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January 1980

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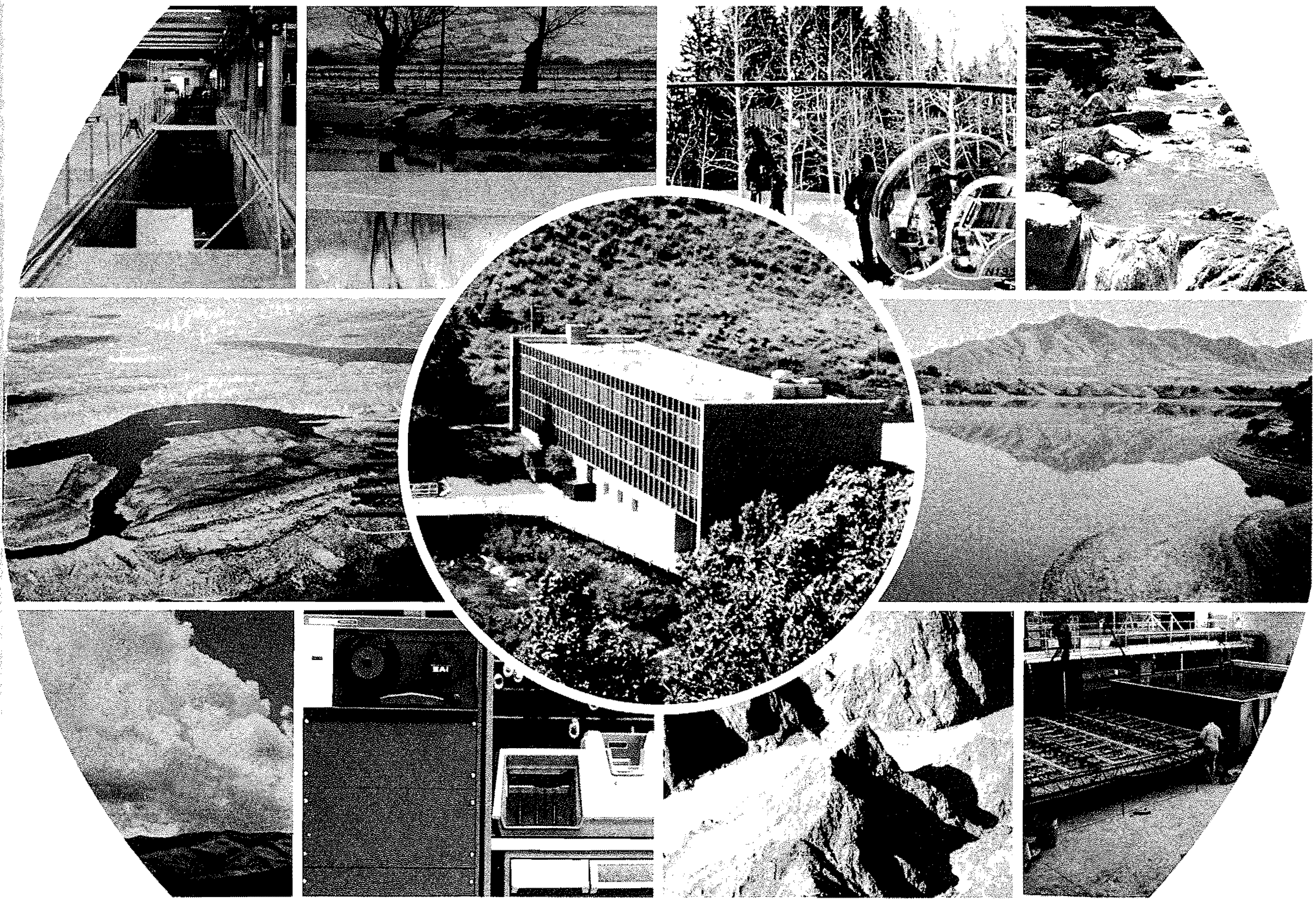
Final Report to CONWED CORPORATION

C. Earl Israelsen, William F. Campbell, Eugene K. Israelsen, Ronald V. Canfield, David Ianson



Utah Water Research Laboratory and
Plant Science Department
Utah State University
Logan, Utah 84322

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CONWED CORPORATION

Final Report

EVALUATION OF PARTICULAR MULCHES AS PLANT GROWTH MEDIA AND EROSION INHIBITORS

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INTRODUCTION

Increasing public awareness of the desirability of protecting the environment from soil erosion caused by wind and water has centered attention on large construction projects such as highways and housing subdivisions, as well as on individual building sites and parking lots. If unattended, sediment produced from these areas pollutes surface water, restricts drainage, fills reservoirs, damages adjacent land, and upsets the natural ecology of lakes and streams.

The search continues for products and practices that will prevent or lessen the amount of sediment leaving construction sites. Products currently in use include chemical as well as organic materials, and they are applied with varying degrees of success. Many designed to stabilize the unprotected soil for a long enough period of time for vegetation to become established are in wide use and are quite effective (Clyde et al. 1978). Moreover, applying organic material to the soil surface around shallow-rooted crops has been a cultural practice for many years (Russell 1961). Janick (1963) summarized the effects of mulching as conservation of soil moisture, reduction of surface runoff and erosion, reduction of evaporation, and possible control of weeds. Others (Borst and Woodburn 1942; Duley 1939) have indicated the value of mulches in reducing runoff and erosion. Mulching has been reported as superior to other treatments for reducing soil and water losses and stabilizing bare slopes before grass is established (Swanson et al. 1965). Gilbert and Davis (1967) and Blaser (1962), in studies of highway slope stabilization, found mulches improved seed germination and seedling growth by conserving moisture and protecting highway slopes against erosion.

Many materials have been evaluated for use as a mulch, including bark, wood wastes, soybean residues, wheat straw, and seaweed (Bollen and Glennie 1961; Kidder et al. 1943; Latimer and Percival 1947). McKee et al. (1964) found wheat straw to be one of the best mulches, particularly when used to aid vegetation establishment on steep cut slopes of highways. Osborne and Gilbert (1978) also demonstrated that shredded hardwood bark mulch provided adequate erosion control on highway slopes. CONWED Corporation produces and markets wood fiber mulches that are intended to foster plant growth and inhibit erosion. The objective of this study was to evaluate, using simulated rainfall and sunlight, the effectiveness of various fiber mulches for controlling erosion to facilitate the establishment and growth of barley on a 2:1 (50 percent) slope.

MATERIALS AND METHODS

Description of Testing Facility

Rainfall simulator. 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 a 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. Each 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 toward the tilting flume. Each module has 672 needles spaced on a 1 inch triangular pattern.

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.

Tilting flume. The tilting flume is square and measures 20 feet on each side. The flume is designed so that a vacuum can be maintained beneath the soil to aid infiltration when this is necessary, and water sheet 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 onto the soil layer.

