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ASPEN Environmental Consultants, Inc; Report of Tests: Preliminary Evaluation of Three Erosion Control Products

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Aspen Environmental Consultants, Inc.

Report of Tests

Preliminary Evaluation of Three Erosion Control Products

Gilberto Urroz
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July 1990

Utah Water Research Laboratory
Utah State University
Logan, UT 84322-8200

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INTRODUCTION

Controlling the erosion of soil is a growing concern in the developed countries of the world, and continuing attempts are being made to develop new and better erosion control products. Only by careful comparative testing of such products under similar conditions is it possible to determine their relative merits. In the test facility at the Utah Water Research Laboratory (UWRL), the variables of wind, sunlight, soil, hillslope, and rainfall rate and duration can all be independently controlled, thus providing an ideal location for determining the actual effectiveness of various kinds of erosion control products.

Aspen Environmental Consultants, Inc. contracted with the UWRL to make preliminary evaluations for their clients of two erosion control blankets and several concentrations of a liquid control material.

MATERIALS AND METHODS

Description of Testing Facility

Rainfall simulator. The rainfall simulator is a drip-type device in which 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 each orifice with an electrically operated solenoid valve, it is possible to vary flow in on-off increments from 1 to 31 inches per hour. Outlet from the chambers or modules is through equally spaced brass tubes that form raindrops. Each module is a 24-inch square enclosed box about 1-inch deep and oriented so that the ends of the tubes or needles form a horizontal plane to let the water drip vertically toward a tilting flume. Each module has 672 needles spaced on a 1-inch triangular grid pattern.

The rainfall simulator consists of 100 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 manually operated or can be controlled by a programmed computer if desired.

Raindrop sizes and velocities of impact are representative of typical high intensity storms. The spatial distribution of rain is essentially uniform, and the control of application rates is within the accuracy requirement of most experiments.

Testing flume. The square test flume measures 20 feet on each side and can be tilted to any slope up to approximately 43° from horizontal. The rainfall simulator is supported over the flume so that rain falls directly onto the test plots.

Approximately 1 foot depth of soil is supported in the testing flume by a metal grating which is covered with a filter cloth through which water can drain. For the Aspen Environmental Consultants tests, the flume was divided into six test plots, each measuring 2 feet by 19.5 feet. There were three sets of two plots each, and the sets were separated from each other and from the side walls by 2-foot wide walkways. The rainfall simulator was arranged so that rain fell upon the plots and not upon the walkways. Runoff from each test plot was collected in a plastic container and weighed. The water was decanted off, and the soil was dried and weighed to determine the amounts of soil and water leaving each plot per unit of time.

Sunlight simulator. A balance of radiant energy needed for good growth of plants is provided to the test plots by a sunlight simulator which utilizes incandescent as well as fluorescent lamps. It has the same dimensions as the tilting flume, square, measuring 20 feet on a side. It is rolled on and off the test plots on wheels, riding on horizontal rails mounted on top of the sidewalls 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 $\mu E \bullet m^2 \bullet sec^{-1}$ (measured with a La-Cor 190 S quantum sensor on a Model LI-185 quantum radiometer/photometer).

Products Included in Tests

The following products provided by clients of Aspen Environmental Consultants were included in the tests:

1. A needle-punched, adhesive backed, coirtex (coconut) fiber blanket.

2. An organic tall oil emulsion for soil sealing.

3. A biodegradable mulch blanket bound by a high strength adhesive.

TESTING PROCEDURE

Plot Preparation

Each of the six test plots was filled with a sandy loam soil having the following approximate composition: total sand = 63 percent, total silt = 24 percent, total clay = 13 percent, and total organic matter = 1.41 percent. Each plot was cultivated with a garden tiller to a depth of approximately 6 inches. To prepare for applying the test products, the soil was raked smooth and uniformly compacted with a lawn roller filled with water.

