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New Product Performance Evaluation Under Simulated Rain

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CONWED CORPORATION

Report of Tests

NEW PRODUCT PERFORMANCE EVALUATION UNDER SIMULATED RAIN

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INTRODUCTION

Manufacturers are continually seeking ways of improving the effectiveness of their erosion control products. Products currently in use include chemical as well as organic materials, and they are applied with varying degrees of success. The Fibers Division of the CONWED Corporation, one of the nation's most progressive producers of erosion control products, requested the comparative testing of some of their new products with those of some leading competitors. This report contains results of those tests.

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 with 31 steps. Outlet from the chambers or modules is through equally spaced brass tubes. 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 those 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 at any angle up to approximately 43 degrees. 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 covered with filter cloth through which water can drain. For the CONWED tests, the flume is divided into six test plots, each measuring 2 feet by 19.5 feet. There are three sets of two plots each, and the sets are separated from each other and from the side walls by 2-foot wide walkways. The rainfall simulator is arranged so that rain falls on the plots and not on the walkways. Runoff from each test plot is collected in a plastic container and weighed. The water is decanted off, and the soil is dried and weighed to determine amounts of soil and water leaving each plot per unit of time.

Products Included in Tests

The following products were included in the tests:

1. Excelsior mat with netting on one side only.
2. Excelsior mat with netting on both sides.
3. Erosion control straw mat by North American Green with netting on one side only.
4. Erosion control straw mat by North American Green with netting on both sides.
5. 90# Conwed mat with netting on one side only.
6. 90# Conwed mat with netting on both sides.

TESTING PROCEDURE

Plot Preparation

Each of the six test plots was filled and compacted 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. After each test run, the top layer of soil and mulch on each plot was removed and discarded 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. The soil was then raked smooth and uniformly compacted with a lawn roller filled with water in preparation for the next application of test product.

After the plots were prepared and the various mats to be tested were installed, the test flume was tilted to the desired slope in preparation for the rain application.

On all tests of mats that had netting on one side only, the plots were set at a 4:1 slope (25 percent). The mats that had netting on both sides were tested on a 2:1 slope (50 percent).

Rainfall Application

When the plots were tilted to the desired slope, they were covered with a plastic sheet. 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 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.

Total time was recorded from the instant the rain began falling onto the plots until failure of a mat or slope occurred. As each failure occurred, or the catchment was filled, rainfall to that plot was stopped so no additional soil would be lost.

On the 4:1 slope, rain was applied at 4 inches per hour for approximately 40 minutes and was then increased to 6 inches per hour until the end of the test. On the 2:1 slope, rain was applied at the rate of 8 inches per hour for 1 hour.

Runoff Measurement

All of the sediment and water leaving each plot during a test were collected in large plastic containers and then weighed. After the sediment had settled, water was decanted from the containers and the soil was dried and weighed.

RESULTS AND DISCUSSION

Photographic Results

A narrated VHS video and color prints were made of each test run; they include close up shots of each plot after rainfall ceased. These are already in the possession of the Fibers Division of CONWED and are considered to be a significant part of this final report.

Numerical and Graphic Results

Table 1 presents the data corresponding to the different tests performed during the present study. This table includes an entry for a single test performed on a 135-lb CONWED product (Test No. 1, Plot No. 5). The information contained in Table 1 has been summarized in terms of test conditions (netting, rain, and slope conditions) in Tables 2 and 3. Table 2 corresponds to products that had netting on the top side only, were tested in 4:1 slopes, were under a rain condition of 0.7 hours of rain at a rate of 4 in/h, and were followed by 0.55 hours at an increased rate of 6 in/h. Table 3, on the other hand, contains data corresponding to products that had netting on both sides, were tested in 2:1 slopes, and were under a fixed rain intensity of 8 in/h for 1 hour. Average values of soil erosion and water flow rates are

Table 1. Test data.

