REPORT ON EROSION-CONTROL TECHNIQUES

Frank H. Brant, Landscape Engineer, North Carolina State Highway and Public Works Commission, pointed out that last year the fundamentals of erosion control had been summarized. This year there is something new in erosion control to report--the development covered in the following paper.

STUDIES WITH POLYELECTROLYTES: PRELIMINARY FIELD APPLICATION FOR EROSION CONTROL

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CONTROL of soil losses resulting from erosion of freshly graded slopes presents a challenge to any highway construction engineer. In most cases, vegetation (usually grass) is established to stabilize soil against the beating action of rainfall and scouring of surface water. The common practice is to seed the area and then wait for a grass cover to develop. ~~This interim period may require a month or longer.~~

While the vegetation is developing it is desirable to provide adequate protection to the bare soil. Vegetative mulches are often applied to give this temporary protection. Mulches cushion the impact of raindrops and minimize slaking of soil particles. Thus soil loss is reduced and infiltration enhanced.

Although the performance of mulch is usually satisfactory for interim protection, it has the following disadvantages: flammability, unsightliness, high cost, and expensive and tedious application. Stabilization of mulch to wind action in many cases requires tying down. Moreover, in many areas mulch is not available.

Certain resins which have been found to improve soil structure[1] have also shown promise in stabilizing soil against erosion. Two of the resins considered were sodium salt of hydrolyzed polyacrylonitrile (CRD 189-A) and calcium carboxylate polymer (CRD 186-1). → p. 22

Properties of these resins are given in Table I. The stabilizing characteristics of CRD-189-A (known as Krilium) were well demonstrated by high-speed movie photography (3,500 frames per sec.) which recorded the impact of water droplets falling upon treated and untreated soils. Figure 1 shows excerpts from the drop action on untreated soil. Note the soil splashed on the white card in the background. Where the soil was treated with a surface application of 1 lb. of CRD-189-A per 100 sq. ft. (at right), the surface remained intact and no soil was splashed on the white background card.

1/ - Hedrick, R. M., and Mowry, D. T., The Effect of Synthetic Polyelectrolytes on Aggregation, Aeration, and Water Relationships of Soil. "Soil Science" - in press.

TABLE I

PHYSICAL PROPERTIES OF SOIL CONDITIONERS

	CRD-186-1	CRD-189-A
Rate of solution in water	Rapid	Rapid
Stability to acids	Gels slowly	Precipitates
Excess Ca^{++} Al^{+++}	Precipitates	Precipitates
Effect of formaldehyde	None	Gels
Brookfield viscosity of 1.0 percent aqueous solution in poises	1.2	1.7
pH Values		
at 0.1%	5.4	10.4
at 1.0%	4.9	11.4
Bulk Density in lb. per cu. ft.	42.8	42.2

Particle Size Data	Percent Retained on Sieve					
	#20	#40	#80	#140	#200	Passing #200
CRD-186-1	0.1	0.3	2.4	14.7	24.7	57.8
	0.2	3.0	31.3	19.2	14.4	32.1

Special Plot Tests and Rainmaking Equipment.

In order to obtain quantitative data on the performance of the soil conditioners, ridges about 100 ft. long by about 15 ft. wide at the base were constructed. The slant length of each slope was 8 ft. Plots 4 ft. wide were partitioned off by metal borders, and cloth collectors were placed at the base of each plot to obtain data on soil loss.

A 22-deg. slope was used to obtain data on both soil loss and runoff where tanks were used in place of cloth collectors at the base of each plot. Figure 2 shows the slope with tanks or lysimeters which were used to collect both soil losses and total water runoff during each rainfall.

The soil used in construction of the slopes was Dayton alluvial, composed of 47.2 percent sand, 33.8 percent silt, and 19.0 percent clay. This soil was compacted near the surface to about 85 lb. (dry weight) per cu. ft.

A Skinner irrigation system was used for application of artificial rainfall. Water was applied at an intensity of about 3 in. per hr. from Type SS nozzles spaced at 2-ft. intervals on an oscillating pipe mounted $4\frac{1}{2}$ ft. above and perpendicular to the midpoint of the slope. The rate of oscillation used was one complete cycle per min.

Methods for Application

Treatments were made to determine what method of application would be optimum. Figure 3 presents results obtained by two methods of conditioner application; raking-in and surface applications.

