Spray drones in Switzerland

Image: S. Rüttimann

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The Swiss legal approach

- For spray drones a «National standard scenario» has been developed
  https://www.bazl.admin.ch/bazl/en/home/drohnen/specific/sts/ch-sts.html

→ drone type must be authorised by Agroscope for «ground application» and each drone passes a sprayer test
→ drone operating company needs a «Specific Operations Risk Assessment» (SORA) approved by the Federal Office of Civil Aviation

- After 2025: Spray drones need an authorisation of the Federal Office of Civil Aviation based on SORA or EU-PDRA, according to (EU) 2019/947
  → an adaptation of the PDRA S-01 for spray applications is under work

- Today about 100 spray drones are in use in Switzerland

Homologation of spray drones

- each drone type (1 machine) needs to be homologated by Agroscope
- each single drone passes a sprayer tests all 3 years (like other sprayers)

Testing criterias for the homologation

- spray system fulfils principles of ISO 16122
- transversal distribution of spray liquid: coefficient of variation < 15 %
- accuracy of automated flight route: +/- 50 cm

- max. lateral windspeed (check for drift reduction)

Distance from drone	Meters above soil	wind speed m/s
10 m	1 m	5 m/s
	2 m	3 m/s
20 m	1 m	3 m/s
	2 m	2 m/s

Details see:
https://www.bazl.admin.ch/bazl/en/home/drohnen/specific/sts/ch-sts.html
«Spray drones: Testing and approvals of sprayers»

Agroscope

Control of spray system (ISO 16122)

Standard checks of the spray system like:
filters available, dripping of nozzles after stop of spraying, nozzle flow, flow or pressure indication, leakages, weights…

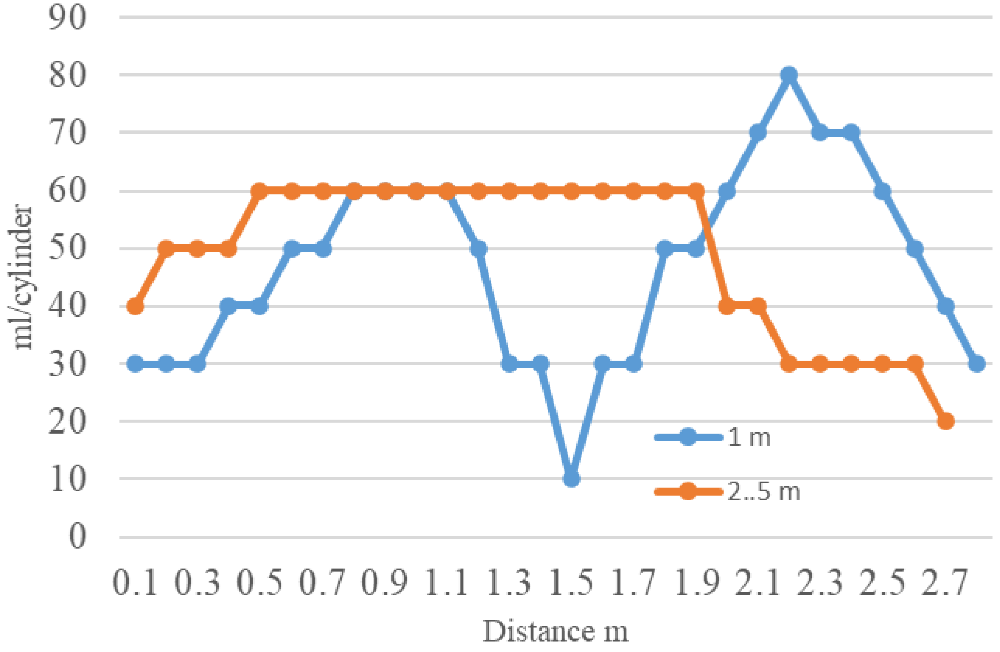
Transversal distribution of spray liquid

Patternator (6 m x 3 m, same principle as the ones for field sprayers)

- drone is hovering at the same place over the patternator
- lateral wind is strongly influencing the distribution
- flying height 2.5 m

