Herbicide Drift and Chemical Residue

Herbicide Drift

Herbicide drift is the movement of herbicide from target areas to areas where herbicide application was not intended. Herbicide drift generally is caused by movement of spray droplets or by movement of herbicide vapors. Herbicide granules or dried particles of herbicide may move short distances in high winds but are not considered important sources of herbicide drift.

Sunflower is susceptible to many of the postemergence herbicides commonly used on crops grown in proximity to sunflower. Herbicides that may damage sunflower include most all ALS (acetolactate synthase) herbicides (Accent, Ally, Amber, Beacon, Express, Affinity, Pursuit and Raptor), atrazine, dicamba, bentazon, Bronate, Buctril, Curtail, glyphosate, MCPA, paraquat, Stinger, 2,4-D and Tordon.

Sunflower yield may be severely reduced by 2,4-D or dicamba (Figure 112). The amount of loss varied from 25 percent to 82 percent, depending on the sunflower growth stage when the herbicide was applied in tests. Sunflower yield loss averaged from three rates each of 2,4-D and dicamba to simulate spray drift was greatest when the herbicides were applied in the bud stage and least when applied during bloom. Sunflower in the V-2 to V-4 leaf stage was affected less than larger prebloom sunflower.

Only a small portion of an applied herbicide drifts from the target area. However, some nontarget areas can receive rather high doses of herbicide since herbicide drift can accumulate in the nontarget areas. Herbicide accumulated in downwind areas occasionally may exceed the rate applied to the target field. A small portion of the herbicide applied with each sprayer pass may accumulate in an adjoining field. Also, a taller crop, such as sunflower, may intercept more spray drift than a shorter crop, such as wheat or barley. The amount of herbicide that contacts the sunflower and the environment during and following application influences the yield loss caused by herbicide drift. For example, experiments at North Dakota State University showed that 2,4-D at 0.5 ounce per acre applied to 12- to 14-leaf sunflower caused a 5 percent loss in 1973 and 93 percent loss in 1978. Low but equal levels of drift may cause very different effects on sunflower yield, depending on environment. Sunflower injury from herbicide drift will be greatest with warm temperatures and good soil moisture.

Sunflower may exhibit herbicide injury symptoms without a yield loss. Experiments at North Dakota State University indicated that sunflower height reduction, as compared with undamaged sunflower, caused by 2,4-D, MCPA or dicamba was significantly correlated with sunflower yield loss. Drift of 2,4-D,

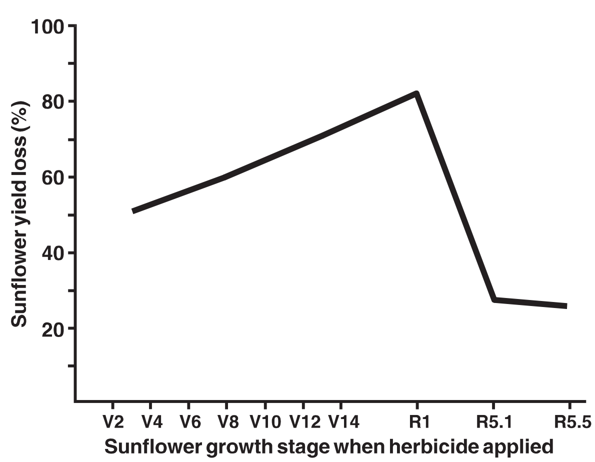

Figure 112. Sunflower yield loss from herbicides applied at various growth stages averaged over 2,4-D rates of 0.5, 1 and 2 oz./A and dicamba at 0.1, 0.5 and 1.0 oz/A. (A. Dexter)

MCPA or dicamba, which causes a sunflower height reduction, also would be expected to reduce yield. However, typical injury symptoms can occur without height reduction and this would not be expected to reduce yield.

MCPA, 2,4-D, dicamba and Tordon are growth-regulator herbicides and all produce similar symptoms on sunflower. Sunflower exhibits epinasty, which is an abnormal bending of stems and/or leaf petioles, shortly after contact with a growth-regulator herbicide. Figure 113 shows the bending of sunflower only 24 hours after 2,4-D application while Figure 114 shows the abnormal twisting of leaf petioles several days after 2,4-D application. Sunflower growth often is slowed or stopped by growth-regulator herbicides.

Leaves that develop after contact with a growth-regulator herbicide often are malformed. Leaves may have more parallel vein patterns and abnormal leaf shapes (Figure 115). A higher degree of injury from a growth-regulator herbicide may stop plant growth totally. Some plants die without further growth, some will remain green and not grow the rest of the season, and some plants will begin growing later after the herbicide is partially metabolized. Sunflower in Figure 116 did not grow for several days and then produced a stalk and flower.