Test	Plot	Product	Test Conditions	Soil Weight (lb)	Water Volume(ft^3)	Collection Time (h)	Soil erosion rate (lb/h)	Water flow rate (ft^3/h)
1	1	NAGreen straw 1†	T1*	4.440	N/A ***	1.133	3.919	N/A ***
1	2	90# CONWED 1	T1*	0.110	N/A ***	1.133	0.097	N/A ***
1	3	Excelsior 1	T1*	7.590	N/A ***	1.133	6.699	N/A ***
1	4	Excelsior 2	T2**	70.50	N/A ***	0.519	135.8	N/A ***
1	5	135#CONWED 2††	T2**	1.240	N/A ***	0.669	1.854	N/A ***
1	6	NAGreen straw 2	T2**	91.30	N/A ***	0.674	135.5	N/A ***
2	1	90# CONWED 1	T1*	0.080	2.770	1.033	0.077	2.682
2	2	Excelsior 1	T1*	14.98	5.850	1.033	14.50	5.663
2	3	NAGreen straw 1	T1*	1.990	4.740	1.033	1.926	4.589
2	4	NAGreen straw 1	T1*	2.460	4.940	1.033	2.381	4.782
2	5	Excelsior 1	T1*	15.94	5.740	1.033	15.43	5.557
2	6	90# CONWED 1	T1*	0.083	1.670	1.033	0.080	1.617
3	1	Excelsior 2	T2**	87.00	5.190	0.433	200.7	11.978
3	2	NAGreen straw 2	T2**	29.00	5.620	0.450	64.44	12.489
3	3	90# CONWED 2	T2**	14.00	3.380	0.475	29.47	7.116
3	4	90# CONWED 2	T2**	13.75	2.180	0.475	28.94	4.589
3	5	NAGreen straw 2	T2**	28.25	4.650	0.492	57.45	9.458
3	6	Excelsior 2	T2**	79.75	5.150	0.500	159.5	10.300
4	1	Bare soil	T2**	70.00	2.340	0.244	286.8	9.590
4	2	Bare soil	T1*	54.50	4.460	0.500	109.0	8.920
4	3	Bare soil	T2**	81.50	2.910	0.242	337.3	12.045
4	4	Bare soil	T1*	54.00	4.760	0.500	108.0	9.520
4	5	90# CONWED 2	T2**	7.000	3.590	0.383	18.27	9.373
4	6	Bare soil	T2**	112.5	3.630	0.183	613.7	19.804
5	1	Excelsior 2	T2**	N/A****	N/A ****	N/A****	N/A****	N/A****
5	2	NAGreen straw 2	T2**	N/A ****	N/A ****	N/A****	N/A****	N/A****
5	3	90# CONWED 2	T2**	N/A ****	N/A ****	N/A ****	N/A****	N/A****
5	4	90# CONWED 2	T2**	N/A ****	N/A ****	N/A ****	N/A ****	N/A****
5	5	NAGreen straw 2	T2**	N/A ****	N/A ****	N/A ****	N/A ****	N/A****
5	6	Excelsior 2	T2**	N/A ****	N/A ****	N/A ****	N/A ****	N/A ****

†1: top side only

*T1: rain: 0.7h @ 4"/h and 0.55h @ 6"/h; slope: 4:1

*** No water volume data were recorded in test No. 1

††2: both sides.

**T2: rain: 1.0h @ 8"/hr; slope: 2:1

**** Slope failure in all plots; no data were collected.

Table 2. Data summary for all products with netting on top side only. Rain: 0.7h@ 4"/h and 0.55h @ 6"/h. Slope: 4:1.

Product	Soil Erosion Rate (lb/h)	Average	Water Flow Rate (ft^3/h)	Average
90# CONWED	0.097	0.085	N/A*	2.150
90# CONWED	0.077		2.682	
90# CONWED	0.080		1.617	
NAGreen straw	3.920	2.742	N/A*	4.686
NAGreen straw	1.926		4.589	
NAGreen straw	2.381		4.782	
EXCELSIOR	6.699	12.210	N/A*	5.610
EXCELSIOR	14.500		5.663	
EXCELSIOR	15.430		5.557	
Bare soil	109.000	108.500	8.920	9.220
Bare soil	108.000		9.520	

*No water volume data was collected in test No. 1.

Table 2. Data summary for all products with netting on both sides. Rain: 1.0h@ 48"/h. Slope: 2:1.

Product	Soil Erosion Rate (lb/h)	Average	Water Flow Rate (ft^3/h)	Average
90# CONWED	29.47	15.58	7.116	7.026
90# CONWED	28.97		4.589	
90# CONWED	18.27		9.373	
NAGreen straw	135.50	85.81	N/A*	10.970
NAGreen straw	64.44		12.480	
NAGreen straw	57.45		9.458	
EXCELSIOR	135.83	165.30	N/A*	11.130
EXCELSIOR	200.78		11.970	
EXCELSIOR	159.50		10.300	
Bare soil	337.30		12.040	
Bare soil	613.70		19.800	

*No water volume data was collected in test No. 1.

also presented in Tables 2 and 3; these average values are presented in graphical format in Figures 1 and 2, respectively.

