TOWER SIMULATES RAINFALL PROVIDES FACTS ABOUT MULCHES

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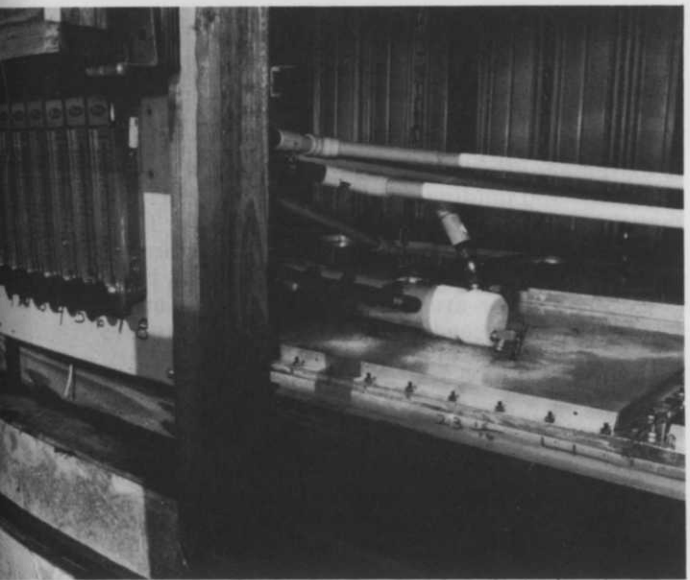
How effective are the many erosion-control products being developed or offered for sale? Do these glues and mulches protect the soil surface, holding seed and moisture in place as the salesmen claim? Are they compatible with commercial fertilizers? These questions prompted the construction of a raintower for study of the effect of raindrops on soil surfaces given various treatments.

Selected for tests are problem soils from highway cuts as determined by the California Department of Transportation. These soils are placed in greenhouse flats of 11 x 19 inches, and mulch, glue, seed, etc., are sprayed over the surface with a hydromulcher. Tests have been run on these surfaces with the flats tilted at 1:1 to 2:1 (horizontal to vertical measurement) under both natural rainfall and rainbird-type sprinklers. The need soon became apparent for a more uniform artificial rainfall that would expose each tested surface to exactly the same size and number of "raindrops."

The raintower developed to fill the need is adapted in design from a mobile drip-type infiltrometer reported by W. H. Blackburn et al. (1974). They used the portable model to measure infiltration rates and sediment production on Nevada rangelands. Dr. Blackburn donated two 4-by-4-ft modules containing hollow needles on a 1-by-1-inch grid. The needles form drops of 2 mm diameter. The modules consist of two plexiglass sheets spaced ½ inch apart and sealed. The needles project ¼ inch above and below the lower plexiglass sheet. The needles are ¾ inch long with an outside diameter of 0.025 inch. Needles are held in

Figure 1 (above): Raintower produces artificial rain which strikes the surface of erosion-control treatments on inclined surfaces.
Figure 2 (left): Water drops 3mm in diameter are formed by water dropping from holow steel tubes mounted in a plastic chamber.
Figure 3 (above right): Rainfall rate is controlled by flowmeters on left, which control flow to modules on the right.



place with epoxy cement. Water pressure is supplied from a reservoir mounted 4 ft. above the flow regulators. Rainfall intensities are possible of 0.2 inch to 3.3 inches per hour controlled by a Manostat (Cat. No. 36-541-30) flowmeter.

The above plates were mounted in an enclosed tower (Fig. 1) which allows the drops to fall 14 ft. 10 in. to the surfaces to be observed. Twelve of these surfaces (greenhouse flats) are mounted in a cart which can be adjusted for slope angle.

Initial testing was with the above plates making 2 mm drops at an intensity of 2 inches per hour. The results were uniform but not as erosive as natural rainfall. An additional 4 inches per hour was applied by a mist system. These very small drops had no effect on erosion, even though they tripled the amount of water applied. Erosion was initiated by the energy of the large raindrops striking the soil, with the smaller drops merely helping to flush away the soil particles.

Reports of rainfall intensities and drop sizes (Laws and Parsons, 1943) indicate that natural rainfall commonly has rates that are briefly much higher than 2 inches per hour and with drop sizes larger than 2 mm. Because maximum effect seems desirable with the short slopes being tested (19 inches), we decided to make some changes.

New modules (Fig. 2) constructed at 2-by-2-ft reduced the center sag of the 4-by-4-ft modules and allowed for more precise metering. Eight flowmeters (Fig. 3) (Dwyer RMB-83) are fed from a common manifold located 4 ft. below a 55-gallon drum which serves as a common reservoir. A float valve maintains the drum at capacity. Needle size was increased to 0.028 inch O.D. (Drop size is determined by the outside diameter and surface characteristics of the needle, since drops are formed via the sides and lower surface of the needle rather than the inside diameter.) Drop size is now about 3 mm, compared with the 2mm used earlier, and weigh over 3 times as much as before. Falling 14 ft. 10 in., they reach a velocity of 22.5 ft./sec., or 85% of the terminal velocity achieved by raindrops in an unlimited fall (Laws, 1941).

We have found that using the above modules at a rate of 6 inches of "rain" per hour is a practical compromise between the maxima found in nature and the amount of time available to make observations. The extremely short slope makes it impossible to compare the results with what might happen with similar amounts of rainfall on a field slope.

The value of the raintower is that twelve different soil surface treatments can be compared in a single test under identical testing conditions. We can determine whether a treatment is better than no treatment, or better than a standard treatment such as wood hydromulch fiber at 1,500 lb/acre. It is fascinating to watch the raindrops strike the surface and see how destructive this energy can be if not absorbed by a mulch.

What have we learned about the erosion-control products? Some of the highlights are that straw is extremely effective in absorbing the energy of raindrops and holding soil. Hydromulch fibers, although not nearly as effective as straw, will, if applied at a high enough rate, provide considerable protection. Virgin wood fibers or fibers from corrugated paper are superior to mulches made from newsprint, seed screenings, etc. An organic gum or glue added to a virgin wood fiber has very little effect.

Some of the plastic or synthetic rubber products are the most effective in cementing soil particles together. Optimum dilution rates of these products were determined. Wood fiber was shown to increase the effectiveness of these products. Some glues are not compatible with fertilizer.

References

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