2019 South Carolina Pest Management Handbook
### Table of Measurements and Conversions

<table>
<thead>
<tr>
<th>Standard Measure</th>
<th>Metric Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length:</strong></td>
<td></td>
</tr>
<tr>
<td>1 ft = 12 in</td>
<td>1 in = 25.4 mm = 2.54 cm</td>
</tr>
<tr>
<td>1 yd = 3 ft</td>
<td>1 ft = 304.8 mm = 30.48 cm</td>
</tr>
<tr>
<td>1 mi = 5,280 ft</td>
<td>1 yd = 914.4 mm = 91.44 cm = 0.914 m</td>
</tr>
<tr>
<td>1 mph = 88 ft/1 min</td>
<td>1 mi = 1,609 m = 1.61 km</td>
</tr>
<tr>
<td></td>
<td>1 mm = 0.03937 in</td>
</tr>
<tr>
<td></td>
<td>1 cm = 0.394 in = 0.0328 ft</td>
</tr>
<tr>
<td></td>
<td>1 m = 39.37 in = 3.281 ft</td>
</tr>
<tr>
<td></td>
<td>1 km = 3,281 ft = 0.621 mi</td>
</tr>
<tr>
<td><strong>Area:</strong></td>
<td></td>
</tr>
<tr>
<td>1 sq in = 0.007 sq ft</td>
<td>1 sq in = 6.45 sq cm</td>
</tr>
<tr>
<td>1 sq ft = 144 sq in</td>
<td>1 sq ft = 929 sq cm</td>
</tr>
<tr>
<td>1 sq yd = 1,296 sq in = 9 sq ft</td>
<td>1 sq yd = 8,361 sq cm = 0.8361 sq m</td>
</tr>
<tr>
<td>1 ac = 43,560 sq ft = 4,840 sq yd</td>
<td>1 ac = 4,050 sq m = 0.405 h</td>
</tr>
<tr>
<td></td>
<td>1 sq m = 1,550 sq in = 10.76 sq ft</td>
</tr>
<tr>
<td></td>
<td>1 h = 107,600 sq ft = 2.47 ac</td>
</tr>
<tr>
<td><strong>Volume:</strong></td>
<td></td>
</tr>
<tr>
<td>1 tsp = 0.17 fl oz</td>
<td>1 fl oz = 29.5 ml = 0.0295 L</td>
</tr>
<tr>
<td>1 tbs = 3 tsp</td>
<td>1 pt = 437 ml = 0.437 L</td>
</tr>
<tr>
<td>1 fl oz = 2 tbs = 6 tsp</td>
<td>1 qt = 945 ml = 0.945 L</td>
</tr>
<tr>
<td>1 cup = 8 fl oz = 16 tbs</td>
<td>1 gal = 3,785 ml = 3.785 L</td>
</tr>
<tr>
<td>1 pt = 2 cups = 16 fl oz</td>
<td>1 ml = 0.033 fl oz</td>
</tr>
<tr>
<td>1 qt = 2 pt = 32 fl oz</td>
<td>1 L = 33.8 fl oz = 2.112 pt = 1.057 qt = 0.264 gal</td>
</tr>
<tr>
<td>1 gal = 4 pt = 8 pt = 128 fl oz = 231 cu in</td>
<td>Note: To convert liquid ounces to gallons, multiply by 0.0078125(.008)</td>
</tr>
<tr>
<td><strong>Weight:</strong></td>
<td></td>
</tr>
<tr>
<td>1 oz = 0.0625 lb</td>
<td>1 oz = 28.35 g</td>
</tr>
<tr>
<td>1 lb = 16 oz</td>
<td>1 lb = 454 g = 0.4536 kg</td>
</tr>
<tr>
<td>1 ton = 2,000 lb</td>
<td>1 ton = 907 kg</td>
</tr>
<tr>
<td>1 gal of water = 8.34 lb</td>
<td>1 gal of water = 3.786 kg</td>
</tr>
<tr>
<td><strong>Concentration:</strong></td>
<td></td>
</tr>
<tr>
<td>1 part per million (ppm)= 0.00001 percent = 0.013 oz in 100 gal of water</td>
<td>1 part per million (ppm)= 1 milligram/liter = 1 milligram/kilogram</td>
</tr>
<tr>
<td>1 percent = 10,000 ppm</td>
<td>1 percent = 10 grams/liter</td>
</tr>
<tr>
<td>0.1 percent = 1,000 ppm</td>
<td>0.1 percent = 1,000 milligrams/liter</td>
</tr>
<tr>
<td>0.01 percent = 100 ppm</td>
<td>0.01 percent = 100 milligrams/liter</td>
</tr>
<tr>
<td>0.001 percent = 10 ppm</td>
<td>0.001 percent = 10 milligrams/liter</td>
</tr>
<tr>
<td><strong>Temperature:</strong></td>
<td></td>
</tr>
<tr>
<td>To convert degrees Celsius (°C) to degrees Fahrenheit (°F): multiply by 1.8 and add 32.</td>
<td>Example: 30 degrees °C = 86 degrees °F. (30x1.8+32)</td>
</tr>
<tr>
<td>To convert degrees Fahrenheit (°F) to degrees Celsius (°C): subtract 32 multiply by 0.56.</td>
<td>Example: 50 degrees °F = 10 degrees °C (50-32x0.56).</td>
</tr>
</tbody>
</table>

**Abbreviations:** ac = Acre; cm = Centimeter; fl oz = Fluid ounce; ft = Foot or Feet; g = Gram; gal = Gallon; h = Hectare (1h = 10,000 square meters); in = Inch; kg = Kilogram; km = Kilometer; L = Liter; lb = Pound; ml = Milliliter; mm = Millimeter; qt = Quart; sq = Square; tbs = Tablespoon; tsp = Teaspoon; yd = Yard.
2019 South Carolina Pest Management Handbook

The Pest Management Handbook is a set of recommendations developed by Clemson University Extension pest management specialists and university researchers for South Carolina growers. These recommendations were derived from various sources of information available to these contributors at times prior to publishing this handbook and represent their current views on managing field crop pests based on pesticide labels, their own research or experience, and/or through other sources. The chemical recommendations provided here are based on pesticide active ingredients. Pesticide products mentioned here are for applicator convenience and are examples only.