Discussion

Three replications were made of each product test. Three replications were made also of the bare soil test on a 2:1 slope, but only two replications were made on a 4:1 slope. The data from one set of tests were discarded and the tests were repeated due to the fact that initial soil moisture content in the plots was noticeably higher than for the other sets of tests; this unfairly affected test results. However, this set of tests was included in the photographic documentation.

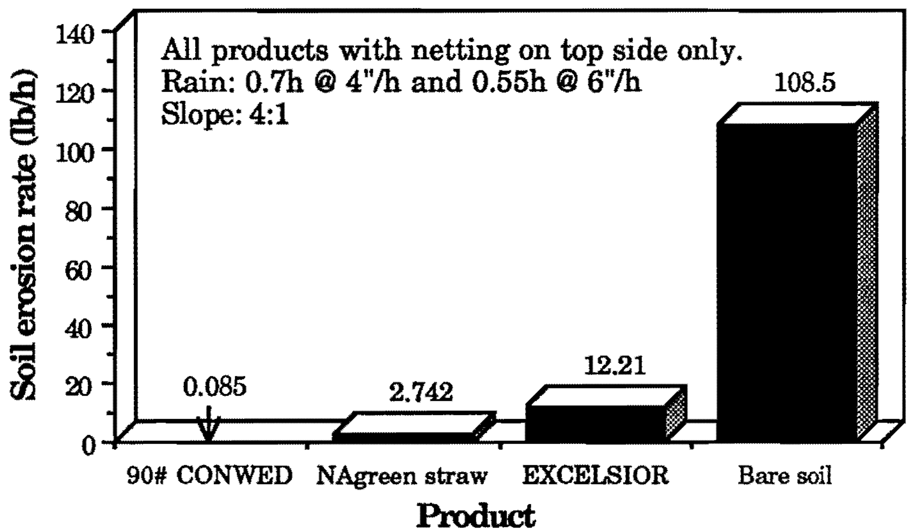
Both the observed and weighed results of the CONWED blanket show that it is noticeably better than either the North American Green or the Excelsior products under the conditions tested, as is evidenced by the bar graphs in Figures 1 and 2.

Data from the tests performed on the different erosion control mats are summarized in terms of products and test conditions (netting, rain intensity, and soil slope) in Tables 2 and 3 and presented graphically in Figures 1 and 2. From those tables and figures, it is evident that the CONWED products, under similar test conditions, dramatically decrease the rate of soil erosion when compared to the other two products. It is also evident that the water flow rate is reduced when using the CONWED products as opposed to the other two products tested.

SUMMARY AND CONCLUSIONS

Based on data collected in the foregoing tests, as well as observations made and impressions received as a result of performing the tests, the following summary statements, suggestions, and conclusions are presented:

1. The performance of erosion control products herein described was for a particular set of soil, slope, and rainfall conditions and may be expected to be different if any or all of these conditions are changed.



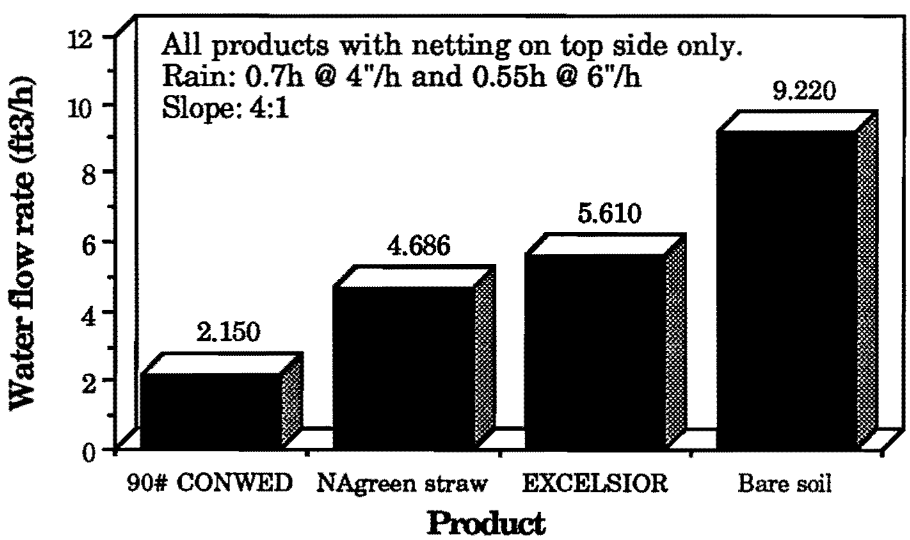
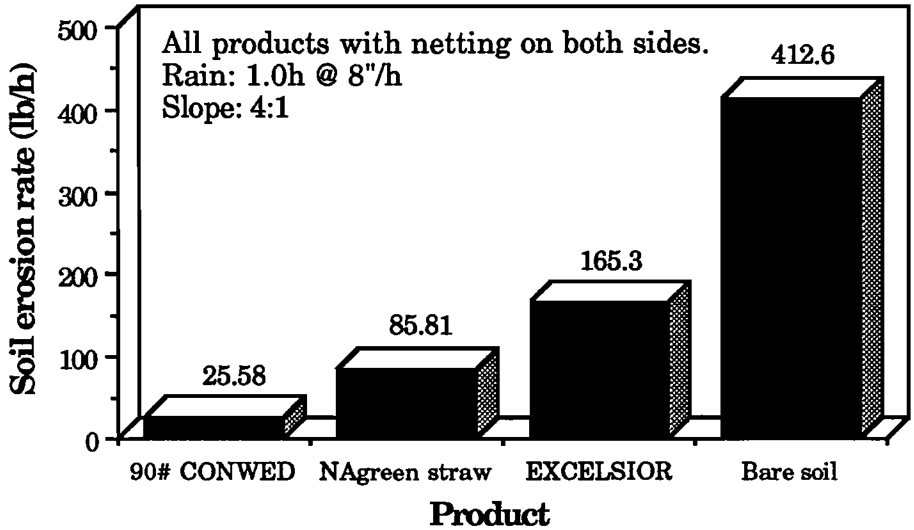