Flying height influences distribution

transversal distribution at 1 and 2.5 m flying height

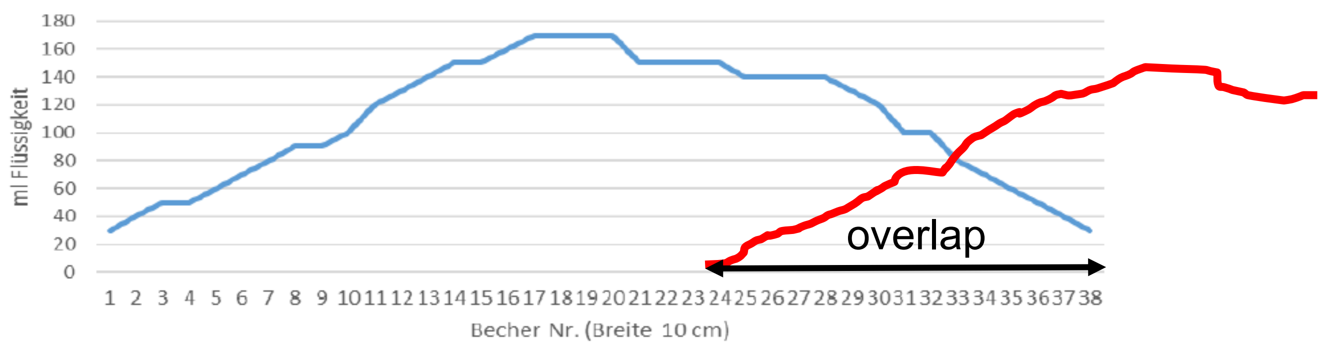


- Flying height of 1 m and less is not delivering a good distribution
- 2.5 – 3 m delivers a much better distribution

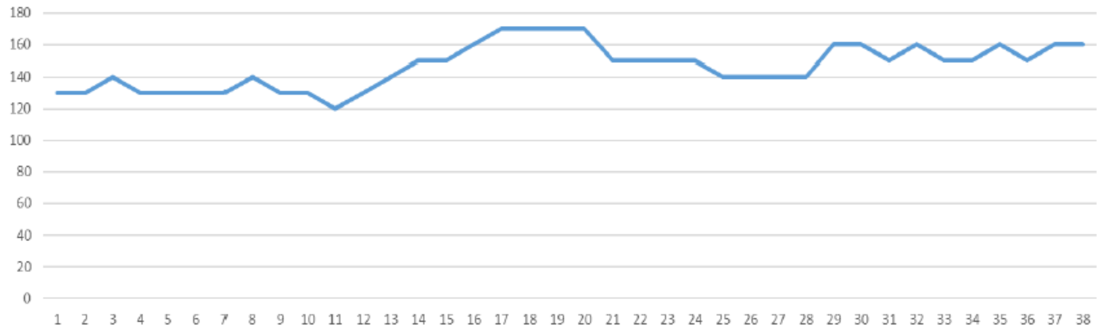
→ less influence of the single propellers, more homogeneous air flow

Overlap of two spray swathes is calculated

no overlap, working width of 3.8 m – coefficient of variation 48 %



overlap 1 m on both sides, working width of 2.8 m – coeff. of variation 9.4 %



→ During the sprayer tests we calculate the optimal overlap to reach the lowest coefficient of variation
→ working width are lower than the indications of DJI
→ today most drones achieve a coefficient of variation < 15 %

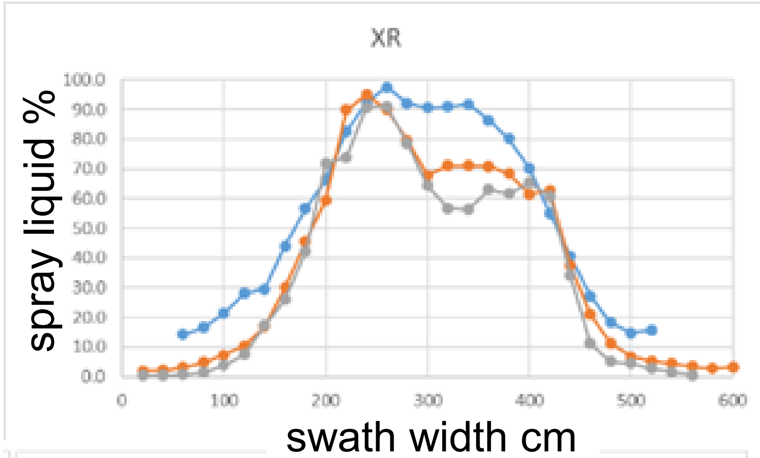
Comparison of 3 methods to measure transversal distribution

