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WG 271

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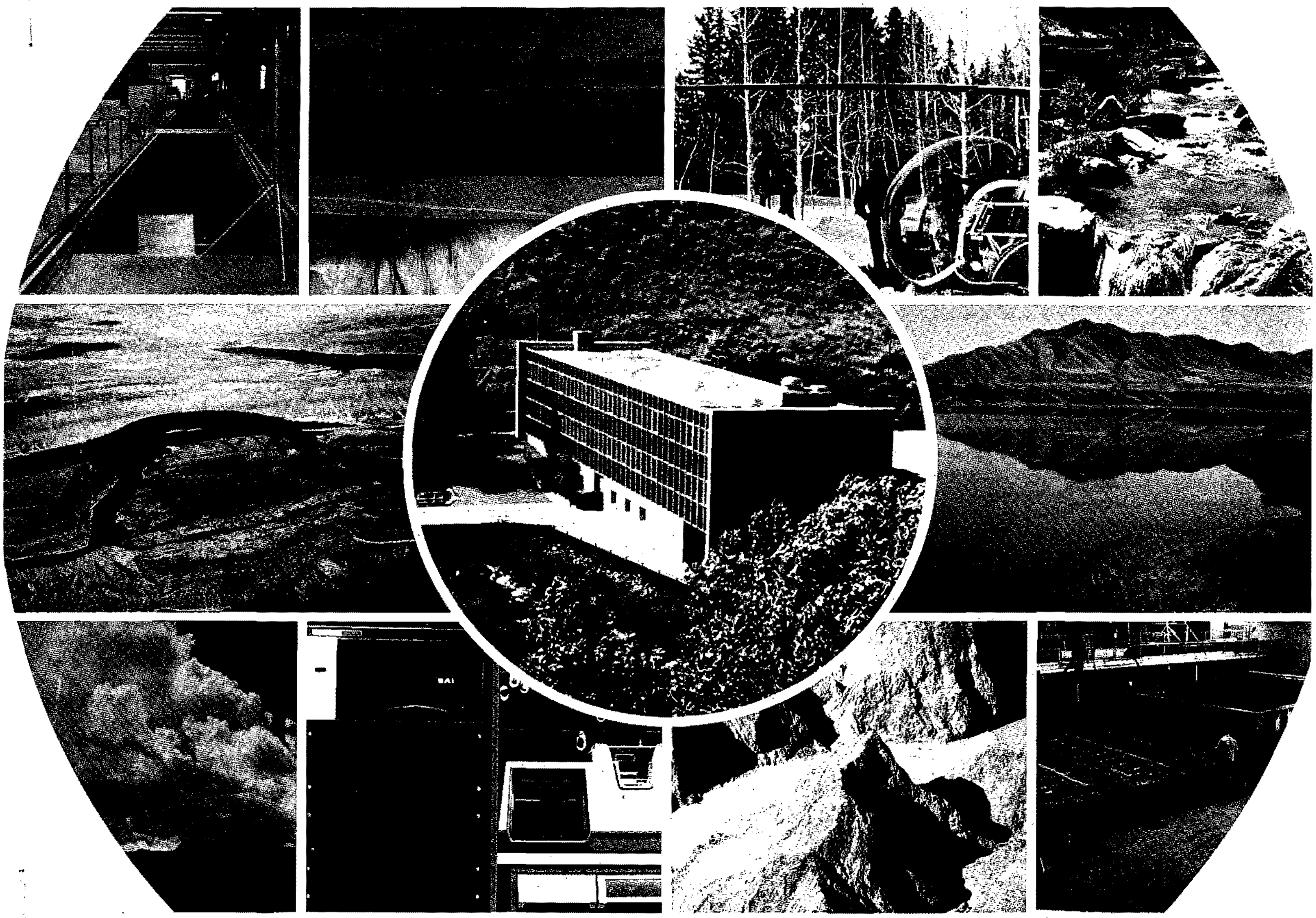

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FIBREX CORPORATION

Report of

EROSION CONTROL PRODUCT TESTING

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INTRODUCTION

FIBREX CORPORATION has capability for manufacturing various blends of cellulose fibers which have been used at locations throughout the country for temporarily controlling erosion on denuded land areas, and for serving as growth media for grass and other vegetation. Soil and climatic conditions vary greatly where these products are used, and it is not possible to determine by observation whether one is more effective than another in controlling erosion or promoting vegetative growth. FIBREX is desirous of knowing with some degree of confidence which products have the highest level of erosion control so that additional efforts can be directed towards their production and sales for the purpose of meeting erosion control needs.

