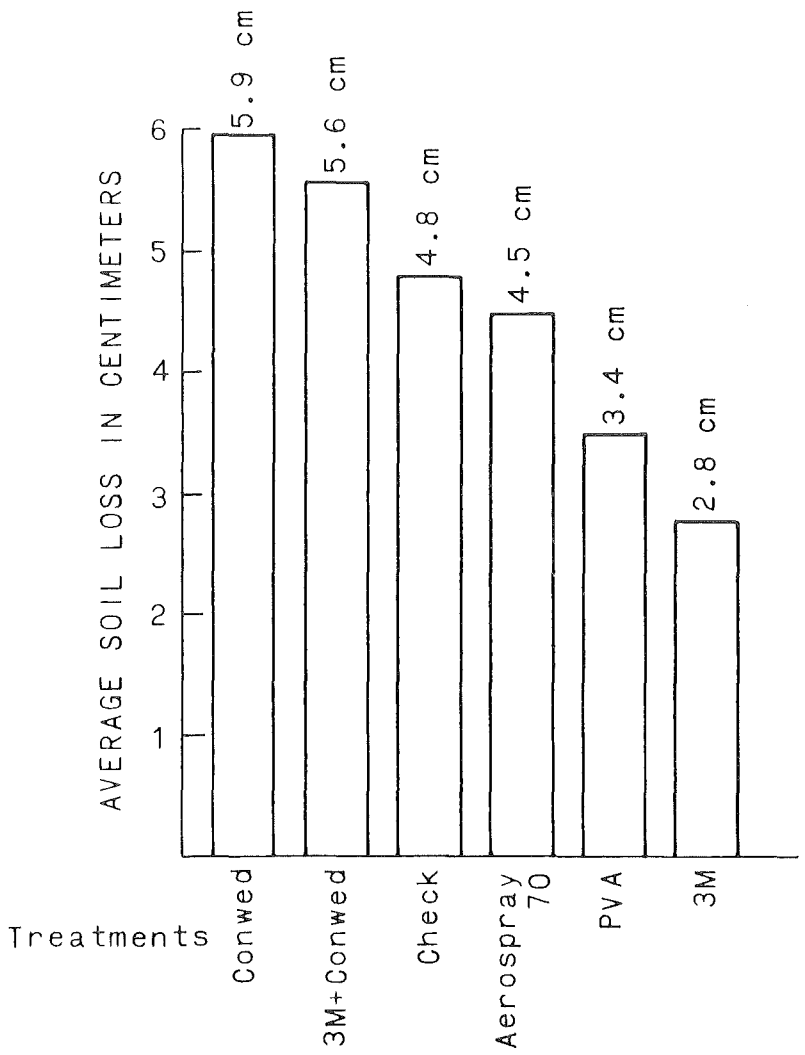

Figure 11. Soil loss at the Ida County site

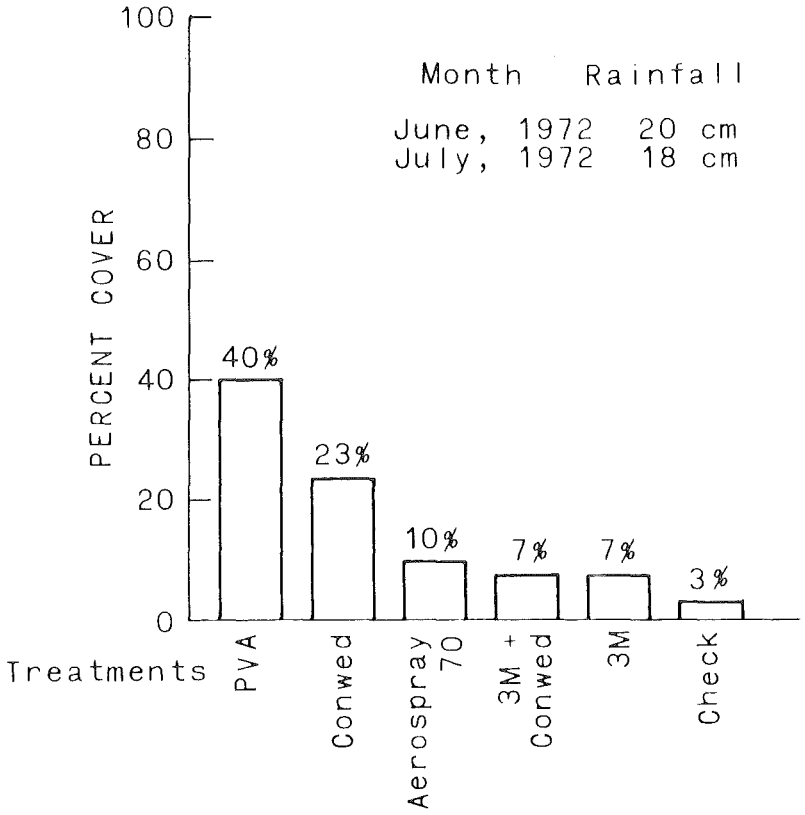

Figure 12. Cover and monthly rainfall at the Ida County site

