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## Introduction

A lot of study groups in Germany, Spain, Morocco and other countries use small mobile rainfall simulators to quantify soil and water losses under different crops, tillage systems and treatments especially on agricultural land in semi arid and arid landscapes. Often a small portable nozzle type simulator with a motor-driven pump and a single conventional nozzle in a height of 2 m is used (Photos 1-3). A lot of field measurements with portable nozzle type simulators have been accomplished by researchers, but only a small number of experiments analyzing the structure and the fall velocity of artificial rainfall have been published. Therefore the aims of the project were to elaborate the artificial rainfall.

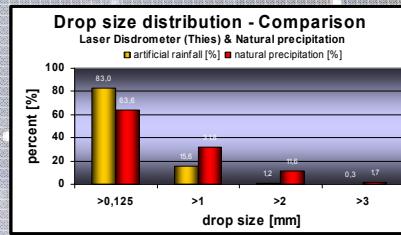
## Main Objectives

1. Drop size distribution (method 1)
2. Fall velocity (methods 1 and 2)



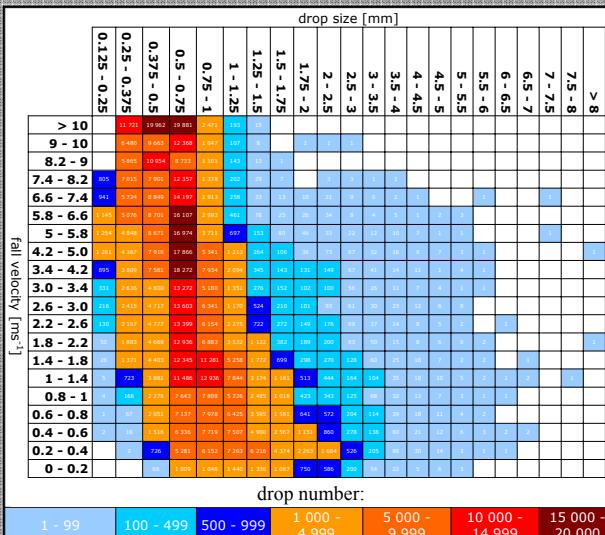
## Results

### 1) Drop size distribution



- maximum drop number: 0.125 – 1 mm
- maximum drop size: > 3 mm
- Artificial rainfall distribution resembles natural precipitation patterns (Marshall-Palmer distribution).
- Compared to natural rainfall artificial rainfall creates more smaller drops and less larger drops which are important for splash erosion.

### 2) Fall velocity



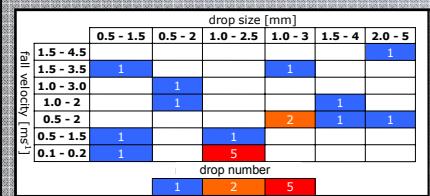
drop number:

1 - 99    100 - 499    500 - 999    1 000 - 4 999    5 000 - 9 999    10 000 - 14 999    15 000 - 20 000

### Laser Disdrometer (Thies®)

30 minutes; intensity 40 mmh<sup>-1</sup>; 657 977 drops

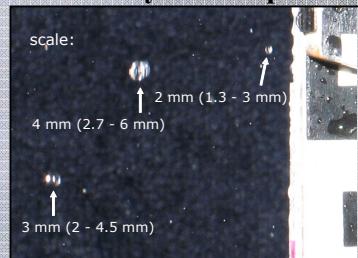
- maximum drop number: total: 0.375 - 0.5 mm; >10 ms<sup>-1</sup>  
class: 0.125 - <1.0 mm; >10 ms<sup>-1</sup>  
class: 1.0 - >3.0 mm: 0.2 - 0.4 ms<sup>-1</sup>
- increasing drop sizes → decreasing fall velocity
- > 0.125 - 0.75 mm increasing number
- > 0.75 - >8.0 mm decreasing number



↑ Digital Camera (Canon PowerShot G6®)  
intensity 40 mmh<sup>-1</sup>; 18 drops

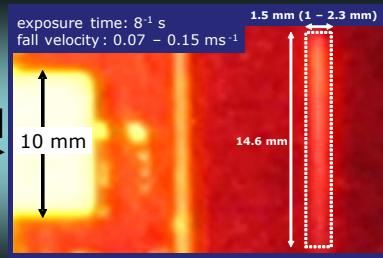
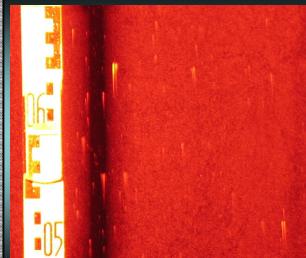
- maximum drop number: 1.0 - 2.5 mm; 0.1 - 0.2 ms<sup>-1</sup>

## Photo analysis examples



- before brackets: result
- maximum factor ±1.5
- in brackets: result ± factor 1.5

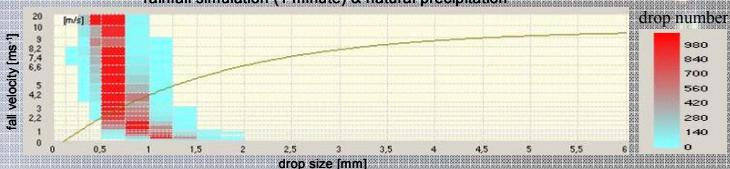
- drop size & fall velocity
- exposure time: 8<sup>-1</sup> sec
- drop size: 1 - 2.3 mm
- fall velocity: 0.07 - 0.15 ms<sup>-1</sup>



## Discussion

### Laser Disdrometer (Thies®) - Comparison

rainfall simulation (1 minute) & natural precipitation



The analyzed simulations show that the artificial drops with small diameters are faster than natural rain drops (green line) with same diameter. Large artificial drops show reciprocal behaviour. They are slower than natural rain drops with the same diameter.

## Conclusion

1. Compared to natural rainfall the simulator produces more smaller drops and less larger drops. Besides, smaller drops are too fast and larger drops are too slow. This is an important factor for the applied kinetic energy, which increases potentially with increasing drop size under natural conditions.
2. The larger and faster natural drops generate most of the soil detachment. This leads to the conclusion that calculated erosion rates from such experiments might underestimate natural rates.
3. It seems that the nozzle produces this problem. The water is atomized by the used pressure. Therefore small drops are accelerated to an unrealistic velocity for natural raindrops. Big drops are created by a 'large drop adapter' behind the nozzle. The height of 2 m is not sufficient for reach the terminal velocity of natural large drops.