The following formulations of dicamba are approved for use in the Roundup Ready® Xtend Crop System as of November, 2017 and are covered by this training:

- XtendiMax® herbicide with VaporGrip® Technology (Monsanto)
- FeXapan® herbicide Plus VaporGrip® Technology (Corteva)
- Engenia® Herbicide (BASF)

- The application requirements in this training apply to all labeled uses of these products in Oklahoma.

- Some slides contain language from XtendiMax®/FeXapan® labels; Engenia® label language may vary. Always read and follow the specific product label.

- These products are Restricted Use Pesticides for retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator’s certification.

- Enlist Duo™ and Enlist ONE™ are NOT currently a part of this required training nor is this training required for their use in Oklahoma.
ALWAYS FOLLOW THE INDIVIDUAL PRODUCT LABELING AVAILABLE AT:

- XtendiMax® herbicide with VaporGrip® Technology (Monsanto)
  xtendimaxapplicationrequirements.com

- FeXapan® herbicide Plus VaporGrip® Technology (Corteva)
  www.fexapanapplicationrequirements.dupont.com

- Engenia® Herbicide (BASF)
  Stewardship: http://agproducts.basf.us/campaigns/engenia/#stewardship
  Tank Mix: www.engeniatakmx.com
MANDATORY DICAMBA APPLICATOR TRAINING

- This training is designed to satisfy the federal requirement for mandatory dicamba applicator training.

- This training satisfies the Oklahoma Department of Agriculture, Food, and Forestry requirement for dicamba specific training.

- This training is not a substitute for the state-specific Certified Applicator training which is required to purchase and use Restricted Use Pesticides
  - Retail sale to and use only by Certified Applicators or persons under their direct supervision
  - Refer to specific state and local requirements for certification process
  - Other familiar products categorized as RUP include paraquat and atrazine
AGENDA

This session will address:

- Why Is This Training Important
- Recordkeeping Requirements
- Buffer Requirements and Protection of Susceptible Crops
- Chemistry, Mixing and Handling
- Equipment Preparation
- Application
- Spray System Hygiene
- Summary
WHY IS THIS TRAINING IMPORTANT
Synthetic Auxin Herbicides

- Synthetic auxins are a very effective herbicide site of action
  - Broadleaf plants (dicots) are very susceptible
  - Grass plants (monocots) are generally tolerant
- Effect on plant growth is “systemic”
- Symptomology can develop at very low rates
  - Only affects new growth
  - Visual symptoms are delayed

Very low rates can cause symptomology in new growth
### Synthetic Auxin Herbicides

#### Sensitivity scale for dicamba

<table>
<thead>
<tr>
<th>Lower</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>Cantaloupe</td>
<td>Cotton</td>
<td>Grapes*</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Cucumber</td>
<td>Pepper</td>
<td>Lima bean</td>
</tr>
<tr>
<td>Kale</td>
<td>Peach</td>
<td>Tomato</td>
<td>Southern pea</td>
</tr>
<tr>
<td>Mustard</td>
<td>Peanut</td>
<td>Watermelon</td>
<td>Snap bean</td>
</tr>
<tr>
<td>Pecan</td>
<td>Squash</td>
<td></td>
<td>Soybean</td>
</tr>
<tr>
<td>Turnip</td>
<td></td>
<td></td>
<td>Sweet potato*</td>
</tr>
</tbody>
</table>

**Herbicide Rate of Visually Detectable Response**

- **> 1/75X**
- **1/75-1/300X**
- **1/300-1/800X**
- **< 1/800X**

**Most broadleaf crops are very sensitive to dicamba**

Adapted from Dr. Stanley Culpepper, UGA Cooperative. *Data from literature; all other data generated in GA field studies.
### Soybean Sensitivity To Herbicides