Test 1. Each of the six plots was seeded with barley by hand at a rate of 200 lbs per acre. Barley seed was Steptoe variety, grown in Utah, tested 9/89, with a purity of 99.50 and a germination of 96.00 percent. Beginning on the north side of the flume, plot #1 was sprayed with a 4:1 dilution of Entac emulsion at a rate of 300 gal/Ac; #2 was covered with a coconut fiber channel liner; #3 had a 7:1 dilution of Entac emulsion at a rate of 200 gal/Ac; #4 and #5 were bare soil controls; and #6 had an adhesive-bound (Proseed PS100) mulch blanket. Blankets were laid by hand and stapled, and the Entac emulsions were applied with a small hand-held garden sprayer and with sprinkler cans.

Plots were allowed to settle overnight, then they were tilted to the desired slope and covered with a plastic sheet. The rainfall simulator was turned on at full capacity to purge air from the system. During this purging, rain fell onto the plastic and ran into a drain without wetting the plots. When the purging was complete, the rainfall was adjusted to the desired rate and allowed to stabilize. The plastic sheet was then quickly removed so the rain fell directly onto the plots, and the time clock was started. Rain was applied for 40 minutes, and all runoff was collected and weighed.

The sunlight simulator was installed over the plots. Lights were turned on for 12 hours per day for six days, at the end of which time the flume was lowered to horizontal, lights were removed, and the barley crop was sampled, counted, dried, and weighed.

Test 2. The second rainfall application took place after plant data had been gathered from test 1. The flume was tilted to a 3:1 slope, and rain was applied to the one-week-old barley crop for an additional 40 minutes. Again, all runoff was collected and weighed.

Test 3. After a week under the lights, the soil was dry enough to allow the plots to be reworked. Soil was removed from each plot to the depth of eroded gullies and replaced with new soil. The soil was tilled, compacted, and smoothed and the following products were applied: in plot #1, a 7:1 dilution of Entac emulsion at a rate of 200 gal/Ac, followed by a second application of a 4:1 dilution of Entac emulsion at a rate of 300 gal/Ac; in plot #2, a 4:1 dilution of Entac emulsion was applied at a rate of 300 gal/Ac, followed by a second application of a 2:1 dilution of Entac emulsion at a rate of 300 gal/Ac; plot #3 was covered with straw sprayed with a straight non-diluted Entac emulsion; plots #5 and #6 were covered with 4:1 dilutions of Entac emulsion at rates of 600 gal/Ac and 450 gal/Ac, respectively; and plot #4 was a bare soil control. The plots were tilted to a 3:1 slope, rain was applied for 36 minutes, and all runoff was collected and weighed.

On each of the above three tests, the runoff soil and water were captured and weighed together. When the sediment in each container had settled, the water was decanted off, the sediment samples were placed on drainage mats in the sun to dry, and then the sediment from each plot was weighed separately.

RESULTS AND DISCUSSION

Photographic Results

Representatives from Aspen Environmental Consultants, Inc. video-taped the entire testing procedure, and took numerous still photos as well which will supplement the written report provided by the UWRL.

Numeric and Graphic Results

Figure 1 shows the plot configuration for all three tests. Water and sediment runoff data are presented in Table 1 for all three tests. Table 2 contains plant data collected from the first test. Figures 2 through 6 are graphical representations of data presented in the tables.

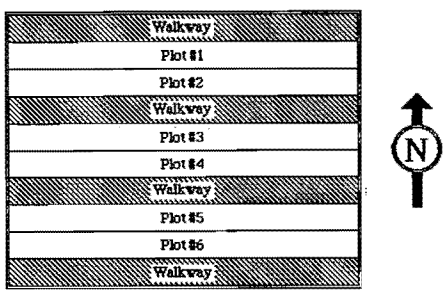


Figure 1. Plot configuration.

Discussion

Water runoff rate. The water runoff rates for the six plots of Test 1 are presented in Table 1 and Figure 2. As shown in the tables, the Coconut fiber channel liner (plot #2) had the best retention capacity as the water runoff rate was the smallest of all products tested. The 300 gal/Ac Entac emulsion at 4:1 dilution on plot #1 and the Proseed PS100 mulch blanket on plot #6 had the next best performances. The performance of the 200 gal/Ac Entac emulsion at 7:1 dilution (plot #3) was similar to the two control plots, plots 4 and 5.

The water runoff rates for Test 2, presented in Figure 3 and in Table 1, indicate very little difference between the plots. This is because the soil at the start of the rain had a high moisture content which remained from the first run; therefore, most of the water from the second test ran off.