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 mulch and soil leaving the plot.

The flume can be tilted to any angle up to 43^{o} from horizontal by means of a hydraulic hoist. Figure 1 shows the rainfall simulator in position over the tilting flume.

Sunlight simulator. A balance of radiant energy needed for good plant growth is provided to the test plots by a sunlight simulator which utilizes incandescent as well as fluorescent lamps. It is the same size as the tilting flume, square, measuring 20 feet on each side. It is rolled on and off the test plots on horizontal rails mounted on top of the side walls of the tilting flume. When in position, it is about 3 feet above the test plot surfaces, and provides illumination at a photon flux density (400 - 700 nm) of 216 $\mu E \cdot m^{-2} \cdot sec^{-1}$ (measured with a Li-cor

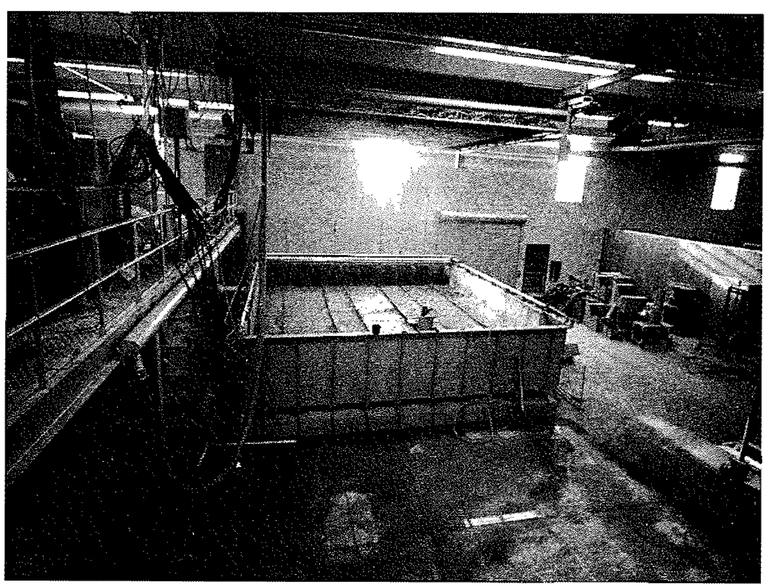

Figure 1. Erosion control testing facility.

190 S quantum sensor on a model LI-185 quantum radiometer/photometer). Figure 2 shows the sunlight simulator in position on the tilted flume.

Products Included in Tests

Five different products were provided by CONWED Corporation in sufficient amounts to accomplish the desired testing. Their brand names and manufacturers are as follows:

1. Hydro Mulch Fiber
2. Hydro Mulch Fiber plus Additive 80
3. Hydro Mulch 2000 Fiber

The above mulches are manufactured by

CONWED Corporation
332 Minn. Street
P.O. Box 43237
St. Paul, Minnesota 55164

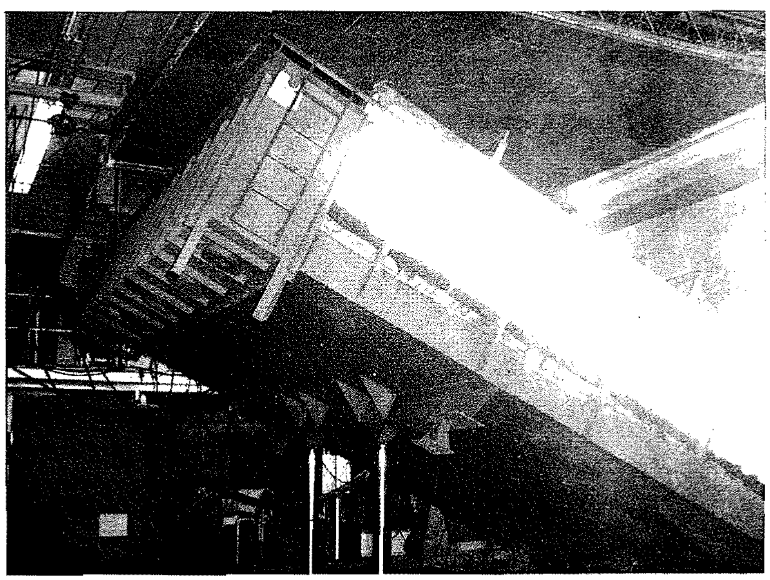

Figure 2. Rainfall and sunlight simulators in position over tilting flume.

4. Cellin Fiber Mulch

Cellin Mfg. Inc
P.O. Box 688
Springfield, Virginia 22150

5. Fibrex Spray Sod

FIBREX Corporation
P.O. Box 258
Grain Valley, Missouri 64029

Test Description and Procedures

Plot preparation. Each of the three test plots was filled with a silt loam soil having the following composition: Very coarse sand = 0.6 percent; coarse sand = 0.9 percent; medium sand = 1.1 percent; fine sand = 9.2 percent; very fine sand = 8.8 percent; total sand = 20 percent; total silt = 57 percent; total clay = 23 percent; total organic matter = 2.9 percent.

After every test run the top layer of soil and mulch 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 to a depth of approximately 6 inches. It was then raked smooth and uniformly compacted with a lawn roller filled with water.

Installation and use of psychrometers. After the plots were prepared and before the mulch was applied, three psychrometers were installed in each plot at preselected locations along the lengthwise axes (see Figures 3 and 4). These were buried at a depth of 6 inches beneath the soil surface, and leads from them extended to the outside of the test bed for ease in reading. With the aid of these psychrometers, soil moisture and temperature readings were taken in each plot after the crop was planted