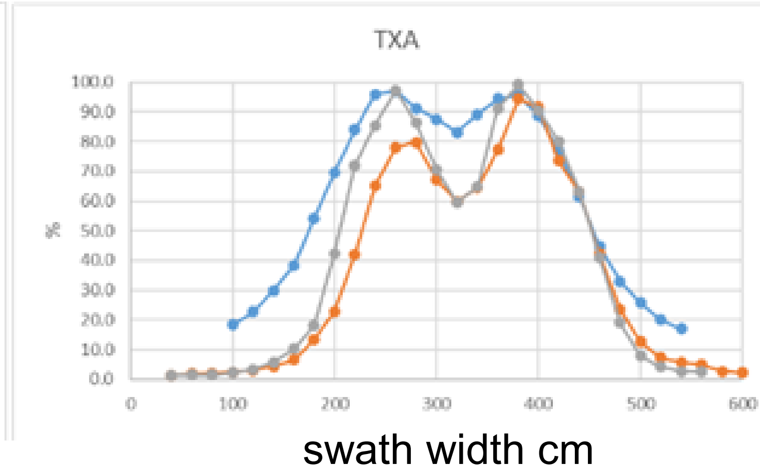
- patternator
- tracer and photometric analysis
- water sensitive paper: treated surface determinded by computer vision