The Utah Water Research Laboratory is experienced in erosion control activities and was contacted by FIBREX to evaluate the effectiveness of five particular products for controlling erosion. All testing was done inside the laboratory using a rainfall simulator and a fixed tiltable test bed. Erosion control materials were applied on a slope of 2:1 (50 percent) at the rate of 2000 lbs per acre.

TESTING FACILITY

The rainfall simulator is a drip type device in which individual raindrops are formed by water emitting from the ends of small diameter brass tubes. The rate of flow is controlled by admitting water into the manifold chamber through fixed orifice plates under constant hydraulic pressure. Five separate inlet orifices are used in each chamber or simulator module. The ratios of the areas of the orifices are 1:2:4:8:16. By controlling the flow to the orifice with an electrically operated solenoid valve it is possible to vary flow in on-off increments with 31 steps. Outlet from the chambers or modules is through uniform equally spaced brass tubes. The module is a 24 inch rectangular box about 1 inch deep and oriented so that the tubes or needles form a horizontal plane to let the water drip vertically downward toward the tilting flume. Each module has 672 needles spaced on a 1 inch triangular pattern. The simulator module is illustrated in Figure 1.

The rainstorm simulator consists of 100 simulator modules spaced and supported to make a continuous simulator 20 feet square. Each module has separate controls so that a spatially moving storm with time-changing intensities can be simulated. The 500 switches are controlled by a programmed computer or if desired can be manually operated.

Raindrop sizes and velocities of impact have been designed to represent the energy of typical high intensity storms. The spatial distribution of the rain is essentially uniform and the control of application rates is within the accuracy requirement of most experiments. The simulator has been extensively tested and used in research since its construction in 1973.

The tilting flume contains a soil layer 20 feet square 1 foot deep. The flume is designed so that a vacuum chamber can be maintained beneath the soil to aid infiltration when this is necessary, and water flow can be maintained over the top of the soil when desired. The rainfall simulator is supported over the flume so that rain falls directly on to the soil layer.

