Effectiveness of Polyacrylamide (PAM) for Wind Erosion Control

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Introduction

The use of vegetative and nonvegetative mulches to control wind erosion is not new. Wheat straw and prairie hay (3,4, and 5); cotton gin trash (6); and feedlot manure (10) are effective in controlling wind erosion if application rates are high enough and materials are well anchored to the soil surface. Desirable characteristics for surface mulches are: (a) indispersible in water, durable, yet porous to allow rainfall percolation; (b) weak enough to allow seedling emergence; (c) remain sticky indefinitely if used alone; and (d) easy to apply (2).

Commercial materials for temporary wind erosion control have been tested (1,7, and 8). Field and laboratory studies indicated that 25 percent of the manufacturers recommended rate was effective if material: (a) covered total soil surface, (b) was diluted and applied at recommended rate with coarse-spray nozzles, and (c) was applied with fine-spray nozzles at the recommended dilution (7). Additional desirable characteristics were: (a) cost less than $123.00/ha, (b) Initial prevention of wind erosion and reduction for 2 months, (c) no adverse effects on plant growth and emergence, and (d) easy application (1).

Polyacrylamide (PAM) has; been shown to greatly reduce irrigation-induced soil erosion at numerous loctations (9). It can be applied as a liquid or as a dry powder through furrow and sprinkler irrigation. The objective of this study was to evaluated various PAM formulations for their effectiveness in controlling wind erosion by their effect on: (a) amount of loose erodible material on the surface after treatment, (b) the freestream threshold velocity, and (c) abrasion resistance of the treated surface.

Methods

Haynie very fine sandy loam (fine-sandy, mixed, mesic, Pachic Haplustolls) and Smolan silty clay loam (fine, montmorillonitic,.mesic, Pachic Argiudolls) surface layers (0 to 10 cm) were brought to the laboratory, passed through a 64 mm sieve, and air dried in the greenhouse. Air dried soil was placed in trays 1.52 m long, 0.2 m wide, and 0.04 m deep. Polyacrylamide formulations were applied to the soil surface at 25, 50, 100, 200, and 400 percent of the recommended rate and at the recommended dilution, and soil was allowed to dry in the greenhouse. Formulations, recommended rates, and recommended dilutions are shown in Table 1. After drying, trays were placed in the wind tunnel to determine the loose erodible material on the surface, freestream threshold velocity, and abrasion resistance.

Loose erodible material (LEM) was determined by exposing the trays for 5 mm to a freestream wind speed of 13.4 m/s Soil loss was determined by weighing the trays before and after exposure. Wind speeds were measured 16 cm above the tunnel floor with a pitot-static tube and pressure transducer.

Freestream threshold velocity (U_{fst}) was determined by measuring the soil loss from the trays after a 3-mm exposure to a freestream wind speed of7 m/s and increasing the wind speed in 1.0 m/s increments until soil loss was>38.0 g for 3 exposures. The cumulative soil loss was plotted against wind speed to determine the U_{fst} at which soil loss was 37.0 g.

Abrasion resistance was determined by exposing the trays for 5 min to a l3.4 m/s wind speed and measuring the soil loss. Trays that were stable to wind were exposed to 1.3 kg of sand (0.297-0.42 mm diameter) placed 9 m upwind of the trays. Exposures were repeated until soil loss approached that of the untreated trays.

Results

Though soil losses were smaller on the Smolan soil than on the Haynie soil, the effects of the PAM formulations were the same, so only the Haynie results will be discussed. Application of PAM formulations to the soil surface reduced the amount of loose erodible material (LEM) by 38 to 98 percent (Fig. 1). PAM binds the surface particles together to form a crust. Although the dry formulations performed better than the liquid formulation, except at twice the recommended rate, effects did not differ from results of applying 0.5 cm of simulated rain.

The threshold wind velocity (U_{fst}) required to initiate soil movement was increased by all PAM formulations (Fig. 2). Only the dry formulations required a higher U_{fst} than 0.5 cm rain.

Resistance to abrasion by sand was decreased 2 to 3 times, except for the dry formulations activated by rain at the recommended rate or higher (Fig. 3). The surface crusts formed by PAM are not well anchored to the soil below the crust and are penetrated easily by salting particles. The water used to dilute the PAM formulations tended to destroy the natural aggregates, forming a more erodible surface.