<table>
<thead>
<tr>
<th>Dosage</th>
<th>Dicamba</th>
<th>Other Herbicides</th>
<th>Glufosinate</th>
<th>Glyphosate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/100 of field rate</td>
<td>Severe Growth Regulator Effect</td>
<td>Slight to No Effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/1000 of field rate</td>
<td>Very Visual Growth Regulator Effect</td>
<td>No Effect</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Soybeans are extremely sensitive to dicamba relative to other herbicides.
Exercise extreme care with dicamba applications with nearby broadleaf crops.
Synthetic Auxin Herbicides
Summary

- Most dicot plants are very sensitive to synthetic auxin herbicides
- Extremely low doses (below 1% of a full rate) can cause auxin like symptoms
- Product labels must be carefully followed to prevent both drift to sensitive species or spray system contamination

Following application requirements are critical to mitigate off-target movement
WHY IS THIS TRAINING MANDATORY AND IMPORTANT?

- In response to an elevated number of off-target movement claims in many states in 2017, this training has been mandated by the EPA for application of newly formulated dicamba products.

- It is important to understand the potential impacts these products can have on sensitive and susceptible plants.

- It is extremely important to understand the factors that can cause off-target movement and how to effectively manage it.

- EPA has set an expiration date for these labels of December 2018.

- Renewal of these labels will depend on the success demonstrated in 2018.

- As a weed management tool, the loss of this technology would be detrimental to growers in Oklahoma.
RECORDKEEPING REQUIREMENTS
RECORD KEEPING REQUIREMENTS

- Record keeping is required for each application of these products. The certified applicator must keep required documentation for a period of two years; records must be generated as soon as practical but no later than 14 days after application.
  - e.g., if 10 fields are sprayed, 10 sets of records are required, including if the same field is sprayed twice

- Records must be made available to State Pesticide Control Official(s), USDA, and EPA upon request.
<table>
<thead>
<tr>
<th><strong>1. Name of Certified Applicator</strong></th>
<th><strong>2. Certification # of Applicator</strong></th>
<th><strong>3. Brand or Product Name</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Certified Applicator Name: John Doe</td>
<td>State Certification # of Applicator: 1243574</td>
<td>![Dicamba Products]</td>
</tr>
</tbody>
</table>

**4. EPA Registration #**

Active Ingredient: Glyphosate salt of 2,4-d, 3,6-dichloro-o-anisic acid (550 grams per liter)

EPA Reg. No. 524-617

**5. Total Amount Applied**

120 Acres x 22 oz/acre = 2,640 oz (20.6 gallons)

**6. Month, Day, Year Applied**

6. **7. Location Of Application**

(e.g., GPS coordinates)

**8. Crop, Commodity, Stored Product or Site**

To Be Applied To: Cotton □ Soybeans □ Other □

(e.g., DT soy)

**9. Size of Treated Area**

Size of Treated Area: 120 Acres
RECORDKEEPING REQUIREMENTS - FOR EACH APPLICATION OF DICAMBA PRODUCTS

10. Dicamba Training Date, Provider and Proof of Completion

11. Application Timing
   (e.g., pre, post) and # of days after planting if post

12. Receipts of Purchased Product

13. Product Label

14. Record That a Sensitive Crop Registry Was Consulted or Document Survey of Neighboring Fields for Susceptible Crops
   ODAFF Environmental Sensitive Area Registry

15. Confirmation of Sprayer Cleanout Procedure Both Before and After Use
RECORDKEEPING REQUIREMENTS - FOR EACH APPLICATION OF DICAMBA PRODUCTS

16. Brand Names and EPA Registration #'s for All Tank Mix Products

17. Time of Application Start and Finish

| Time: | APPLICATION START: 9:00 AM | APPLICATION END: 12:02 PM |

18. Air Temperature (F°) at Start and Finish

| Air Temperature 19F: | 79°F | 85°F |

19. Wind Speed at Boom at Start and Finish

| Wind Speed at boom height: | 5 MPH | 7 MPH |
| Wind Direction (degrees from which wind is blowing): | NW - 225° | W - 270° |

20. Nozzle Manufacturer/Brand, Type, Orifice Size and Operation Pressure

| Manufacturer/Brand: | TEE JET | Type: TTI 110 |
| Orifice Size: | 0.8 |
| Operating Pressure: | 45 |