For Test 3 the soil was drier than at the start of Test 2 but not as dry as at the beginning of Test 1. The water runoff rates for this test are shown in Figure 4 and Table 1. The best performance in water retention occurred for plot #3 which was covered with straw and a straight Entac emulsion. This combination was able to absorb and retain a good percentage of the total water applied so that very little runoff occurred as compared to the other plots. All other applications performed equally among themselves retaining water in comparable amounts to that of the control plot (plot #4). The runoff rates for all plots, excluding plot 3, are similar to those obtained in Test 2, indicating a considerable amount of moisture in the soil at the beginning of the test.

Soil erosion rate. Soil erosion rates for Tests 1, 2, and 3 are presented in Figures 2, 3, and 4, respectively. They are also listed in Table 1. In Test 1, in terms of erosion protection, the Coconut fiber channel liner (plot #2), and the Proseed PS100 mulch blanket (plot #6) performed better than the two Entac emulsion applications (plots #1 and #3). Their erosion rates were two orders of magnitude smaller than those of the Entac emulsion plots. The Coconut liner and the PS100 mulch blanket performed even better when compared with the bare soil control plots (plots #4 and #5). Their erosion rates were between two and three orders of magnitude smaller than those of the control plots. From the two Entac emulsion applications, plot #1, 300 gal/Ac at 4:1 dilution, performed better than plot #3, 200 gal/Ac at 7:1 dilution. Both applications reduced the erosion rate in comparison with the control plots.

In Test 2 wherein the same products were used as in Test 1, the values of the erosion rate were similar to, although in general smaller than, those of Test 1. This conclusion is easily reached by comparing the lower parts of Figures 2 and 3. These results indicate that the higher water content of the soil in Test 2 had very little effect on the erosion rates of Test 2 over those of Test 1.

Table 1. Test data for runoff.

Test	Plot	Product	Collection time(hr)	Soil weight, lb	Water vol.,ft3	Water runoff rate, ft3/hr	Soil erosion rate, lb/hr
1	1	Entac (1)	0.625	10.50	2.50	4.00	16.80
1	2	Coconut liner	0.625	0.10	1.70	2.72	0.16
1	3	Entac (2)	0.625	37.00	4.80	7.68	59.20
1	4	Bare soil	0.625	71.00	5.60	8.96	113.60
1	5	Bare soil	0.625	46.00	4.60	7.36	73.60
1	6	PS100 blanket	0.567	0.50	2.70	4.76	0.88
2	1	Entac (1)	0.658	18.50	5.30	8.05	28.10
2	2	Coconut liner	0.625	0.10	5.10	8.16	0.16
2	3	Entac (2)	0.658	38.50	5.50	8.35	58.48
2	4	Bare soil	0.658	72.00	7.50	11.39	109.37
2	5	Bare soil	0.658	45.00	5.40	8.20	68.35
2	6	PS100 blanket	0.625	0.50	6.00	9.60	0.80
3	1	Entac (3)	0.550	19.30	5.30	9.64	35.09
3	2	Entac (4)	0.567	14.80	5.00	8.82	26.12
3	3	Entac on straw	0.508	0.30	1.20	2.36	0.59
3	4	Bare soil	0.533	57.80	4.90	9.19	108.38
3	5	Entac (5)	0.575	22.80	5.30	9.22	39.65
3	6	Entac (6)	0.558	18.30	5.60	10.03	32.78

(1) 300 gal/Ac Entac emulsion (4:1 dilution)
(2) 200 gal/Ac Entac emulsion (7:1 dilution)
(3) 200 gal/Ac Entac emulsion at 7:1 dilution, followed by second application of 300 gal/Ac Entac emulsion at 4:1 dilution.
(4) 300 gal/Ac Entac emulsion at 4:1 dilution, followed by second application of 300 gal/Ac Entac emulsion at 2:1 dilution.
(5) 600 gal/Ac Entac emulsion (4:1 dilution)
(6) 450 gal/Ac Entac emulsion (4:1 dilution)

The results of erosion control for Test 3 indicate that the combination of straw with a straight Entac emulsion (plot #3) gave the best performance in terms of erosion protection. The erosion rate of plot #3 was two orders of magnitude smaller than were the rates of the other Entac emulsion applications (plots #1, 2, 5, and 6), and three orders of magnitude smaller than the bare soil control plot. Erosion rates for the four different Entac emulsion applications were very similar in magnitude. However the best rate resulted in plot #2, which had 300 gal/Ac Entac emulsion at 4:1 dilution followed by a second application of 300 gal/Ac Entac emulsion at 2:1 dilution. The erosion rates for all the Entac emulsion applications were in the order of three times smaller than the erosion rate of the control plot.

