Drift and Volatility of Broadleaf Herbicides

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Unintentional damage to desirable ornamentals, fruits and vegetables and other plantings is an undesirable side effect of using broadleaf herbicides. There are many factors which can affect the amount of damage observed to non-target plants when using broadleaf herbicides. Two of the most important processes which can lead to injury of non-target plants are spray drift and volatility. Spray drift is the airborne movement of spray particles to non-target sites. The type of spray equipment used and the wind speed are the two factors having the greatest effect on spray drift.

Volatility is the airborne movement of the pesticide as a gas, or vapor, to the non-target site. Volatility occurs when the pesticide is applied to the target site but then volatilizes, or evaporates, and moves in the air as a gas. A herbicide's potential to be volatile is controlled by the physical properties of the herbicide, primarily its vapor pressure. Conversely, spray drift is primarily controlled by spray parameters such as boom height, nozzle orifice size, boom pressure, wind speed etc. Thus, volatility is dependent upon the properties of the herbicide while spray drift is dependent upon the properties of the sprayer.

The biggest factor affecting broadleaf herbicide volatility is not so much the physical properties of the free acid, e.g. 2,4-D, but the physical properties of formulated herbicide. Because most the commonly used broadleaf herbicides are organic acids, e.g. 2,4-D, 2,4-DP, MCPP, dicamba, and triclopyr, and as such can be formulated in different ways without significantly altering the herbicidal activity. Thus, the free acid of 2,4-D can be reacted with an amine or alcohol to form either an amine salt or ester formulation. These formulations have very different physical properties. Esters are considered very good herbicidal formulations but they are volatile. Amine salts are not quite as good herbicides as esters yet they are essentially non-volatile.

The goal of the present research was to determine whether volatility or drift is the more common cause of non-target damage seen with the commonly used broadleaf herbicides. In 1985, triclopyr ester and amine and 2,4-D ester and amine at rates of 1.0 lb ai/A were tested for volatility and drift. Tomato plants were used as indicator plants and were placed at 2, 4, 8, and 16 feet downwind of the plot area. The plots were sprayed using a CO_2 backpack sprayer with a four nozzles boom, 8002 nozzles, and a spray pressure of 30 PSI. Five minutes after the plots were sprayed the tomato plants were removed and replaced with a set of fresh plants which remained in place for 24 hours. The plants which were removed after five minutes served as indicators of drift damage while those in place the remaining 24 hours served to indicate volatility damage. The results are seen in Tables 1 and 2 which give the ratings at one week after exposure. Data in Table 1 is from experiments conducted in 1985 during which time we used a rating scale of 0-9 with 0 representing no damage and 9 representing complete kill. In 1986 we changed our relative rating scale to 0-100 with 0 representing no damage and 100 representing complete kill. In 1985 (Table 1) ester formulations of 2,4-D and triclopyr gave very similar values for volatilization and caused significant injury all the way to 16 feet. Drift injury was fairly severe from all herbicides at 2 and 4 feet from the sprayed areas but caused little damage beyond 4 feet. In 1986 (Table 2) only triclopyr ester caused serious volatility damage. 2,4-D ester did not cause the same level of damage as triclopyr ester. Interestingly, dicamba was as volatile as 2,4-D ester. This is interesting since the formulation of dicamba is a dimethyl amine salt. Apparently, the amine is hydrolyzed generating the free acid of dicamba which volatilizes and causes injury. Drift injury was slight in 1986 and about the same for all five herbicides tested. The fact that all five herbicides behaved the same is to be expected since spray drift is more dependent on spraying equipment and wind and thus the effect of the herbicide is minimal.

Our research seems to indicate that under normal use conditions, volatility may be more of a potential problem than spray drift.

Table 1. Drift and volatility damage by four herbicides on potted tomato plants. One week after spraying.* 1985 test.

	distance from spray block (ft)			
Herbicide (1.0 lb ai/A)	2	4	8	16
2,4-D ester (Esteron)				
drift injury	5.0[a] ± 4.0	2.7 ± 2.1	2.0 ± 1.0	1.0 ± 1.7
volatilization injury	7.3 ± 2.9	5.7 ± 2.5	2.3 ± 0.6	1.7 ± 1.2
2,4-D amine (Formula 40)				
drift	7.0 ± 1.7	3.3 ± 2.5	0.3 ± 0.6	0.7 ± 1.2
volatilization	1.0 ± 1.0	1.7 ± 0.6	0.7 ± 1.2	0
triclopyr ester (Garlon 4)				
drift	4.3 ± 4.5	2.3 ± 3.2	0.3 ± 0.6	0
volatilization	6.3 ± 1.5	5.3 ± 3.5	2.0 ± 3.5	3.7 ± 2.9
triclopyr amine (Garlon 3A)				
drift	3.3 ± 4.0	0.7 ± 0.6	2.3 ± 3.2	0.3 ± 0.6
volatilization	3.0 ± 3.6	1.0 ± 1.0	1.3 ± 1.5	0
check				
drift	0	0	0	0
volatilization	0	1.0 ± 1.0	1.0 ± 1.7	0.7 ± 1.2

*wind: SW 6-10 mph; temperature: 75-80°F; relative humidity: 77-68%

[a]Injury rating 0-9; 0 = no injury 9 = severe curling of all leaves, branches, and stem. Lesions on stem.

Table 2. Drift and volatility damage by five herbicides on potted tomato plants. One week after spraying.* 1986 test.

treatment	distance from spray zone (ft.) 2	4	8	16
triclopyr amine				
drift	5[a] ± 5	3 ± 5	3 ± 5	3 ± 3
volatility	5 ± 5	6 ± 4	5 ± 4	3 ± 3
triclopyr ester				
drift	7 ± 3	6 ± 4	1 ± 1	2 ± 3
volatility	57 ± 12	57 ± 25	28 ± 18	20 ± 20
2,4-D amine				
drift	8 ± 8	8 ± 6	5 ± 9	3 ± 6
volatility	10 ± 9	7 ± 3	2 ± 3	0
2,4-D ester				
drift	7 ± 8	7 ± 3	8 ± 8	2 ± 3
volatility	17 ± 10	11 ± 9	7 ± 7	9 ± 6
dicamba				
drift	7 ± 3	7 ± 3	7 ± 3	5 ± 4
volatility	17 ± 3	15 ± 13	12 ± 6	5 ± 0
check				
drift	0	0	0	0
volatility	0	0	0	0

*wind: SW 2-8 MPH; temperature: 80°F; relative humidity: 44%

[a]Injury rating (0-100)