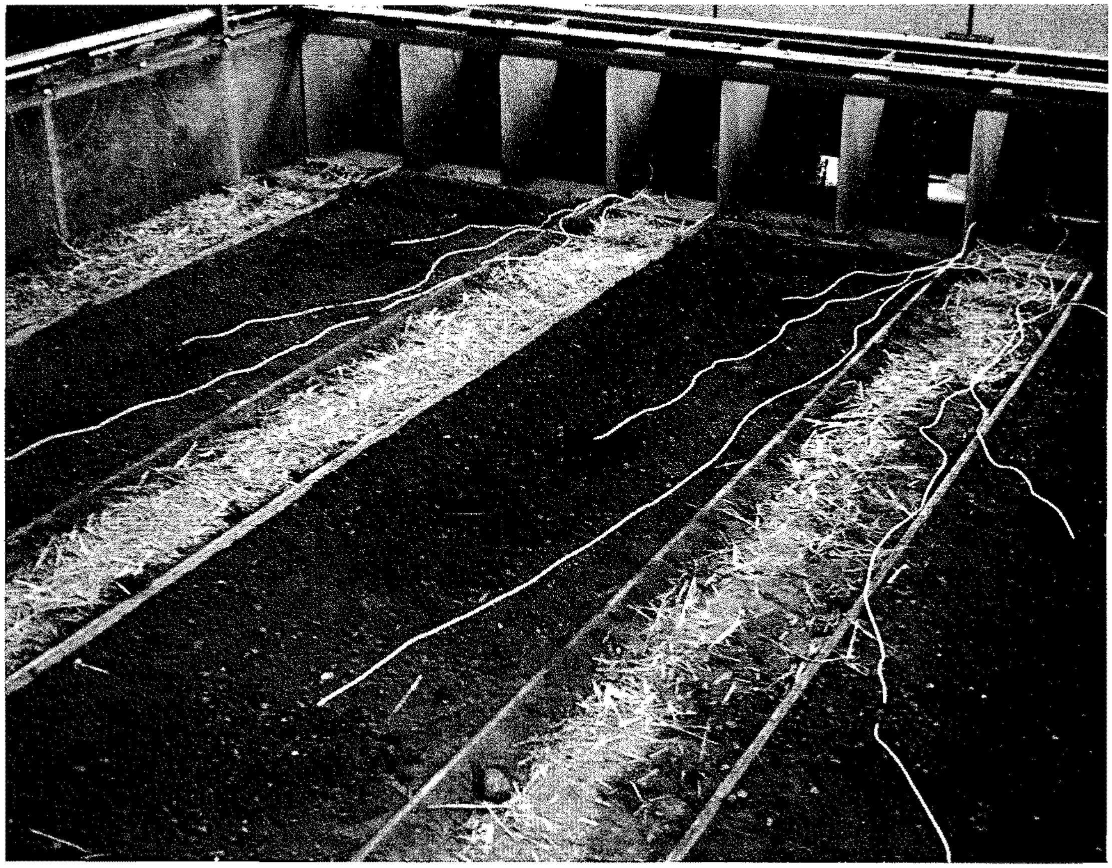

Figure 3. Psychrometers in position in bare soil test plots for measuring moisture and temperature.

Figure 4. Mulched and seeded test plots after psychrometers are in place.

but before the rain was applied, and then on a daily basis therefore until the end of each test.

Rainfall application. The test bed containing the mulch-covered plots 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 4 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 time at which the equivalent of approximately two tons per acre of soil had been washed from the plot. As each plot failed, rainfall to that plot was stopped so that no additional soil, seed or mulch would be lost.

Mulch and seed application. Two of the products, Cellin Fiber Mulch and Conwed Hydro Mulch, were applied to the plots in three replications each, at rates of 800, 1600, and 2400 pounds per acre. The other three mulches were applied at a single rate of 1600 pounds per acre, also with three replications of each. The mulch and seed were mixed thoroughly in a water slurry in a hydromulcher and then applied under pressure through a hose to the plots while the test bed was in a horizontal position (Figure 5). Afterwards the plots were allowed to drain overnight before rain was applied.

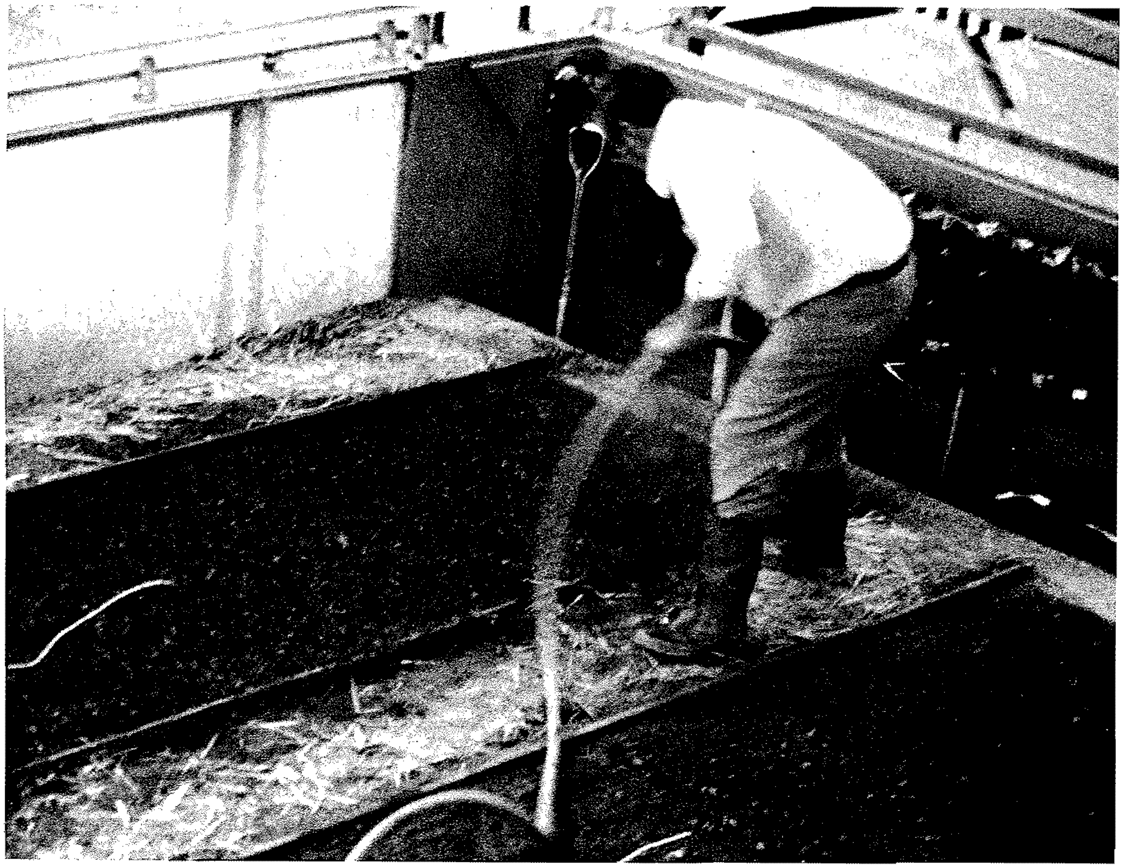

Figure 5. Applying mulch and seed with hydromulcher.

Sunshine application. When rainfall ceased, the sunlight simulator was rolled into position over the plots, and the entire assembly was tilted to a 2:1 slope (50 percent). Sunlight was applied to the plots for 12 hours and then removed for 12 hours, alternately, throughout the period of each test. Plants can be seen growing in the plots beneath the sunlight simulator in Figure 6.

Harvesting the crop. When the predetermined time for the test had elapsed, the test bed was returned to a horizontal position and the sunlight simulator was removed from above the plots. Using the template shown in Figure 7, three 1-foot square sample areas were randomly selected

Figure 6. Plant growth in test plots beneath sunlight simulator.