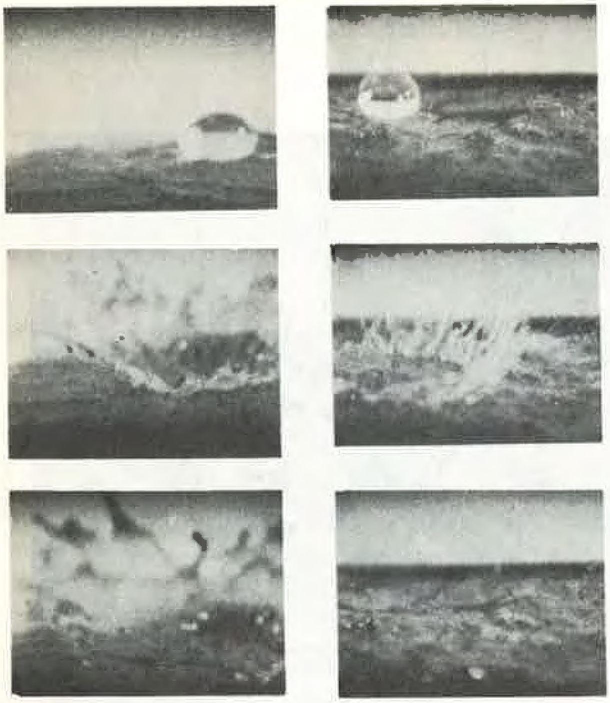

Figure 1. Untreated soil (at left) causes water turbitidy and splash on background when drop hits the soil surface. Treated soil (at right) is not splashed out, and splashed water is left clear and free from soil matter.

The raking-in treatment consisted of raking the resin into the soil to about 3/4-in. depth and wetting down to dissolve. Surface application was carried out by uniformly distributing the resin over the surface and wetting down. Where plots were seeded, a mixture consisting of 40 percent Kentucky bluegrass, 25 percent red top, 30 percent domestic ryegrass, and 5 percent white clover, was broadcast by hand, and raked in to about $\frac{1}{4}$-in. depth. Seeding followed the raking-in resin application and preceded the surface treatment.

The surface application was about twice as effective as the raked-in treatment.

Comparison of Straw Mulch and Resins

Comparison of the resins with straw mulch was made by setting up a replicated series of plots where four replications were made of each treatment. Erosion losses versus rainfall are exhibited in Figure 4.

Data on runoff from the lysimeter plots are presented in Figures 5 and 6.

CRD 189-A was effective in reducing soil losses and lowering runoff, or in other words promoted infiltration. The performance level approximated that of straw mulch.

Equipment for Field Application

For application of resin to very small areas, broadcasting by hand is suitable. Larger areas can be treated by distributing the powder with a fertilizer spreader. For large-scale operations, such as roadsides, spray equipment is being developed in cooperation with the Connecticut State Highway Department. Spray equipment used for seeding and fertilizing operations can be adapted to spray the resin. This is done by use of an eductor inserted in the discharge stream. The high-pressure flow picks up resin from a hopper and discharges the mixture to a distance of about 65 ft. or more in an even pattern. The resin is introduced into the stream at a controlled rate. It has been demonstrated that this equipment can be used to apply the resins simultaneously with seed and fertilizer. This method of application provides a very inexpensive and convenient way to distribute the resin over almost any type terrain.

Accompanying photographs (Figs. 11 and 12) show hand and spray application of CRD-189-A in the field.

Field Tests

So far, only limited field tests have been made. Where plots were treated, 1 lb. of CRD-189-A per 100 sq. ft. was applied by the surface method.

