

Auxin herbicides in Arizona Cotton: Avoiding Off-Target Movement

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Off target movement of 2,4-D and dicamba can cause substantial injury to downwind sensitive plants. Any off-target injury is the responsibility or liability of the applicator and is a significant economic risk (Fig. 1). The auxin herbicides 2,4-D and dicamba received EPA registrations (section 3 and 2[ee] labels) for use in cotton in late 2016 and Arizona labels were granted a short time later. The premix herbicide Enlist Duo® contains 2,4-D, choline salt, and glyphosate from Dow Agrosciences. The herbicide Engenia® from BASF contains the dicamba N-bis-(aminopropyl) methylamine (BAPMA) salt and the herbicide XtendiMax® with VaporGrip® technology from Monsanto contains the dicamba diglycolamine (DGA) salt. These herbicide formulations also contain other components that reduce the volatility of 2,4-D and dicamba in spray solutions and from plant surfaces.

The labels for Enlist Duo, Engenia, and XtendiMax specify several practices and restrictions on the use of these herbicides in an effort to reduce off-target movement and protect applicators and neighbors from economic harm. **The label is law**, and this publication reiterates the instructions and required practices on the labels that must be followed by applicators to minimize off-target movement of 2,4-D and dicamba.

Tank Mixing and Nozzles

Only tank-mix partners and nozzles **explicitly permitted** on the Enlist Duo, Engenia, and XtendiMax labels can be used with these herbicides; **all other tank-mix partners or nozzles are prohibited**. All tank-mix partners, nozzles, and pressure combinations are tested in a wind tunnel using an EPA protocol to make sure that they do not reduce the size of the spray droplets produced by the nozzle or otherwise increase the potential for drift. Drift increases as droplet size decreases. Applicators must check the list of tested products and nozzles at the manufacturer's website (see below) no more than 7 days before applying the auxin herbicide.

Enlist Duo: www.EnlistTankmix.com

Engenia: www.EngeniaTankmix.com

XtendiMax: www.XtendimaxApplicationRequirements.com

All nozzles approved for use with Enlist Duo, Engenia, and XtendiMax are air-induction or venturi nozzles designed to produce large, air-filled droplets in the extremely-course (XC) and ultra-course (UC) droplet size categories (>502 microns as defined by the ASAE standard S-572.1) that minimize the number of drift-prone small droplets. Applicators must use EPA approved nozzles at less than the maximum pressure listed on the herbicide labels or manufacturer's websites (see above).

Several nozzles and orifice sizes from ABJ Agri, GreenLeaf, Hypro, Lechler, TeeJet, and Wilger are currently listed on the manufacturers' websites.

Volatility

Volatility is the tendency of a chemical to vaporize or turn into a gas. **The movement of auxin herbicides in the gas phase through the atmosphere can occur over long distances (miles), often farther than the physical drift of small spray droplets, and cause substantial injury to nearby crops.** The herbicides 2,4-D and dicamba are weak acids so at neutral and alkaline pH they lose a hydrogen atom and become anions that attach to cations to form salts. Older formulations of 2,4-D and dicamba (e.g., Banvel) contain dimethylamine salts and are much more volatile than the Enlist Duo, Engenia, and XtendiMax formulations. The new formulations also contain components that enhance the stability of the choline, BAPMA, and DGA salts in Enlist Duo, Engenia and XtendiMax, respectively, provide some buffering capability and act as surfactants.

These new formulations greatly reduce the volatility of 2,4-D and dicamba, but the technology can be defeated if a source of hydrogen atoms is added to the spray tank, for example, acids, ammonia (e.g., ammonium sulfate or urea ammonium nitrate), or some other sources of nitrogen. This practice is prohibited because it lowers the pH of the spray solution significantly increasing the volatility of 2,4-D and dicamba. **DO NOT add AMS (ammonium sulfate) to the spray tank even if glyphosate herbicides are also in the spray tank.**



Figure 1. Off-target drift of auxin herbicides, such as dicamba, can cause damage to sensitive plants (e.g., cotton shown here) and expose applicators to economic liability.

Weather and Sprayer Operation

Increasing boom height and sprayer speed both increase the time it takes spray droplets to land on a surface. This increases the exposure of spray droplets to the action of wind and increases the evaporation of water from spray droplets in hot, dry weather thereby reducing droplet diameter and increasing the potential for off-target movement. Applicators must follow label instructions for sprayer speed, boom height, and nozzle manufacturers'

recommended nozzle/boom heights when applying Enlist Duo, Engenia, and XtendiMax herbicides. For example, boom heights should generally not exceed 24 inches above the target vegetation and large booms should make use of boom stabilizing technology. **Never apply these products when wind speeds are greater than 15 MPH.** Sprayer speeds are stipulated on two of the three product labels and generally should not exceed 15 mph (see Table 1).

