Large semi-outdoor Wind Tunnel as versatile Test System for investigating airborne Transport and Deposition of Plant Protection Products

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Introduction

Airborne plant protection products (PPP) may be an important source of non-target area exposure. PPP transport can take place in different physical states: liquid (spray drift), vapour (local or long distance after volatilisation) and solid (when sticking to soil particles subjected to wind erosion).

Materials and Methods

The system consists of two main sections: the target area where the PPP can be applied, and the non-target sampling area, which is located adjacent to the target area in downwind direction (cf. Figure 1). By means of a wind engine, an adjustable, constant wind speed in constant direction can be established.

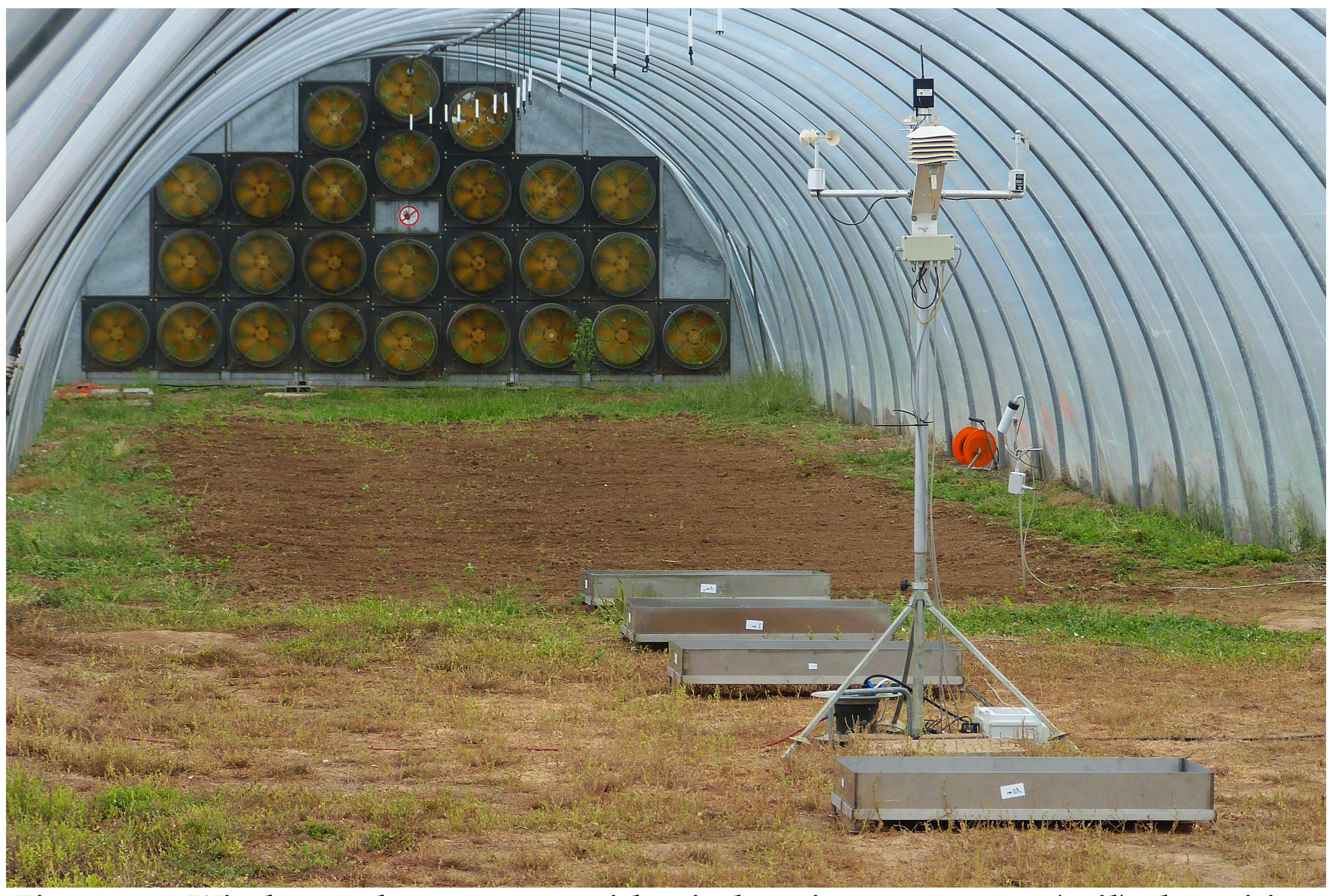

Figure 1: Wind tunnel test system with wind engine, target area (soil), deposition sampling points and climatic data logger on non-target area.

To determine the influence of different target matrices on volatilisation followed by aquatic deposition, two wind tunnel experiments with lindane as model substance were performed. The PPP was applied on the target area on bare soil and lettuce, respectively. Afterwards, water filled steel trays serving as artificial water bodies were placed in different downwind distances on the non-target area and the wind engine was started. Water samples were taken up to 96 hours after application and analysed for lindane by means of GC-ECD.

Effects of volatilised PPP on non-target plants were investigated by placing the sensitive test plant *Stellaria media* on the non-target area in 1 m, 10 m and 20 m downwind distance from the target area, which was treated with the herbicide clomazone. The influence of distance from the treated area on bleaching symptoms was evaluated by visual assessment.