Plant data. Plant data were collected only for Test 1; these results are presented in Table 2. The top part of Figure 5 shows the average plant heights for all six plots. It is evident that no significant difference in plant heights existed among the different plots. This indicated that none of the erosion control methods tested had an effect on plant height. However, this test served to demonstrate that plants can grow through the Coconut fiber channel liner and through the Proseed PS100 mulch blanket.

Table 2. Test data for plants.

Test-Plot	Material	Number of Plants Top	Middle	Bottom	Total	Plant Height (cm) Top	Middle	Bottom	Average h(cm)
1.1	Entac (1)	29	22	13	64	9.80	8.19	7.83	8.61
1.2	Coconut fiber liner	43	27	31	101	10.30	9.29	7.81	9.13
1.3	Entac (2)	44	13	5	62	9.82	8.44	6.30	8.19
1.4	Bare soil	22	7	12	41	8.50	9.20	6.98	8.23
1.5	Bare soil	18	30	29	77	10.75	8.20	7.79	8.91
1.6	PS100 blanket	35	26	20	81	11.83	8.18	8.29	9.43

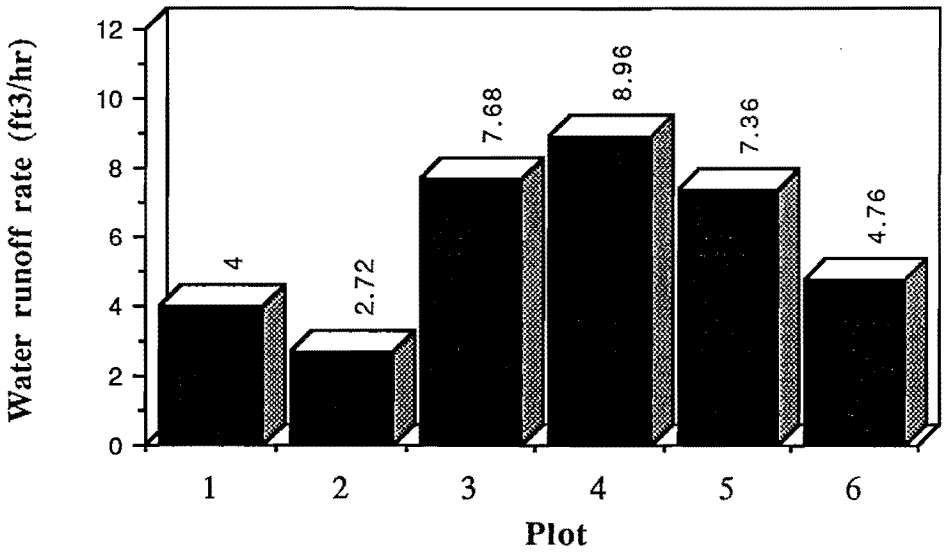
Test-Plot	Material	Dry weight (gm/sample) Top	Middle	Bottom	Total	Plant Height (cm) Lost	germ.	non-g.	check
1.1	Entac (1)	0.23	0.17	0.08	0.48	13.89	44.44	41.67	100
1.2	Coconut fiber liner	0.34	0.21	0.18	0.73	21.53	70.14	8.33	100
1.3	Entac (2)	0.48	0.10	0.04	0.62	9.72	43.06	47.22	100
1.4	Bare soil	0.17	0.06	0.08	0.31	45.83	28.47	25.69	100
1.5	Bare soil	0.17	0.22	0.21	0.60	0.00	53.47	46.53	100
1.6	PS100 blanket	0.35	0.20	0.15	0.70	29.17	56.25	14.58	100