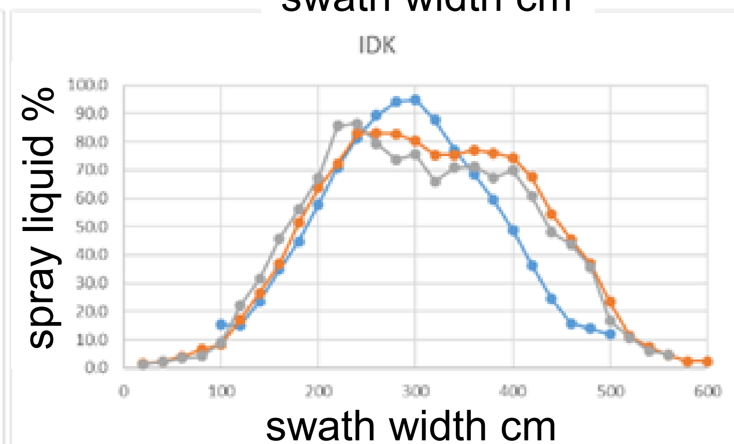
executed in collaboration with Syngenta

- yellow water sensitive paper
- white filter paper for tracer

Transversal distribution of different nozzles and measuring methods



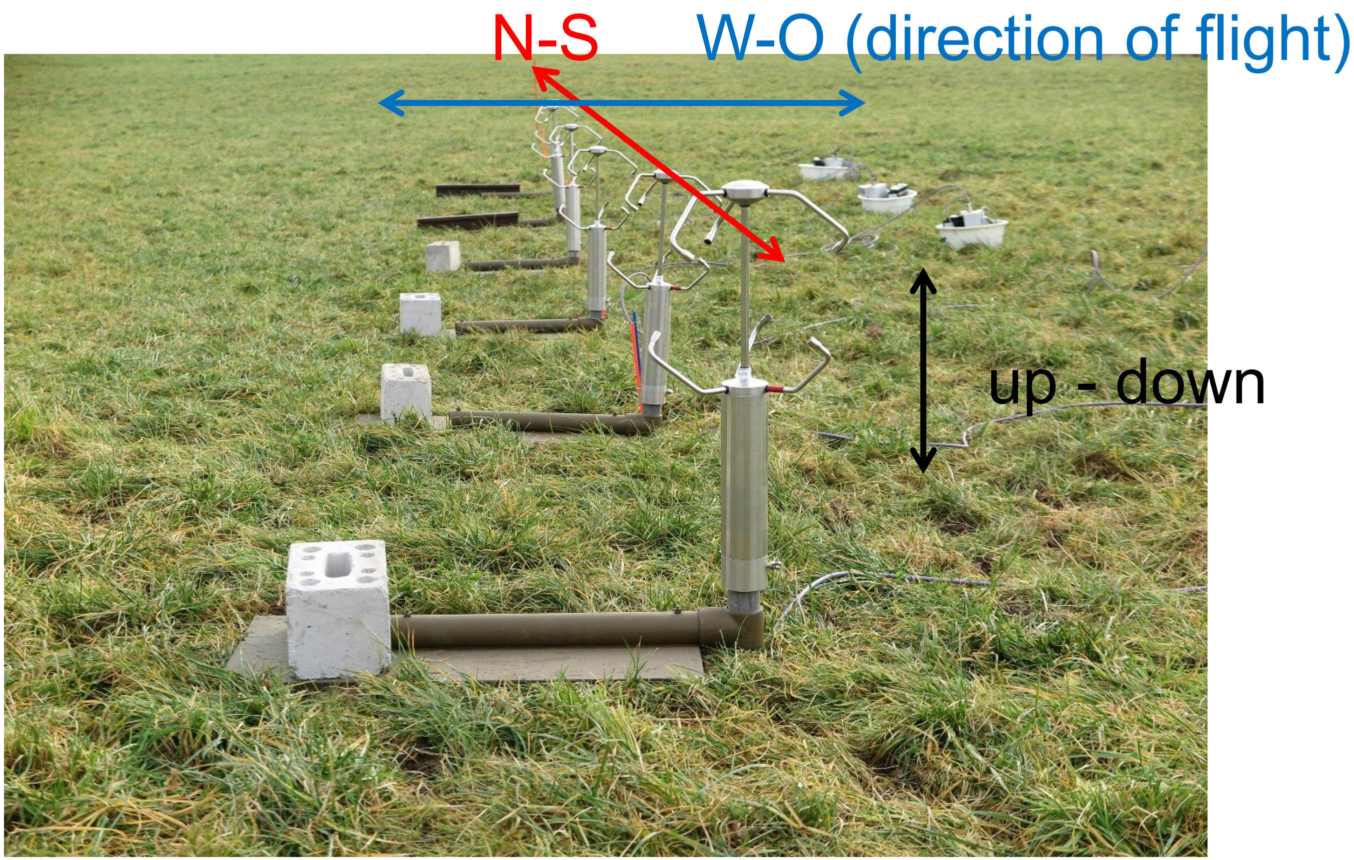




patternator
tracer
water sensitive paper

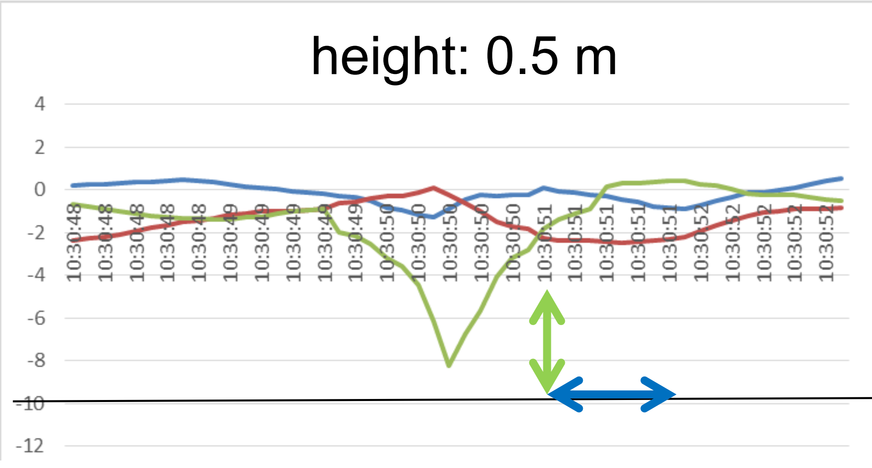
- Teejet XR (flat fan) & TXA (hollow cone), Lechler IDK (flat fan air injection) (Drone DJI T16)
- «water goes where the wind blows» → no significant influence of nozzles
- no significant differences between different methods