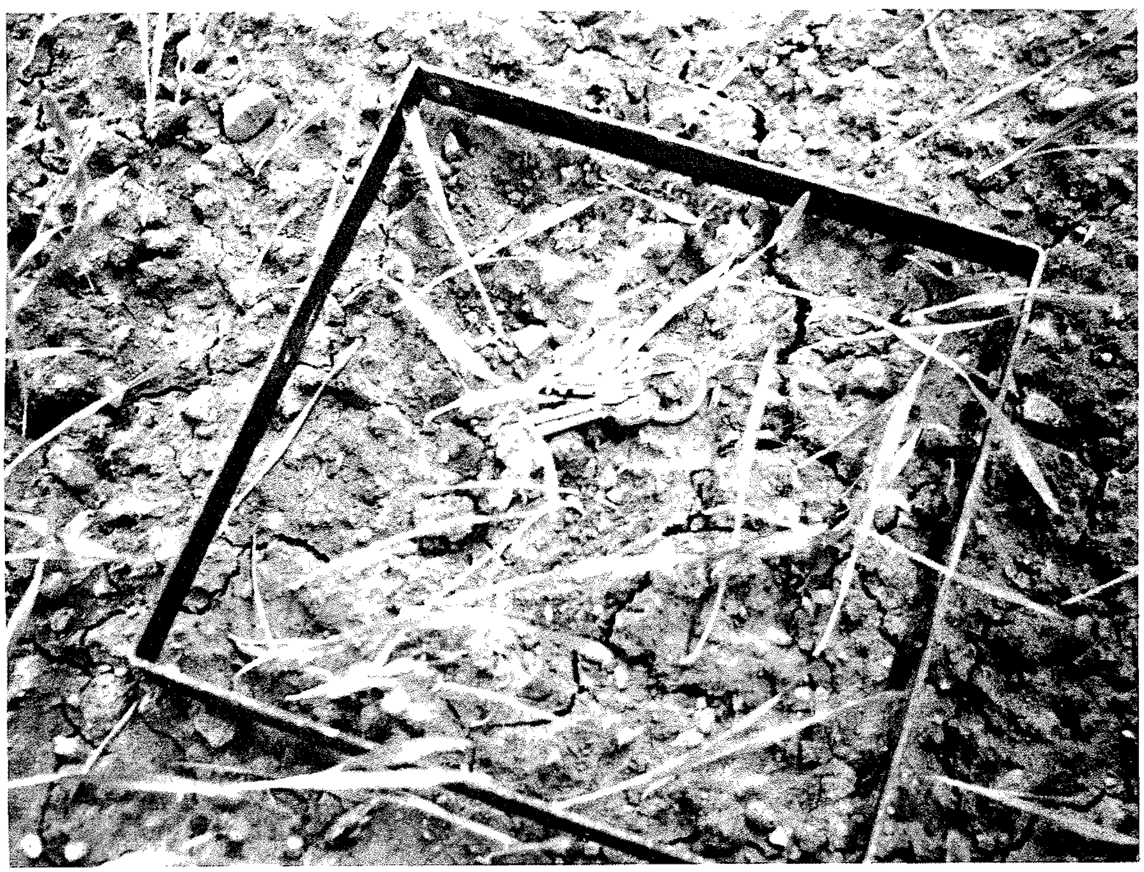

Figure 7. Square metal template for isolating sampling areas in test plots.

on each plot, one at the lower end of the slope, one towards the center, and another near the top. Within each of these areas a count was made of the total number of plants and also of the seeds that did not germinate. The height of each plant was measured, then all plants within each sample area were cut off at the soil surface and weighed. Psychrometers were removed from the plots, and preparations were begun for the next test.

RESULTS AND DISCUSSION

Vegetation

Barley growing on the bare soil exhibited the greatest amount of growth as judged by plant height and dry weight (Table 1). Cellin and Conwed Hydro Mulch, at the various rates, appeared to cause a slight reduction in plant height and a substantial reduction in dry weight. Major reductions in plant height as well as the dry weight were noted when Conwed Hydro Mulch-2000, Conwed Hydro Mulch plus additive 80 and Fibrex Spray Sod were used. It should be pointed out, however, that with the last three products tested the plants were grown for only 5 days whereas with the other products the plants were grown for 7 days. Thus plant height and plant dry weight, are understandably less. It may well be that an additional two days of growth would eliminate the differences in these parameters. The slightly greater difference in plant height and dry weight of plants grown on the bare soil may be explained on the basis of plant competition, as the seeding rate for the bare soil was 185 lbs/A as compared to 215 lbs/A for all of the tested compounds.

When all of the plant parameters are examined as a function of position in the experimental plot some interesting observations are

Table 1. Effects of various mulches on plant height, soil temperature, plant dry weight, and percentage germination of barley seeds.

	Treatment	Pl. Ht. cm		Soil Temp. °C		Dry Wt. gms		No. Plts.		No. Seeds		% Germ.
		$\bar{x}$	± Sd	$\bar{x}$	± Sd	$\bar{x}$	± Sd	$\bar{x}$	± Sd	$\bar{x}$	± Sd	
1	Bare Soil	12.0	1.8	21.9	1.2	0.75	0.70	25.8	16.3	-	-	-
2	Cellin - 800 lbs/A	9.0	2.1	19.9	1.6	0.11	0.05	12.2	3.6	-	-	-
3	Cellin - 1600 lbs/A	10.4	1.7	22.7	3.1	0.14	0.06	14.0	6.0	12.8	5.7	52
4	Cellin - 2400 lbs/A	9.7	0.9	21.2	2.9	0.31	0.12	30.1	10.5	7.4	3.1	80
5	Conwed Hydro Mulch 800 lbs/A	10.4	1.1	24.7	2.8	0.30	0.12	24.0	9.6	11.8	4.9	67
6	Conwed Hydro Mulch 1600 lbs/A	10.2	1.3	21.0	2.8	0.27	0.17	24.0	13.9	12.1	2.9	66
7	Conwed Hydro Mulch 2400 lbs/A	10.0	0.6	23.1	0.9	0.35	0.06	26.6	5.1	14.1	5.5	65
8	Conwed Hydro Mulch-2000 1600 lbs/A	5.5	0.5	25.6	3.7	0.21	0.04	41.2	8.5	4.1	2.7	91
9	Conwed Hydro Mulch + Add. 80 1600 lbs/A	5.4	0.6	26.7	5.7	0.18	0.04	39.1	6.5	7.2	2.1	84
10	Fibrex Spray Sod 1600 lbs/A	7.2	0.9	25.6	3.3	0.20	0.05	23.2	9.3	6.6	4.0	78

noted. There was no visible movement or removal of seeds, mulch, or soil from the upper ends of the plots on any of the runs during the time that rain was falling. However, this was not the case on the central and lower portions. Generally plants on the lower portions of the slopes exhibited greater plant height, dry weight, and number of plants per square foot (Tables 2, 3, 4, 5, and 6). The increase in number of plants per unit area is easily explained on the basis of seeds from above washing down, lodging and becoming established. The slightly greater plant height might be explained on the basis of the decreased lighting in that region inducing slight etiolation in the plants. This is a readily accepted phenomenon of plants growing in low light areas. It does not, however, account for the greater dry weight as etiolation is a function of cell elongation rather than of growth.

