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Environmental Exposure Reduction Using Spot Spraying Robots in Vegetable Row Crops

Joshua Witsoe, Thomas Poiger and Martina Keller [a]

[a]*Agroscope, Wädenswil, Switzerland*

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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 (Witsoe et al., 2024). 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 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.

METHODS

- In 2024, drift trials with two spot spraying robots (Figure 1) were conducted. The crop was sprayed with a tracer and deposition was measured on filter paper targets (Figure 2).
- The measured deposition rates were compared to Rautmann's standardized drift values for field crops (JKI, 2022).

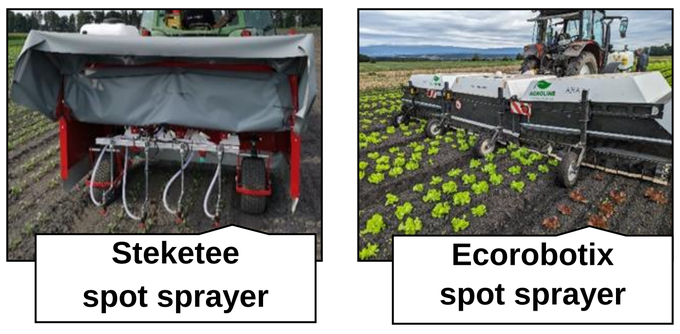


Figure 1. *Tested spot spraying devices.*

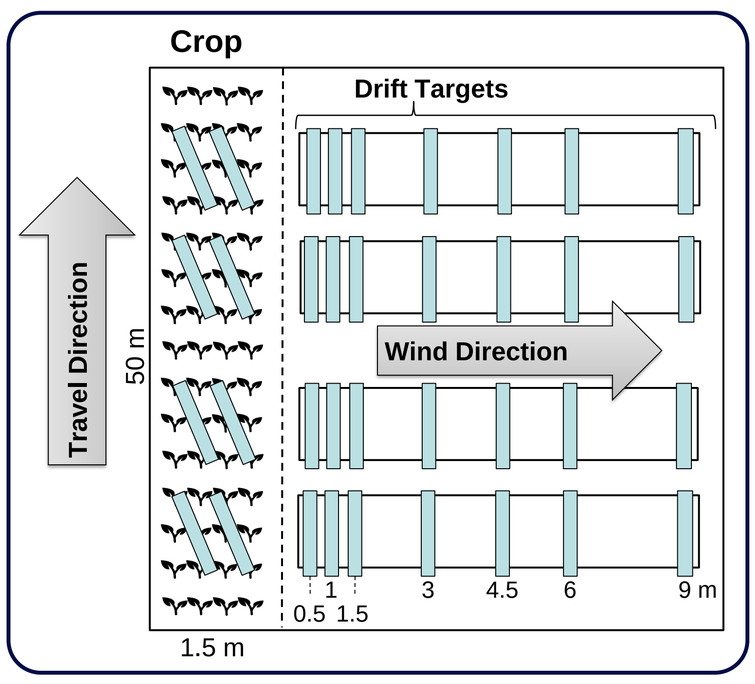
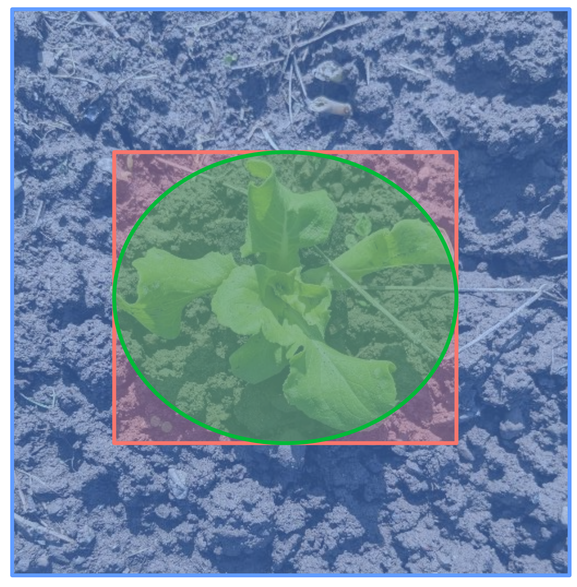


Figure 2. *Drift trial design.*



- Run-off potential was modelled in **R** using parameters measured from different vegetable crops, growth stages and seasons.
- Model calculations (depicted in Figure 3) included:
  - ➢ **Crop cover**
  - ➢ **Run-off from spot spraying**
  - ➢ **Run-off saved**

Figure 3. *Modelled run-off savings potential due to spot spraying in a lettuce crop, eight days after planting (BBCH 15). Crop cover shown in green, run-off from spot spraying in red and run-off saved in blue.*

RESULTS

- All spot spraying trials showed that drift can be reduced by over 95%, with nearly all cases surpassing a 99% reduction when compared to Rautmann drift values for field crops (Figures 4 and 5).
- Both spot spraying devices showed similar drift values.
- Compared to conventional sprayers, the shielding and low nozzle heights of the spot spraying devices (Table 1) seem to be very effective at reducing spray drift.