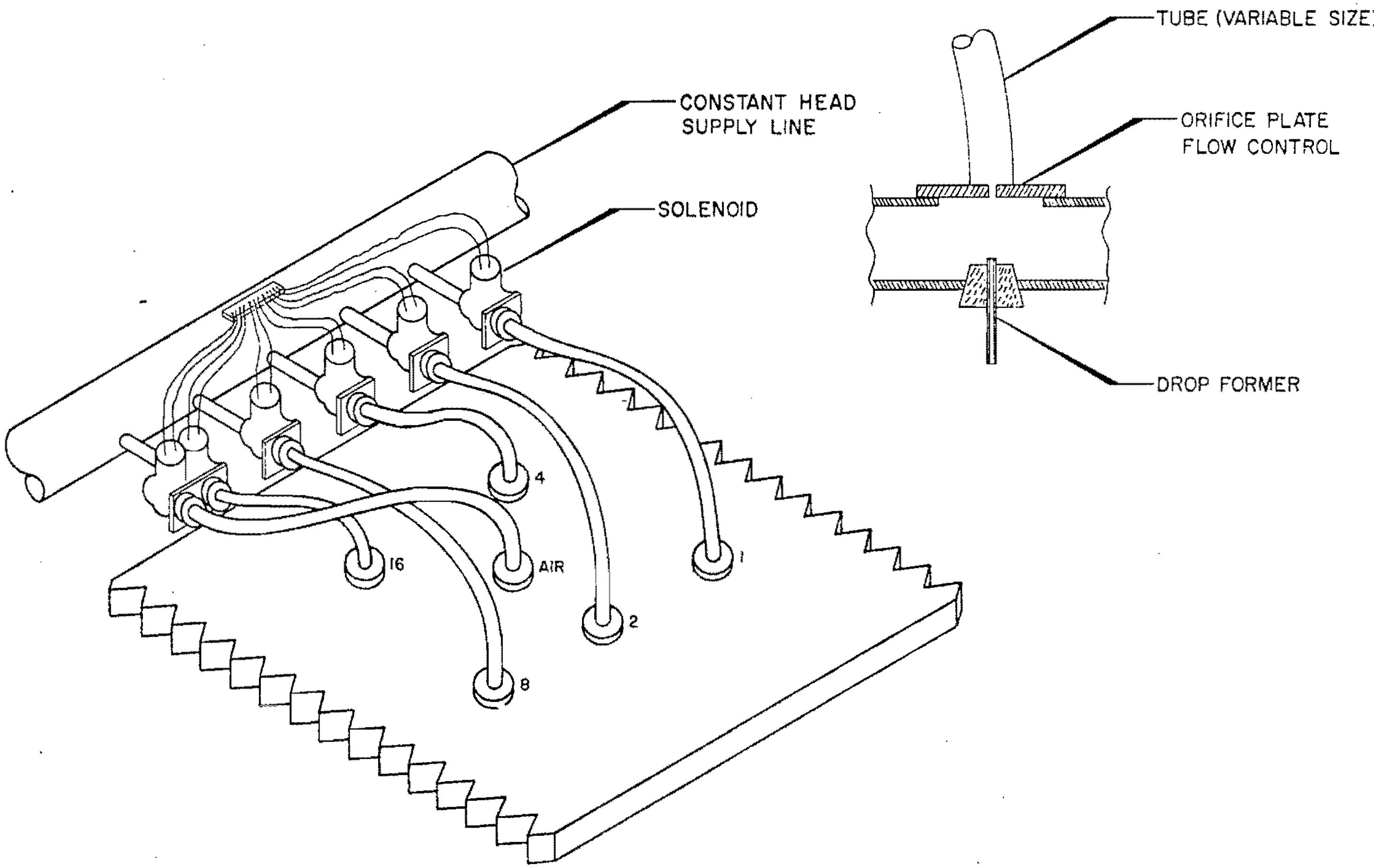


Figure 1. Typical rainstorm simulator module.

Approximately 1 foot depth of soil is supported in the tilting flume by a metal grating covered with filter cloth through which water can drain. The flume is divided into three test plots, each measuring approximately 4 feet by 19.5 feet. These plots are separated from each other and from the side walls of the flume by 2-foot wide buffer strips. Runoff from each test plot is captured in a cone-shaped filter, then dried and weighed for determining the exact amount of fiber and soil leaving the plot.

The flume can be tilted to any angle up to about 40° from horizontal by means of a hydraulic hoist. The simulator and tilting flume are illustrated in Figure 2.

EROSION CONTROL PRODUCTS

Five different products were provided by FIBREX CORPORATION in sufficient amounts to complete the desired testing. The composition of these products is as follows:

No. 1. 50% newspapers and 50% cardboard.

No. 2. 10% wood chips, 50% newspapers, and 40% cardboard.

No. 3. 20% wood chips, 40% magazines, and 40% cardboard.

No. 4. 20% wood chips, 40% newspapers, and 40% cardboard.

No. 5. 50% newspapers and 50% cardboard (made in Hyrum, Utah).

TEST PROCEDURES

Plot Preparation

After every test run the top soil was removed and discarded from each plot to the depth that erosion had occurred. New soil was added to replace that removed, then each plot was cultivated with a garden tiller

