Influencing Parameters on Volatilization and Aqueous Deposition of Dicamba at Laboratory Scale

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Introduction

Off-site movement of volatilized plant protection products (PPP) to adjacent non-target areas, forced by local climatic conditions and dependent on their physicochemical properties can vary widely. Laboratory test systems allow the adjustment of defined parameters and enable investigations about the extent of influence with a high repeatability even at low concentrations. The commonly used herbicide Dicamba which is in discussion by the reason of causing damage to non-genetically modified plants was investigated in a specific test system. The influences of soil moisture, soil type and form of compound (unformulated acid vs. sodium salt) have been assessed regarding the volatilization and aqueous deposition of the active ingredient.

Materials and Methods

Two linked glass chambers (volume: about 3.4 L, each) with a connected air trap represented the main components of the test system (Figure 1). A constant air flow of 10 L/min was established by means of a suction pump and a flow controller.

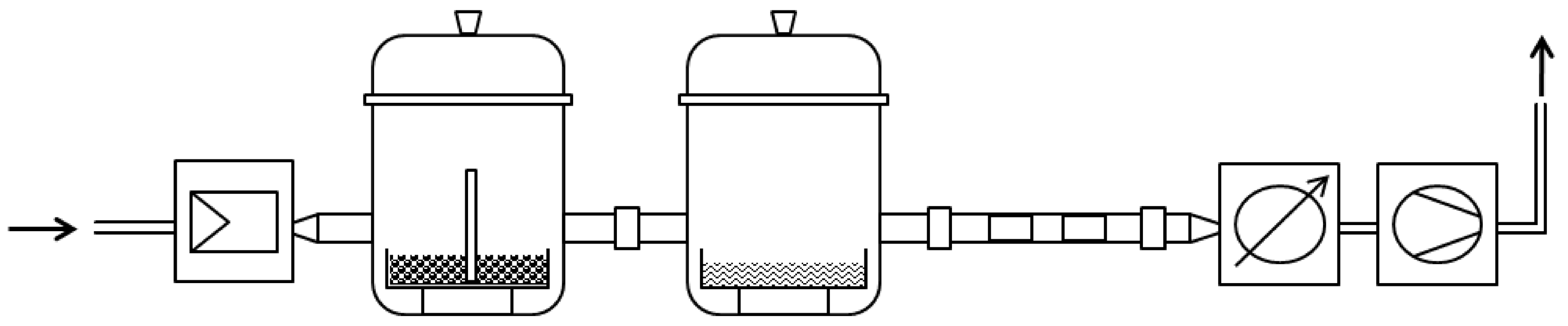

Figure 1: Test system components in downwind direction: air pre-conditioning, volatilization chamber, deposition chamber, air trapping system, flow controller, suction pump.

The pre-conditioned air (constant humidity and temperature), sucked through the system, allowed the transport of volatiles from an applied soil surface placed in the volatilization chamber to an artificial water body in the deposition chamber (Figure 2). Afterwards, the air passed a series of polyurethane trapping foams. Aliquots of the water samples and extracts of the foams were analyzed by LC-MS/MS.

Figure 2: Volatilization chamber (left) with treated soil in petri dish and connected deposition chamber (right) with water filled petri dish.

A set of five 24 hours test variants was conducted at 30 °C (each in duplicate) in the dark. Applied with an application rate of 50 mg/dish corresponding to about 44.2 kg/ha, influences of the following parameters (Table 1) were investigated: Soil moisture given as % of the maximum water holding capacity (WHC_{max}), sodium salt applied as water dispersible granule formulation (WG) and soil organic carbon content (% C_{org}). Volatilization and aqueous deposition are given in % of applied Dicamba (%a). Variant I served as reference. In test variant II to V, one parameter was modified, respectively:

Table 1: Parametric conditions of test variants. The modified parameters are given in bold font.

Test Variant No.	Soil Type [% C_{org}]	Soil Moisture [% WHC_{max}]	Air Humidity [%]	Form [-]
I	1.7	60	50	acid (unform.)
II	1.7	60	50	**sodium salt (WG)**
III	1.7	**90**	50	acid (unform.)
IV	1.7	**30**	50	acid (unform.)
V	**0.4**	60	50	acid (unform.)

Results and Discussion

Due to the relatively low vapor pressure of Dicamba (1.67 mPa at 25 °C), volatilization and deposition took place at a residue level below 0.001% of applied active substance (Figure 3). The increased application rate enabled measurable values above the limit of quantification (1.0×10^{-6}%a). Mean aqueous deposition (n=2) resulted in values between 8.5×10^{-6}%a (variant III) and 25×10^{-6}%a (variant V). In contrast, volatilization showed results about one order of magnitude higher compared to deposition. Most influencing investigated parameter was measured after application of the sodium salt (36×10^{-6}%a). In comparison to the reference (121×10^{-6}%a), volatilization was 71% lower.