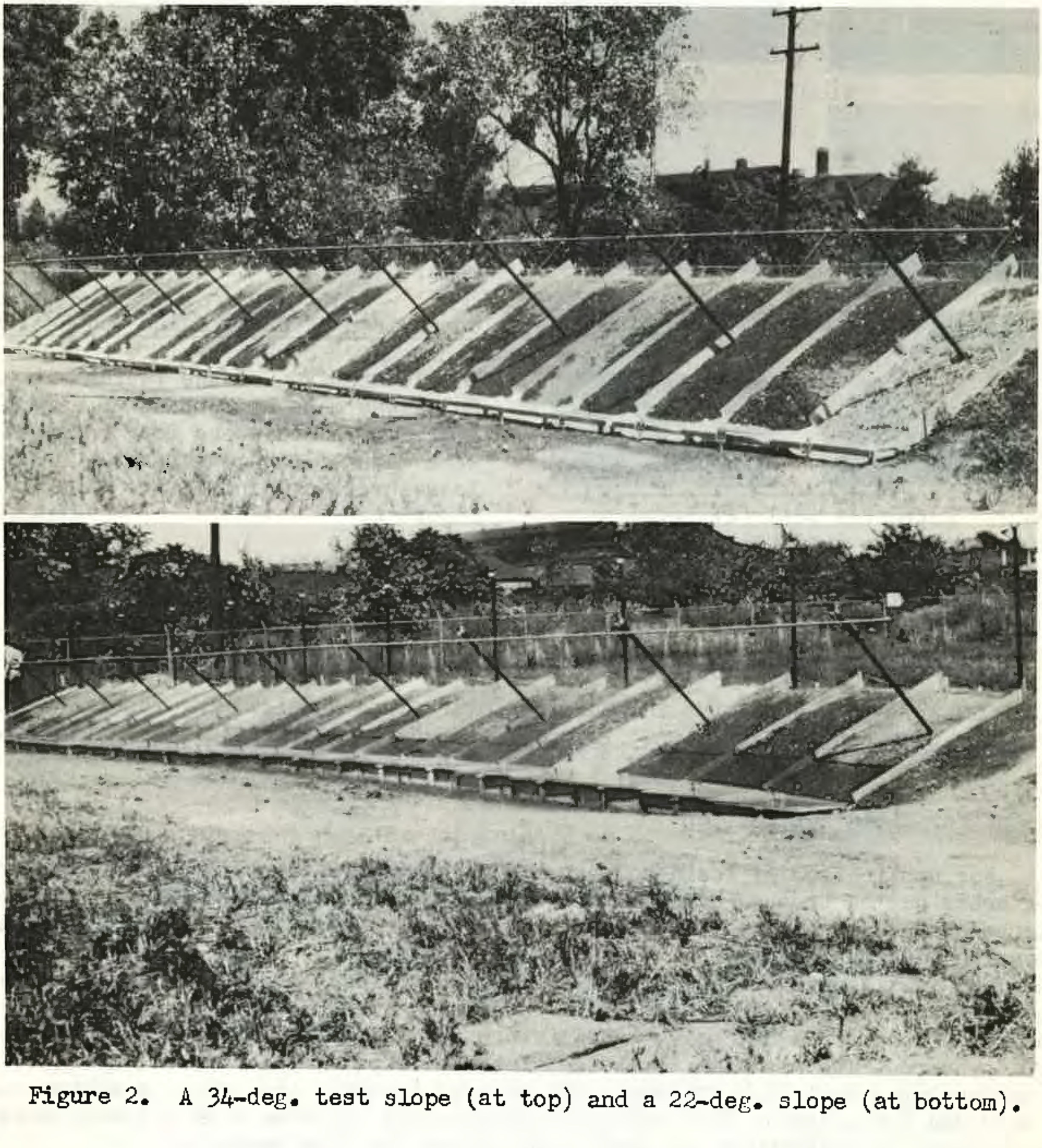

Figure 2. A 34-deg. test slope (at top) and a 22-deg. slope (at bottom).