Soil temperature remained relatively constant until the testing of the last three products (Table 1). This may have been due to the fact that a longer time, therefore more rainfall, was needed to cause failure of the Conwed 2000 and Conwed plus additive 80 mulches. Fibrex Spray Sod was tested after these two and the soil was still extremely wet. Water, being a relatively good conductor of heat, retained the heat from the lights to a greater extent than the earlier experiments that did not require as much water. The extra water may also have caused some waterlogging of the soil, thereby reducing plant growth. When these data are compared as a function of position in the experimental plot there is not much change (Table 6). It is interesting to note (Table 1) that the

Table 2. Effects of various mulches on plant height (cm) as a function of position in the experimental plot.

	Treatment	Position		
		Upper	Middle	Lower
1	Bare Soil	12.48	10.28	13.15
2	Cellin- 800 lbs/A	7.78	6.30	11.13
3	Cellin- 1600 lbs/A	10.62	10.65	11.12
4	Cellin- 2400 lbs/A	9.67	9.27	10.07
5	Conwed Hydro Mulch- 800 lbs/A	9.47	10.87	11.02
6	Conwed Hydro Mulch- 1600 lbs/A	10.12	9.83	10.50
7	Conwed Hydro Mulch- 2400 lbs/A	9.84	10.09	9.99
8	Conwed Hydro Mulch-2000- 1600 lbs/A	5.69	5.73	5.06
9	Conwed Hydro Mulch+Add. 80- 1600 lbs/A	4.86	5.25	6.11
10	Fibrex Spray Sod- 1600 lbs/A	8.25	6.87	6.57

Table 3. Effects of various mulches on plant dry weight (gms) as a function of position in the experimental plot.

	Treatment	Position		
		Upper	Middle	Lower
1	Bare Soil	1.12	0.15	0.97
2	Cellin- 800 lbs/A	0.08	0.11	0.14
3	Cellin- 1600 lbs/A	0.16	0.10	0.16
4	Cellin- 2400 lbs/A	0.34	0.24	0.36
5	Conwed Hydro Mulch- 800 lbs/A	0.15	0.36	0.38
6	Conwed Hydro Mulch- 1600 lbs/A	0.24	0.24	0.34
7	Conwed Hydro Mulch- 2400 lbs/A	0.35	0.39	0.31
8	Conwed Hydro Mulch-2000- 1600 lbs/A	0.19	0.25	0.18
9	Conwed Hydro Mulch+Add. 80- 1600 lbs/A	0.17	0.17	0.21
10	Fibrex Spray Sod- 1600 lbs/A	0.17	0.22	0.22

Table 4. Effects of various mulches on the number of plants per square foot as a function of position in the experimental plot.

	Treatment	Position		
		Upper	Middle	Lower
1	Bare Soil	36.7	15.7	25.0
2	Cellin- 800 lbs/A	10.7	12.3	13.7
3	Cellin- 1600 lbs/A	15.3	10.3	15.0
4	Cellin- 2400 lbs/A	35.3	23.3	31.7
5	Conwed Hydro Mulch- 800 lbs/A	13.3	26.7	32.0
6	Conwed Hydro Mulch- 1600 lbs/A	22.0	19.7	30.3
7	Conwed Hydro Mulch- 2400 lbs/A	26.0	29.7	24.0
8	Conwed Hydro Mulch-2000- 1600 lbs/A	37.7	46.0	40.0
9	Conwed Hydro Mulch+Add. 80- 1600 lbs/A	39.0	37.2	41.4
10	Fibrex Spray Sod- 1600 lbs/A	31.3	21.0	24.3

Table 5. Effects of various mulches on the number of ungerminated seeds as a function of position in the experimental plots.

	Treatment	Position		
		Upper	Middle	Lower
1	Bare Soil	-	-	-
2	Cellin - 800 lbs/A	-	-	-
3	Cellin - 1600 lbs/A	16.7	9.7	10.3
4	Cellin - 2400 lbs/A	5.7	6.7	10.0
5	Conwed Hydro Mulch - 800 lbs/A	8.3	15.1	14.7
6	Conwed Hydro Mulch - 1600 lbs/A	9.7	13.7	13.0
7	Conwed Hydro Mulch - 2400 lbs/A	17.6	19.3	11.7
8	Conwed Hydro Mulch-2000 - 1600 lbs/A	3.7	5.0	3.7
9	Conwed Hydro Mulch + Add. 80 - 1600 lbs/A	7.4	6.4	7.1
10	Fibrex Spray Sod - 1600 lbs/A	6.3	10.0	3.3

Table 6. Effects of various mulches on soil temperature as a function of position in the experimental plot.

	Treatment	Position		
		Upper	Middle	Lower
1	Bare Soil	22.2	22.2	23.6
2	Cellin - 800 lbs/A	20.3	20.1	18.8
3	Cellin - 1600 lbs/A	21.5	23.4	23.1
4	Cellin - 2400 lbs/A	21.0	21.0	21.7
5	Conwed Hydro Mulch - 800 lbs/A	25.6	27.0	23.2
6	Conwed Hydro Mulch - 1600 lbs/A	21.6	20.8	20.6
7	Conwed Hydro Mulch - 2400 lbs/A	23.1	23.3	22.6
8	Conwed Hydro Mulch-2000 - 1600 lbs/A	28.3	26.3	25.4
9	Conwed Hydro Mulch + Add. 80 - 1600 lbs/A	26.3	26.4	27.4
10	Fibrex Spray Sod - 1600 lbs/A	26.0	25.6	25.7

number of plants with CONWED 2000 and CONWED Hydro Mulch plus additive 80 was much greater than for any other treatment, including bare soil. CONWED 2000 had also the fewest number of nongerminated seeds. (Non-germinated seed counts were not taken on runs nos. 1 and 2.)

None of the compounds tested appeared to have any phytotoxic effects on the barley. In general, a stand density of 185 to 215 lbs/A in combination with the various mulches appears to give good erosion control. Moreover, these data indicate that some of these compounds can be used successfully as mulches for road bank stabilization.