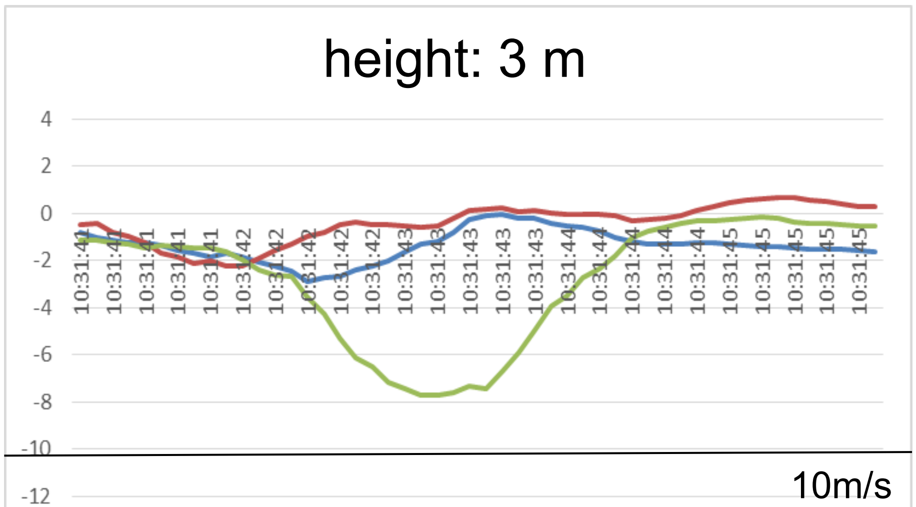
Measuring wind speeed



Each sensor is measuring wind speed in three directions
west-east; north-south; up-down (10 Hz)

Windspeeds directly below a drone of 25 kg



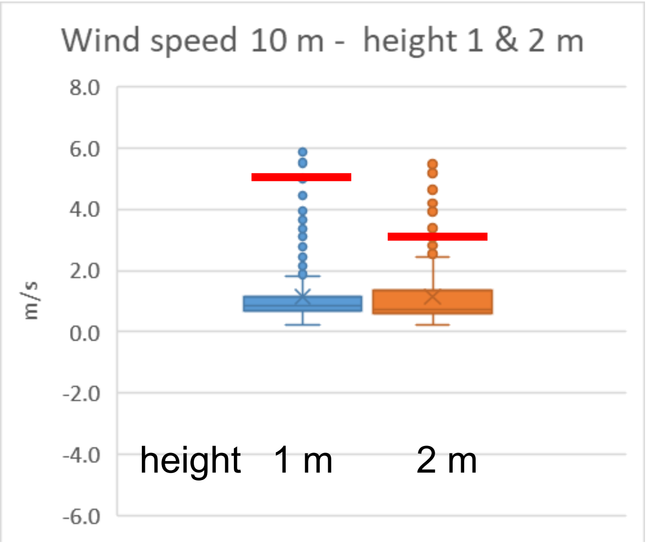


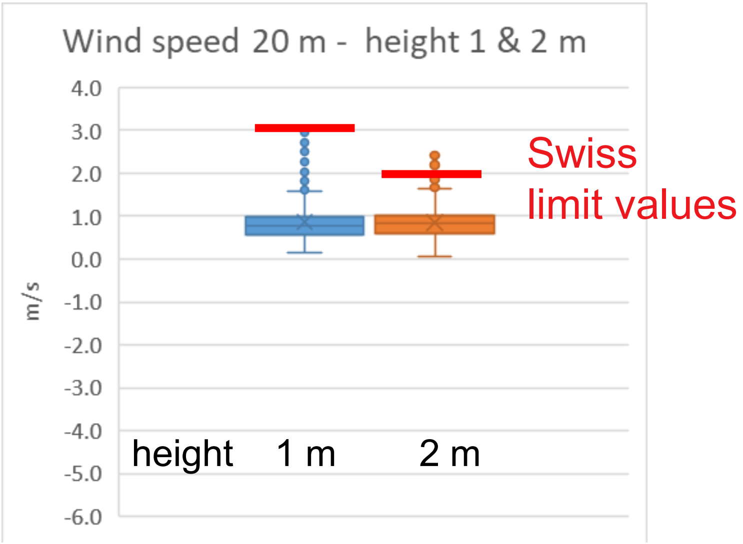
- low lateral windspeeds, vertical speeds up to 8 m/s