Temperature Inversions

Applications of Enlist Duo, Engenia, and XtendiMax are prohibited during atmospheric temperature inversions.

During temperature inversions, cooler air is trapped beneath a warmer layer of air above (i.e., temperature increases with altitude) and there is no vertical air mixing (calm or light and variable winds below 3 MPH). Small spray droplets can remain suspended in a concentrated cloud and move in unpredictable directions such as down slopes with cool air and in response to light, variable winds common during inversions. Inversions persist until the ground is warmed or winds sufficiently mix layers of air. Risk of inversions is greatest just prior to sunrise. Applicators should monitor weather conditions and exercise caution when there are cloudless nights with no wind.

Sprayer Cleanout

Sprayer contamination is a common cause of off target movement of auxin herbicides. All three auxin herbicide labels describe extraordinary, but required, sprayer cleanout procedures to mitigate this risk. Clean sprayers immediately after spraying. **Do not allow auxin herbicide solutions to sit overnight in spray tanks, hoses, and booms.** Follow label instructions for each herbicide, because each has specific cleanout procedures. In general, the basic procedure includes **triple rinsing** the sprayer:

1. Completely drain all of the herbicide solution out of the sprayer including tank, pump, boom, and hoses. Fill the tank to 10% volume with clean water, agitate, circulate and spray the rinse solution out of the boom.
2. Drain the sprayer again and clean strainers, screens and filters. Fill with clean water again and add a strong detergent-based commercial cleaner. Agitate and circulate; this should also wash the internal surfaces of the spray tank. Spray some cleaning solution out of the boom and nozzles. Let detergent solution sit at least 15 min or longer in the spray system. Then spray the cleaning solution out of the boom and nozzles.
3. Fill the tank to 10% volume and circulate to contact all internal surfaces for at least 15 minutes. Then spray the rinse solution out of the spray boom. Completely drain the spray system including the pump; remove nozzle tips, strainers, and filters, and clean them separately.

Sprayers that use an injection pump and mix the formulated herbicide into the spray water downstream from the tank, pump, and many other sprayer components are simpler to clean.

Buffer Requirements

Applicators should measure the wind direction before starting any spray swath that is within the buffer distance required on the auxin herbicide labels (see Table 1). The downwind buffer distance may include: 1) Roads, paved, or gravel surfaces; 2) agricultural fields that have been prepared for planting; 3) planting fields with crops tolerant to the auxin herbicides; and 4) areas covered by the footprint of a man-made structure. The list of tolerant crops is different on each label, so read the appropriate label.

All three labels prohibit spraying if the wind is blowing in the direction of specialty crops such as tomatoes and other fruiting vegetables (EPA Crop Group 8), cucurbits (EPA crop group 9), and grapes. The labels also lists many other sensitive crops that cannot be downwind, see labels for specifics. Some crops are so sensitive to either dicamba (e.g., soybeans and peaches) or 2,4-D (e.g., cotton) or both (e.g., grapes) that observing the label buffer requirements (Table 1) may not prevent injury to downwind sensitive crops. The auxin herbicide labels are ambiguous with respect to the downwind distance required to protect sensitive crops downwind in part because the distances required will depend on the crop and a large number of environmental factors.

Table 1. Important restrictions on and guidelines for application of auxin herbicides.

Product	Active Ingredient	Mixing ¹	Nozzles ¹	Boom Height	Windspeed ²	Buffers ³
Engenia	dicamba BAPMA salt	Only products listed on labels and websites	Only nozzles producing Extremely-coarse or Ultra-coarse droplets	≤24 inches	<3 mph, only if temperature inversion is not present >15 mph, prohibited	110' downwind
Enlist Duo	2,4-D choline salt + glyphosate			per nozzle manufacturer's specifications	>15 mph, prohibited	30' downwind
XtendiMax	dicamba DGA salt			per nozzle manufacturer's specifications; ≤24 inches	<3 mph & > 15 mph, prohibited; 10–15 mph, prohibited when blowing toward sensitive crop	For 22 oz: 110' downwind For >22 to 44 oz: 220' downwind

1, Only products and Nozzles specifically permitted on the label, supplemental label, or on the manufacturer's website

2, Do not apply at windspeeds > 15 mph; Never apply during a temperature inversion

3, Do not apply while wind direction is towards sensitive specialty crops such as in EPA Crop Groups 8 & 9; See label for specifics

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A PDF of this publication is available on-line at:

<http://ag.arizona.edu/crops/cotton/files/AuxinDrift.pdf>

References

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