Erosion

In the erosion control tests the rainfall rate, its height of fall, the type of soil, and the soil slope were all held constant. A standardized procedure for preparing the test plots was also used so that this parameter was kept as constant as possible. Soil moisture was more difficult to control because of the variable amounts of water that were required to fail the different mulches.

If, using the recorded data (Table 7), 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 results shown in Table 8.

Figure 8 presents graphically what is indicated in Table 8, and also shows the confidence limits for the various values presented.

Table 7. Eroded material under 4 inches/hr rainfall and 2:1 slope.

Product		Replications		
		South	Center	North
1. Bare Soil	Elapsed time until erosion begins	3'-0"	3'-40"	4'-0"
	Total elapsed time	12'-30"	14'-0"	16'-0"
	Runoff material	27.3 lbs	23.4 lbs	33.7 lbs
2. Cellin (800 lbs/ac)	Elapsed time until erosion begins	2'-30"	2'-50"	2'-45"
	Total elapsed time	3'-40"	3'-40"	3'-40"
	Runoff material	5.8 lbs	5.8 lbs	6.6 lbs
3. Cellin (1600 lbs/ac)	Elapsed time until erosion begins	5'-0"	5'-15"	5'-0"
	Total elapsed time	9'-20"	10'-30"	8'-30"
	Runoff material	9.4 lbs	12.8 lbs	8.2 lbs
4. Cellin (2400 lbs/ac)	Elapsed time until erosion begins	5'-0"	5'-0"	4'-30"
	Total elapsed time	8'-0"	9'-30"	10'-30"
	Runoff material	8.3 lbs	8.5 lbs	15.4 lbs
5. Conwed (800 lbs/ac)	Elapsed time until erosion begins	2'-0"	1'-50"	2'-05"
	Total elapsed time	8'-45"	7'-45"	10'-44"
	Runoff material	9.5 lbs	9.5 lbs	18.6 lbs
6. Conwed (1600 lbs/ac)	Elapsed time until erosion begins	5'-0"	4'-30"	4'-15"
	Total elapsed time	9'-30"	9'-0"	9'-45"
	Runoff material	10.0 lbs	7.4 lbs	11.8 lbs
7. Conwed (2400 lbs/ac)	Elapsed time until erosion begins	6'-30"	6'-40"	6'-0"
	Total elapsed time	12'-0"	13'-40"	13'-0"
	Runoff material	10.8 lbs	11.2 lbs	9.3 lbs
8-a. Conwed 2000 (1600 lbs/ac)	Elapsed time until erosion begins	18'-30"	19'-0"	19'-20"
	Total elapsed time	41'-10"	44'-50"	49'-18"
	Runoff material	5.1 lbs	5.6 lbs	6.6 lbs
8-b. Conwed 2000 (1600 lbs/ac)	Elapsed time until erosion begins	20'-21"	20'-58"	20'-08"
	Total elapsed time	41'-39"	42'-58"	46'-10"
	Runoff material	6.7 lbs	5.8 lbs	6.8 lbs

Table 7. Continued.

Product		Replications		
		South	Center	North
9. Conwed (1600 lbs/ac) plus Additive 80 (8 lbs/ac)	Elapsed time until erosion begins	11'-22"	11'-01"	11'-04"
	Total elapsed time	22'-09"	26'-02"	23'-17"
	Runoff material	5.7 lbs	6.4 lbs	8.7 lbs
10. Fibrex (1600 lb/ac)	Elapsed time until erosion begins	3'-47"	5'-51"	5'-58"
	Total elapsed time	8'-48"	12'-20"	13'-54"
	Runoff material	8.5 lbs	9.0 lbs	10.0 lbs

Table 8. Mulch effectiveness ranking as indicated by apparent erosion rate.

Treatment No.	Apparent Erosion Rate	Ranking of Effectiveness of Products
1	1.99 lbs/min	10th
2	1.65 lbs/min	9th
3	1.06 lbs/min	6th
4	1.13 lbs/min	7th
5	1.35 lbs/min	8th
6	1.03 lbs/min	5th
7	0.81 lbs/min	4th
8	0.14 lbs/min	1st
9	0.30 lbs/min	2nd
10	0.80 lbs/min	3rd

