Laser-Based Measuring Equipment for the Analysis of Size and Velocity Distribution of Liquid Drops

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The Particle Dynamic Analyzer is a laser device based on the phase Doppler-Anemometry. The equipment is used for continuous measurements of size, velocity, and concentration of globular particles contained in the liquid jet from nozzles.

INTRODUCTION

The size and velocity of drops are significant factors in connection with pesticide spraying and plant irrigation.

The nozzle type used determines drop size, liquid volume, and liquid pressure. Drop diameter of fog will typically be below 15 µm, and for aerosols it will be below 50 µm. For fine, medium, and coarse sprays the drop diameter will be respectively 100 to 200 µm, 200 to 300 µm, and over 300 µm.

For pest control spraying the spray coverage of plants should be as high as possible. The smaller the drop size, the higher the spray coverage that can be achieved. However, because of environmental considerations—wind currents and workers inhaling the small particles—limits exist on how small the drops can be. Therefore, drop diameters of 200 to 400 µm are recommended.

A coarse atomization can be achieved using rain-drop nozzles. The drop must be sized so as not to harm the plants, and the drop size must be sized in proportion to the plant species being sprayed. Therefore, for field irrigation a drop diameter greater than 4000 µm should not be used.

MEASURING METHODS

The distribution of drop velocity and size from a liquid flow were measured by laser-based equipment.

The equipment consists of laser, beam splitter, Bragg cell section, adjustable prisms, and front lenses. Photo multiplier sections pick up the signals and transmit them via a signal processor to a computer for analysis.

Laser effects may be achieved from nearly all light-emitting materials. The laser equipment used is based on an argon-ion laser unit. The laser unit will emit laser light of different wavelengths and a laser line is selected by turning the prism to achieve the optimum intensification for the desired wavelength. A wavelength of 514.3 µm was chosen for this study.

In order to measure the particle size, the laser beam is split into two beams. One of the beams is transmitted through a Bragg cell in which the frequency shifts. The beams are transmitted through a front lens with a specific focal length. Where the beams intersect, interference fringes are created. The point of intersection serves as the measuring point. The laser frequency determines the intervals between the fringes.

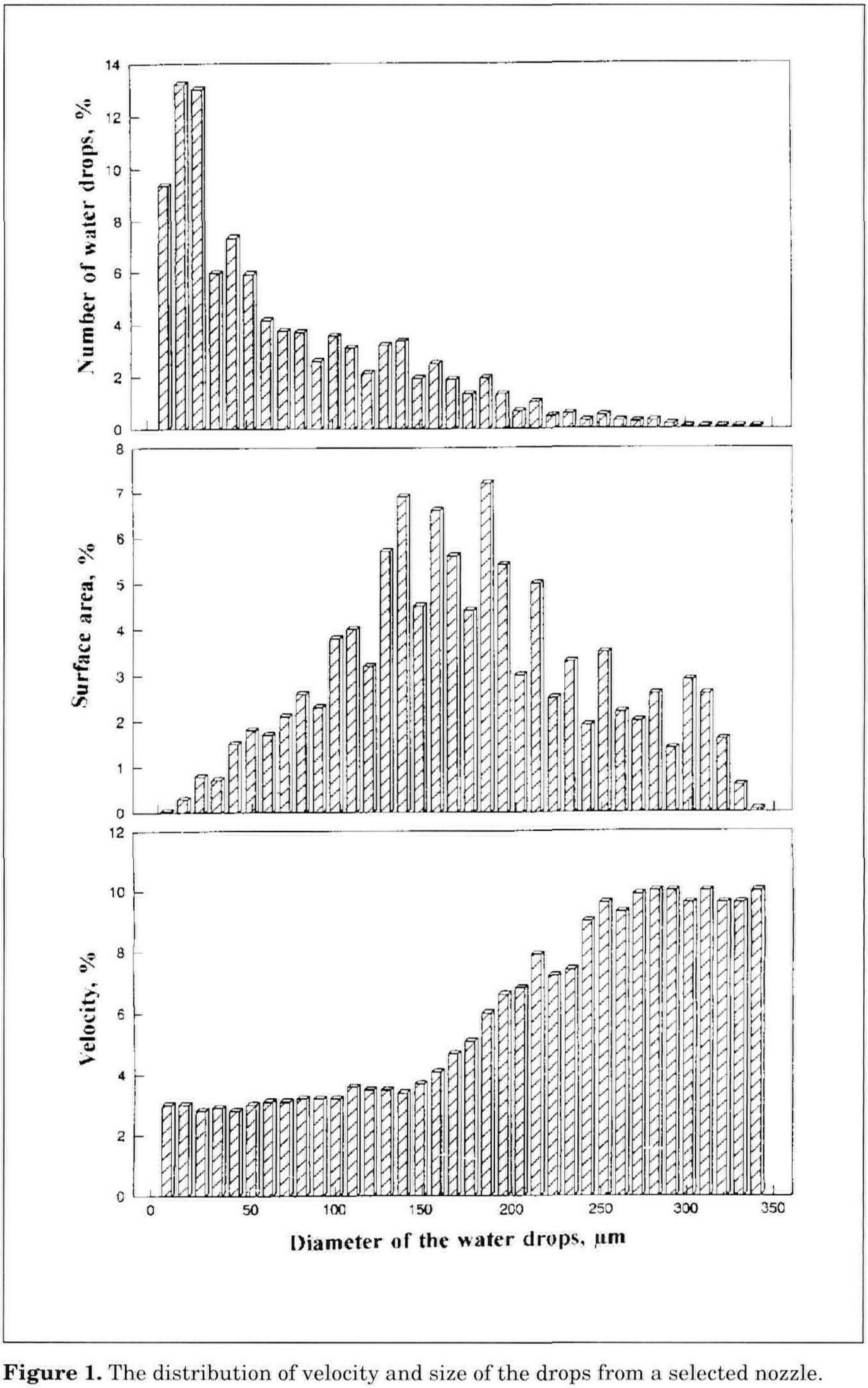

Figure 1. The distribution of velocity and size of the drops from a selected nozzle.

To measure the drop velocity a photo multiplier is used to pick up the pulsation of light occurring as the drops pass vertically through the horizontal parallel fringes.

The above-mentioned frequency is proportional to the drop velocity.

For measuring the drop diameter the equipment is fitted with two photo detectors for picking up light pulsations. The detectors are located so that they will both pick up the light pulsations at the same frequency, however, with a phase difference. The drop size is determinative of the difference in phases.

RESULTS

Figure 1 shows that the liquid spray contains a large number of drops with a small diameter. From the determination of the distribution in percentages of surface area of the drops according to size the large amount of drops with a small diameter is rather insignificant. It can furthermore be seen that the velocity increases with increasing drop diameter.

DISCUSSION

Other known drop analysis equipment will only measure drop sizes and distribution. The laser-based equipment will additionally measure drop velocities. This is essential when measuring wind deviation.