The information in this publication was current as date of printing January 18, 2019 and applies only to South Carolina. It may not be appropriate for other states or locations.

The 2019 Pest Management Handbook is also available as an electronic copy on the Clemson University Extension web page: http://www.clemson.edu/extension/rowcrops/

DISCLAIMER

The mention of a pesticide product is not an endorsement nor discrimination against any other product by Clemson University Cooperative Extension Service. Pesticide products not mentioned here may also be efficacious and their absence from these recommendations does not necessarily mean that they are not also effective pest management tools. These recommendations are not meant to be an exhaustive recommendation, and associated comments, given here are in all cases are superseded by the pesticide product labels.

It is your responsibility as a pesticide user to read and follow the instructions on the product label in deciding your pesticide purchases and in their use, including mix/loading of the product, application, clean-up, and the disposal of unwanted product, rinsates, and clean empty product containers. Remember: The Label is the Law. For further assistance, please contact your local county Extension office.
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INTRODUCTION

SPRAYER CALIBRATION
Mike Marshall, Extension Weed Specialist

Accurate application of pesticides is essential to adequately control target pests, avoid excessive crop injury, and minimize chemical costs and harm to the environment. This has become even more critical in recent years as some pesticide use rates go from pounds per acre to fractions of one ounce per acre. Unfortunately, sprayer calibration is often neglected or avoided. There are many ways to calibrate a sprayer, some more difficult than others. If you have a reliable method with which you are comfortable, stick with it. The following is a guide to a straightforward method.

Sprayer calibration should be done with clean water, not with the chemical mix in the spray system. Before you calibrate your sprayer, thoroughly clean it. Also, be sure to check for nozzle output uniformity, as defects or uneven wear will cause some nozzles to put out significantly more than others of the same type. To do this, catch and measure the output of each nozzle for a specific length of time (30 seconds, 1 minute, etc.) and determine the average output per nozzle (total combined output of all nozzles divided by the number of nozzles). Discard and replace any nozzle that varies more than 5 percent from the average.

1/128 acre method:

This is perhaps the most frequently used and quickest method of calibration. It involves measuring a specific driving distance rather than an area. Follow these steps to calibrate by the 1/128 acre method.

1. Measure a specific distance in a field according to table 1. Select a driving distance which matches the nozzle spacing on your boom (for broadcast sprays) or row spacing you use (for band applications). The distance should be measured in a field typical of those you will be spraying, rather than a smooth surface.

2. Select a gear and engine speed combination which will allow you to comfortably drive across your fields and develop adequate spray pressure for the selected nozzles on your rig. Drive the measured distance at your preselected gear and engine speed combination and record the time required to drive the distance in seconds. To improve precision, you may want to time two or more separate runs and take the average of two runs.

<table>
<thead>
<tr>
<th>Nozzle or Row spacing (inches)</th>
<th>Distance to time for calibration (feet)</th>
<th>Nozzle or Row spacing (inches)</th>
<th>Distance to time for calibration (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>102</td>
<td>26</td>
<td>157</td>
</tr>
<tr>
<td>38</td>
<td>107</td>
<td>24</td>
<td>170</td>
</tr>
<tr>
<td>36</td>
<td>113</td>
<td>22</td>
<td>185</td>
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<tr>
<td>34</td>
<td>120</td>
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<tr>
<td>32</td>
<td>127</td>
<td>18</td>
<td>227</td>
</tr>
<tr>
<td>30</td>
<td>136</td>
<td>16</td>
<td>255</td>
</tr>
<tr>
<td>28</td>
<td>146</td>
<td>14</td>
<td>291</td>
</tr>
</tbody>
</table>

3. Park the sprayer and, using a measuring cup or bucket, catch the spray output from a single nozzle for the length of time it took you to drive the measured distance in step one. Be sure that the sprayer is running at the same engine speed and spray pressure. Note: For banding rigs where you used row spacing to determine the distance in step 1 and where more than one nozzle is
directed to the row, catch the output for all nozzles directed to a single row.

4. The total amount of water, measured in ounces, collected per nozzle or row in step 3 equals gallons per acre (GPA).

**Determining how much herbicide product to add to the spray tank:**

Now that you have successfully calibrated your sprayer, the next step is to determine how much chemical you need to add to the tank.

1. Divide the tank capacity by gallons per acre to get the number of acres a full tank can spray:

\[
\text{[Tank capacity (gallons) ÷ GPA]} = \text{Number of acres covered by one full tank}
\]

2. Multiply the recommended pesticide rate from the label (pt/A, oz/A, lb/A, etc.) by the number of acres covered by a full tank (from step 1.)

3. **Note:** All pesticide rates in this handbook are given as broadcast rates. For band applications, you must adjust the rate using the following formula:

\[
\text{[Band Width × Broadcast Rate] ÷ Row Width} = \text{Band Rate}
\]

**Examples of calibration & how much to put in the tank.**

**Broadcast Application:**

You plan to spray generic glyphosate herbicide, plus a nonionic surfactant for burn-down prior to planting cotton. Your sprayer has a uniform nozzle spacing of **18 inches**. You have thoroughly cleaned your sprayer and replaced all non-uniform nozzles (and yes there were some!)

1. From **Table 1**, note that the distance to drive is **227 feet**. Measure this distance in the field to be sprayed.

2. Set your throttle and drive the **227 feet** for several runs. Let’s say that it took you an average of **39 seconds** to drive this distance.

3. Now, at the same engine speed and at your desired spray pressure, and with your sprayer standing still, catch the output in ounces for 39 seconds from any one nozzle, the average time it took your rig to travel the 227 feet. You catch 20 ounces during the 39 second time period. Therefore, your sprayer output is **20 GPA**.

4. After reading the generic glyphosate label and the weed control recommendations for cotton, you decide to spray glyphosate at **1 qt/A**, plus a nonionic surfactant at **1 qt/100 gallons** of spray mix. Let’s assume you have a 500-gallon spray tank.