Affected plants also may branch and produce multiple heads when growth resumes (Figure 117). Root

Figure 113. Bending of sunflower only 24 hours after 2,4-D application. (A. Dexter)

Figure 115. Growth regular herbicides may cause leaves of sunflower to have more parallel vein patterns and abnormal leaf shapes. (A. Dexter)

Figure 114. Abnormal twisting of leaf petioles several days after 2,4-D application. (A. Dexter)

Figure 116. Interrupted growth of sunflower due to exposure to growth regulator herbicide. (A. Dexter)

growth may be retarded by growth-regulator herbicides and abnormal lumps or knots may develop on sunflower roots (Figure 118). Sunflower contacted by growth-regulator herbicides during the bud or flowering stage may develop malformed heads or heads with sterility (Figure 119).

Figure 117. Multiple branching and heading of sunflower due to exposure to growth regulator herbicides. (A. Dexter)

Figure 118. Abnormal lumps and knots on sunflower roots developed after exposure to growth regulator herbicides. (A. Dexter)

Sunflower plants contacted with a growth-regulator herbicide will not develop all of the symptoms shown in Figures 112 through 117. Considerable variation in symptomology can occur, depending on herbicide rate, sunflower stage and environment.

Symptoms similar to those shown in Figures 114 to 119 also may be produced by soil residues of herbicide. MCPA and 2,4-D have very short soil residual, but damage to sunflower could occur if they were applied just before planting or emergence. Tordon has a long soil residual and can carry over from the previous year and cause sunflower injury. Dicamba at rates used in small grains would not be expected to carry over to the next year. Dicamba used in the fall at rates necessary to control certain perennial weeds may persist in the soil and damage sunflower the next year. Accent, Ally, Amber, atrazine, Beacon and Pursuit are long residual herbicides that may persist for more than one year at levels that can injure sunflower. The length of persistence can be affected by pH (high pH causes longer residue of some herbicides), application rate and soil moisture.

The symptoms from these herbicides are not similar to symptoms from growth-regulator herbicides. Sunflower affected by Accent, Ally, Amber, Beacon or Pursuit emerge and become well-established. Chlorosis starts on the young leaves often with a distinct yellowing. Top growth and roots may be severely stunted. Plants may remain small for several weeks or they may die.

Figure 119. Sunflowers contacted by growth regulator herbicides during bud or flowering stage developed malformed heads or heads with sterility. (A. Dexter)

Low doses may cause temporary stunting and plants later may begin to grow normally. Sunflower affected with atrazine emerge and look normal for a short time. Leaf burn starts on the outer edges of the oldest leaves and progresses toward the middle of the leaf. Veinal areas are the last to turn brown in an affected leaf.

The risk of sunflower injury from herbicide drift is influenced by several factors.

Spray particle size: Spray drift can be reduced by increasing droplet size since larger droplets move laterally less than small droplets. Droplet size can be increased by reduced spray pressure; increased nozzle orifice size; use of special nozzles, such as "Raindrop," "LFR," "XR" or "LP;" use of additives that increase spray viscosity; rearward nozzle orientation; and increased nozzle pressure on aircraft. Research has shown that increasing nozzle pressure in a rearward-oriented nozzle in a high-speed air stream will produce larger droplets and less fines. This is due to less secondary wind shear, and does not happen with ground sprayers.

Spray pressure with standard flat-fan nozzles should not be less than 25 pounds per square inch (psi) because the spray pattern from the nozzles will not be uniform at lower pressures. The "XR" and "LP" nozzles are designed to give a good spray pattern at 15 to 50 psi. Operating at a low spray pressure results in larger spray droplets. Some postemergence herbicides, such as bentazon, require small droplets for optimum performance, so techniques that increase droplet size may reduce weed control with certain herbicides. Herbicides that readily translocate, such as 2,4-D, MCPA, dicamba and Tordon, are affected little by droplet size within a normal droplet size range, so drift control techniques would not be expected to reduce weed control with these herbicides. Glyphosate is translocated readily, so droplet size has minimum effect on weed control. However, glyphosate is inactivated partially by increased water volume and spray volume recommendations on the label should be followed.

Herbicide volatility: All herbicides can drift in spray droplets, but some herbicides are sufficiently volatile to cause plant injury from drift of vapor or fumes. The ester formulations of 2,4-D and MCPA may produce damaging vapors, while the amine formulations are essentially nonvolatile. Dicamba is a volatile herbicide and can drift in droplets or vapor.

Herbicide vapors may cause crop injury over greater distances than spray droplets. However, spray droplets can move long distances under certain environmental conditions, so crop injury for a long distance does not necessarily result from vapor drift. A wind blowing away from a susceptible crop during herbicide application will prevent damage from droplet drift, but a later wind shift toward the susceptible plants could move damaging vapors into the susceptible crop.

Herbicide volatility increases with increasing temperature. The so-called high-volatile esters of 2,4-D or MCPA may produce damaging vapors at temperatures as low as 40 degrees Fahrenheit, while low-volatile esters may produce damaging vapors between 70 and 90 F. The soil surface temperature often is several degrees warmer than air temperature, so a low-volatile ester could be exposed to temperature high enough to cause damaging vapors, even when the air temperature was less than 70 F.