Figure 1. Graphical representation of data in Table 2.



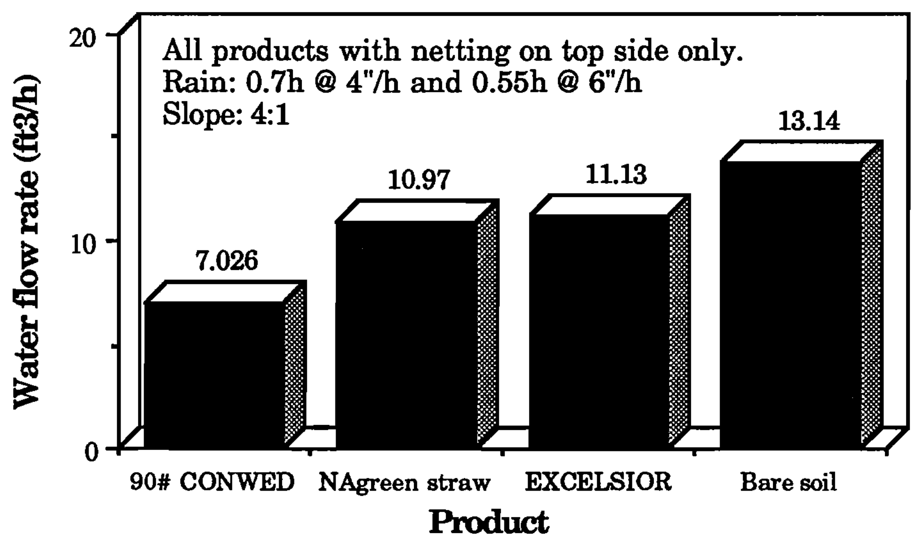


Figure 2. Graphical representation of data in Table 3.

2. On both the 2:1 and 4:1 slopes, the CONWED product was noticeably more effective than the other two products in decreasing the amount of soil eroding from the plots.
3. The CONWED product also caused more water to seep into the soil on the slope, i.e., less water left the CONWED plots than left those of the other products. It appeared from close observation of the plots during the rain that this was caused by the CONWED product being in close contact with the soil surface at all points, leaving no room for water to flow between the mat and the soil. This was not true of either the North American Green or the Excelsior mats. Even though both of these adhered fairly closely to the soil surface, there were still openings where water flowed downslope beneath the mats.
4. Because the mat adheres closely to the soil surface and causes more water to infiltrate, less soil is eroded. A disadvantage of this mat, however, is that during a sustained rainfall on a soil with a high clay content the additional water will saturate the soil more quickly and cause a mass failure of the slope. The other products would allow more water to flow overland, increasing the amount of surface erosion, but delaying the time of slope failure. On well-drained soil, such mass failure might never occur.
5. Material with netting only on the top side appeared to perform better than that with netting on both sides. The bottom netting, resting on small clods of soil, tended to form bridges over minor depressions on the soil surface and prevented the wood fibers from adhering closely to the soil surface. This could not happen when the netting was on the top side only. Rain would saturate the fibers and force them down firmly against the soil over the entire area, then the top netting held everything in place so nothing could move downslope.
6. Performance of the CONWED product was impressively positive for decreasing surface erosion.