   **How many acres will one tank load cover?**

\[
\text{[500 gal tank ÷ 20 GPA]} = 25 \text{ acres covered by one tank load}
\]

So, **1 qt/A × 25 acres = 25 quarts (~6.25 gallons)** of glyphosate per tank load

**What about the surfactant:**

\[
500 \text{ gal} × (1 \text{ qt/100 gal}) = 5 \text{ qts. surfactant per spray tank load.}
\]

**Band Application:**

You plan to apply Staple herbicide plus nonionic surfactant in a **19 inch band** on **38 inch rows**. Your banding rig is set up with three nozzles directed to the band on each row.
Your sprayer has been thoroughly cleaned, and the nozzles are uniform in output, after replacing those out of range.

1. Using the chart again, the distance to travel for a **38 inch row** is **107 feet**. You measure your course drive it several times. Let’s assume it took an average of 18 seconds.

2. Park the sprayer and at the same engine speed and your desired pressure, collect the output of each of the three nozzles for 18 seconds. If the **combined** total output of the three-nozzle band cluster is, for example, 25 ounces, the sprayer is applying **25 gallons per acre**.

3. Now, let’s say your sprayer has a **200 gallon tank**. The broadcast rate for Staple is **2.2 fl oz/A**, and **nonionic surfactant** is to be added at **1 qt/100 gal. of spray mix**.

   \[
   \frac{200 \text{ gal tank}}{25 \text{ GPA}} = 8 \text{ acres covered per tank}
   \]

4. Now, reduce the rate for a 19 inch band:

   \[
   \frac{19 \text{ inch band}}{38 \text{ inch broadcast}} \times 2.2 \text{ oz/A Staple product} = 1.1 \text{ oz/A Staple}
   \]

   Therefore: **8 acres \times 1.1 \text{ fl oz/A} = 8.8 \text{ fl oz Staple needed per tank}**

   **Surfactant** needed per tank is, 200 gallon tank \times (1 qt surfactant/100 gallon spray) = **2 qts. nonionic surfactant** per tank

   **Note:** the surfactant rate in this example is calculated based on *amount per volume of spray mix*, rather than amount per acre, it is calculated the same as for broadcast applications.

### Post-Directed and Hood Applications:

You plan to use a hooded sprayer to make post-directed and hooded applications in your **38 inch row** cotton. Given, the gallon per acre (GPA) under the hood needs to match as close as possible to the GPA of your post-directed band. The hooded rig is set up to use **two nozzles** post-directing on a **13 inch band** and has **three nozzles** under the hood spraying a **25 inch band**.

**Scenario 1: One pump applying one tank mix.**

1. The distance to travel for a **38 inch row** is **107 feet (Table 1)**. You measure your course and drive it. Let’s assume it took an average of **18 seconds**.

2. Park the sprayer and at the same engine speed and at the desired pressure and collect the output of the **three nozzles** under the hood for 18 seconds. Combine the output of the three nozzles and measure. The combined total, for example **20 ounces**, equals the application rate in GPA. In this case your hoods are applying at **20 GPA**.

3. Next, with your sprayer running at the same engine speed and pressure, collect the output of the **two post-directing nozzles**. Combine the output from these **two nozzles** and measure. The combined total, for example **13 ounces**, equals the application rate in GPA. In this case the post-directing nozzles are applying at **13 GPA**.

4. Remember, you want the application rate to be the same for both the post-directed and hooded application. To accomplish this, decide which application rate fits your needs. In this example, we will assume that **13 GPA post-directed** is ideal. To get your hooded application to be **13 GPA**, instead of **20 GPA**, **reduce the size of the spray tips** under the hood and re-run the calibration procedure. Continue this process until your hooded application rate and post-directed application rate are similar.

**Scenario 2. Two (2) pumps applying separate tank mixes.**
1. From Table 1, the distance to travel for a 38 inch row is 107 feet. Your course is measured and you drive it. Let’s assume it took 18 seconds.

2. Park the sprayer and at the same engine speed and desired pressure, collect the output of the three nozzles under the hood for 18 seconds. Combine the output of the three nozzles and measure. The combined total, for example 18 ounces, equals the application rate in GPA. In this case the hoods are applying at 18 GPA.

3. Next, with the sprayer running at the same engine speed and desired pressure, collect the output of the two post-directing nozzles. Combine the output from these two nozzles and measure. The combined total, for example 15 ounces, equals the application rate in GPA. In this case the post directing nozzles are applying at 15 GPA.

4. Remember, you want the application rate to be the same for both the post-directed and hooded application. To accomplish this, decide which application rate fits your needs. In this example, we will assume that 15 GPA post-directed is ideal. To get your hooded application to be 15 GPA instead of 18 GPA, you have two (2) options.

   a) First reduce the pressure for the pump applying under the hood. Caution: Be sure that after reducing the pressure the spray tip still produces an acceptable spray pattern. Repeat the calibration procedure. Continue this process until your hooded application rate and post-directed application rate are similar.

   b) The second option is to change to a smaller spray tip size under the hood to reduce the application rate to 15 GPA. Repeat the calibration procedure. Continue this process until your hooded application rate and post-directed application rate are similar.

SPRAY DRIFT MANAGEMENT
Mike Marshall, Extension Weed Specialist

A variety of factors including weather conditions (e.g., wind direction, wind speed, temperature, and relative humidity) and method of application (e.g., ground, aerial, and airblast) can influence pesticide drift. The applicator must evaluate all factors and make appropriate adjustments when applying pesticides.

✓ READ the PESTICIDE LABEL for guidelines on preventing drift!
✓ Select a nozzle that maximizes product performance (i.e., small droplets for contact herbicides, such as paraquat) and minimizes spray drift potential (i.e., ultra-coarse droplets for auxin type herbicides, such as dicamba).
✓ Use recommended spray pressure according to the nozzle manufacturer guidelines.
✓ Don’t apply pesticides under windy or gusty conditions (do not spray when wind speeds are greater than 15 mph).
✓ Use the minimum boom height according to nozzle manufacturers recommendations. Spray drift increases as boom height increases.
✓ Use a hand-held anemometer to determine wind speed and direction at the application site.
✓ Don’t spray when the wind is less than 3 mph to avoid spraying in temperature inversions where vertical mixing of the air is limited.
✓ Maintain required buffer zones according the label instructions.
✓ Utilize drift control/reduction agents in your tank mix.
If possible, don’t spray when the temperature is above 90 – 95°F.