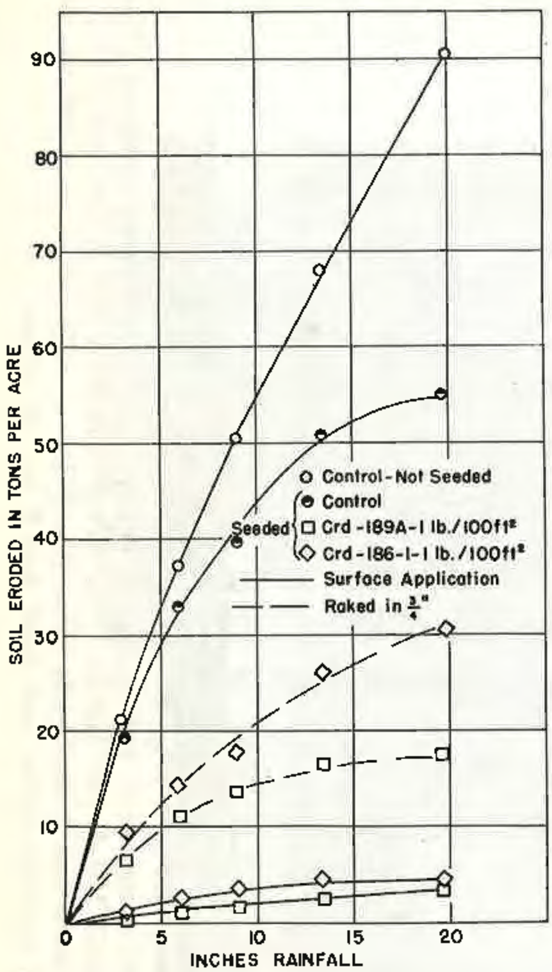

Figure 3. Soil movement for two methods of conditioner application on a 34-deg. slope for a 5-week period.

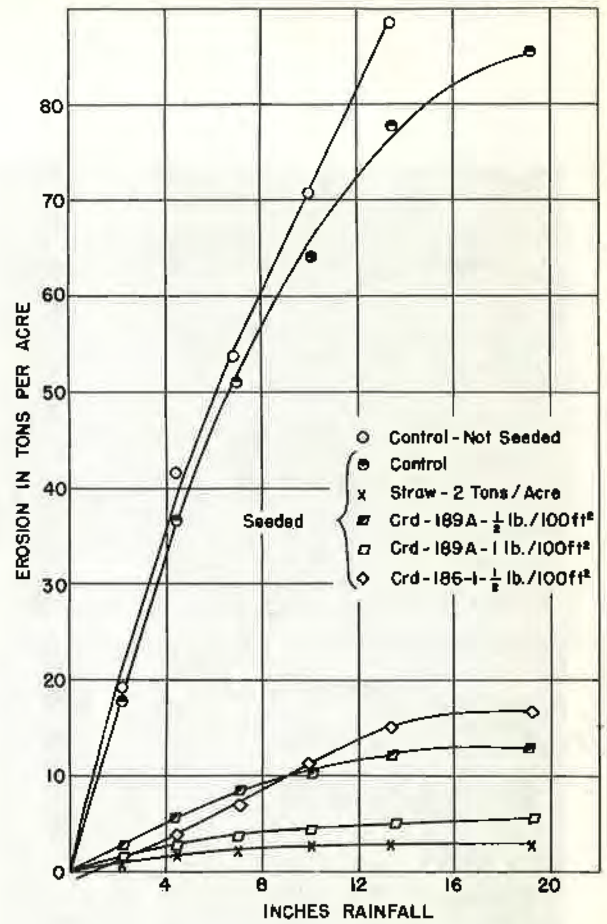

Figure 4. Erosion control on a 34-deg. slope with CRD resins (5 weeks).

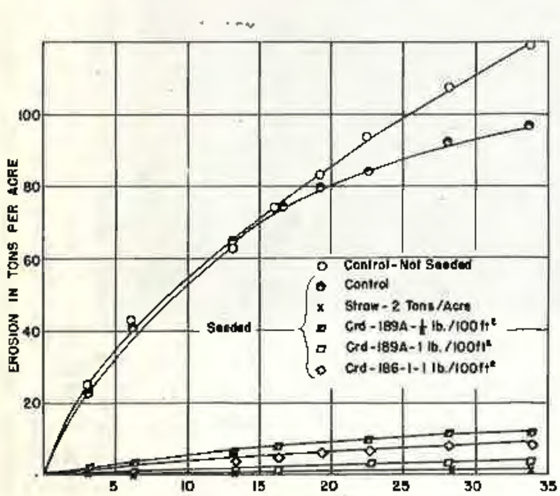

Figure 5. Erosion control on a 22-deg. slope with CRD resins (6 weeks).

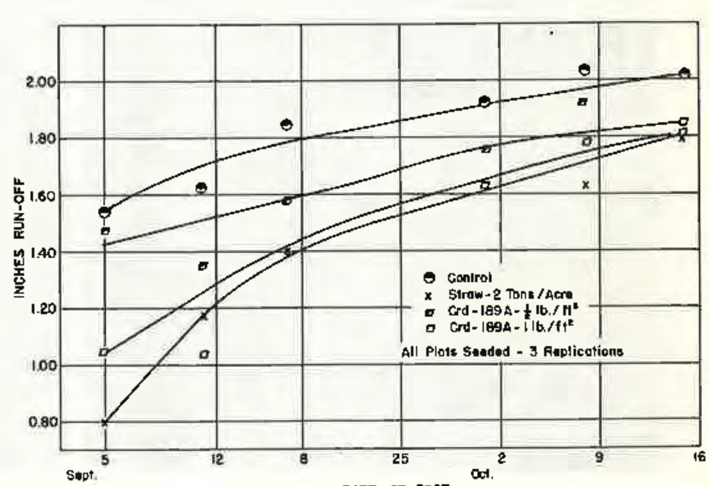

Figure 6. Runoff data on a 22-deg. slope over a 6-week period (2.8 in. of rain applied during test).