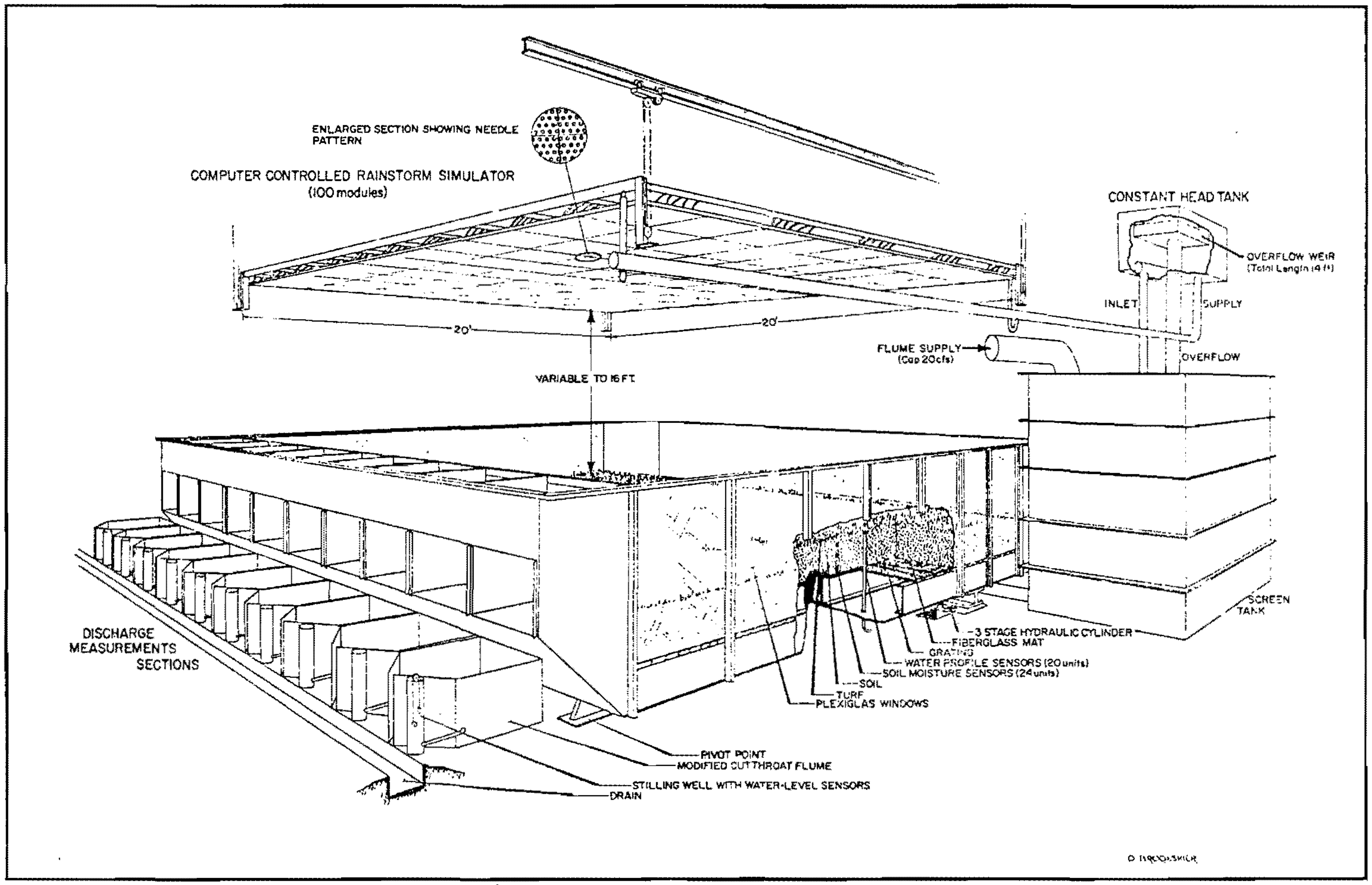


Figure 2. Rainstorm simulator with tilting flume.

to a depth of approximately 6 inches. It was then raked smooth, and compacted with a lawn roller filled with water. Soil used in the plots is a silty clay loam containing 2.9 percent organic matter.

Product Application

At an application rate of 2000 lbs per acre, each square foot of soil surface received 0.046 lbs of product, or a total of 3.6 lbs per test plot. The material was mixed thoroughly with water in a laboratory-size hydromulcher and applied uniformly to the soil surface while the test bed was in a horizontal position. A bank of lights was installed over the test bed for approximately 12 hours to provide heat for partially drying the material before rain was applied.