(1) 300 gal/Ac Entac emulsion (4:1 dilution)
(2) 200 gal/Ac Entac emulsion (7:1 dilution)

The bottom part of Figure 5 indicates some effect of the erosion control treatments on the dry weight of plants per plot. Both the Coconut fiber channel liner (plot #2) and the Proseed PS100 mulch blanket (plot #6) produced a higher dry weight of plants per plot than did the control plots (plots #4 and #5) or the two Entac emulsion applications (plots #1 and #3). The relatively high yield in dry weight per plot of plots #2 and #6 can be attributed to the fact that they contained the highest percentage of germinating seeds, as indicated in Figure 6. The dry weight per plot for plots #1 and #3, both with Entac emulsions, were higher than control plot #4 but comparable to that of control plot #5. Again, the higher percentage of germinating seed seem to be the cause of the greater dry weight per plot. The evidence is inconclusive regarding beneficial effects of the Entac emulsion on dry weight of plants per plot.

In terms of percentages of seed lost, germinating and non–germinating, the results are presented graphically in Figure 6. The best performance in germinating seed was that of the Coconut fiber channel liner (plot #2), followed by that of the Proseed PS100 mulch blanket (plot #6). However, the latter was only slightly better than control plot #5. Strangely enough, control plot #4 lost only about half as many seeds as did control plot #5. For the two Entac emulsion plots (plots #1 and #3), the percentage of germinating seed is similar in magnitude, smaller than the other two treatments, and in between the results of the two control plots.

The large discrepancy in seed percentage data between control plots #4 and #5 may lead to unrealistic results. Control plot #5 indicates no seeds lost, which we know is not so. This result came about because the total number of plants and non–germinating seeds from the three samples taken in that plot was equal to the estimated number of seeds applied. The sample areas had an over–supply of seeds resulting in the unrealistic high count. Therefore, the data of control plot #5 in terms of seed percentages should be disregarded, and all other data compared to those of plot #4 only. If that is the case, then the performances of the Coconut liner, the mulch blanket, and the two Entac emulsion applications are definitively better than the performance of control plot #5 in terms of the percentage of seed retained and germinating.



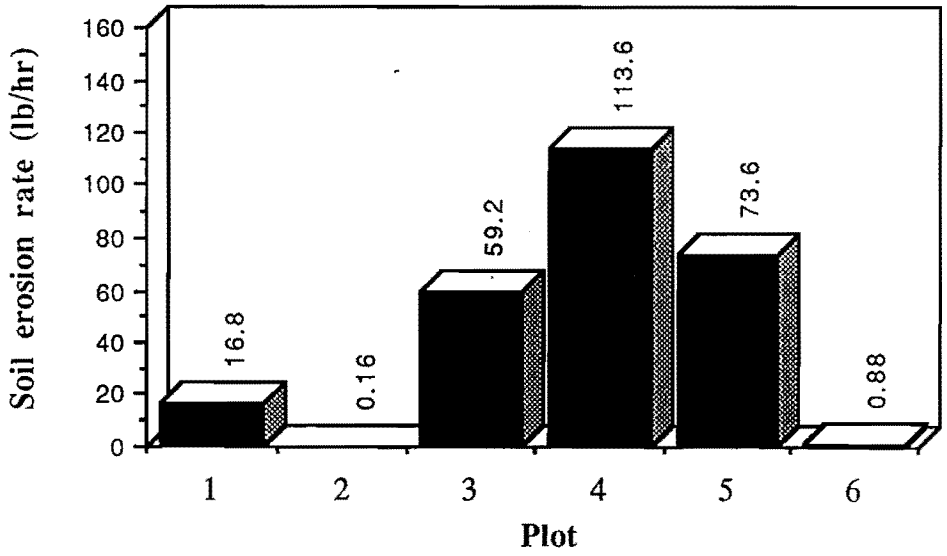
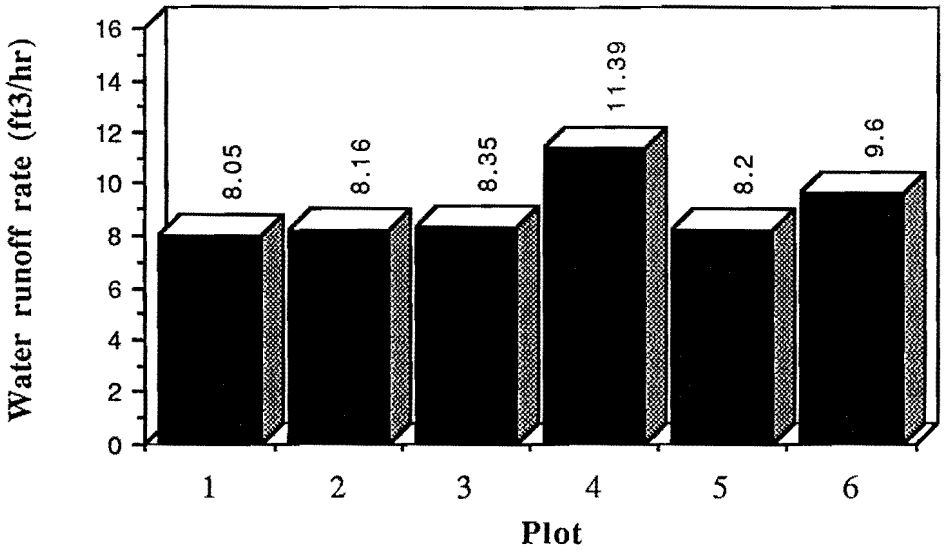