21. Record of Buffer Distance Calculation and Any Areas Included Within

| Buffer Distance Calculation: | 30' PAVED ROAD & 80' CORN FIELD (e.g., road) |
BUFFER REQUIREMENTS AND PROTECTION OF SUSCEPTIBLE/SENSITIVE CROPS
Goal: To locate sensitive areas and crops around your dicamba tolerant crop field and to develop an application plan

- Survey surroundings for potential neighboring sensitive areas and crops
- Visit with your neighbors on their cropping plans around your fields
- Consult sensitive crop registries for location of specialty crops and other sensitive sites
- Record areas of potential buffer zones around all edges of the field
- ODAFF Environmental Sensitive Area Registry
- Document your efforts to identify sensitive crops

Improve decision making with prior knowledge of your surroundings
PROTECTION OF ADJACENT SUSCEPTIBLE/SENSITIVE CROPS:

DO NOT APPLY this product when the wind is blowing toward adjacent non-dicamba tolerant susceptible crops; this includes NON-DICAMBA TOLERANT SOYBEAN AND COTTON.

- Susceptible crops include but are not limited to tomatoes and other fruiting vegetables (EPA crop group 8), fruit trees, cucurbits (EPA crop group 9), grapes, beans, flowers, ornamentals, peas, potatoes, sunflower, tobacco, other broadleaf plants, and including plants in a greenhouse.

CONTACT WITH FOLIAGE, GREEN STEMS, OR FRUIT OF CROPS, OR ANY DESIRABLE PLANTS THAT DO NOT CONTAIN A DICAMBA TOLERANCE GENE OR ARE NOT NATURALLY TOLERANT TO DICAMBA, COULD RESULT IN SEVERE PLANT INJURY OR DESTRUCTION.
ADJACENT FIELD EXAMPLE – DO NOT SPRAY

COLOR LEGEND

- Blue
  XtendFlex® Cotton

- Green
  Non-Dicamba Tolerant Cotton

- Yellow
  Corn

- Brown
  Agricultural Fields
  Prepared for Planting

THESE TRAINING MATERIALS ARE DESIGNED TO SATISFY FEDERAL TRAINING REQUIREMENTS AND THE TRAINING AND APPLICATION REQUIREMENTS IMPOSED BY THE OKLAHOMA DEPARTMENT OF AGRICULTURE, FOOD, and FORESTRY.

V1-1220
COLOR LEGEND

- **Blue**
  - XtendFlex® Cotton

- **Green**
  - Non-Dicamba Tolerant Cotton

- **Yellow**
  - Corn

- **Brown**
  - Agricultural Fields
  - Prepared for Planting
BUFFER REQUIREMENT

The applicator must always maintain a downwind buffer between the last treated row and the nearest downwind field edge (in the direction the wind is blowing) for all uses of these products.

Maintain infield downwind buffer (in the direction in which the wind is blowing).

- 110 feet (when applying 0.5 lb acid equivalent (ae) per acre)
- 220 feet (when applying > 0.5 lb up to 1.0 lb ae per acre)
BUFFER REQUIREMENT

To maintain this required buffer:

- The following areas may be included in the buffer distance calculation when directly adjacent to the treated field edges:
  - Roads, paved or gravel surfaces
  - Planted agricultural fields containing: corn, dicamba tolerant cotton, dicamba tolerant soybean, Sorghum, proso millet, small grains and sugarcane
  - If the applicator intends to include such crops as dicamba tolerant cotton and/or dicamba tolerant soybeans in the buffer distance calculation, the applicator must confirm the crops are in fact dicamba tolerant and not conventional cotton and/or soybeans
  - Agricultural fields that have been prepared for planting.
  - Areas covered by the footprint of a building, silo, or other man made structure with wall and/or roof.
BUFFER SITUATION – INFIELD BUFFER

COLOR LEGEND

- **Blue**
  - XtendFlex® Cotton

- **Green**
  - Non-Dicamba Tolerant Cotton

- **Yellow**
  - Corn

- **Brown**
  - Agricultural Fields
  - Prepared for Planting
BUFFER SITUATION – DICAMBA TOLERANT CROP FIELD (CORN)

