

Analysis of day rainfall characteristics of Zhengzhou

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Abstract. Raindrop characteristics, including speed and size of raindrops, in Zhengzhou city of Yellow River basin were analyzed through a natural rainfall on the loess slope. Results showed that the process of natural rainfall belonged to a parabola and counts, size and terminal velocity would increase with the rainfall intensity rising. Besides, the size and terminal velocity of natural raindrops were relatively scattered; In the process of individual rainfall, the terminal velocity and its peak value were mainly focused between 0.8~5m/s and 1m/s, respectively. Size of raindrops were mainly consisted of 0.125-0.5mm, among which the terminal velocity of raindrops with a size of 0.125mm, 0.25mm, 0.375mm, 0.5mm were primarily 0.8-3.4m/s, 0.6-3.4m/s, 0.8-1m/s, 1-1.4m/s, respectively.

1 Introduction

Loess Plateau, the region with extremely serious problems of loss of water and soils in the world, has been the main source of outflow sediments in Yellow River. Management of the sediments is the critical factor to curb sediment hazard^[1-2]. However, due to complexity of soil and water loss and limitations in observation methods and procedures^[3] for field research. For example, mechanism of watershed soil and water loss, erosion and sediment yields still unknown. There are still lack of practical soil and water loss models for Loess Plateau^[4], around the world^[4-8]. These restrictions limit the comprehensive development of soil and water loss management^[9-10].

Study of natural rainfall distribution^[11] by combining the field observation and laboratory test are the focus of research to explore the mechanism of soil and water loss to develop the optimized model and to establish a mathematical model of soil and water loss on the Loess Plateau. Therefore it is imperative to analyze the scale transformation and rainfall similarity and finally the raindrops characteristics in the soil erosion experiments must be solved^[12-15]. This study aims to analyze the terminal velocity and gradation (sizes) of raindrops, combined with the eroded sediments resulted from different rainfall conditions in order to offer a technology support for dynamic rainfall simulation.

2 Experimental program

2.1. Experiment design of runoff plots

The experiment was carried out at the Zhengzhou test base of model Yellow River (34°45'36"N 113°40'27"E) of Yellow River Institute of Hydraulic Research. The

length, width, depth and slope of runoff plots are 5.0 m, 1.0 m, 0.6 m and 20°, respectively. Structure of plots is brick-concrete and a water channel is at the outlet in each plots. Soil filled in each plots is surface loessal soil from the Mangshan Mountain in Zhengzhou, with the proportion of particle size of 0.05-0.01 mm, 0.02-0.05 mm being 43.4% and 35.45%, respectively. Soil bulk density is 1.20 g/cm³.

2.2 Test methods

The 5 m long slope was divided into five fractal surface from top to bottom. The laser optical disdrometer was used here to collect the information about characteristics of raindrops, including intensity, size, terminal velocity and number under the same terminal velocity. Slope velocity radar gun and steel rule were used to record hydraulics parameters, including speed, width and depth of runoff. Sediments were collected by 1 minute after producing runoff and analyzed the parameters mentioned above. Erosion amounts and sediment concentration were calculated by the method of substitution or oven drying and calculated the parameters like infiltration of runoff according to rainfall and runoff yield.

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Fig.1. Soil erosion model



Fig.2. The laser optical disdrometer

3 Results and discussion

In this paper, five typical rainfall time points in natural rainfall on April 23, 2016 (hereinafter referred to as 20160423) were selected. The length of each time point was 1min. The particle size of raindrops in the min length, the speed of raindrops, and the number of raindrops with the same raindrops were collected by LPM laser raindrop spectrometer. The raindrops characteristics were also analyzed. The results are as follows.