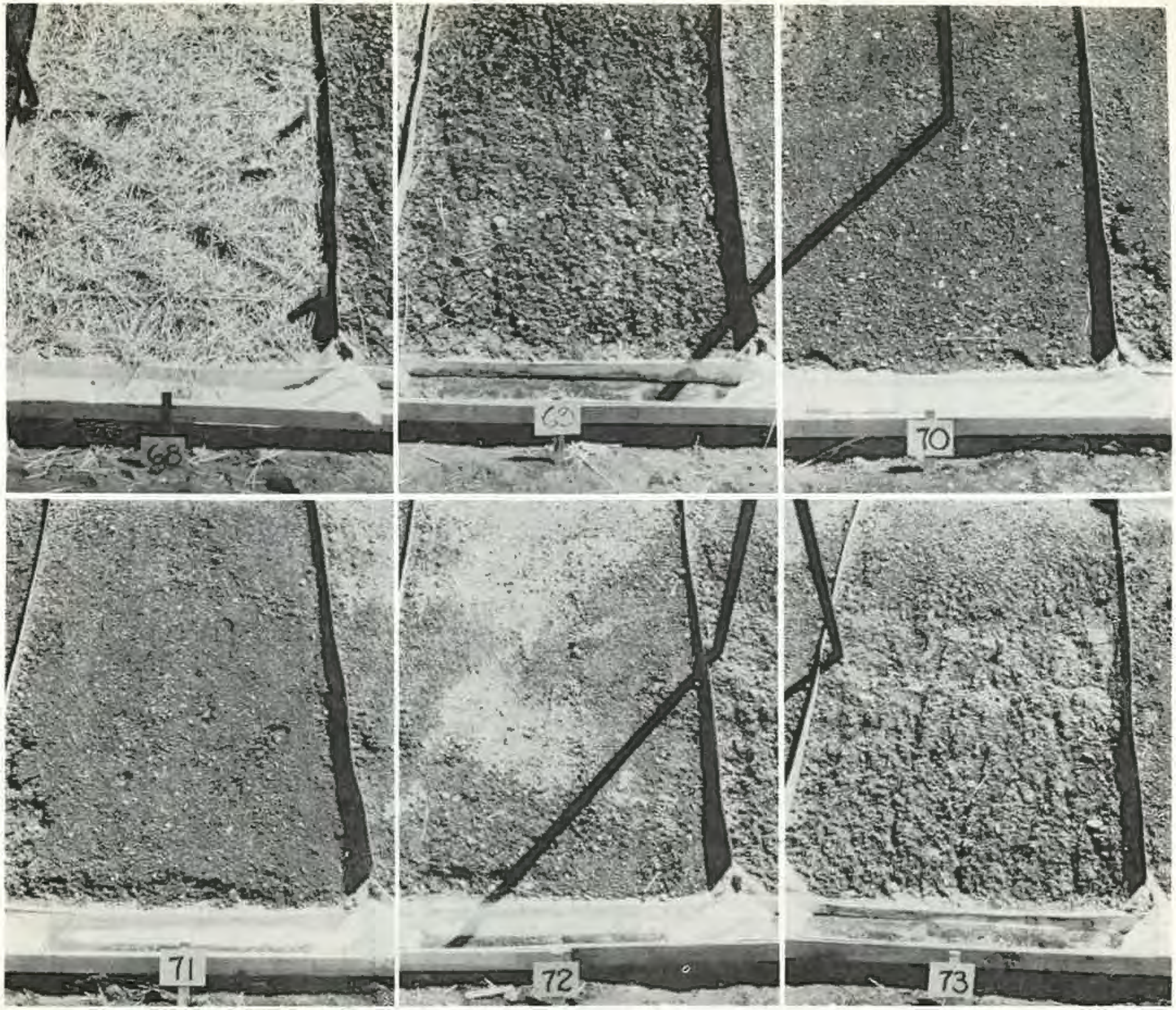

Figure 7. Test Plot 68, 2 tons straw acre after one week and 4 in. of rain; No. 69, unseeded control after one week and 4 in. of rain; No. 70, 1 lb. CRD 189-A per 100 sq. ft. after one week and 4 in. rain; No. 71, ½ lb. CRD 189-A per 100 sq. ft. after one week and 4 in. rain; No. 72, ½ lb. CRD 186-1 per 100 sq. ft. after one week and 4 in. rain; No. 73, seeded control after one week and 4 in. of rain.

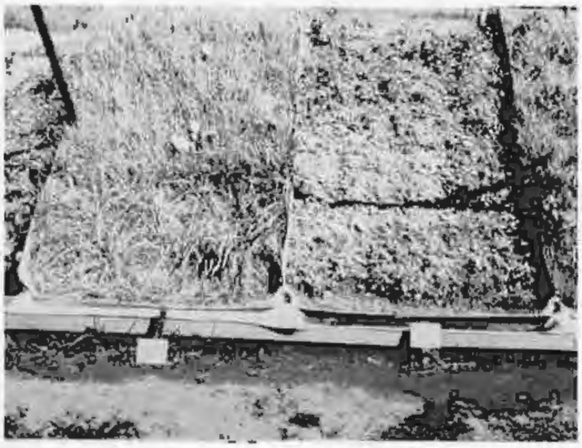

Figure 8. Mulch (left) and unseeded control (right) after five weeks and 19 in. of rain.

Figure 9. At left is a plot treated with 1 lb. CRD 189-A per 100 sq. ft.; right, ½ lb. CRD 189-A per 100 sq. ft.; after five weeks and 19 in. of rain.

Figure 10. At left, ½ lb. CRD 186-1 per 100 sq. ft.; at right, seeded control; after five weeks and 19 in. rain.

Figure 11. Hand broadcasting the dry resin.

Other field tests are in progress and the results will be reported by our cooperators. So far, encouraging reports have been obtained but there are also instances of failure. Our objective is to define the performance characteristics of these resins through additional field tests on a wide variety of soil types under different climatic conditions. An intensive program along this line is planned for 1952.

Another application for CRD-189-A in erosion control is its ability to hold mulch for resisting losses due to wind and water. This application is far less costly than the use of special nettings or burlap. Successful field applications have