COLOR LEGEND

- **Blue**
  XtendFlex® Cotton

- **Green**
  Non-Dicamba Tolerant Cotton

- **Yellow**
  Corn

- **Brown**
  Agricultural Fields
  Prepared for Planting

---

2-10 MPH WIND
DOWNWIND BUFFER AND SUSCEPTIBLE CROPS

DOWNWIND BUFFER
Maintain the required label buffer to protect sensitive areas (110’ or 220’)

SUSCEPTIBLE CROPS
Do not apply when wind is blowing toward adjacent susceptible crops

DO NOT SPRAY

Dicamba Tolerant Crop
Downwind Buffer

Susceptible Crop
Including Non-Dicamba Tolerant Soybeans and Cotton
CHEMISTRY, MIXING, & HANDLING
CHEMISTRY, MIXING AND HANDLING

- Use only approved, low-volatility formulations of dicamba
- Use only approved herbicides, other pesticides, and additives as tank-mix partners which have been found not to adversely affect off-target movement (OTM) potential
- Some tank-mix partners with dicamba require an approved drift reduction agent (DRA).
- Approved tank-mix partners and required DRAs are included at each specific product labeling website.
  - Applicator must check the list of approved products no more than 7 days before applying
- Follow the tank mix order recommended for the specific DRA selected
  - Before mixing components, always perform a compatibility jar test
- Agitation is recommended following the addition of each component within a tank mix
- DO NOT add ammonium sulfate or other acidifying adjuvants to the tank when applying dicamba
  - AMS will increase volatility of dicamba even in small amounts

Refer to the specific product website for approved tank mix partners
Impact of AMS on Dicamba Volatility

Test Conditions:
- Duration: 24 hours
- Air flow: 0.5 l/min using 2.5 l tank
- RH: 35%
- Substrate: glass

Low volatility dicamba formulation* at 0.5lb ae/ac
AMS – 0.5% w/v at 10 GPA

AMS increases potential volatility by 20 times

*BASF Lab Study
Engenia herbicide: 12.8 fl oz/A
EQUIPMENT PREPARATION
EQUIPMENT PREPARATION – NOZZLE SELECTION

Use only approved nozzles within specified operating pressure range

Nozzle Selection: Droplet Size

- The smaller the droplets, the slower they fall, and the farther they can drift
- Large spray droplets improve on-target application and reduce the likelihood of drift
- Nozzle selection is only part of the equation
  - Nozzle selection and pressure combined determine droplet size and percentage of driftable fines (<141 microns)

AVOIDING SPRAY DRIFT AT THE APPLICATION SITE IS THE RESPONSIBILITY OF THE APPLICATOR
Nozzle Selection
First & most important decision made by an applicator

Go to registrant websites for list of approved nozzles
EFFECT OF DROPLET SIZE (MICRONS) – TIME IT TAKES TO FALL 10 FEET

Adapted from: Ross and Lemi, 1985. For illustrative purposes only.

<table>
<thead>
<tr>
<th>Micron Size</th>
<th>Time to Fall 10 Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 micron</td>
<td>28 hours</td>
</tr>
<tr>
<td>10 micron</td>
<td>17 minutes</td>
</tr>
<tr>
<td>100 micron</td>
<td>11 seconds</td>
</tr>
<tr>
<td>200 micron</td>
<td>4 seconds</td>
</tr>
<tr>
<td>400 micron</td>
<td>2 seconds</td>
</tr>
<tr>
<td>1,000 micron</td>
<td>1 second</td>
</tr>
</tbody>
</table>
UNDERSTANDING REQUIRED NOZZLE MANAGEMENT

Nozzle Type

- Use only approved nozzles within the pressure ranges listed on the specific product websites.

- **Do not use** any nozzle and pressure combination not specifically listed on the label or the specific product website.

- Applicators are required to consult specific product website no more than 7 days before application for a complete list of nozzles, DRAs, and other herbicides, pesticides, and additives approved for use with dicamba.