Summary

Application of PAM formulations will protect the soil surface from wind erosion IF the treated area can be protected from incoming saltation particles.. Twice the recommended rate gave maximum resistance to abrasion, but the crusts formed by 0.5 cm of simulated rain were more resistant to abrasion than PAM crusts.

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Table I. Polyacrylamide (PAM) formulations, recommended rates, and recommended dilutions tested in the wind tunnel. HMW and LMW are high and low molecular weights, respeetfirily. Simulated rain was applied after dry formulations to activate the material.

Formulation	Recommended	
	Rate	Dilution
Liquid PAM	9.3 l/ha	1:1000
HMW Dry PAM Liquid	5.6 kg/ha	1:1000
HMW Dry PAM	5.6 kg/ha	0.5 cm rain
LMW Dry PAM Liquid	5.6 kg/ha	1:1000
LMW Dry PAM	5.6 kg/ha	1:1000

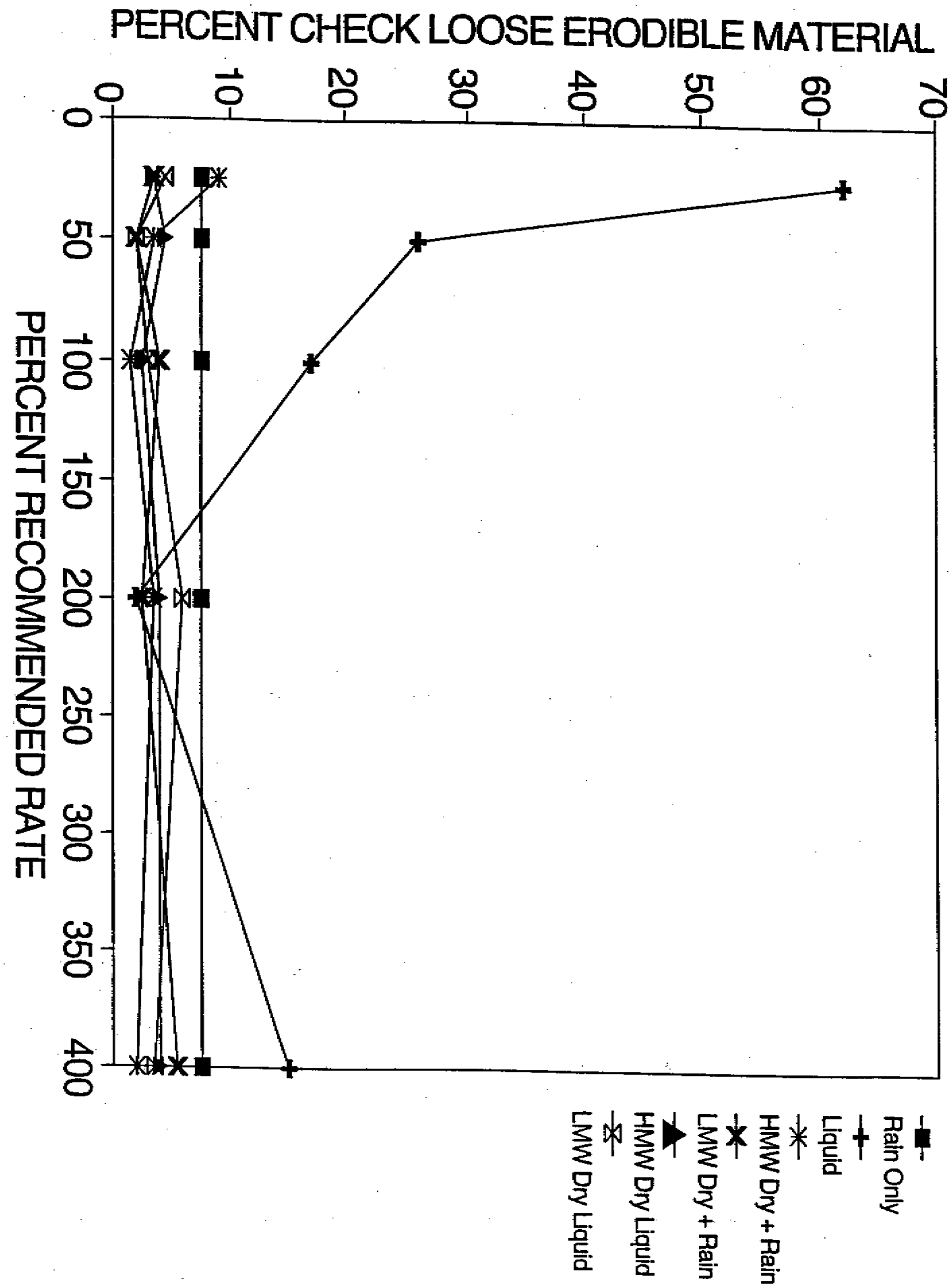

Figure 1. Effect of PAM formulations on Haynie fsl loose erodible material (LEM).