Table 1. *Application details from the 2024 drift trials.*

Device	Application Type	Nozzles	Nozzle Height [cm]	Pressure [bar]	Travel Speed [km/h]	Application Rate [l/ha]
Steketee spot sprayer	Spot	TeeJet TP40-02E	34	2	3.5	400
Ecorobotix spot sprayer	Broadcast	EUSPRAY IC1X502E	26	3	7	263

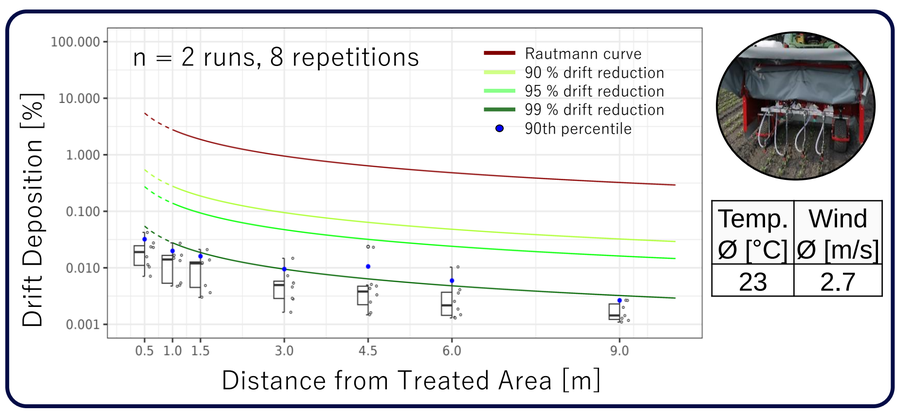


Figure 4. *Drift deposition and reference curves from drift trials with the Steketee spot sprayer. The dashed lines are extrapolations of these reference curves. Drift deposition is in % of the application rate.*

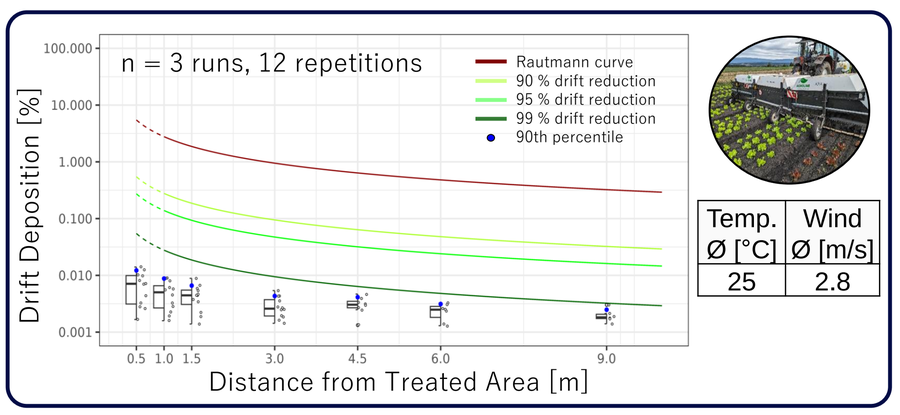


Figure 5. *Drift deposition and reference curves from drift trials with the Ecorobotix spot sprayer. The dashed lines are extrapolations of these reference curves. Drift deposition is in % of the application rate.*

- Modelling showed that with spot spraying, run-off could be reduced by 50-85% during early stages of cultivation (Figure 6).

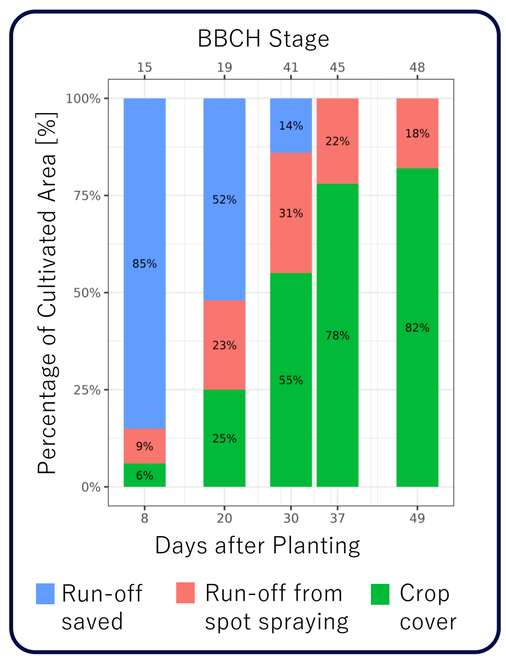


Figure 6. *Modelled spot spraying run-off potential in lettuce planted on 21.08.2024, n = 120 plants measured.*

CONCLUSIONS

- Spot spraying technology has the potential to advance sustainable crop protection by reducing the use of PPPs while minimizing environmental exposure.
- The knowledge gained may provide valuable data for regulatory assessments and support broader adoption of the technology in agricultural practice.

Link to the final report of project 1 (in German only).

Link to the final report of project 2 (in German only).

Link to watch the Steketee spot sprayer in action.

REFERENCES

- Julius Kühn-Institut (JKI), 2022. Tabelle der Abdrifteckwerte [Stand Oktober 2022]. https://wissen.ju-lius-kuehn.de/at-dokumente/pruefung-und-listung/themen/abdrift. Last accessed on 15.01.2025.
- Witsoe J., Total R., Haberey P., Heitkämper K., Bravin E., Möri H., Steffen P., Wyssa T., Anken T., Matter R., Keller M., 2024. Nachhaltiger Pflanzenschutz im Gemüsebau durch Spotspraying-Technik (2021-2023). Agroscope Science, 186, 1-39.

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