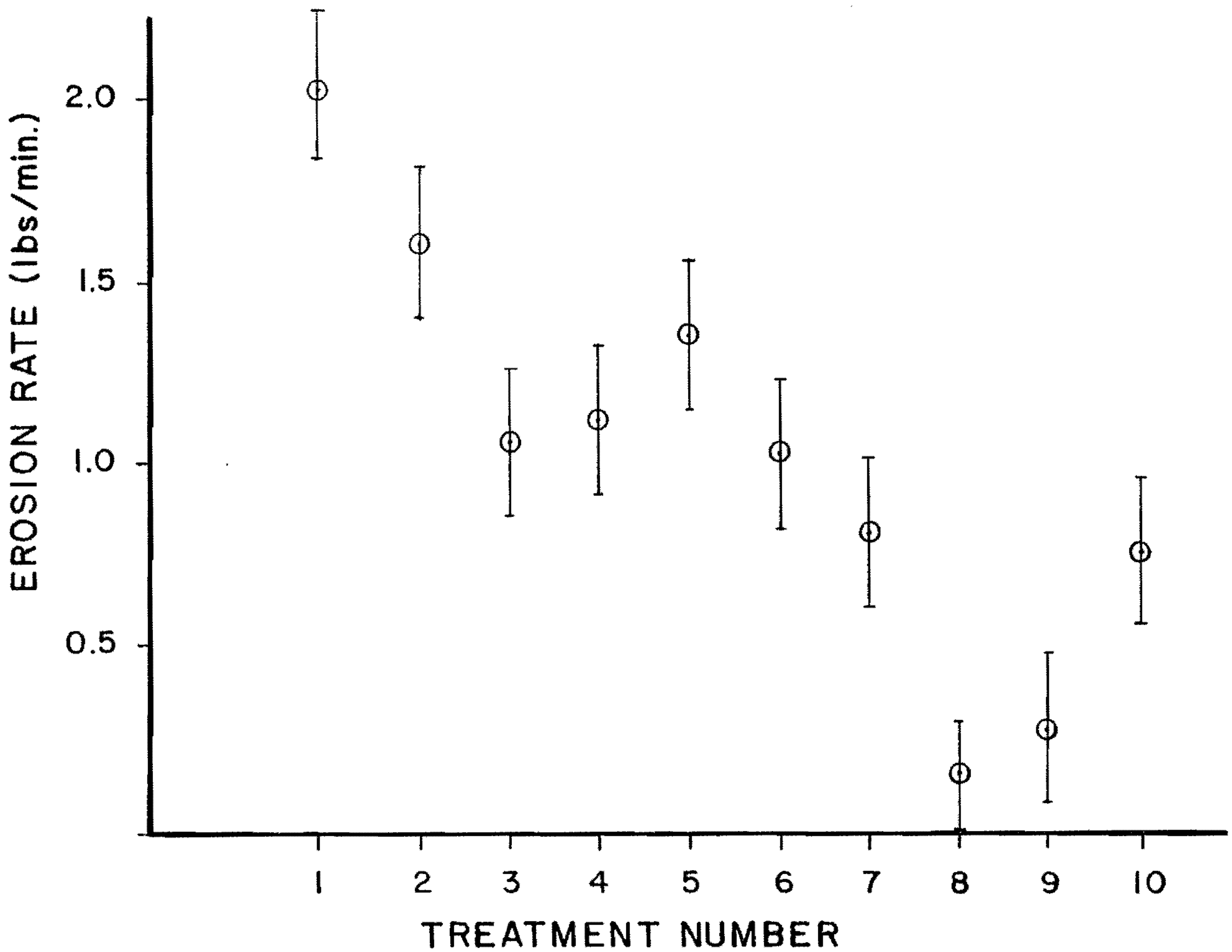

Figure 8. Apparent rate of erosion.

Each particular mulch affects the length of time that elapses from the moment rainfall starts until sediment begins running from the plots (Figure 9). It was not possible to determine exactly when sediment runoff began because the water was cloudy, so the times shown are close approximations. However, using these initiation times, calculations were made also of the average rate of erosion under each treatment from the time sediment runoff began, and these values are presented in Figure 10.

On runs numbered 8-a, 8-b, and 9 (Table 7) additional data were gathered for determining whether or not the erosion rate was constant throughout the test. Run No. 8-1 provided good erosion data, but the lights were inadvertently left off for a day and ruined the vegetation data so the test was repeated as Run No. 8-b. Erosion data from 8-a and 8-b were combined and averaged for Table 8. Figure 11 shows that rates of erosion increased quite uniformly throughout the period of the tests for CONWED-2000 and for Conwed Hydro Mulch plus additive 80.

SUMMARY

Significant differences exist among the mulches tested as to their effectiveness in controlling erosion on a slope, not only because of differences in application rates of the materials but also because of apparent inherent differences in the mulches themselves. Their differences in fostering plant growth are not as pronounced, although some might be significant. If one were to use total number of plants or percent germination of seeds (Table 1) as indicators of effectiveness of mulches for fostering plant growth, then treatment Number 8 (Conwed Hydro Mulch-2000 @ 1600 lbs/acre) is noticeably more effective for both fostering plant growth and for controlling erosion than any of the other mulches tested.

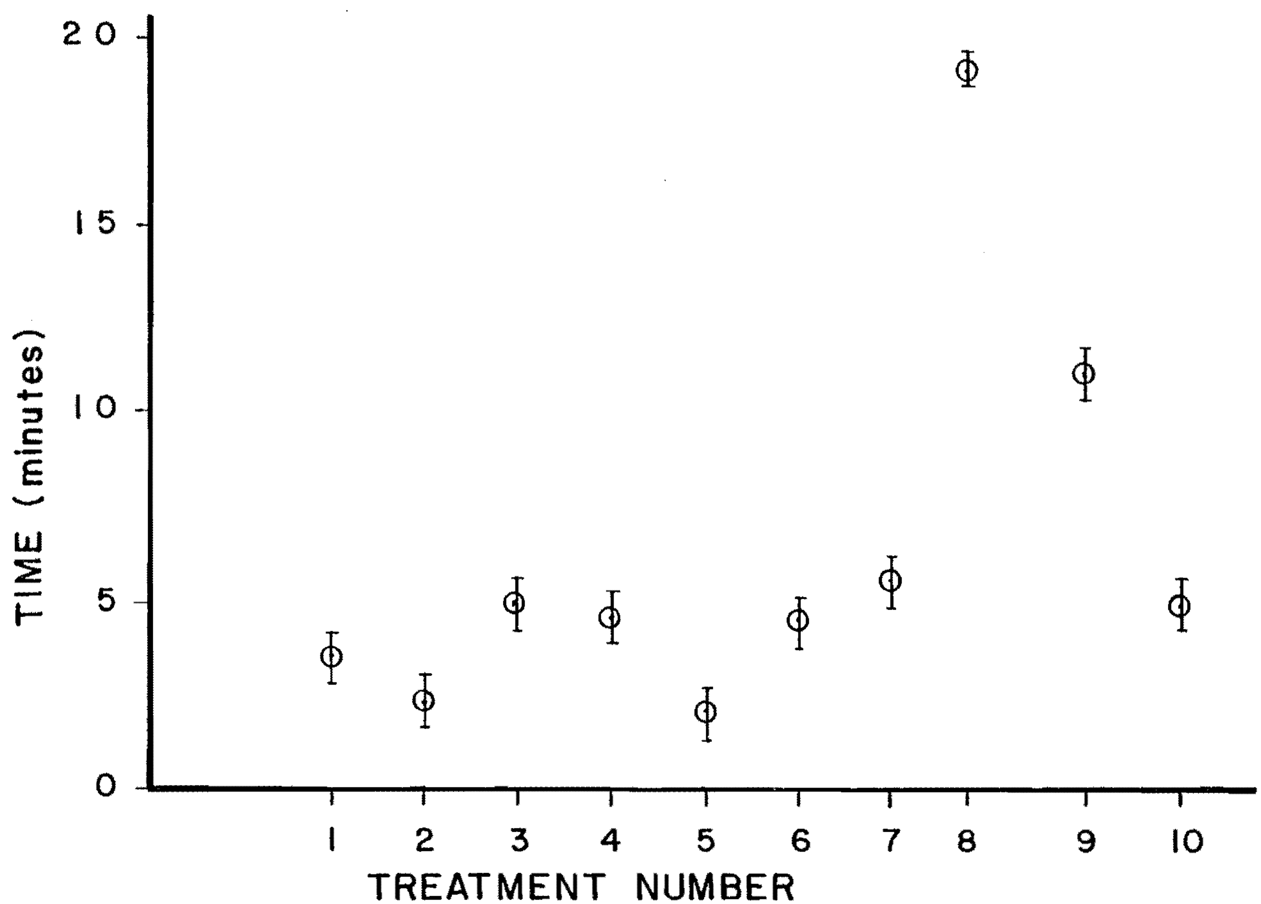

Figure 9. Elapsed time from beginning of rainfall until sediment runoff begins.