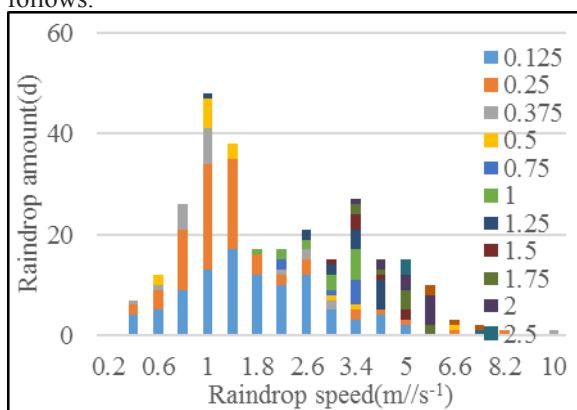


Fig.3. the first minute during the natural rainfall on 20160423

The distribution of the particle size and the final velocity of the raindrops in the first 1 minute during the natural rainfall on 20160423 is shown in Fig.3. It can be seen from the figure that the final velocity of the raindrops in the first 1min of the rainfall is mainly concentrated between 0.4-5.8m/s and the peak velocity is 1m/s, and the number of raindrops with the final velocity of the raindrop is about 48, accounting for about 17%; The rainfall is mainly composed of raindrops with particle size of 0.125-0.5mm. The final velocity of 0.125mm is mainly between 0.4-4.2m/s, and the final velocity of the raindrops with 0.25mm particle size is mainly concentrated on the range of 0.4-3.4m/s, 0.375mm diameter of the raindrops mainly concentrated on the 0.8-1m/s, the 0.5mm diameter of the raindrops mainly concentrated on the 1-1.4m/s.

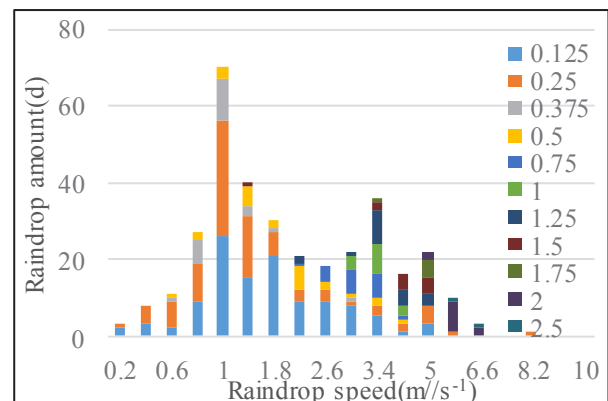


Fig.4 the second min during the natural rainfall on 20160423

According to the distribution of the raindrops and the final velocity of the raindrops in the second minute during the natural rainfall process (Figure 4), the final velocity of the raindrops in the second minute of the rainfall is mainly concentrated between 0.4-5.8m/s and the peak velocity is 1m/s, with the number of raindrops at the end of the raindrops is about 70, accounting for about 15%; We can also see the rainfall is mainly composed of 0.125-0.5mm diameter raindrops, the final velocity of 0.125mm particle size is mainly concentrated on the 0.8-3.4m/s, the final velocity of 0.25mm size is mainly concentrated in the 0.4-5m/s, the final velocity of 0.375mm particle size is mainly concentrated in the 0.8-1.4m/s, the final velocity of 0.5mm particle size is mainly concentrated in the 1-2.6m/s.

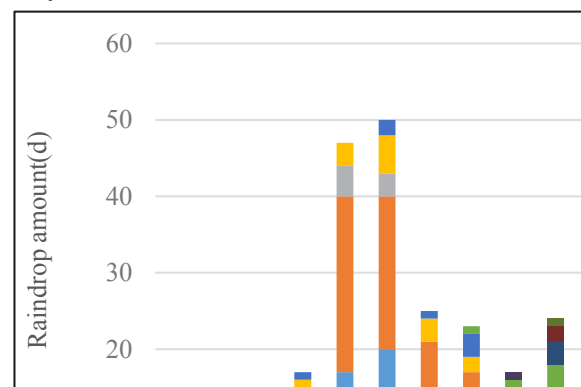


Fig.5 the third minute during the natural rainfall on 20160423

Fig.5 shows the distribution of the particle size and the final velocity of the raindrops in the third minute

during the natural rainfall in 20160423, it can be seen from the figure that the final velocity of the rains in the third minute of the rainfall is mainly concentrated in the range of 0.4-6.6m/s, and the velocity of the raindrops in the third minute of the natural rainfall is analyzed. At the same time, the final velocity and the peak velocity was formed, the value is 1.4m/s and 3.4m/s respectively. That is, most of the raindrop speed is 1.4m/s and 3.4m/s or so, with the number of raindrops about 50 and 28 or so, accounting for about 30% or so; We can also see the rainfall is mainly composed of 0.125-1mm diameter raindrops, of which 0.125mm particle size of the end of the rain mainly concentrated in the 0.4-3.4m/s, 0.25mm diameter of the raindrops mainly concentrated in the 0.6-4.2m/s, the 0.375mm diameter of the raindrops mainly concentrated in the 0.6-1.4m/s, the 0.5mm diameter raindrops is mainly between 0.8-2.2m/s, the 0.75mm particle size of the raindrops mainly concentrated in the 1.4-2.6m/s, the 1mm particle size of the rain speed is mainly between 2.6-3.4m/s.