Figure 2. Water runoff and soil erosion rates for the six plots of Test 1.



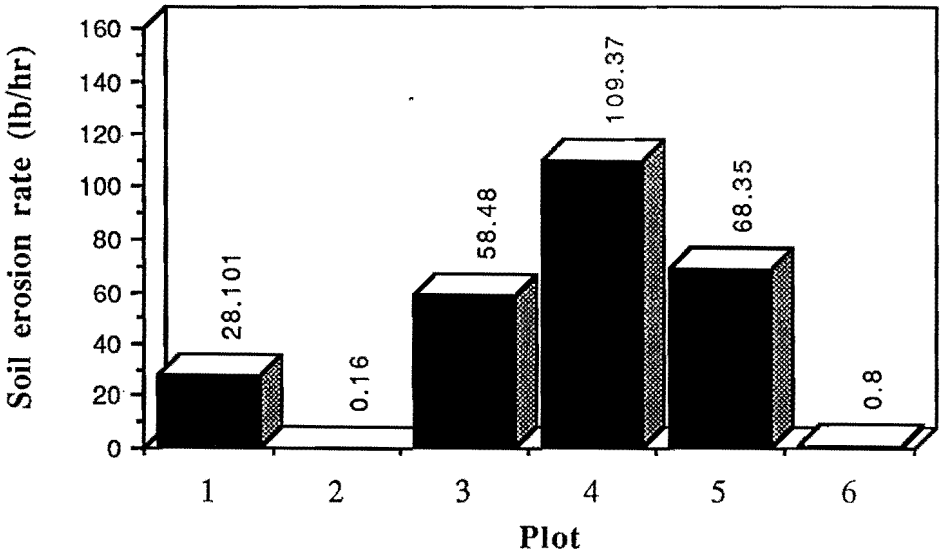
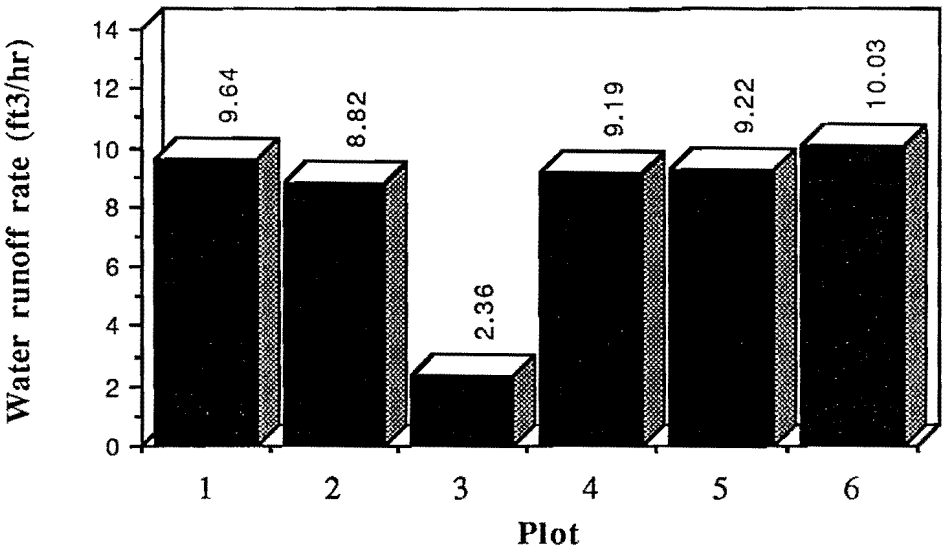