REFER TO THE SPECIFIC PRODUCT WEBSITE FOR APPROVED NOZZLES AND PRESSURE RANGES
Nozzle Selection
First & most important decision made by an applicator

Incorrect nozzles can increase drift by 66 times*

*Based on AGDISP modelling comparing approved
TTI 11004 vs. unapproved TT 11004 each at 60 PSI
DEMONSTRATION ON IMPORTANCE OF PROPER NOZZLES

8 MPH WIND

SPRAYED WITH TTI NOZZLES
STOPPED HERE TO SWITCH NOZZLES
SPRAYED WITH XR FLAT FANS

RATE: 0.5lb ae/acre dicamba
Dicamba (0.5 lb ae/acre) + Roundup PowerMAX® herbicide (1.125 lb ae/acre) + DRA (0.5% V/V)

Both pressures shown below are within approved range; yet higher PSI improves coverage.
APPLICATION
APPLICATION

- Apply when wind speeds are between 3 - 10 mph
- Do not exceed a ground speed of 15 mph
  - Provided the applicator can maintain the required nozzle pressure, it is recommended that tractor speed is reduced to 5 miles per hour at field edges
- Minimum of 15 gallons of spray solution per acre for XtendiMax® and FeXapan®
- Minimum of 10 gallons of spray solution per acre for Engenia®
Wind Speed

Influence on physical spray drift

Doubling wind speed (i.e. from 10 to 20 MPH) can increase potential drift by 3.4 times*

*Based on AgDISP modelling comparing 10 vs. 20 mph with approved TTI 11004 at 60 PSI
**Boom Height Requirement**

Key for consistency of nozzle performance

24” Maximum Boom Height Above Target

48” height can increase drift potential by 5.6 times*

*Based on AGDISP modelling comparing 24” vs. 48” above target with approved TTI 11004 at 60 PSI
WINDOW OF APPLICATION

- Target weeds when they are < 4” tall

Photo credit: Aaron Hager – University of Illinois
APPLICATION

- Do not apply this product between sunset and sunrise
- Do not apply this product during a temperature inversion
  - OTM potential can increase during a temperature inversion
- Do not make application of this product if rain is expected in the next 24 hours
  - Could result in runoff from area of application
- Do not apply this product aerially

- You must ensure that the spray system used to apply dicamba is clean before using the product
TEMPERATURE INVERSIONS

A layer of cool air trapped below a layer of warmer air

- During a temperature inversion, the atmosphere is very stable and vertical air mixing is restricted, which can cause small, suspended droplets to remain in a concentrated cloud.

- The inversion will typically dissipate with increased winds (>3 mph) or at sunrise when the surface air begins to warm (~3°F from morning low).

- Do not apply this product between sunset and sunrise.

- Inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator.

- Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.
VERTICAL MIXING OF AIR

Smoke test demonstration in 4-8 mph winds at 11:00 a.m. (Nebraska)

INVERSION LAYER NEAR SURFACE

Smoke test demonstration in < 1 mph winds at 7:15 a.m. (Nebraska)
Temperature Inversions

Impact on physical spray drift

HySplit Modeling of Spray Drift Utilizing Actual Weather Conditions

Labeled Application
Turbo TeeJet Induction (TTI) nozzles at 60 PSI applied at 1 PM on June 6, 2017. Wind speed ~9 MPH.

During An Inversion
Turbo TeeJet Induction Nozzles (TTI) at 60 PSI applied at 9 PM on June 2, 2017. Wind speed < 3 MPH

~6 times larger area impacted during inversion conditions

June 6 modeling with 15 minute droplet half life. June 2 modeling with no droplet half life. Based on weather data from Keiser, AR.
SPRAY SYSTEM HYGIENE
SPRAYER SYSTEM EQUIPMENT CLEANOUT

- Clean equipment immediately after using dicamba
  - refer to specific product label for cleanout procedure
- Do not allow the spray solution to remain in the system overnight prior to flushing
- Failure to properly clean the entire system can result in inadvertent contamination of the spray system
- Small quantities of dicamba may cause injury to non-dicamba tolerant soybeans or other susceptible crops
- All rinse water must be disposed of in compliance with local, state, and federal guidelines

SINGLE RINSE  |  DOUBLE RINSE  |  TRIPLE RINSE
Why focus on hygiene of the entire handling process of pesticides?