been made in cooperation with the Connecticut State Highway Department. Applications were made at a rate of $\frac{1}{2}$ to 1 lb. per 100 sq. ft. by spreading the powder over the mulch already in place. Wetting the area down with a water spray may be desirable in certain cases.

Summary and Conclusions.

Preliminary field testing has indicated that surface treatment of soil with CRD-189-A provides a permeable film, resistant to water erosion. Data from small plots show that erosion was reduced by resin application to about one thirtieth that of untreated areas. Runoff was also greatly reduced. The performance level of the resin approximates that of straw mulch.

Current laboratory work consists of formulation studies, investigation of soil types, and various simulated rain tests. New developments indicate the cost of the resin in place may be considerably less than mulch in many instances.

Future field work will be directed toward determining the activity of the resin in the stabilization of various soil types under natural conditions. Special emphasis will be placed upon continued development of application equipment.

Figure 12. Connecticut State Highway Department spray equipment is used to seed, fertilize, and spray resin simultaneously.

Acknowledgment.

The assistance of T. W. Salomon on the slope tests and the photography by Miss S. J. Aulabaugh are gratefully acknowledged.

Suggestions by R. G. Fordyce, L. V. Sherwood, D. T. Mowry, and C. A. Van Doren (Soil Conservationist, U.S.D.A.) were especially helpful.