Before spraying, document your surroundings, especially the location, direction, and distance of susceptible crops and sensitive sites relative to the treated site.

As an applicator, YOU are responsible for where the chemicals from your spray rig go!

SPRAIER EQUIPMENT CLEANING

Mike Marshall, Extension Weed Specialist

Residues of pesticide solutions left in sprayer tank or lines can cause severe damage later if applied to susceptible crops. For example, traces of growth regulator type herbicides used for burndown and/or pasture weed control, including 2,4-D amine/ester, can create serious problems if accidentally applied to susceptible broadleaf crops including tobacco, cotton, tomatoes fruiting vegetables, and other susceptible plants. Most of these herbicides, particularly the oil based formulations of 2,4-D and Crossbow, are difficult to thoroughly wash out of a sprayer. Therefore, we recommend using a dedicated sprayer for application of growth regulator type herbicides.

The sulfonylureas and imidazolinones herbicides, including Accent, Classic, Exceed, Staple, and Scepter, have also created sprayer cleaning challenges. These herbicides have a high unit activity (a small amount of product that is left in the sprayer is very active on a per acre basis). Tiny amounts of these dry materials can cause severe damage to non-target, susceptible crops. Some pesticides have specific clean-out instructions outlined on the label and should be followed explicitly to prevent subsequent contamination and injury of the next sensitive crop sprayed by the applicator.

Your tank is only one part of the sprayer. You can do an excellent job of cleaning the tank, but if chemical residues are left in the hoses, strainers, and pump, serious crop damage can still occur. Pesticides can be absorbed into the lines, in addition to polyethylene or fiberglass tanks, where they can remain for a long time. Some dry flowable and wettable powder formulations can precipitate out of solution and accumulate on the bottom of the spray tank and suction line, particularly in sprayers with poor agitation. The longer a spray mix is left in the system, the greater is the potential contamination problem the next time you use the sprayer unit. Sprayers should be cleaned as soon as possible and pesticide spray mixtures (especially dry pesticide formulations suspended in water) should never be allowed to dry in the sprayer.

Personal protective equipment that is recommended on the pesticide label for that product should be worn during clean-up. Do not clean sprayers near wells, sink holes, creeks or other surface water, or near desirable vegetation.

Many herbicide labels have specific sprayer cleanup procedures on the label. For example, Valor product label recommends a specific tank mix cleaner product (i.e., Valent tank cleaner) after each use of a flumioxazin containing product. Other pesticides recommend adding household ammonia at 1 gallon of ammonia for each 100 gallons of water. Ammonia is also useful for removing 2,4-D ester residues left in the sprayer because ammonia changes the less soluble ester into a more highly water-soluble ammonium salt of 2,4-D. Many commercial tank cleaners are available and most do an excellent job, if properly used, of cleaning a sprayer tank and components. They are just like ammonia in that plenty of water and proper procedure are required.
Sprayer cleaning procedure for pesticides

1. After spraying, drain the sprayer, boom and lines in an area appropriate for rinsate disposal. Do not allow the spray solution to remain in spray boom lines overnight prior to flushing the system.
2. Flush the tank, hoses, boom, and nozzles with clean water. Open boom ends and flush if appropriate.
3. Inspect and clean all strainers, screens, and filters.
4. Prepare a commercial detergent, sprayer cleaner, or ammonia according to the manufacturer’s directions.
5. Take care to wash all parts of the tank including the inside top surface. Start agitation in the sprayer and thoroughly recirculate the cleaning solution for at least 15 minutes. All visible deposits must be removed from the spraying system.
6. Flush hoses, spray lines, and nozzles for at least 1 minute with the cleaning solution.
7. Repeat the previous steps for 2 additional times to accomplish an effective triple rinse.
8. Remove nozzles, screens, and strainers and clean separately in the cleaning solution after completing the above procedures. Drain the sump, filter, and lines.
9. Rinse the complete system with clean water.
10. Clean and wash off the outside of the entire sprayer and boom.
11. Dispose of rinsate from all the steps above in an appropriate manner that complies with all applicable local, state, and federal requirements, laws, and regulations.

Sprayer cleaning procedure for Xtendimax, Engenia, FeXapan, Enlist One, Enlist Duo herbicides:

1. Completely drain the spray system including pumps, lines, and spray boom for at least 5 minutes.
2. Fill the spray tank with clean water to at least 10% of the total tank volume and circulate the solution through the entire system so that all internal surfaces are contacted for at least 15 minutes to complete the first rinse of the application equipment. Spray the solution from the tank out through the boom.
3. Completely drain the spray system including pumps, lines, and spray boom for at least 5 minutes; remove and clean filters and strainers.
4. During the second rinse, fill the container with clean water to at least 10% of the total tank volume. The addition of tank cleaning agents may be used at the manufacturer’s recommended rates. Circulate the solution through the entire system for at least 15 to 20 minutes. Let the solution stand for several hours or overnight. Spray the solution out of the tank through the boom.
5. Completely drain the spray system including pumps, lines, and spray boom for at least 5 minutes.
6. Fill the spray tank with clean water to at least 10% of the total tank volume and circulate the solution through the entire system so that all internal surfaces are contacted for at least 15 minutes to complete the third rinse of the application equipment. Spray the solution out of the tank through the boom.
7. Completely drain the spray system, remove nozzles tips and strainers and clean them separately.
8. Clean and wash off the outside of the entire sprayer and boom.
9. Dispose of rinsate from all the steps above in an appropriate manner that complies with all applicable local, state, and federal requirements, laws, and regulations.

Important: Remember to clean all other associated application equipment. Personal protective equipment, as prescribed on the label, should be worn during the clean-up process and
do not clean sprayers near wells, sink holes, creeks or other surface water, or near desirable vegetation.

PESTICIDE SPRAY ADDITIVES
Mike Marshall, Extension Weed Specialist

Spray Additives

A spray additive is any substance added to an herbicide tank mix to enhance performance. Adjuvants are classified based on their use rather than chemistry. Adjuvants types include surfactants, emulsifiers, wetting agents, stickers, de-foamers, compatibility agents, crop oils, and drift control agents.