→ ideal for reducing drift

Visualisation using smoke

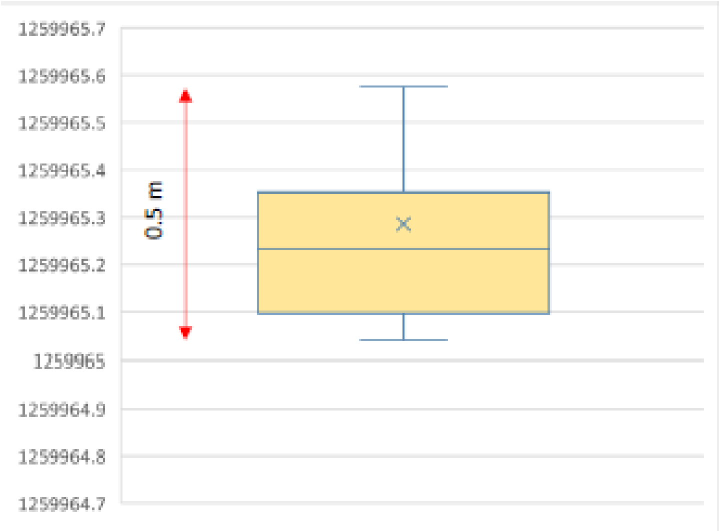
Wind speeds of DJI T30, distance 10 & 20 m





→ heavier drones like DJI T30 lead to higher wind speeds, slowly approaching the limit values

Accuracy of flight route



drone is flying along a defined route simulating a field (3 swathes)

drone is carrying an additional RTK-GNSS data logger to measure the deviation of the defined route

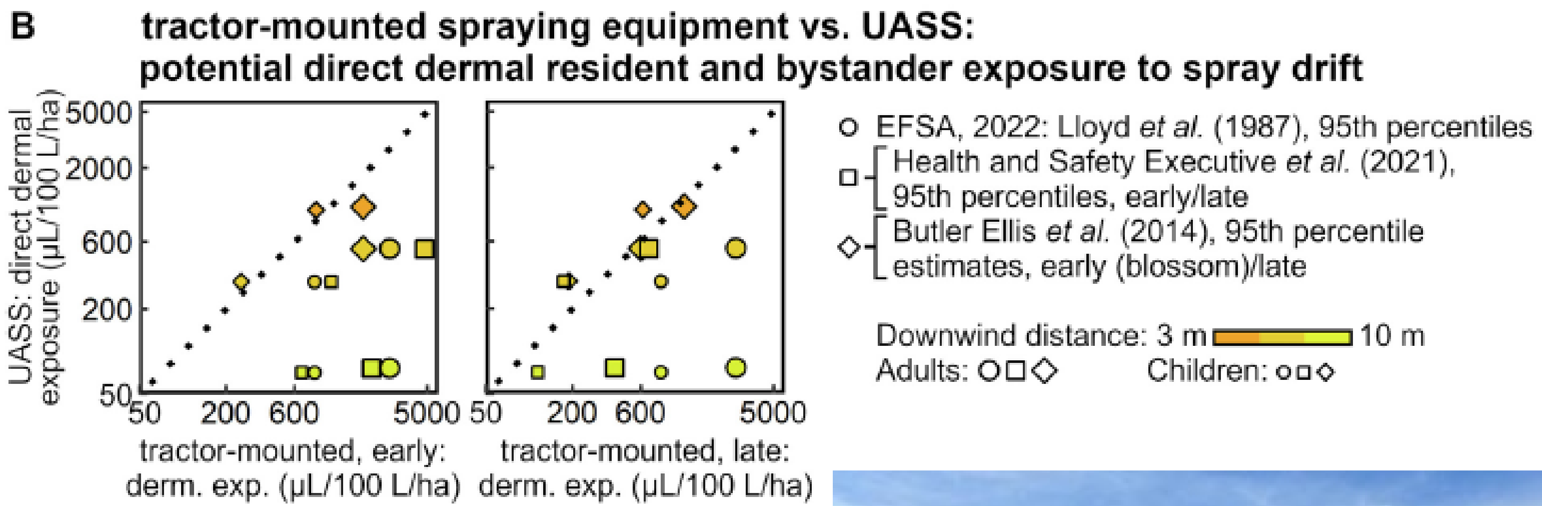
achieved accuracies in general:

- values are within 0.5 m
- 50 % of values +/- 10 cm

RTK logger

Drift and bystander measurements

→ spray drift of drones has been quantified by means of bystanders and tracer measurements



(Dubuis et al. 2023)

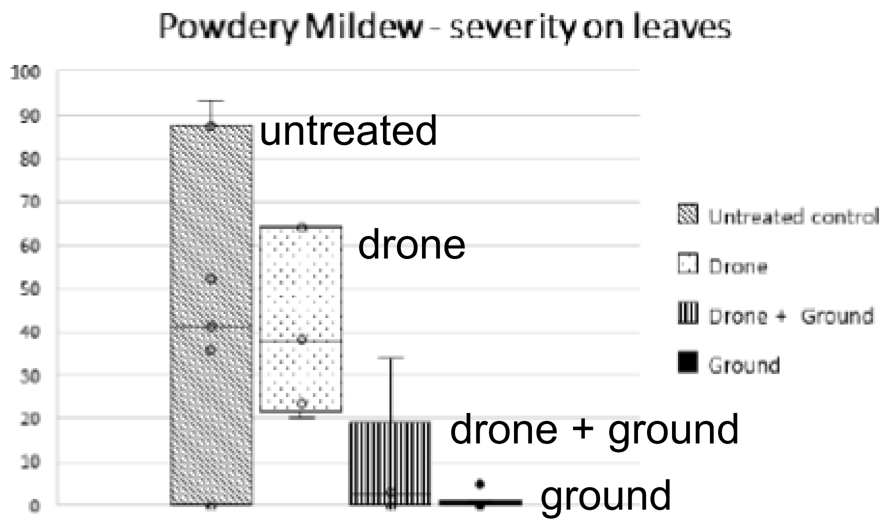
→ spray drift of drones is lower than standard tractor mounted blast sprayers

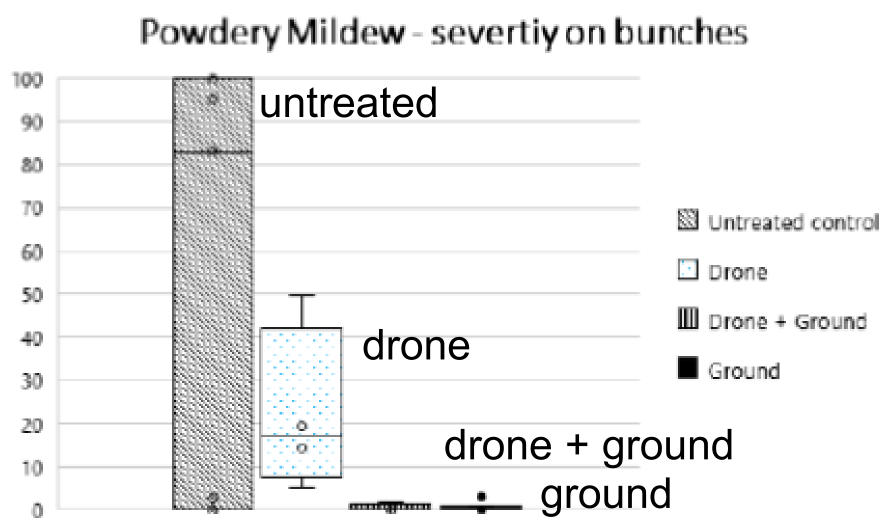
Efficacity of the treatment on vine

- downsides of leaves and bottom of plants as bunches are not well treated

(Dubuis & Jaquero 2021)

Efficacity of the treatments on vine





Average disease pressure:
combination with at least one complementary spray from the ground allows reaching reasonable levels of control

(Dubuis & Jaquero 2022)

Conclusions

- drones found their place in vineyards with steep slopes
- homologation and sprayer tests work well since 5 years
- many positive echoes as hard, exposed work with knapsack sprayers can be replaced
- drones are replacing helicopters but not tractors
- limits in efficacity have to be well respected