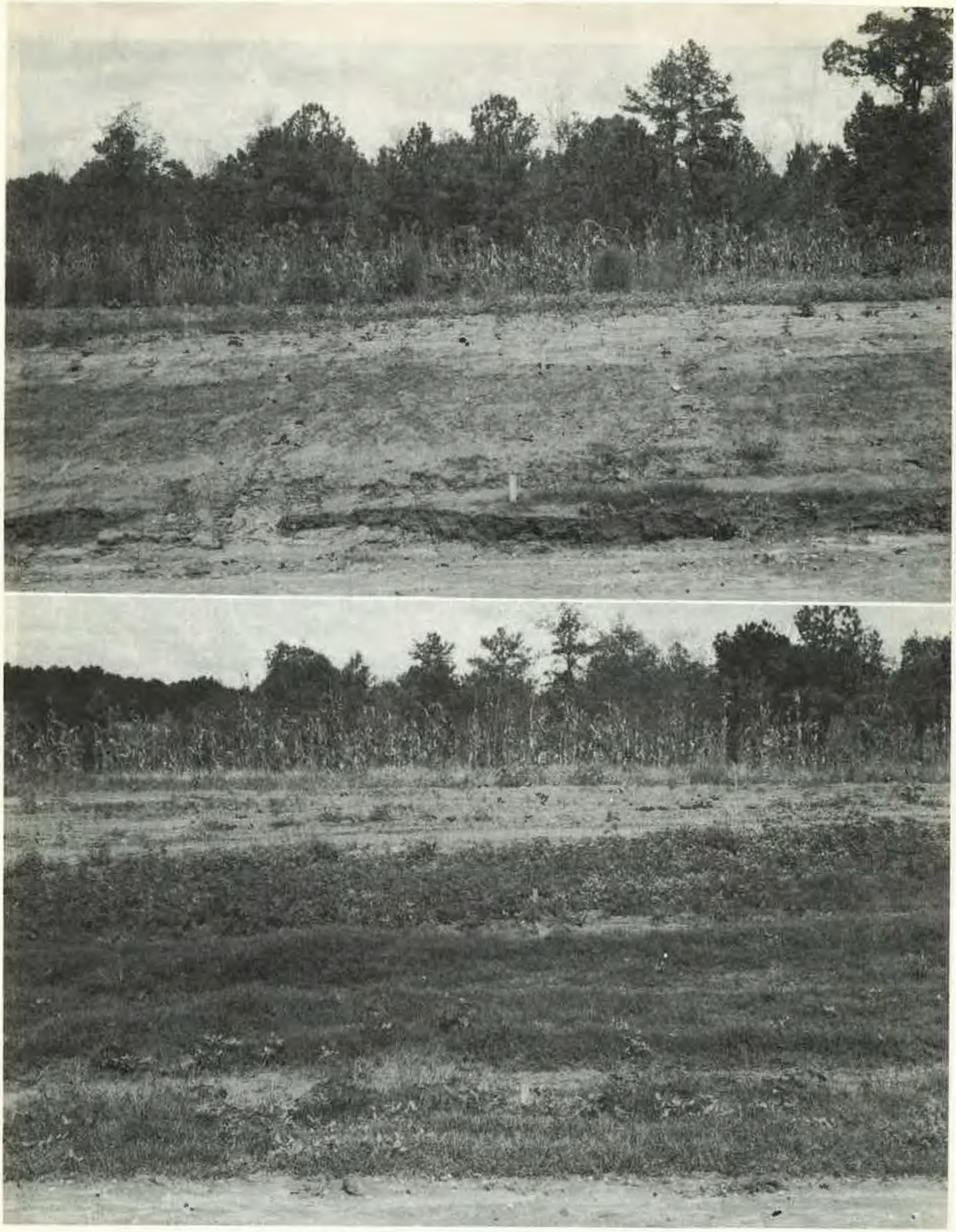

Figure 13. At top is a seeded blackslope near Birmingham, Alabama; a period of heavy rainfall washed away seed and left soil caked and impervious. Below is an adjacent plot, showing seeded backslope treated with CRD 189-A at 1 lb. per sq. ft.; seed remained in place during the period of heavy rain.