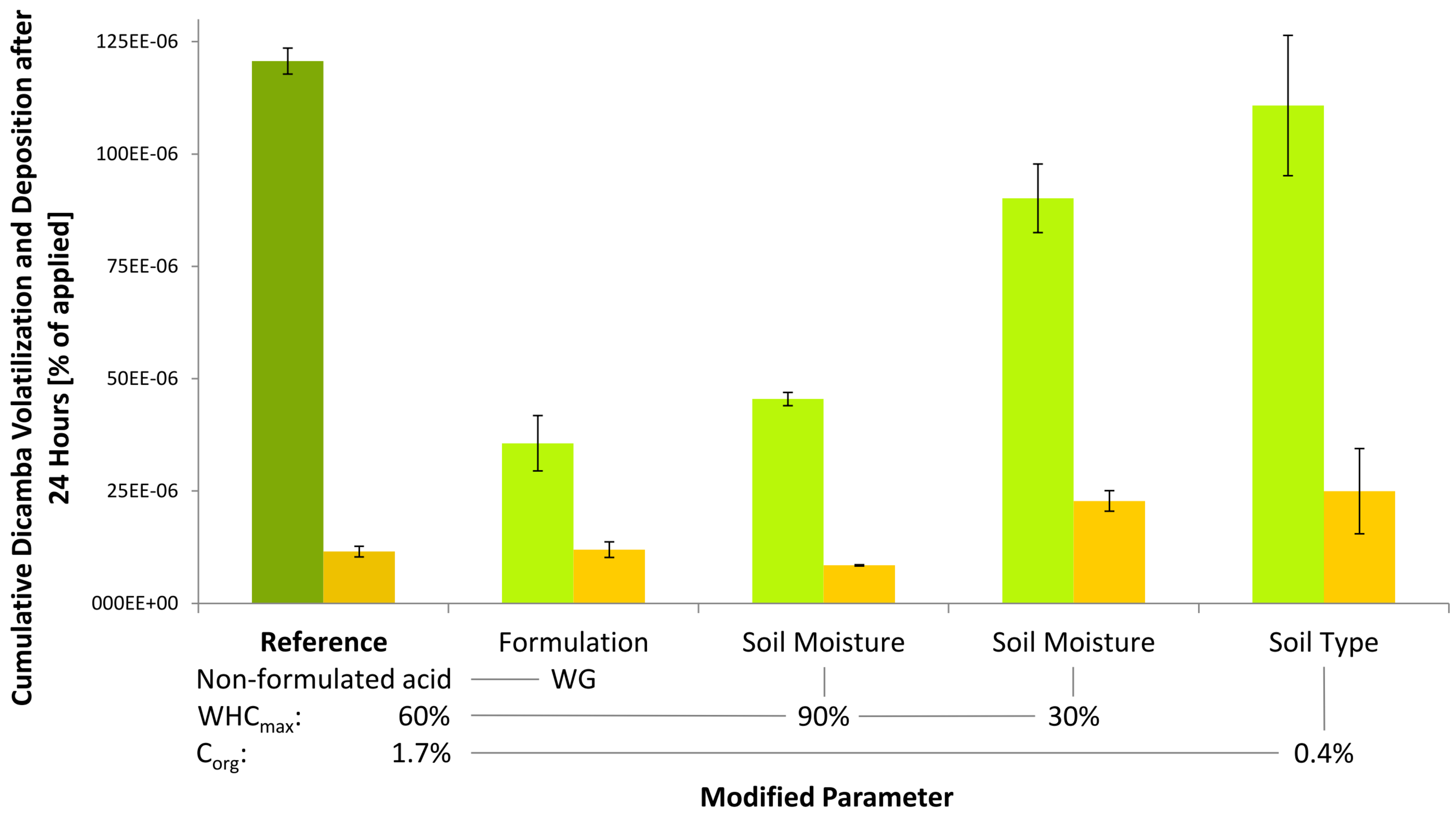

Figure 3: Amounts of volatilized (green bars) and deposited (orange bars) Dicamba 24 hours after application. Error bars represent the deviation from mean value (n=2).

This result is in line with published data [1], with the acid being more volatile than the sodium salts of Dicamba. The correlation between enforced volatilization with increasing soil moisture [2] could not be confirmed under the selected conditions. Air humidity can act as a potential factor which indirectly influences soil moisture and therefore the volatilization process. Ranking the importance of the investigated parameters from high to low the following order can be given: Form of compound > soil moisture > soil type.

Conclusion

The test system is suitable even for compounds with low vapor pressures and works as a reasonable tool for the identification of relevant parameters. Generated data can serve for further assessment in higher tier studies.

References

[1] Behrens, R., & Lueschen, W. E. (1979). Dicamba volatility. Weed Science, 27(5), 486-493.

[2] Bedos, C., Cellier, P., Calvet, R., Barriuso, E., & Gabrielle, B. (2002). Mass transfer of pesticides into the atmosphere by volatilization from soils and plants: overview. Agronomie, 22(1), 21-33.