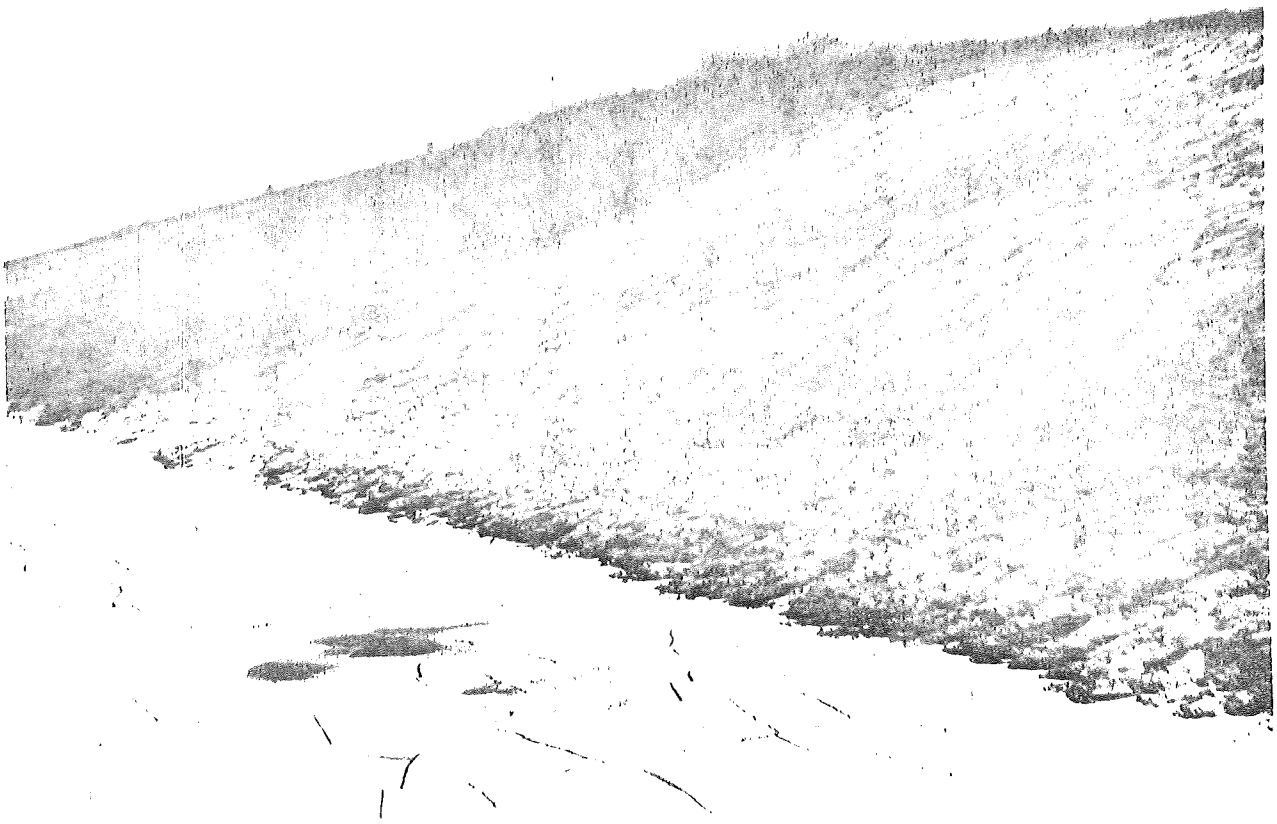

Figure 13a. Comparison of PVA with Aerospray-70, Ida County site -- soil surface difference of PVA in background and Aerospray-70 in foreground