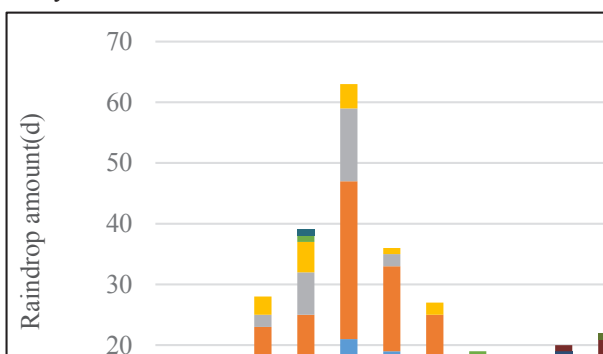


Fig.6 the fourth min during the natural rainfall on 20160423

Fig.6 shows the distribution of the particle size and the final velocity of the raindrops in the fourth minute during the natural rainfall in 20160423. It can be seen that final velocity of the raindrops in the fourth minute of the rainfall is mainly concentrated between 0.4-5m/s, forming two final velocity peaks, namely 1m/s and 4.2m/s respectively, that is, most of the raindrops is mainly 1m/s and 4.2m/s or so, with the number of raindrops is 63 and 30 or so, accounting for about 30%; We can also see the particle size of rainfall is mainly 0.125-0.5 mm raindrops. Of which 0.125, 0.25, 0.375, 0.5mm particle size of the rain speed is mainly concentrated in 0.4-3.4, 0.4-4.2, 0.8-1, 0.6-2.6 m/s.

Fig.7 shows the distribution of the particle size and the final velocity of the raindrops in the 5th minute during the natural rainfall, we can see that the final velocity of the raindrops in the first 5min of the rainfall is mainly concentrated between 0.4-6.6m /s, and the velocity of the raindrops in the 5th minute during the natural rainfall is analyzed. Forming a final velocity peak is 1m/s, that is, most of the raindrop speed is 1m/s, with the raindrop speed of the number of raindrops for about 54, accounting for about 17%; We can also see the rainfall is mainly composed of 0.125-0.5mm diameter raindrops, of which 0.125,0.25,0.375,0.5mm diameter of the raindrops mainly concentrated in 0.8-3.4,0.4-3.4,0.8-1.4,1-3.4m/s.

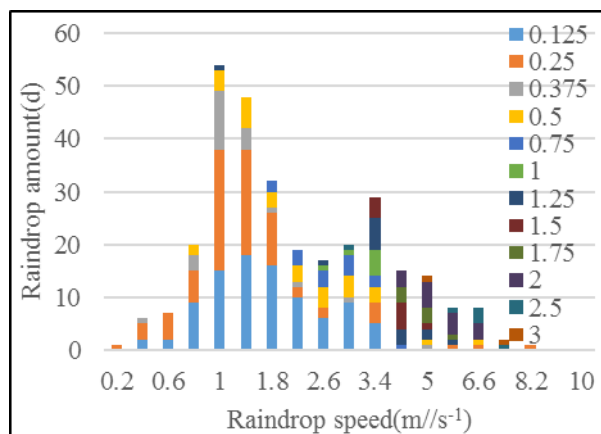


Fig.7 the fifth minute during the natural rainfall on 20160423

4 Conclusions

Through the analysis of natural raindrops, the following aspects were obtained:

- (1) The natural rainfall process is a process of rainfall intensity changes.
- (2) During the process of this rainfall, the final velocity of the rain is mainly concentrated between 0.8-5m/s, the peak of the final velocity is generally 1m/s; rainfall is mainly composed of the particle size of 0.125-0.5mm raindrops. The velocity of the raindrops of 0.125mm diameter is mainly between 0.8-3.4m/s, the final velocity of the raindrops of 0.25mm particle size is mainly concentrated between 0.6-3.4m/s, 0.375mm concentrated in the 0.8-1m/s, the 0.5mm particle size of the raindrops mainly concentrated in the 1-1.4m/s.

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