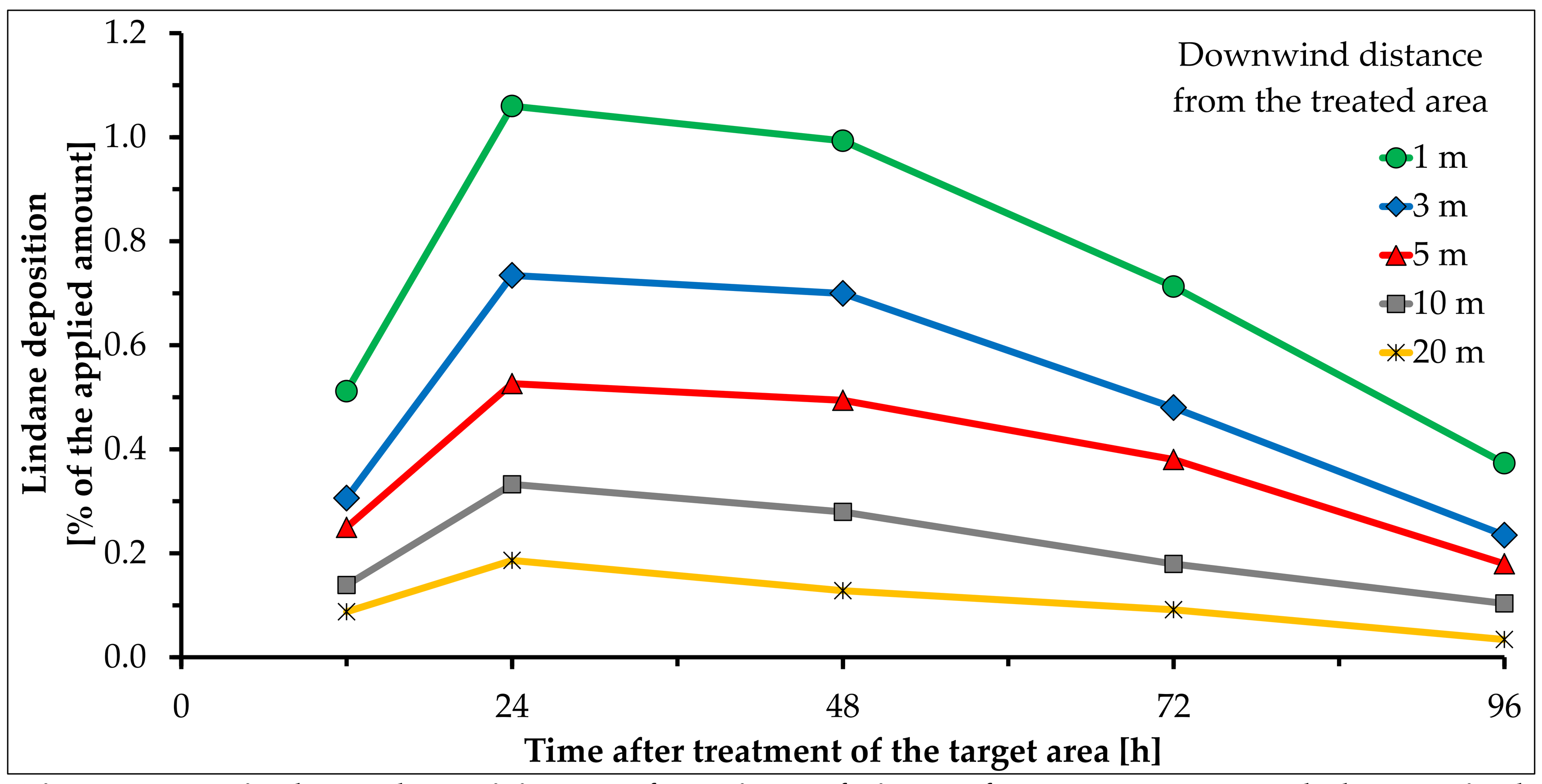

Figure 2: Lindane deposition as function of time after treatment and downwind distance from the treated area.

In a third exemplary test setup, spray drift reduction potential of air injector nozzles compared to hollow cone nozzles was investigated. Therefore, a static boom sprayer was mounted within the wind tunnel and pyranine as tracer was applied with the wind engine switched on. In different downwind distances, spray drift collectors (stainless steel rings covered with gauze) were established 150 cm above ground. After each application, the amount of tracer collected was determined by extraction of the gauze followed by fluorometry.

Results

Deposition: In general, lindane deposition in the artificial water bodies was about three times higher when applied on lettuce compared to application on bare soil. In Figure 2, deposition after soil application followed by volatilisation is shown as a function of time after treatment. Maximum deposition was measured 24 hours after application at the 1 m downwind distance and corresponded to 1.1% of the applied amount. For the following samplings, deposition decreased due to decreasing volatilisation from the target area and revolatilisation from the water surface. For all samplings, deposition decreased with increasing distance from the target area.

Figure 3: Indicator plants *Stellaria media* showing high (left) and low (middle) bleaching effects compared to the control (right).

Bleaching: After four days of exposure to volatilised clomazone in the wind tunnel, the indicator plants were further cultivated in a greenhouse and assessed 21 days after application. For the plants exposed in 1 m distance from the target area, about 60% of the total leaf area showed bleaching, decreasing to about 25% in 10 m distance. No bleaching effects were observed on the plants placed in 20 m distance and on the control plants. Different extents of bleaching are shown in Figure 3.

Table 1: Spray drift reduction of air injector nozzles compared to hollow cone nozzles tested with the wind tunnel test system (mean values, n=3).

Sampling distance [m]	Hollow cone nozzle	Air injector nozzle	Spray drift reduction [%]
	Tracer [mg/m²]		
5	10	0.76	92.5
10	4.0	0.29	92.7
20	1.7	0.10	94.2

Spray drift: The results showed that spray drift was reduced by more than 90% for all sampling distances when using air injector nozzles compared to hollow cone types. Individual data are given in Table 1.

Conclusion

With a semi-outdoor wind tunnel, the gap between small scale laboratory tests and extensive field studies can be filled. The higher tier test system allows the investigation of different aspects concerning the airborne transport of PPPs under realistic worst-case conditions.