Mitigation of environmental impacts caused by farm chemicals and proposal of new certification procedures

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The spraying of pesticides has been a crucial step in the food system while distributing pesticide droplets precisely to a target area has always been a challenge. To solve this problem the AgroForestry Innovations Lab at the Free University of Bolzano is researching in collaboration with local farmers and machine builders to enhance the precision of pesticide droplet distribution in South Tyrol, Italy. In the first part we did Particle/Droplet Image Analysis (PDIA) and an Oxford Lasers N60 shadowgraphy to collect data for nozzles characterization. We investigated a simplified deposition assessment strategy involving Uranine tracer. This data will aid in evaluating nozzle performance and developing models to predict drift during chemical treatments.

Mitigazione degli impatti ambientali causati da farm chemicals e proposta di nuove procedure di certificazione

L'irrorazione di pesticidi è stata una fase cruciale nel sistema alimentare, mentre la distribuzione di goccioline di pesticidi in modo preciso su un'area target è sempre stata una sfida. Per risolvere questo problema, l'AgroForestry Innovations Lab della Libera Università di Bolzano sta conducendo ricerche in collaborazione con agricoltori locali e costruttori di macchine per migliorare la precisione della distribuzione delle goccioline di pesticidi in Alto Adige, Italia. Nella prima parte abbiamo eseguito Particle/Droplet Image Analysis (PDIA) e un'ombreggiatura Oxford Lasers N60 per raccogliere dati per la caratterizzazione degli ugelli. Abbiamo studiato una strategia di valutazione della deposizione semplificata che coinvolge il tracciante dell'uranina. Questi dati aiuteranno nella valutazione delle prestazioni degli ugelli e nello sviluppo di modelli per prevedere la deriva durante i trattamenti chimici.

**Key words**: Data acquisition, Drift and spraying,Nozzles, Image Analysis, MATLAB.

# **1. Introduction**

In accordance with the PhD thesis project, this poster reports the main results of the first two activities concerning:

(A1) The characterization of individual nozzles via VisiSizer N60V Laser System

(A2) Evaluation of different tracers for quick and cost-effective spray deposition measurements

# **2. Materials and Methods**

A typical Nozzle examination with N60 for test methodology development at two pressures each: Three standard hollow-cone nozzles and their anti-drift (air-inclusion) equivalent were evaluated at 4 and 8 bar pressure. Before proceeding with the test, the flow rate of each nozzle is tested with the aid of a dedicated device provided by composed of a tight-fitting tube collecting the nozzle output and conveying it to a container. The pump was run for a time of at least 90 seconds, after which the collected liquid is weighted to an accuracy of ±1 g and divided by the elapsed time to obtain the flow rate. The nozzle orifice is placed 30 cm above the center of the laser FOV. The procedure is as follows. After mounting each nozzle on the holder, the circuit is primed with the pump set to the first desired pressure with an accuracy of ±0.1 bar. An image acquisition sequence (Kashdan et al., 2003, Kashdan et al., 2007) is commanded in each of three different positions of the nozzle concerning the laser FOV making sure to acquire at least 10000 droplets per acquisition. Evaluation of different tracers for quick and cost-effective spray deposition measurements (Grella et al., 2021.) Smart fertilizers/pesticides spraying technology for precision agriculture and the environment we investigated a simplified deposition assessment strategy involving uranine, a non-toxic and low-cost fluorescent tracer widely used in other fields to minimize the measurement uncertainties exploiting the well-known phenomenon of optical absorbance. A nozzle evaluation bench has been used to deposit the fluorescent solution on a matrix of Petri dishes, which were then oven-dried, and the residuals redissolved in a fixed amount of water. Spectrophotometry was used to retrieve the mass of the deposited solution. After careful calibration against known uranine concentrations, the method yielded results very well correlated to the weight measurements performed before drying and allowed us to trace back an approximate deposition curve. The complete evaporation of the deposited solvent gets rid of the unpredictable atmospheric conditions during the test, while the flexibility of the solution allows one to easily tailor the technique to different application volumes, deposition rates, or collector configurations without losing accuracy. After oven-drying the samples for 18h at 60°C, the residual material was dissolved in 25ml of DI water and the initially deposited material has been estimated from the absorption spectrum (Becce, 2022).

# **3. Results and Discussion**

## **3.1 Determination of the main physical properties**

An example of droplet spectra for the same nozzle operated at different pressures is presented in figure 1, both in terms of drop size distributions (DSD, histogram) and cumulative distribution functions (CDF, solid lines). When compared to the drop spectrum of an equivalent, conventional nozzle, the working principle of the air induction nozzle becomes evident.



*Fig. 1: The B04 vs AI01 nozzle at 4 and 8 bar pressure.*

The figure shows the much broader, coarser droplets produced by AI04 with respect to B04. The decrease in size of the droplets is evident with the greater pressure for the AI0*.*

## **3.2 Evaluation of Fluorescence tracers for cost-effective spray deposition measurements**

The calibration curve has been calculated by depositing a known amount of the sprayed solution and adding DI water to reach the fixed volume used for redissolving the material in the other container.

The negative values for the estimated curve around zero are due to the intercept in the calibration equation. Indicating a threshold of deposited material, from this estimation is possible to identify the minimum distance beyond which less than a certain amount of solution has been deposited.

*Fig. 2: The calibration curve of Uranine representing estimated weight vs measured weight.*

The present work focused on developing a preliminary nozzle test methodology and acquire the know-how necessary to assess nozzle performances. A data parsing system was set up in MATLAB to gather the necessary relevant parameters with routines available to plot several parameters and compare them between tests, while keeping a high level of flexibility. To create an in-house reference database, the next step is to standardize the analysis and apply it to the rest of the stock available at the AFI-Lab.

# **4. References**

Becce, L., Amin, S., Carabin, G. and Mazzetto, F. (2022). Preliminary spray nozzle characterization activities through shadowgraphy at the AgroForestry Innovation Lab (AFI-Lab). [online] Available at: https://ieeexplore.ieee.org/document/9965106.

J. Kashdan, J. Shrimpton, and A. Whybrew, “Two-phase flow characterization by automated digital image analysis. part 1: Fundamental principles and calibration of the technique,” vol. 20, no. 6, pp. 387–397.

J. Kashdan, J. Shrimpton, and A. Whybrew, “Two-phase flow characterization by automated digital image analysis. part 2: Application of PDIA for sizing sprays,” vol. 21, no. 1, pp. 15–23.

M. Grella, P. Marucco, M. Manzone, R. Gallo, F. Mazzetto, and P. Balsari (2021) “Indoor test bench measurements of potential spray drift generated by multi-row sprayers,” in 2021 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor), pp. 356–361, IEEE.