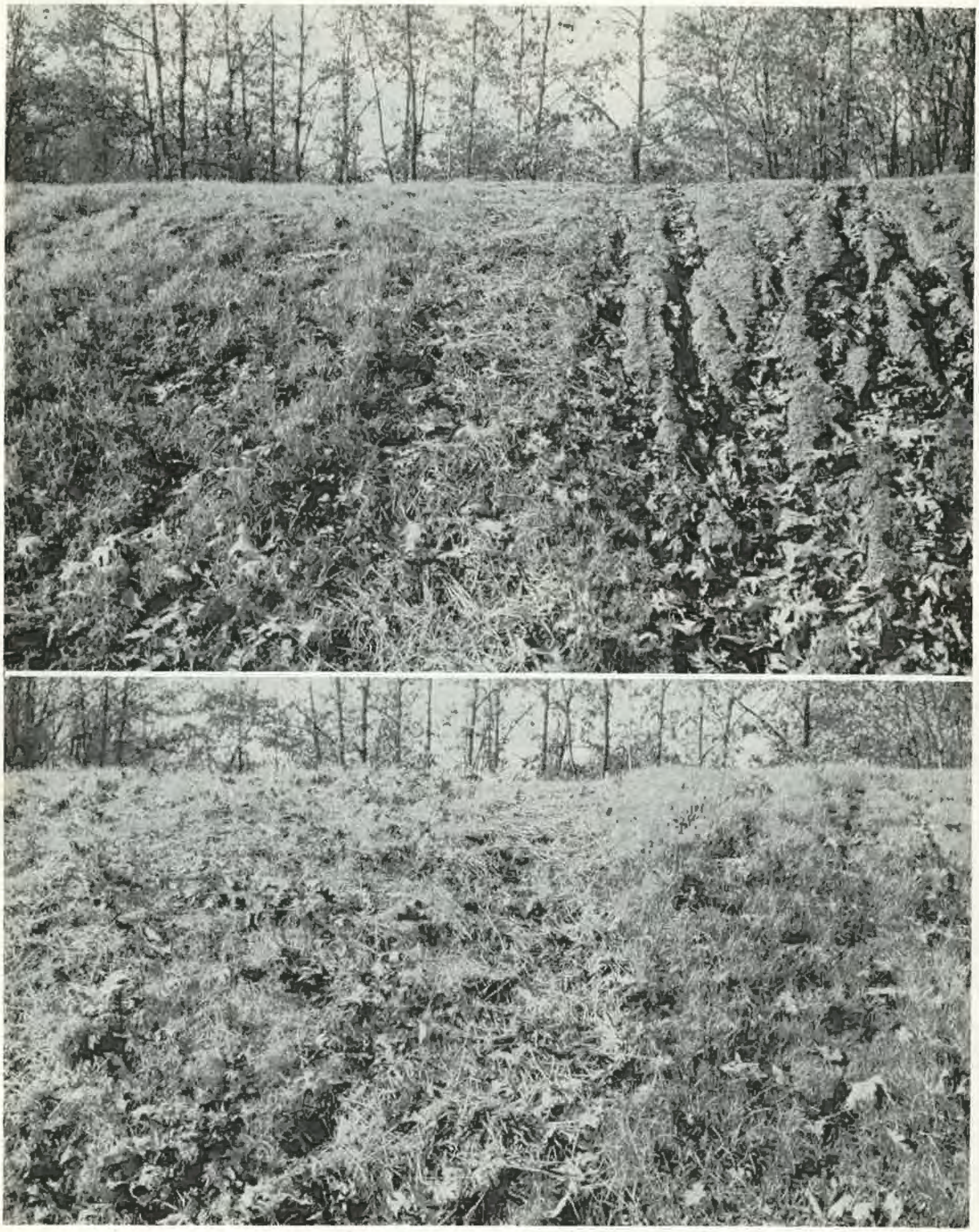

Figure 14. Test plots established by Ohio State University in Blendon Woods, near Columbus, show vegetation firmly established in treated soil (left) and erosion in untreated soil (right) in the upper photograph. Below is a view of vegetation established in a straw mulch plot (left) and in a CRD 189-A plot (right).

DISCUSSION

MR. BRANT: Any questions on Krilium?

QUESTION: Are seed, fertilizers and Krilium applied together?

ANSWER: Yes. We're eliminating a number of usual operations.

MR. BRANT: Let me ask Mr. Wright. Your spraying methods using water and fertilizer have been going on for some years. Does the use of Krilium change these operations?

ANSWER: No. Krilium enters the water stream at the hose nozzle. It is not mixed in the spray tank.

MR. IURKA: Is Krilium equally useful in any type of soil, or is it mainly useful in clays and other heavy soils?

ANSWER: It works best on soils with a large clay fraction. We are still working on this soil factor but present indications are that soils with more than about 70 percent sand are not adapted to best use of Krilium for erosion control.

MR. BRANT asked that persons in highway departments who could carry out field study of the new material meet with Mr. Colter after the meeting. The Monsanto Chemical Company offers to furnish necessary material to any state highway department that will agree to carry out field demonstrations of an erosion-control nature.