Rainfall Application

With the bank of lights removed the test bed was tilted to a slope of 2:1 and covered with a piece of plastic. The rainfall simulator was turned on at full capacity to purge the air from the system. (During this purging the rain fell onto the plastic and ran into the drain without wetting the plots.) When the purging was complete the rainfall rate was adjusted to 8 inches per hour and allowed to stabilize. Plastic covering the test beds was then quickly removed so the rain could fall directly onto the test plots, and the time clock was started. Total time was recorded from the instant that rain began falling onto the plots until failure of the mulch occurred. Failure was defined as the instant at which the equivalent of two tons per acre of soil had been washed from the plot. As each plot failed, rainfall to that plot was stopped and the plot was drained and dried in preparation for the next test.

TEST RESULTS

The following data were recorded during the testing of specified products. Failure point was previously defined as the instant at which the equivalent of two tons per acre of soil had eroded from the plot. In reality, this could not be determined exactly so had to be estimated due to the fact that water, soil and mulch were leaving the plots together as a mixture and there was no way to measure the soil separately during the test. All material leaving each plot was captured, dried, and weighed, so the figures shown below in each case are the combined dry weights of soil plus mulch.

Product		Replications		
		North Plot	Center Plot	South Plot
No. 1.	Time until failure	4 min-0 sec	3 min-40 sec	3 min-35 sec
	Eroded material	10.7 lbs	11.2 lbs	11.9 lbs
No. 2.	Time until failure	3 min-40 sec	3 min-16 sec	3 min-40 sec
	Eroded material	14.5 lbs	17.6 lbs	13.3 lbs
No. 3.	Time until failure	4 min-10 sec	5 min-15 sec	4 min-45 sec
	Eroded material	11.8 lbs	11.0 lbs	9.5 lbs
No. 4.	Time until failure	4 min-10 sec	4 min-0 sec	4 min-10 sec
	Eroded material	14.5 lbs	14.4 lbs	13.3 lbs
No. 5.	Time until failure	4 min-5 sec	4 min-20 sec	3 min-50 sec
	Eroded material	10.3 lbs	15.0 lbs	16.8 lbs
Bare soil	Time until failure	4 min-5 sec	3 min-50 sec	5 min-30 sec
	Eroded material	47.9 lbs	44.6 lbs	75.2 lbs

DISCUSSION OF RESULTS

In these erosion control tests the rainfall rate, its height of fall, the type of soil, and the soil slope were all held constant. A standardized method of preparing the test beds was also used so that this parameter as well as soil moisture were kept as nearly constant as possible. In every case the interval of time from the instant rainfall began until material started leaving the plots was longer for bare soil than for any of the mulches. However, after erosion began, its rate was slower for every mulch-covered plot than for the bare soil. Apparently the wet mulch partially seals the soil surface, causing runoff to begin more quickly, but it also has a binding effect on soil particles which decreases its rate of erosion as compared with bare soil. Thus the time interval between initiation of rainfall and commencement of runoff is determined by the treatment given to the soil surface, in this instance, the kind of mulch used, or no treatment at all.

If, using the recorded data, we divide the total time until failure by the weight of the material eroded, we come up with an "apparent" rate of erosion which reflects the effect of each mulch on the time until erosion begins as well as its effect on the erosion rate. Even though this method could not be used for calculating actual rates of erosion, it is an effective way of comparing one erosion control product with another.

Using this method and averaging the replications, we obtain the following results from the recorded data

Product	Apparent Erosion Rate	Effectiveness of Product
No. 1	3.0 lbs/min	2nd
No. 2	4.3 lbs/min	5th
No. 3	2.3 lbs/min	1st
No. 4	3.4 lbs/min	3rd
No. 5	3.5 lbs/min	4th
Bare soil	12.3 lbs/min	6th

Two additional methods of analyzing the data were employed: 1) adjusting the data so that the weight of eroded material for each test is the same, and then assuming that erosion commenced at time zero and proceeded at a constant rate until failure, and 2) subtracting from total time the interval from rainfall initiation 'til the commencement of run-off, then assuming a constant erosion rate which is obtained by dividing the remaining time by the total weight of eroded material. In each instance product number 3 was most effective, number 2 least effective, and there was very little difference among the other three.