Types of Spray Additives:

Surfactants (surface-active-agent): Are used to improve emulsifying, dispersing, spreading, wetting, or other surface modifying properties of a liquid. Three types of surfactants are emulsifiers, wetting agents, stickers. Choose a non-ionic surfactant based on composition. A surfactant with 80% or greater active ingredient is a desirable choice.

Emulsifiers: Substances that promote suspension of one liquid in another. They are most commonly used to disperse oil in water. These are usually contained in the herbicide package formulation.

Wetting agents: Reduce interfacial tensions between surfaces that would normally repel each other. These allow a spray solution to spread and adhere better to waxy cuticles of plants. Nonionic surfactants (NIS) are the type usually added to a spray tank. They are good dispersing agents, stable in cold water, and have low toxicity to plants and animals.

Stickers: Adjuvants that promote adherence of herbicides to the plant foliage. They reduce runoff potential during application and wash off by rainfall. These are usually blended with wetting agents to provide better coverage and are called spreader-stickers.

Antifoaming Agents: These materials reduce foaming tendency of some pesticides in a sprayer system so that pumps and nozzles can operate effectively.

Compatibility Agents: Aid in holding herbicides in solution when mixed with pesticides or fertilizers.

Crop Oils: These are non-phytotoxic light petroleum or vegetable oils that contain surfactants. Crops oils are used much like a surfactant; but they tend to temporarily burn crop foliage. Choose crop oil which contains 80% or greater oil, and the rest as surfactants or emulsifiers.

Drift Control Agents: Materials used to reduce the number of fine particles in the spray pattern which could move from the application site and result in drift damage.

PESTICIDE STORAGE AND DISPOSAL
Mike Marshall, Extension Weed Specialist

Store pesticides in a cool and dry place, preferably in a locked, detached structure, in their original container with intact and readable labels. Also, pesticides should not be stored with seed, gasoline, fuels, and other flammable solvents.

The proper container rinse procedure requires that you plan accordingly:

✓ Read and follow label directions!
✓ Wear the required protective clothing and equipment.
✓ Rinse containers immediately after emptying because pesticides will dry or solidify quickly and become difficult to remove.
✓ Consider the volume of the rinsate when filling the sprayer tank. Leave enough room in the sprayer tank to accommodate the rinsate before filling the tank.
✓ Have back-flow protection when filling the sprayer tank and rinsing the container.

There are two acceptable ways to rinse empty pesticide containers:
1) Triple-rinsing or  
2) Pressure-rinsing (jet-rinsing) using an EPA approved device specifically manufactured to wash container interiors.

**Triple-rinse container instructions:**
✓ Allow empty pesticide container to drain into the sprayer tank for at least 30 seconds.
✓ Fill container one-quarter full of clean water or appropriate spray rinse diluent. Replace cap securely and roll, swirl and shake the contents vigorously for at least one full minute to rinse all surfaces!
✓ Remove container cap and empty rinsate into the spray tank. Allow the container to drain for at least 30 seconds.
✓ Repeat the fill, shake and drain procedure two (2) more times, using clean water.
✓ Properly dispose of the rinsed containers as soon as possible. Dispose of caps with the containers unless recycling.
✓ Plastic and plastic-lined bags can be triple-rinsed. For paper and fiber bags and similar containers, completely empty the contents into the tank. Open both ends of the container to remove any remaining pesticide and to prevent reuse.

**How to pressure-rinse containers:**
✓ Allow the empty pesticide container to drain into the sprayer tank for at least 30 seconds.
✓ Hold the container upside down over the sprayer tank opening so that rinsate will run into the sprayer tank. For ease and safety, puncture through the bottom of metal containers and through the side of plastic containers with appropriate tool or pressure-rinsing nozzle-follow specific manufacturer directions.
✓ Thoroughly rinse the empty container for the time interval recommended by the pressure-rinse nozzle manufacturer, but no less than 30 seconds, using at least 40 psi water pressure.
✓ Properly dispose of your rinsed containers as soon as possible. Dispose of caps with containers, unless recycling. Caps are not recyclable.

**PESTICIDE RESISTANCE MANAGEMENT**
*Mike Marshall, Extension Weed Specialist*

**Repeated use of any pesticides** – *herbicides, insecticides, fungicides, nematicides, rodenticides, and others* - can lead to the selection of individuals or biotypes that are resistant to that pesticide. Applicators are encouraged to rotate products with differing modes of action within a crop year. Many pesticide labels now give detailed guidance.

Resistance may be defined as “a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species”.

Resistance arises through the over-use and/or misuse of a pesticide against a pest species and results from the selection of resistant biotypes of the pest and the resulting evolution of pest populations that are resistant to that pesticide and its mode of action (MOA). Pesticides do NOT cause the mutations for resistance.

In most cases, not only does resistance render the selecting compound much less effective but it often also confers cross-resistance to other
chemically related compounds. Cross-resistance occurs when resistance to one pesticide confers resistance to another pesticide, even where the pest has not been exposed to the latter product.

The objective of successful Pesticide Resistance Management is to delay the evolution of pest resistance to pesticides, or to help regain susceptibility in pest populations in which resistance has already arisen.

Because many pest populations are usually present in large numbers and quickly reproduce (especially mites, many insects and most plant pathogens), there is always a risk that pesticide resistance may evolve quickly, especially when pesticide are misused or over-used.

If you obtain less control of a pest with a given pesticide than you are accustomed to, or believe is reasonable to expect, first check to be sure that you applied the pesticide properly according to the label instructions. If you made your application properly, next consider if there were any extreme environmental conditions – very hot, very cool, heavy rain, etc. If none of these conditions existed, or are not believed to influence the product’s performance, then pesticide resistance is a possibility.

Doing everything you can to delay pesticide resistance is important for the obvious reasons. Currently, there are few to no new modes-of-action being developed in the pesticide market. This lack of new alternatives gives us few choices when it comes to switching to a different pesticide when resistance arises. For instance, there have not been any significant new modes-of-action for herbicides in about three decades. While new herbicide products are coming onto the market, often in conjunction with herbicide resistant crop varieties, the herbicides themselves are some of the oldest herbicides we have, for instance 2,4-D.