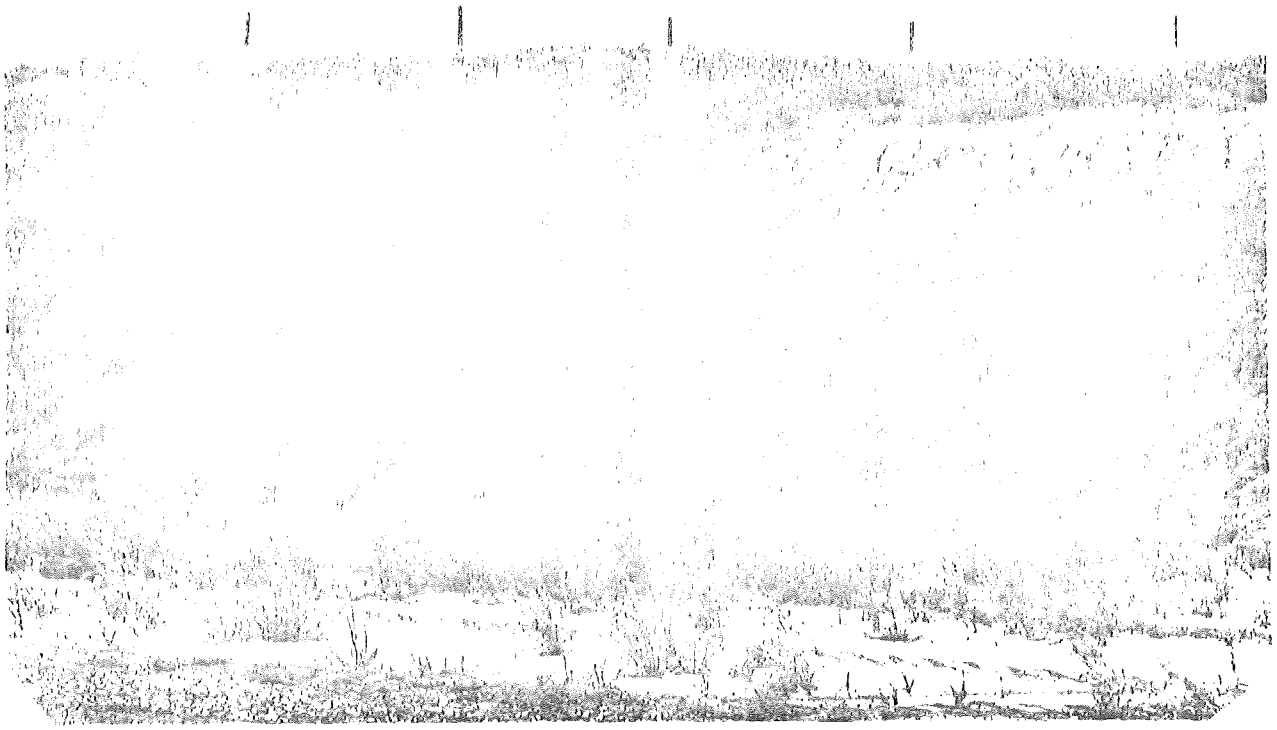

Figure 13b. Comparison of PVA with Aerospray-70, Ida County site -- vegetation difference of PVA on the left and Aerospray-70 on the right

Discussion

At the five sites studied, none of the chemical stabilizers was completely satisfactory. A discussion follows concerning the ability of the soil stabilizers to control erosion, promote plant growth, and stabilize or tack straw. Costs of the various materials that show promise also are discussed.

No soil stabilizer studied controlled erosion as well as the standard straw mulch. In Ida County, where a very intense rain of infrequent occurance fell, the PVA treatment prevented surface seal (Figure 13), which precedes runoff and erosion. Rill erosion resulted because rainfall exceeded the infiltration capacity of the soil. Perhaps, under more normal conditions, this treatment may control erosion. It was effective in preventing erosion in laboratory studies.[4/] The 3M-XB2386 soil stabilizer also was studied at the Ida County site. It did not control erosion, but there are doubts over the quality of the 3M-XB2386 material used at this study site. Consequently, it will be retested when production problems are solved. None of the other soil stabilizers studied showed promise for the control of soil erosion, or even the prevention of surface sealing.