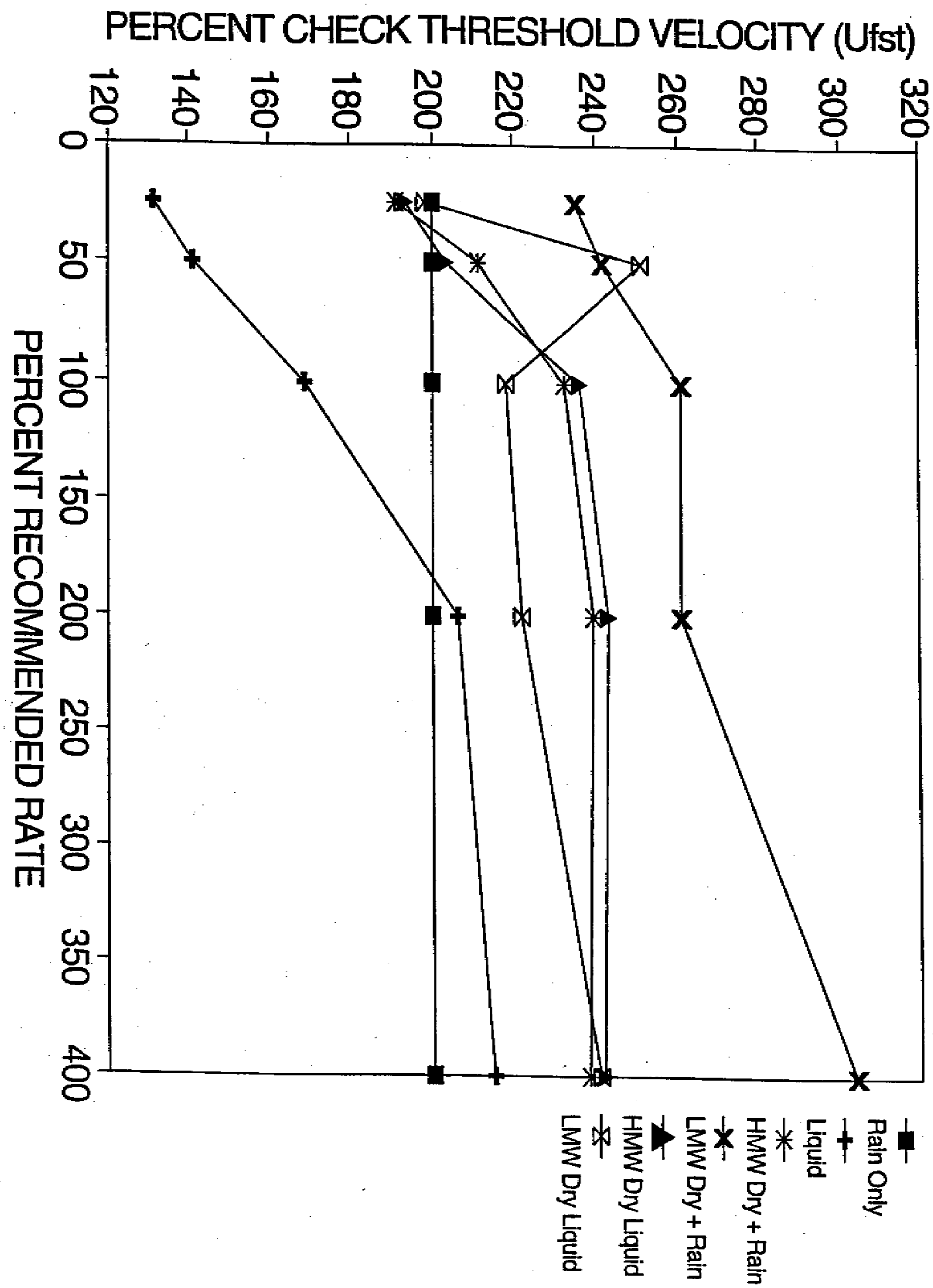

Figure 2. Effect of PAM formulations on Haynie fsl threshold wind velocity (Ufst)