There are several ways to delay pesticide resistance. The best is to use Integrated Pest Management (IPM) and to use economic injury thresholds to determine when to apply a pesticide(s). Other methods include rotating crops to prevent buildup of the same pest populations over time, to use the lowest effective rate or rate recommended by the pesticide label or a knowledgeable expert and make spot or perimeter applications on small or defined pest populations. When using pesticides, rotate pesticide modes of action by rotating pesticide chemical families.

For most growers, however, knowing what pesticides to use to do this has been difficult because of a lack of knowledge of the many different modes of action. Until recently pesticide labels did not provide much information to assist in these decisions.

To help growers and others combat pesticide resistance several national and international resistance action committees have been formed by the pesticide industry and others to address the problem of pesticide resistance. These committees are based on the different major pesticide groups. So, for herbicides there is an Herbicide Resistance Action Committee (HRAC), an Insecticide Resistance Action Committee (IRAC) for insecticides, a Fungicide Resistance Action Committee (FRAC) for fungicides, and so on. These committees have studied the modes of action of the respective pesticide families and developed a system to help growers and others better select pesticides from different pesticide chemical families to allow users to effectively rotate the modes of action and thus combat pesticide resistance in their pests. This information is now appearing on pesticide labels. In addition to the system developed by the respective Action Resistance Committees, many pesticide
manufacturers are beginning to supply information on resistance management on their labels in sections titled “Resistance Management”.
To date, generic pesticide products tend not to have as much information as brand name pesticide products.

When you want to rotate modes of action against your pests, first make sure that whatever pesticide you select is labeled for your intended use. Next, look for a pesticide group number on the label, or a statement indicating the pesticide group. Using these pesticide group numbers, you do not have to know or understand the complex modes of action of these chemicals, you should select a product(s) with a different group number that is labeled for your pest management need. Examples of group numbers when they appear on pesticide labels are usually in the upper right-hand corner of the label, look like this:

<table>
<thead>
<tr>
<th>GROUP</th>
<th>HERBICIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HERBICIDE</td>
</tr>
<tr>
<td>GROUP</td>
<td>FUNGICIDE</td>
</tr>
<tr>
<td>11</td>
<td>FUNGICIDE</td>
</tr>
</tbody>
</table>

When you want to rotate modes of action against your pests, first make sure that whatever pesticide you select is labeled for your intended use. Next, look for a pesticide group number on the label, or a statement indicating the pesticide group. Using these pesticide group numbers, you do not have to know or understand the complex modes of action of these chemicals, you should select a product(s) with a different group number that is labeled for your pest management need. Examples of group numbers when they appear on pesticide labels are usually in the upper right-hand corner of the label, look like this:

<table>
<thead>
<tr>
<th>GROUP</th>
<th>INSECTICIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4A</td>
<td>INSECTICIDE</td>
</tr>
</tbody>
</table>

The information – “data elements” – required to be kept are minimal. Private Applicators will likely want to record more information on their applications, all their applications, to help with their present and future pest management efforts. Good records help you trouble-shoot application problems and duplicate pest management successes.

**The data elements** required to be kept on each RUP application are:
- The brand/product/trade name of the pesticide
- EPA product Registration Number
- Total amount of pesticide product applied
- Size of area or the number of units treated
- Crop or Site applied to
- Actual location of the application
- Date of application: Month, Day, Year
- Certified applicator name and license number

Records must be made within 14 days of each application of an RUP. Records must be maintained for a minimum of two (2) years from the date of the application.

**Spot treatments**: Spot applications are small applications which total less than 1/10th of an acre, and they are made in the same day.
applications do not apply to nurseries or greenhouses.

For Spot treatments, you must record:

☐ Date of application - month, day, year
☐ Brand or product name
☐ EPA Registration Number
☐ Total amount of pesticide applied
☐ Location of the pesticide application, designated as “spot application” with a brief description.

**Record keeping tips:**
Record all three (3) identifiers for your RUP. *They’re all on the label!*

- The **Product** or **Brand (Trade) name**
- The **Common Chemical name** of the active ingredients
- The **EPA Registration No.**

Keep additional information that will help YOU better achieve YOUR pest and pesticide management objectives. For instance, amount of water used, spray pump pressure, boom height, nozzle spacing tip used, tractor speed or rpms, other equipment settings, and weather information such as temperature, rainfall the 24 hours before and 24 hours after the application, wind speed (recorded at the site of the application at the time of the application), notes on any application problems, and any other information that would be useful to you.

You are required to keep records of any worker or handler pesticide safety training you conduct or have conducted for your ag employees.
APPLICATION RECORD KEEPING REQUIREMENTS FOR DICAMBA TOLERANT CROPS

Mike Marshall, Extension Weed Specialist

Applicators must keep the following records for a period of two years, records must be generated within 72 hours of application of a DICAMBA product in a DT crop, and a record must be kept for every individual application. Records must be made available to State Pesticide Control Official(s), USDA, and EPA upon request. The following information must be recorded and kept as required by the Federal Pesticide Record Keeping Program, 7 CFR Part 110:

1. **Full name of certified applicator**
2. **Certification number of certified applicator**
3. **Product name**
4. **EPA registration number**
5. **Total amount applied**
6. **Application month, day, and year**
7. **Crop Planting Date**
8. **Start and Finish Times:** the time the applicator begins and the times the applicator completes applications of the dicamba product.
9. **Location of the application**
10. **Crop or site receiving the application**
11. **Size of the treated area**
12. **Training requirement**: Proof that the applicator completed a dicamba specific training course.
13. **Application Timing:** Whether the applicator applied this product preemergence or, the number of days after planting if applicator applied this product postemergence.
14. **Receipts of purchase:** Receipts for the purchase of the dicamba product.
15. **Product Label:** A copy of the dicamba product label(s), and any state special local needs label that supplements this label.
16. **Sensitive Areas, Sensitive Crops, and Residential Area Awareness:** Document/record that the applicator checked an applicable sensitive crop/speciality crop registry; and document that the applicator surveyed neighboring fields for any sensitive areas or sensitive crops prior to application. The applicator must be aware that WIND DIRECTION may vary during the application.

If wind direction shifts such that the wind is blowing toward neighboring sensitive crops or residential areas, STOP the application. At minimum, records must include the date of applicator consulted the sensitive crop/speciality crop registry, and the name of the speciality crop registry that applicator consulted.