SUMMARY

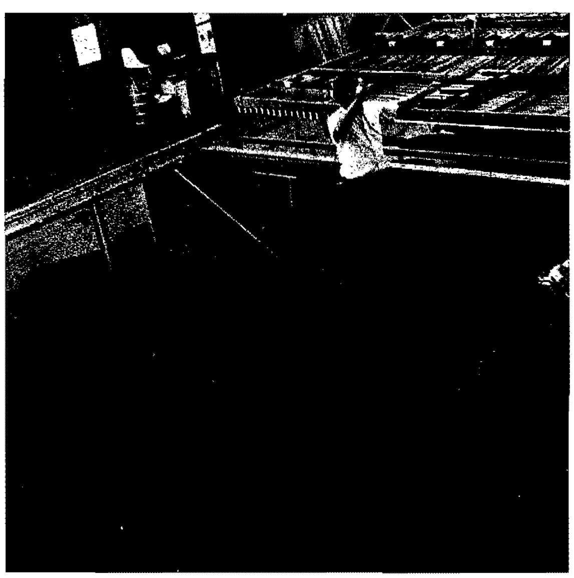
Based on the erosion control tests described in this report, the apparent comparative effectiveness of the products tested is as listed below. Additional testing of the same products on different soils, soil slopes, and rainfall rates may vary this ranking. However, another significant benefit of the various products tested may be in their use as a growth medium for plants as well as for controlling erosion, but this aspect has not been considered in the present tests.

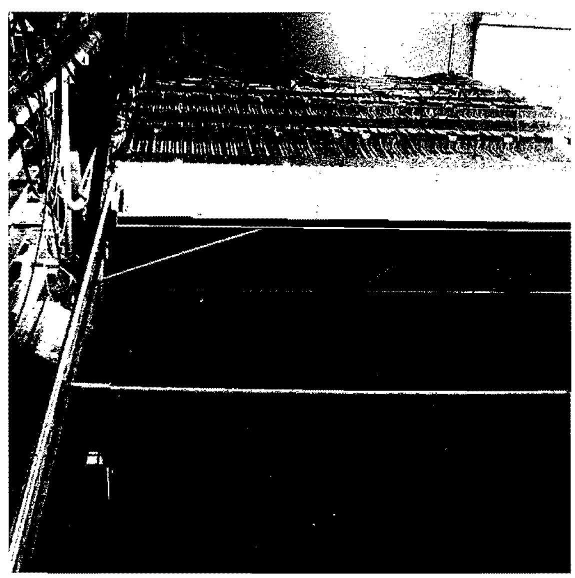
Product	Erosion Rate (lbs/min)		Effectiveness Ranking	
No. 3	2.3		1st	1st
No. 1	3.0		2nd	
No. 4	3.4	Avg. = 3.3	3rd	2nd
No. 5	3.5		4th	
No. 2	4.3		5th	3rd

All five of the products tested appear to have utility for controlling erosion on sloping land, although product number 3 seems to be the most effective. They are beneficial in four ways. First, they tend to bind the soil particles together on the ground surface, making them more resistant to rainfall impact energy as well as to that from water running down the slope. Secondly, the mulch itself absorbs some of the erosive energy of the impacting raindrop as well as that from water running down the slope so that less remains to act on the soil particles themselves. Thirdly, the mulch assists in the retention of moisture, thus delaying the drying-out time of the soil, which aids in the germination of seeds. Fourthly, it assists in holding seeds in place and providing cover for them on the soil surface.