Figure 3. Water runoff and soil erosion rates for the six plots of Test 2.



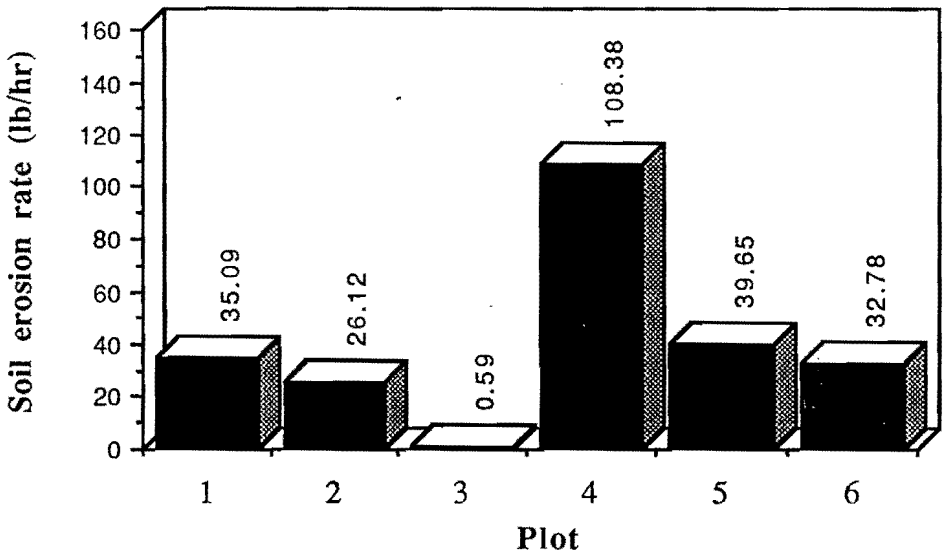
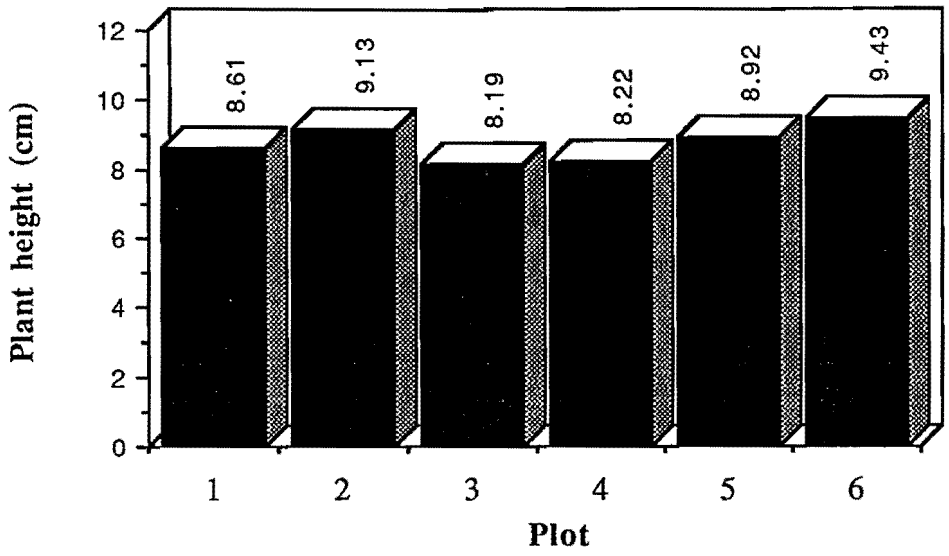


Figure 4. Water runoff and soil erosion rates for the six plots of Test 3.



