Optical sensor for droplet characterization : toward agricultural spraying deposits measurment tool

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Abstract

Nowadays, plant protection still calls on pesticides to prevent disease and pests. This use of phytosanitary inputs became a main issue in the agriculture field, due to the off-target spray particles movement that fails to reach their target when pesticides are applied to crops, these spray drops contaminate the outer regions of the treated area. This spraying loss has a negative impact on environmental, health and economic problems.

One of the way to improve the spraying quality is to estimate the off-target volumes, this information could thus help farmers to optimize their planting performances. Several methods to quantify spray deposition in field conditions have been developed [1–4] such as the use Water Sensitive Paper (WSP) cards. However, these methods are time consuming and has a lack of accuracy.

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The objective of this work is to create an optical sensor based on a RIB waveguide design to characterize the quantity and distribution of a liquid spray deposit. The conception idea is that we assumed that the light guidance properties of these sensors would undergo a modification when spraying droplets are present on their surface. This phenomenon results from partial evanescent wave absorption by the water, highly present in pesticides, which leads to a decrease in the transmitted intensity at the waveguide output.

We firstly studied on an optical bench the influence of a droplet deposits on the waveguide using different droplet volumes (0 to 10 μl). The result obtained was a gradual decrease in the output intensity signal due to the water absorbtion of the evanescent field, and this proportionally to the droplet volume; the bigger the droplet, the greater the loss in output intensity. [5]
Secondly, we performed a second test by successively adding 2.5 μl droplets alongside the waveguide to analyze their cumulative influence. We found out that the decrease in output intensity is also proportionally related to the number of droplets present on the waveguide. [5]In addition, we performed an other test on a spectral analysis bench in order to highlight the light absorption at the specific water wavelenght using the output spectrum. this test aimed to confirm the link between the volume and the absorption to certify the first approach. We proceeded to a droplet deposition on the waveguide with a volume range from 0,1 to 2.5 μl droplets to analyze the sepctra at the output. The result showed that we can see an absorption at 1450μm wavelenght wich is one of the water wavelenght absoprtion. This investigation also exposed the link between the droplet volume and the absorption rate. To conclude, these first results demonstrate the potential of RIB waveguide sensors to accurately quantify droplet deposits and can potentially be used to analyze a chemical composition of a liquid present on the waveguide surface. Our future work should focus on improving the waveguide architecture in order to estimate deposited volumes and also the number of deposited droplets.

Keywords: Pesticide reduction, spray characterization, optical sensors, rib waveguides