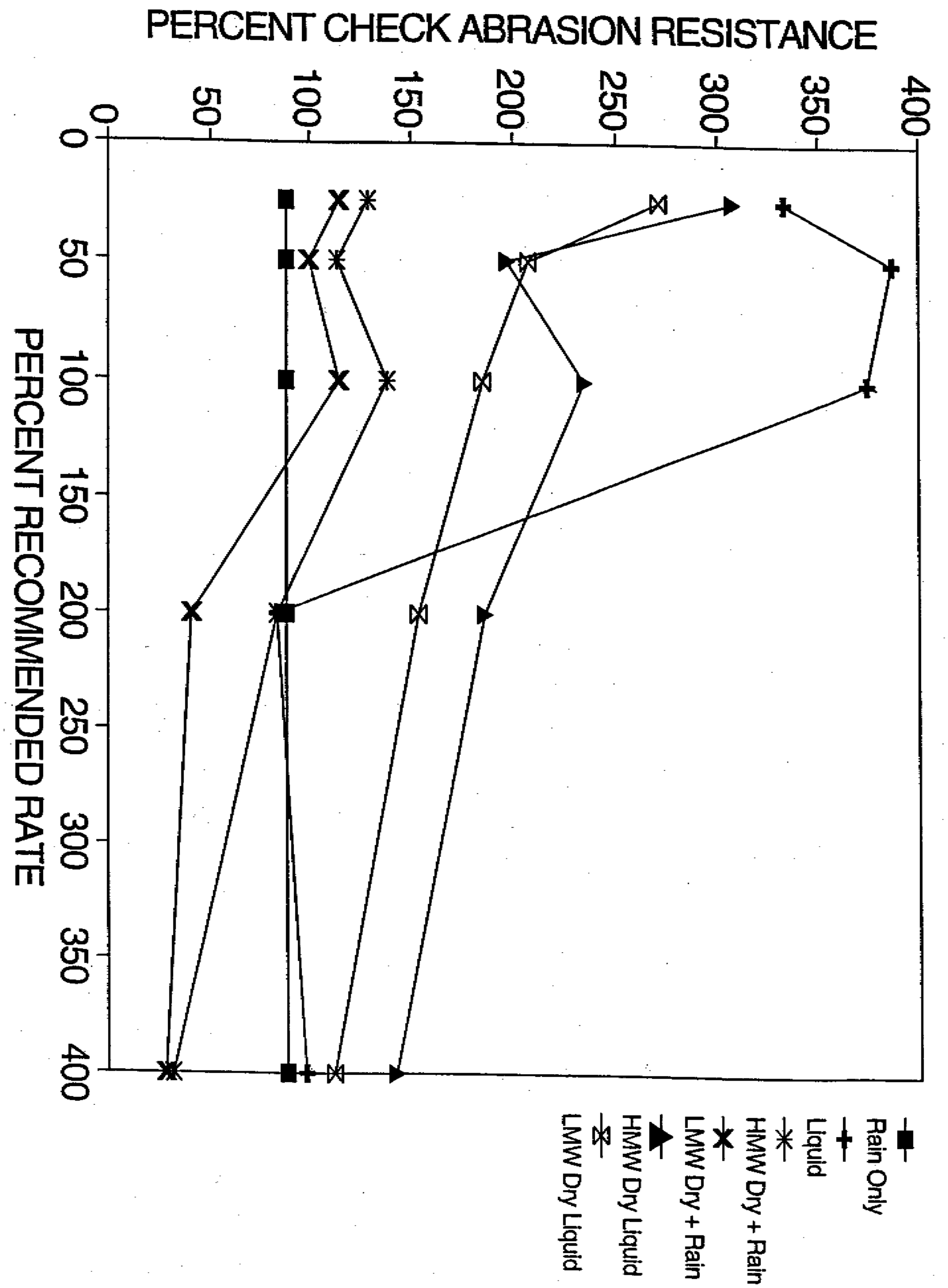

Figure 3. Effect of PAM formulations on Haynie fsl abrasion resistance.