17. **Buffer Requirement:** Record of the buffer distance calculation and any areas included within the buffer distance calculations.
18. **Spray System Cleanout:** Document that the applicator complied with the Spray System Cleanout section of the product label. At a minimum, records must include the date the applicator performed the cleanout, and cleanout method that the applicator followed.
19. **Tank Mix Products:** A list of all products (pesticides, adjuvants, and other products) that the applicator tank mixed with this product for each application. Include EPA registration numbers in the case of any pesticides.
20. **Nozzle Selection:** Which spray nozzle the applicator used to apply this product, and the nozzle pressure the applicator set the sprayer to perform.
21. **Air Temperature:** The air temperature at boom height at the time the applicator starts and finishes applications of the dicamba product.
22. **Wind Speed and Direction:** The wind speed at boom height at the time the applicator starts and finishes applications of this product, and the wind direction at the time the applicator starts and finishes applications of the dicamba product.

*Training Requirements:* Prior to applying a dicamba product in a DT crop, ALL CERTIFIED APPLICATORS must attend a dicamba training course provided by Clemson Extension and your County Agent. Dicamba application recordkeeping forms can be downloaded from the following websites: [www.xtendimaxapplicationrequirements.com](http://www.xtendimaxapplicationrequirements.com) and [www.engeniastewardship.com/documents/Application_Record_Keeping_Dicamba_2019.pdf](http://www.engeniastewardship.com/documents/Application_Record_Keeping_Dicamba_2019.pdf).
Honey bees are our most beneficial insect. The estimated value of honey bee pollination in the US is $19 billion. Many commercially grown crops in South Carolina are heavily dependent on honey bees for good pollination. Annual farm cash receipts of crops harvested in South Carolina that are dependent on honey bees for pollination are estimated at $25 million. This does not include homegrown vegetables and fruits and plants for wildlife that are highly dependent on bees for pollination. Some of the fruits and vegetables that are highly dependent on bees for pollination are apples, cantaloupes, cucumbers, squash, strawberries, and watermelon.

Use integrated pest management recommendations whenever possible to minimize harmful effects to our beneficial insects. Many pesticides are extremely toxic to bees. Those pesticides that are toxic or highly toxic to bees will have a bee protection warning statement on the label. The pesticide applicator should always review the product label directions carefully before each use and follow the guidelines to protect our pollinators, which include native bees as well as honey bees. Keep in mind that even herbicides and fungicides can have negative effects on insect pollinators and can have synergistic effects when combined with other pesticides.

It is not only the formulation of the chemical pesticide that is important, applicators must also be aware of the proper dose. Pesticides should be used only when necessary, especially if flowering plants are present or nearby and are attractive to bees. Select the least toxic pesticide to get the job done when possible and use the least hazardous method of application. Granular pesticide formulations are safest. Directed sprays applied with ground equipment are the next safest method for applying pesticides to protect bees. Aerially applied dusts or sprays are the most likely to contact bees and cause problems. Apply pesticides when air is calm to reduce drift into areas where bees may be foraging or nesting. If a pesticide application is necessary, apply in the evening when bees are not present. If managed bee colonies are present, it is best to give the beekeeper plenty of notice (3-4 days if possible) of your intentions. The beekeeper has the option to relocate their beehives if adjacent fields are to be sprayed. If there are many beehives or hives that cannot be moved on short notice, the beekeeper may cover their beehives with wet burlap for no longer than 2 days. It will be necessary for the beekeeper to spray covered hives with water and keep the burlap wet, especially in hot weather.

Beekeepers are advised to cooperate with growers in the area to help protect bees and are encouraged to have a contract with the landowner. Beekeepers should scout the area before bee colony placement to gain a good understanding of local farming practices, especially the use of highly toxic pesticides. Beekeepers are ill advised to place their colonies in high pest density areas, as they may require multiple pesticide applications. An example is cotton-growing areas where various pests are expected. Beekeepers should post their name and contact information in the apiary or on colonies for identification purposes. Information on the relative toxicities and environmental impacts of specific pesticides to honey bees and natural enemies may be found at www.ipm.ucdavis.edu and nysipm.cornell.edu/eiq.

Mosquito abatement programs should take into consideration the protection of our insect pollinators. Many of the pesticides used to kill mosquitoes will also kill honey bees. Beekeepers are
urged to contact county officials who manage mosquito abatement programs to inform them of the location of their apiaries, so their honey bees can be protected.

Clemson University has started a bee stewardship program to facilitate communication between beekeepers and pesticide applicators and prevent accidental poisoning of honey bees. Beekeepers can map their hive locations and licensed pesticide applicators can access this information when they have an application planned. The applicator can then contact the beekeepers in the area or avoid applying pesticides near the hives. Interested individuals from both sides of this issue are encouraged to read more about the program on the Clemson University Beekeeping website. To sign up, please use the appropriate link below.

For pesticide applicators:  
http://www.kellysolutions.com/clemson/pesticideapplicationnotifications/

For beekeepers:  
http://www.kellysolutions.com/clemson/beekeepers/
# MODE OF ACTION FOR HERBICIDES