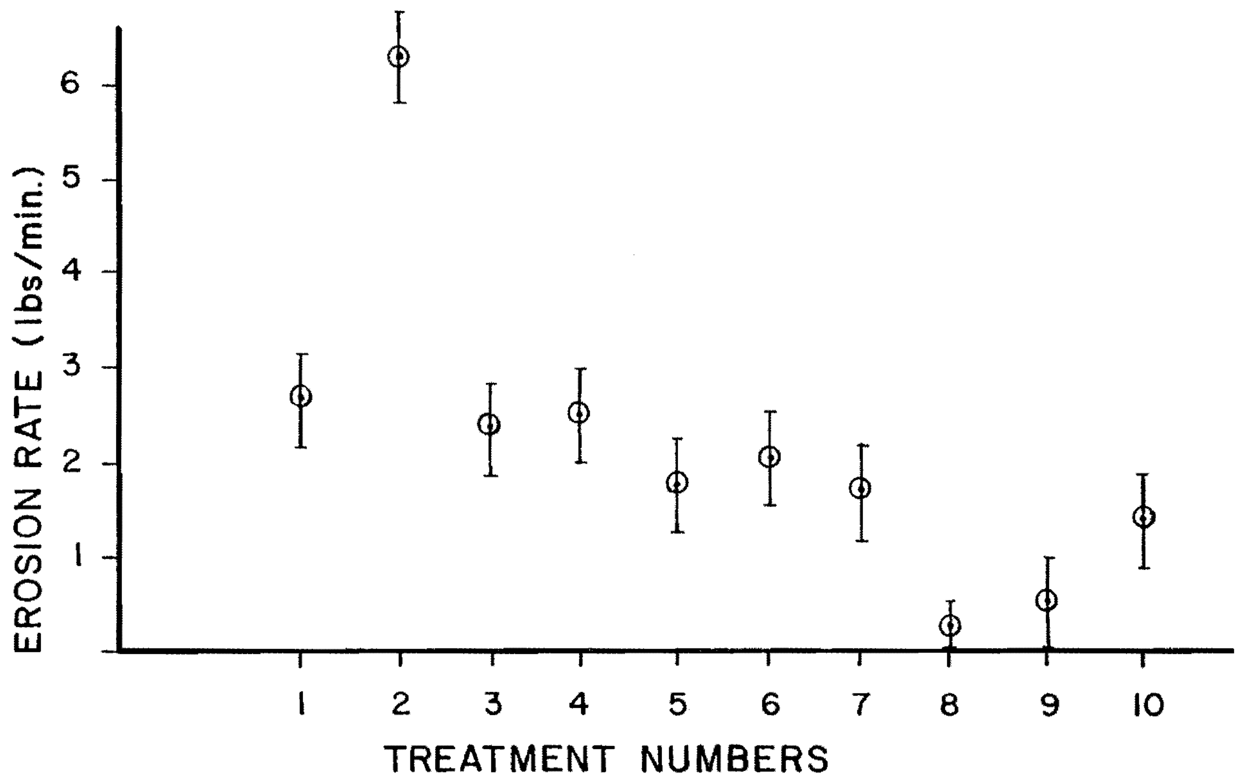

Figure 10. Average erosion rate after sediment runoff begins.

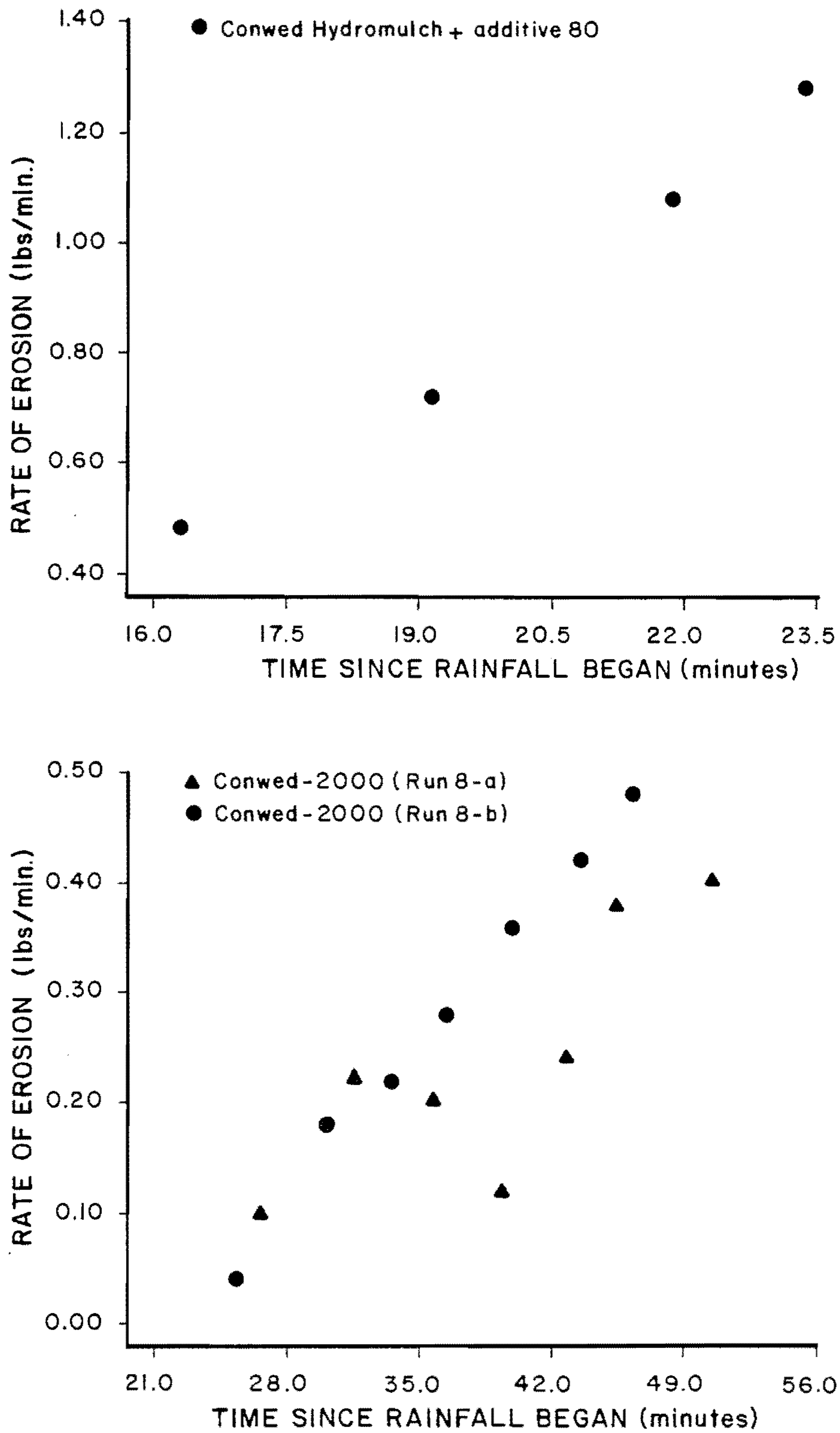

Figure 11. Erosion rate change over time.

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