104. Environmental Exposure Reduction Using Spot Spraying Robots in Vegetable Row Crops

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Abstract:
In early crop stages, spot spraying applications in vegetable row crops can save a significant amount of plant protection products (PPPs) while maintaining crop protection. These PPP savings along with typical spot spraying application settings, also reduce the amount of run-off and drift that could reach non-target areas. In previous research projects, PPP use savings, biological efficacy and economical aspects of a new spot spraying robot were evaluated. The ongoing research project (2023-2026) focuses on the environmental aspects of this technology and aims to establish a link between PPP savings and mitigation of losses to non-target areas.

Keywords: spot spraying, drift, run-off modelling

Introduction
The standard approach for applying plant protection products (PPPs) in vegetable field crops is through broadcast applications. However, studies have shown that spot spraying applications can reduce PPP usage by more than 50% over the entire cultivation period when compared to broadcast applications (Keller et al., 2020). Early spot spraying applications have demonstrated even greater savings, exceeding 85% (Witsoe et al., 2024). Moreover, spot spraying applications of insecticides has been found to be just as effective as broadcast applications (Haberey et al., 2021). The use of spot spraying robots, which target only the intended crop plants, offers the potential to reduce environmental impact while conserving PPPs and ensuring adequate crop protection. The objective of the current research project is to assess the potential of spot spraying applications to reduce spray drift and run-off relative to broadcast applications.

Materials and methods
Drift trials with a plot band sprayer and two spot spraying robots were conducted in accordance with the international standard for field measurement of spray drift (ISO 22866, 2005). To evaluate drift, the crop was treated with a fluorescent tracer and the spray deposition was measured on several drift targets (2.5 x 200 cm strips of filter paper attached to wooden slats). Drift targets were positioned within the spray area and at distances of 0.5, 1, 1.5, 3, 4.5, 6 and 9 meters downwind from the spray swath, with four replicates per run. After each run, 50 ml samples of the spray broth were taken. The measured deposition rates were compared to Rautmann's standardized drift values for field crops (JKI, 2022).

Run-off reduction potential of spot spraying applications was modelled using measurements from various crops at different growth stages and their corresponding spot sprayer settings. The model assumes that all PPPs applied directly to the soil are subject to run-off, while the proportion applied to the crop is not. The proportion of PPPs that are subject to run-off from the soil surface after a spot spraying treatment is then the difference between the spot spraying area and the crop area for each treated plant. The reduction in run-off potential when compared to a broadcast application is then the total area of the vegetable bed less the crop area and the proportion of soil treated with PPPs after a spot spraying application.

Results and discussion
The trials conducted so far have shown that, when compared to the Rautmann drift values, spray drift can be reduced by more than 90% when using band or spot spraying devices. Both spot spraying devices showed a drift reduction of over 95%, with nearly all trials surpassing a 99% drift reduction. Both tested spot spraying devices showed to have similar drift values. Compared to conventional sprayers, the shielding and low nozzle heights of the spot spraying devices seem to be very effective at reducing spray drift.

Modelling of run-off potential with measured crop parameters showed that spot spraying in a lettuce crop, eight days after planting with a crop cover of 6% (BBCH 15), could reduce run-off by 85% when compared to broadcast applications. Twenty days after planting, the crop cover increased to 25 % (BBCH 19) and potential run-off reduction decreased to 52%. At later growth stages (thirty days after planting; BBCH 41), the crop cover increased to 55%, and the potential for run-off savings dropped to 14%. These results show

that spot spraying may significantly reduce run-off potential, particularly at early crop stages.

Conclusions

Spot spraying technology has the potential to make significant contributions to advancing sustainable crop protection by reducing the use of plant protection products (PPPs) and minimizing environmental exposure. While the presented drift trials have yielded promising results, they were based on a limited number of runs. Further drift trials are planned for 2025 to support these findings. Ongoing efforts within the project will include further measurements of crop parameters for run-off modelling, additional drift trials and test drives to determine PPP savings potential across different vegetable crops and crop stages. The knowledge gained may provide valuable data for regulatory assessments and support the broader adoption of this new technology in agricultural practice.

Acknowledgements

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