The Conwed treatment consistently gave even, vigorous stands of vegetation, but did not effectively control erosion. The wood fiber material provided for an even distribution of the seeds and retained

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[4/] F. J. Blavia, W. C. Moldenhauer, and D. E. Law. Materials for stabilizing surface clods of cropped soils. Soil Sci. Soc. Amer. Proc. 35: 119-122. 1971.

moisture long enough for the seeds to germinate. It has the added advantage that more water is needed for application (see Table 2), which may relieve some of the salt effect of the fertilizers on seed germination. Other treatments that required large quantities of water, however, such as Curasol AE and Aerospray-70, did not consistently affect ground cover.

The PVA treatment also gave a satisfactory cover at the Ida County site. This is mainly a result of surface seal prevention. The soil in these areas remained in the same aggregated state as the original seed bed. Petroset SB and 3M-XB2386 stabilizers seemed to inhibit plant growth in these studies. The solvents used in the Petroset SB stabilizer are toxic when applied directly to the seed. Because of this, Petroset SB should not be applied along with the seed or directly on top of the seed. The Phillips Petroleum Company has a new Petroset, which is not toxic, but it has not been tested in this study. The 3M material is not toxic, but created a surface layer about 1 cm thick that is less dense than the underlying material. This layer may dry rapidly, thus preventing germination, expecially at the sandy, Cedar County site.

The PVA material costs approximately $170-220 per hectare; the 3M material costs approximately $1600 per hectare. Both materials use approximately 100 hectoliters H_2O per hectare and require a hydroseeder. At present, the cost of the 3M material is prohibitive, but if it does stabilize the soil it may be adaptable to small areas with

severe erosion hazards. The cost of the PVA material compares favorably with the cost of straw when added costs of application of the straw are included. The cost of the Conwed material is approximately $270 per hectare, but this material requires four times as much water as the PVA material. Total estimated costs of application run as high as $570 per hectare for the Conwed, $370 per hectare for PVA, and $470 per hectare for the straw. These figures include seed and fertilizer plus equipment rental and labor.

All the chemicals tested for tacking straw deteriorate in a short time, with the exception of the asphalt emulsion and the 3M-XB2386 material. However, all chemicals in our study, except Terra Tack, which could not be pumped because of improper solution, seemed to tie the straw down and prevent soil erosion. More study is needed since few erosive rains fell on these experiments with straw. Applying the chemical tack with a hydroseeder resulted in a more even application than with the Finn mulcher. Aerospray-70, Petroset SB, and Terra Tack all cost approximately $240 per hectare for the material needed to tack the straw. The cost of the 3M-XB2386 material is $1100 per hectare, which is prohibitive at present.

Summary

Nine soil stabilizer materials and various combinations of these materials were studied in five counties along the secondary road system in Iowa. These materials were Aerospray-70, Aquatain, Asphalt emulsion

(cationic), Conwed, Curasol AE and AH, Petroset SB, PVA, Terra Tack, and 3M-XB2386. Five of these, 3M-XB2386, Aerospray-70, Asphalt emulsion, Petroset SB, and Terra Tack, were applied as a tack on straw.

The study indicated that the PVA material has the greatest potential for both preventing soil erosion and promoting a good stand of vegetation. Costs of this material compare favorably with the costs of straw mulching. Other materials did not consistently control erosion satisfactorily in this study, but may be useful under different conditions. Slopes in this study were very steep, which gave a severe test for the soil stabilizers.

Although the Conwed material was inconsistent in controlling erosion, it did give consistently better cover when compared with both the other soil stabilizers in the study and the check treatment. This material, therefore, may be useful in establishing a good stand of vegetation.

All materials tested as a tack for straw helped to hold the straw in place and may provide a substitute for asphalt on these steep slopes. A hydroseeder is the best means of applying the tack.

Although present estimated costs of the 3M-XB2386 material are prohibitive, further studies are planned using this material. It seems to have the strength to resist soil erosion and may be useful for erosion control where the erosion hazard is severe. Further testing should also indicate whether the material indeed retards seed germination.