Optimization of air velocity in the plant protection product application in viticulture

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State of the art

At the Department of Viticultural Engineering, different plant protection machinery from different manufacturers in terms of air distribution, vertical distribution, application quality, drift potential, energy consumption and noise emission are surveyed. While the differences in the deposition distribution, the drift behavior and the vertical distribution remain in the expectable extent, the spread between the lowest and highest values concerning energy consumption is surprisingly far. They reached, based on the usable m^3 air flow at the target area, a factor of 5 between the most economical blower and the one with the most intense power consumption. This is even more astonishing against the background that the highest power consumption doesn't mean highest performance in terms of air velocity or flow rate. Beyond that, like many experimental results demonstrate, the quality of deposition with increasing air flow rate tends to decrease.

How much air is enough?

According to relevant literature, the air flow in the plant protection treatment in the vineyard is among other things necessary to open the canopy and to transport droplets on the target surface. Ideally, the leaves of a canopy should be set in motion, so that the droplets of the spray can wet them from all sides. If the blower is too strong, the leaves fold up and remain in this position with significantly reduced surface until airflow breakaway.

Figures 1-3: Behavior of a vine leaf in the air stream (Bräuninger, 2015)

Figures 1 to 3 show how a vine leaf behaves is an air stream. The elapsed time between the first and the third image is 138 ms, ie after 0.14 seconds, the leaf is completely folded and the lower side then is impossible to be reached. Worth noting here is that this behavior is observed already at an air velocity of about 8.5 m/s, with the sprayer passing at a speed of 6 km/h. For larger and older leaves, the required air velocity increases up to 11 m/s, while in practice values less than 12 m/s are considered insufficient and 20 m/s are quite common.

Surveys concerning deposition distribution quality have shown that, regardless of the type of device, reducing the PTO speed and thus the air flow rate doesn't lead to a significant deterioration of the deposition quality. Figures 4 and 5 show the measured leaf depositions in six elevation zones, respectively on the upper (ULS) and lower (LLS) leaf side. Striking in both variants is insufficient deposition on the lower leaf sides, which is typical for vineyards. However, this is observed at all the measured devices, regardless of the blower type and the air flow rate. Figure 4 shows the leaf deposition with a 28 inch axial fan with approximately 6.3 kW power demand, Figure 5 with the Geisenheim prototype with app. 2.7 kW.

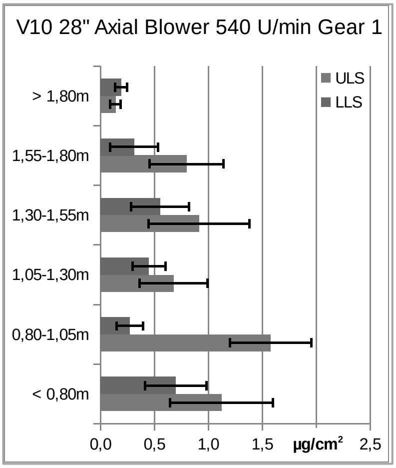

Figure 4: 28 "axial blower, 6.3 kW power demand

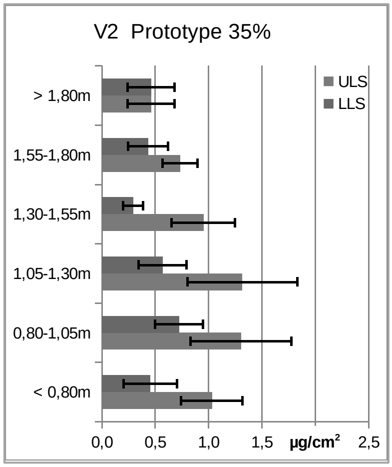

Figure 5: prototype electric drive, 2.7 kW power demand

With efficient machinery and reduced air power not only the power demand and thus the fuel consumption can be significantly reduced, but also the drift behavior is improved. Thus, as shown in Figure 6, the Geisenheim prototype equipped with air injection nozzles reaches 75% drift reduction without any additional restrictions.

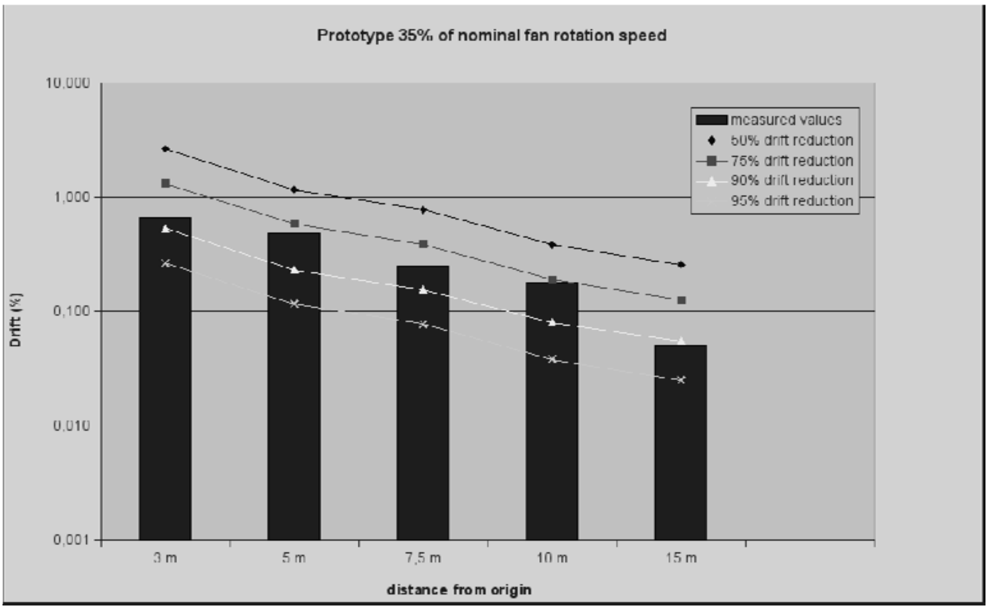

Figure 6: drift behavior Geisenheim prototype

Conclusion

A reduction of air power can reduce fuel consumption and noise emissions, improve the drift behavior and thus, without reduction of application quality, both protecting the environment as well as reduce the cost of the plant protection measurements.