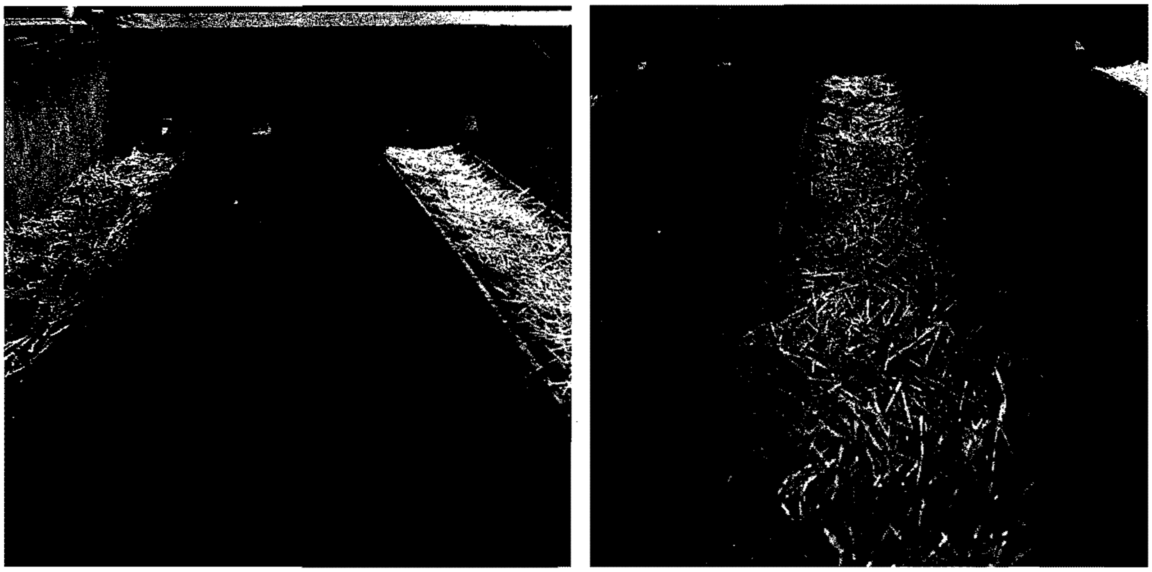
Better results are obtained by mixing the mulch with water and then applying it under pressure with a hydromulcher than by applying it dry and then spraying it with water. This is apparently due to the fact that the wet mulch applied under pressure impacts the soil surface as small blobs which wrap themselves around the soil particles, binding them to each other and to the rest of the mulch blanket. Seed and fertilizer also can be mixed with the water and mulch and all applied together in a single operation.

Three replications of each mulch test were run simultaneously.

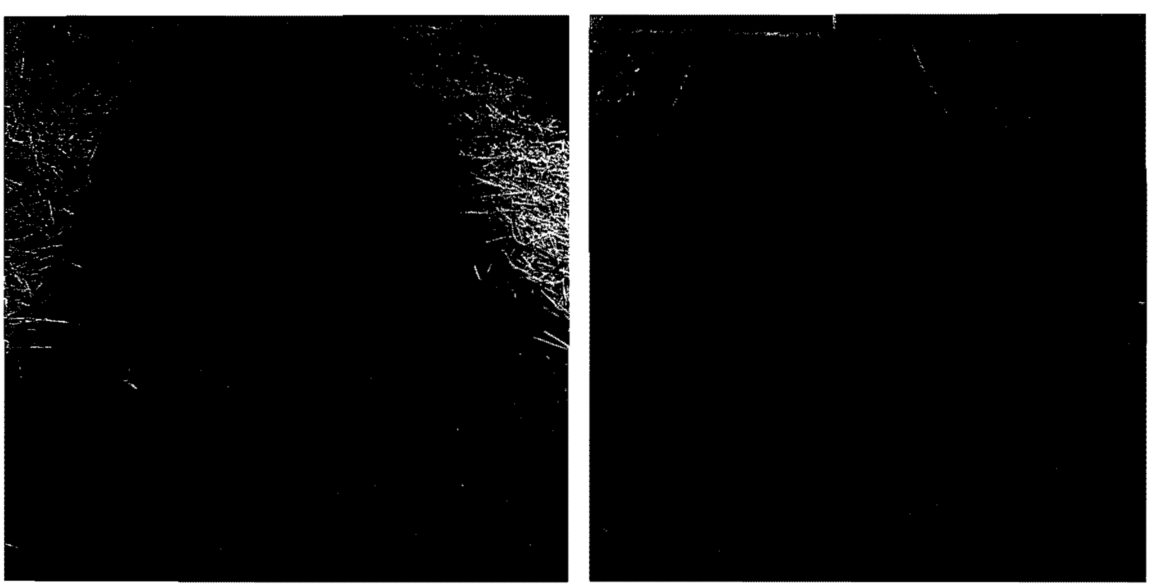




Heat from bank of fluorescent lights was used to shorten drying time of mulch.



Mulched plots viewed downslope.



Mulched plot before and after erosion.