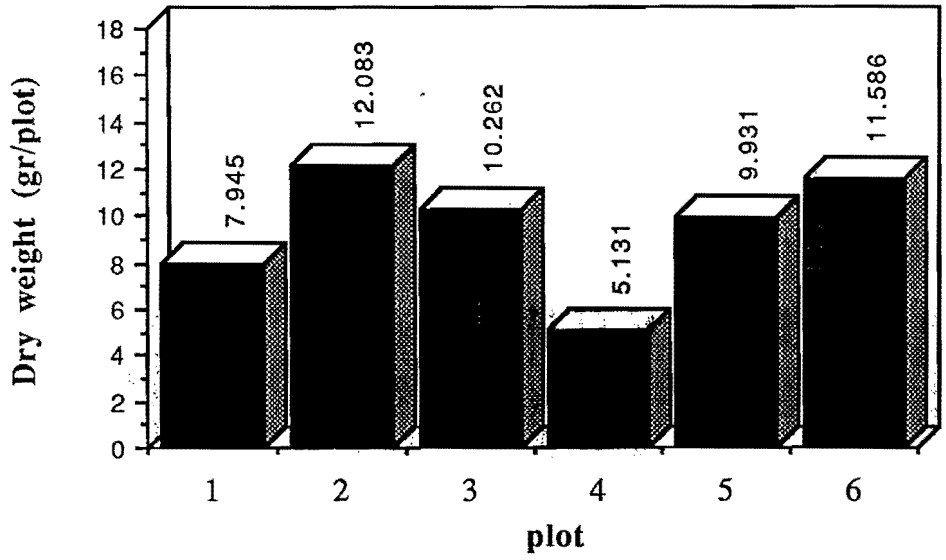


Figure 5. Plant height and dry weight data for the six plots of Test 1.

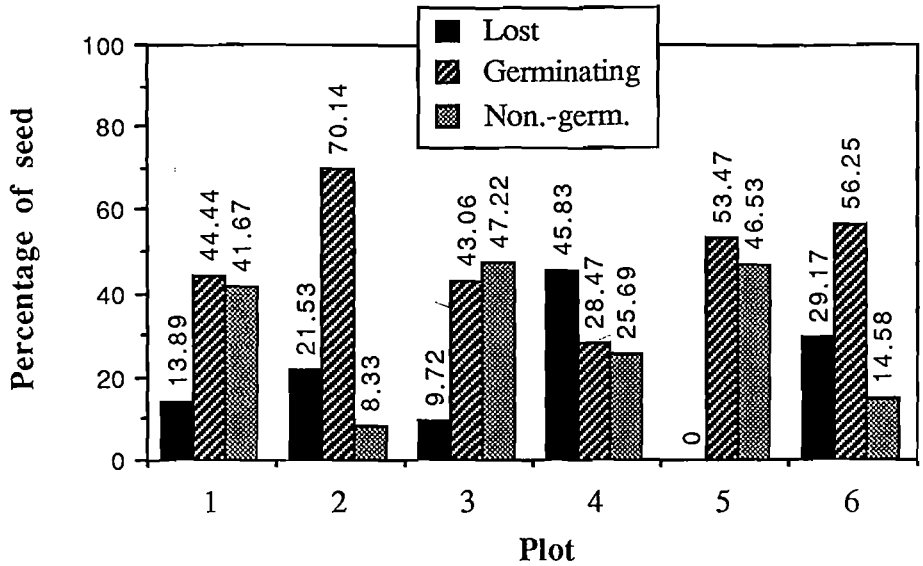


Figure 6. Percentage of seed lost, germinating and non-germinating for the six plots of Test 1.

CONCLUSIONS

It was not the intent of the client to obtain definitive results from these tests, but only to make gross comparisons of several products without making test replications. The most obvious result noted was the superior performance of both the Coconut liner and the PS100 blanket in reducing erosion caused by rain.

Policy Notice

The University has requested that the following be included in all test reports:

It is understood that the production of this report and contents thereof does not constitute an endorsement by the University of any of the products tested. The client shall not use the University's name for advertising purposes, and shall not publish statements pertaining to University research or test findings about such products except statements specifically approved in writing by the University.