- Contamination can damage susceptible crops
  - Potential to affect multiple fields
  - Patterns may or may not be visible

- Contamination can cause incompatibility and plug screens and/or other sprayer parts

- Contamination with ammonium sulfate (AMS) can compromise lower volatility improvements of new dicamba formulations
Complex Handling and Mixing Model
Multiple points of potential contamination

Overhead transfer and filling
Nurse truck “hot loads”

Overhead transfer and filling
In-field mixing and filling

Dedicated system(s) recommended to prevent contamination
CLEANING THE SPRAYER: WHAT COMPONENTS?

Figure 1. Filters and screens should be cleaned to remove residues.
1/20,000th of the 1x Use Rate (0.000025 lb ae/A dicamba) – 14 days after vegetative stages (V3) application on non-dicamba tolerant soybeans
How much dicamba does it take to potentially contaminate a sprayer?

- 3 ml of formulated product
- 12 fl oz of spray solution

Commercial sprayer with 1000 gallon tank
Application volume: 10 GPA

Hygiene is critical to preventing spray system contamination
AFTER SPRAYING: BE AWARE OF DICAMBA SUSCEPTIBLE CROPS

Applicator sprayed dicamba & then parked sprayer in gravel lot prior to triple rinsing and cleaning sprayer. Significant rainfall occurred after cleanout onto the gravel.

Dicamba moved from gravel lot via rain water runoff into adjacent non-dicamba soybean field causing visual injury.
SUMMARY OF APPLICATION REQUIREMENTS
SUMMARY OF APPLICATION REQUIREMENTS (1 of 2)

- **Mandatory training** — prior to applying, applicator must complete dicamba or auxin-specific training.
- **Certified applicator must keep required records for two years**.
- **Use only approved low-volatility formulations of dicamba labeled for use in the Roundup Ready® Xtend Crop System**.
- **Adhere to the application rate on the specific product label**.
- **Apply when wind speed measured at boom height is between 3-10 mph**.
- **Use only approved nozzles within specified pressure range**.
- **Do not exceed 15 mph ground speed**.

These training materials are designed to satisfy federal training requirements and the training and application requirements imposed by the Oklahoma Department of Agriculture, Food, and Forestry. V1-1220
SUMMARY OF APPLICATION REQUIREMENTS (2 of 2)

**Sprayer system equipment cleanout** – ensure entire sprayer system is properly cleaned before AND after using the product.

**Ensure minimum gallons per acre spray volume** (e.g., 10 or 15 GPA, depending on product).

**Do not exceed a boom height of 24 inches above target pest of crop canopy.**

**Ammonium sulfate and ammonium based additives are prohibited in applications.**

**Tank mix partners** – use only approved tank mix partners confirmed on each product website. Refer to all product labels to determine mix order or perform mix compatibility test.

**Application timing** – only spray between sunrise and sunset (DO NOT spray during temperature inversion).

**DO NOT apply when wind is blowing toward adjacent susceptible crops (including non-dicamba tolerant soybeans and cotton).**

**Maintain a minimum of 110 feet downwind buffer for all applications.**
SUMMARY: ALWAYS FOLLOW ALL LABELING FOR PRODUCT BEING APPLIED

• XtendiMax® with VaporGrip® Technology (Monsanto)
  xtendimaxapplicationrequirements.com

• FeXapan® herbicide Plus VaporGrip® Technology (Corteva)
  www.fexapanapplicationrequirements.dupont.com

• Engenia® Herbicide (BASF)
  Stewardship: http://agproducts.basf.us/campaigns/engenia/#stewardship
  Tank Mix: www.engeniatankmix.com
Contacts

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Oklahoma Cooperative Extension Service

Local Oklahoma Cooperative Extension Service County Office

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Questions?