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Experimental study on dynamic mechanism of sheet erosion processes on steep grassland in the loess region of China

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Sheet erosion has been the major erosion process on steep grassland since the Grain-for-Green project was implemented in 1999 in the Loess Plateau with serious soil erosion, in China. Quantifying sheet erosion rate on steep grassland could improve soil erosion estimation on loess hillslopes and provide scientific support for effectively controlling soil erosion and rationally managing grassland. Simulated rainfall experiments were conducted on grassland plot with vegetation coverage of 40% under complete combination of rainfall intensities of 0.7, 1.0, 1.5, 2.0 and 2.5 mm min^{-1} and slope gradients of 7°, 10°, 15°, 20° and 25°. Results showed that sheet erosion rate (*SE*), varying from 0.0048 to 0.0578 kg m^{-2} min^{-1}, was well described by binary power function equation ($SE = 0.0026 I^{1.306} S^{0.662}$) containing rainfall intensity and slope gradient with R^2 = 0.940. The logarithmic equation of shear stress ($SE = 0.084 + \mathrm{Ln}(\tau)$) and the power function equation of stream power ($SE = 1.141$ □$^{.073}$) could be used to predict sheet erosion rate. Stream power (R^2 = 0.903) was a better predictor of sheet erosion than shear stress (R^2 = 0.882). However, predictions based on flow velocity, unit stream power, and unit energy were unsatisfactory. The stream power was an excellent hydrodynamic parameter for predicting sheet erosion rate. The sheet erosion process of grassland slope was also affected by the raindrop impact except the dynamic action of sheet flow. The combination of stream power and rainfall kinetic energy (*KE*) among different rainfall physical parameters had the most closely relationship with the sheet erosion rates, which is also better than the stream power only, and a binary power function equation ($SE = 0.221\ \omega^{0.831} KE^{0.416}$) could be used to predict sheet erosion rate on grassland slope with R^2 = 0.930. The study results revealed the dynamic mechanism of the sheet erosion process on steep grassland in the loess region of China.