Wind velocity and air stability: Wind, or the horizontal movement of air, is widely recognized as an important factor affecting spray drift. However, vertical movement of air also has a large influence on damage to nontarget plants from spray drift. An air mass with warmer air next to the ground and decreasing temperature with increasing elevation will be unstable. That is, the warm air will rise and the cool air will sink, providing vertical mixing of air. Stable air, often called an inversion, occurs when air temperature increases or changes little as elevation increases. With these temperature relationships, very little vertical movement of air occurs since cool air will not rise into warmer air above. Spray droplets or vapor are carried aloft and dispersed away from susceptible plants with unstable air conditions. With stable air (inversion), small spray droplets may be suspended just above the ground in the air mass, move long distances laterally and be deposited on susceptible plants.

Low wind velocity in combination with unstable air generally will result in very little damaging spray drift. However, low wind velocity with stable air (inversion) can result in severe damage over a long distance. Crop injury has been observed two miles or more from the site of application with 10 mph or slower winds, small spay droplets, stable air, highly susceptible crops and nonvolatile but highly active herbicides. Long-distance drift can occur with particle drift as well as vapor drift.

Stable air usually can be identified by observing dust off a gravel road or smoke from a fire or smoke bomb. Smoke or dust moving horizontally and staying close to the ground would indicate stable air. Fog also would indicate stable air. Herbicide application should be avoided during stable air conditions unless spray drift is not a concern.

Distance between nozzle and target (boom height): Less distance between the droplet release point and the target will reduce spray drift. Less distance means less time to travel from nozzle to target, so less drift occurs. Small spray droplets have little inertial energy, so a short distance from nozzle to target increases the chance that the small droplets can reach the target. Also, wind velocity often is greater as height above the ground increases, so reduced nozzle height will reduce the wind velocity affecting the spray droplets.

Shielded sprayers: Shielded sprayers utilize some type of shielding to protect spray droplets from wind. The effectiveness of the shields varies, depending on the design of the shield, wind velocity and wind direction relative to the sprayer. Drift from shielded sprayers has varied from about 50 percent to more than 95 percent less than from similar nonshielded sprayers in experiments with various shield designs and conditions.

Herbicide drift can reduce sunflower yield severely. The risk of herbicide drift can be reduced greatly by increasing droplet size, reducing nozzle height, using nonvolatile herbicides, avoiding spraying during temperature inversions, using shielded sprayers and spraying when the wind is blowing away from a susceptible crop.

Chemical Residue in the Tank and Sprayer Cleanout

Crop injury from a contaminated sprayer may occur when a herbicide not registered on sunflower was used previously in the sprayer. The risk of damage is greatest when the previous herbicide is highly phytotoxic to sunflower in small amounts. Rinsing with water is not adequate to remove all herbicides. Some herbicides have remained tightly adsorbed in sprayers through water rinsing and even through several tank loads of other herbicides. Then, when a tank load of solution including an oil adjuvant or nitrogen solution was put in the sprayer, the herbicide was desorbed, moved into the spray solution and damaged susceptible crops. Highly active herbicides that have been difficult to wash from sprayers and have caused crop injury include ALS herbicides (Accent, Ally, Beacon, Express, Pursuit and Raptor), and growth-regulator herbicides (2,4-D and dicamba).

Herbicides that are difficult to remove from sprayers are thought to be attaching to residues remaining from spray solutions that deposit in a sprayer. The herbicide must be desorbed from the residue or the residue removed in a cleaning process so the herbicide can be removed from the sprayer. Sprayer cleanout procedures are given on many herbicide labels and the procedure on the label should be followed for specific herbicides. The following procedure is given as an illustration of a thorough sprayer cleanup procedure that would be effective for most herbicides.

Step 1. Drain tank and thoroughly rinse interior surfaces of tank with clean water. Spray rinse water through the spray boom. Sufficient rinse water should be used for five minutes or more of spraying through the boom.

Step 2. Fill the sprayer tank with clean water and add a cleaning solution (many herbicide labels provide recommended cleaning solutions). Fill the boom, hoses and nozzles and allow the agitator to operate for 15 minutes.

Step 3. Allow the sprayer to sit for eight hours while full of cleaning solution. The cleaning solution should stay in the sprayer for eight hours so that the herbicide can be fully desorbed from the residues inside the sprayer.

Step 4. Spray the cleaning solution out through the booms.

Step 5. Remove nozzles, screens and filters and clean thoroughly. Rinse the sprayer to remove cleaning solution and spray rinsate through the booms.

Common types of cleaning solutions are chlorine bleach, ammonia and commercially formulated tank cleaners. Chlorine lowers the pH of the solution, which speeds the degradation of some herbicides. Ammonia increases the pH of the solution, which increases the solubility of some herbicides. Commercially formulated tank cleaners generally raise pH and act as detergents to assist in removal of herbicides. Read the herbicide label for recommended tank cleaning solutions and procedures. **WARNING: Never mix chlorine bleach and ammonia, as a dangerous and irritating gas will be released.**

Sprayers should be cleaned as soon as possible after use to prevent the deposit of dried spray residues. If a sprayer will remain empty overnight without cleaning, fill the tank with water to prevent dried spray deposits from forming. A sprayer kept clean is essential to prevent damage from herbicide contamination.