*Mike Marshall, Extension Weed Specialist*

## MODE OF ACTION (MOA) FOR HERBICIDE FAMILIES

<table>
<thead>
<tr>
<th>Site of Action Group</th>
<th>MOA</th>
<th>Chemical Family (ies)</th>
<th>How it kills the plant</th>
<th>Product Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ACCase Inhibitors</td>
<td>Arloxyphenoxypropionate (FOPS)</td>
<td>Blocks the first step in fatty acid synthesis in grasses, broadleaves are naturally resistant to the fops and dims due to an insensitive ACCase enzyme.</td>
<td>FOPS: Assure II, Fusilade DX</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cyclohexanedione (DIMS)</td>
<td></td>
<td>DIMS: Select MAX, Poast Plus</td>
</tr>
<tr>
<td>2</td>
<td>ALS Inhibitors</td>
<td>Sulfonylurea (SU)</td>
<td>Blocks the production of branched chain amino acids (isoleucine, leucine, and valine) in the plant. Plant death occurs due to insufficient branched chain amino acid levels at the growing points.</td>
<td>SU: Accent, Classic, Beacon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Imidazolinone (IMI)</td>
<td></td>
<td>IMI: Cadre, Raptor, Scepter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pyrimidines (PM)</td>
<td></td>
<td>PM: Staple</td>
</tr>
<tr>
<td>3</td>
<td>Microtubule Protein Inhibitor</td>
<td>Dinitroaniline (DNA)</td>
<td>Interferes with the alignment of the spindle apparatus during mitosis and prevents normal cell division in root tissue.</td>
<td>DNA: Prowl, Treflan, Sonolan</td>
</tr>
<tr>
<td>4</td>
<td>Synthetic Auxins</td>
<td>Phenoxy (PX)</td>
<td>Synthetic auxins mimic the natural plant hormone IAA. These herbicides affect cell wall plasticity and nucleic acid metabolism which leads to inhibited cell division and growth in the meristem regions (growing points).</td>
<td>PX: 2,4-D, 2,4-DB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Benzoic Acid (BA)</td>
<td></td>
<td>BA: Clarity, Banvel, Status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carboxylic Acid (CA)</td>
<td></td>
<td>CA: Stinger, Milestone</td>
</tr>
<tr>
<td>5</td>
<td>Photosystem II Inhibitor</td>
<td>Triazine (TZ)</td>
<td>PS II herbicides inhibit photosynthesis by binding to the Qb-binding site on the D1 protein of the photosystem II complex in the chloroplast. It blocks electron flow from QA to Qb and stops CO₂ fixation and production of ATP and NADPH₂ which is the energy needed for plant growth and development. Plant death occurs due to excess free radicals destroying cell membranes.</td>
<td>TZ: Atrazine, Simazine, Caparol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Triazinone (TN)</td>
<td></td>
<td>TN: Sencor</td>
</tr>
<tr>
<td>6</td>
<td>Nitriles (NT)</td>
<td>Nitriles (NT)</td>
<td></td>
<td>NT: Buctril</td>
</tr>
<tr>
<td></td>
<td>Benzothiadiazinones (BZ)</td>
<td>Benzothiadiazinones (BZ)</td>
<td></td>
<td>BZ: Basagran</td>
</tr>
<tr>
<td>7</td>
<td>Ureas (UR)</td>
<td>Ureas (UR)</td>
<td></td>
<td>UR: Lorox, Direx, Cotoran</td>
</tr>
<tr>
<td>8</td>
<td>Fatty Acid/Lipid Biosynthesis Inhibitor</td>
<td>Thiocarbamate (TB)</td>
<td>Most susceptible plants fail to emerge from the soil. Germination is not inhibited but growth of grass coleoptiles/broadleaf epicotyls ceases below soil surface</td>
<td>TB: Tillam</td>
</tr>
<tr>
<td>9</td>
<td>EPSP Synthase Inhibitor</td>
<td>Glycines (GC)</td>
<td>Glycines inhibit EPSP synthase enzyme which leads to the depletion of the aromatic amino acids tryptophan, tyrosine, and phenylalanine.</td>
<td>GC: Glyphosate</td>
</tr>
</tbody>
</table>
### MODE OF ACTION (MOA) FOR HERBICIDE FAMILIES (cont)

<table>
<thead>
<tr>
<th>Site of Action Group</th>
<th>MOA</th>
<th>Chemical Family (ies)</th>
<th>How it kills the plant</th>
<th>Product Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Glutamine Synthesis Inhibitor</td>
<td>Phosphinic Acids (PA)</td>
<td>Phosphinic acids inhibit the activity of glutamine synthase which converts glutamate and ammonia to glutamine. Accumulation of ammonia to lethal levels destroys plant cells and tissue.</td>
<td>PA: Liberty</td>
</tr>
<tr>
<td>12</td>
<td>Phytoene Desaturase Inhibitor</td>
<td>Pyridazinone (PZ)</td>
<td>Pyridazinone inhibits the phytoene desaturase enzyme in the carotenoid biosynthesis pathway.</td>
<td>PZ: Solicam, Zorial, Brake</td>
</tr>
<tr>
<td>13</td>
<td>DOXP synthase Inhibitor</td>
<td>Isoxazolidinone (IA)</td>
<td>Isoxazolidinone inhibits the 1-deoxy-D-xulose 5-phosphate synthase (DOXP), a key component in the plastid isoprenoid biosynthesis pathway.</td>
<td>IA: Command</td>
</tr>
<tr>
<td>13</td>
<td>DOXP synthase Inhibitor</td>
<td>Triketone (TE)</td>
<td>Pyrazole and triketones inhibit the 4-hydroxyphenyl-pyruvate dioxygenase (4-HPPD) which affects carotenoid biosynthesis. These herbicide families deplete the carotenoid (accessory pigments in photosynthesis) pool that protects chlorophyll in the plant which results in a characteristic bleaching (white) of the plant tissue.</td>
<td>TE: Callisto, Impact, Laudis</td>
</tr>
<tr>
<td>14</td>
<td>PPO inhibitors</td>
<td>Diphenylether (DE)</td>
<td>These herbicides inhibit the photoporphyrinogen oxidase (PPO), an enzyme that is responsible for chlorophyll and heme biosynthesis. PPO inhibition leads to accumulation of PPIX (protoporphyrin IX) which creates free radical oxygen in the cell and destroys cell membranes.</td>
<td>DE: Flexstar, Reflex, Blazer, Cobra</td>
</tr>
<tr>
<td>15</td>
<td>VLFA inhibitors</td>
<td>Chloroacetamide (CA)</td>
<td>Acetamides are herbicides that inhibit very long chain fatty acid synthesis (VLFA) in shoot tissue during germination of sensitive plants.</td>
<td>CA: Dual Magnum, Intro, Warrant, Outlook, Parrlay, Zidua</td>
</tr>
<tr>
<td>22</td>
<td>Photosystem I Inhibitor</td>
<td>Bipyridylidiums (BP)</td>
<td>Bipyridylidiums are herbicides that capture electrons from photosystem I complex in the chloroplast and are reduced to form herbicide free radicals. These free radicals destroy cell membranes.</td>
<td>BP: Gramoxone, Reward</td>
</tr>
</tbody>
</table>
# CROP REPLANT GUIDELINES FOLLOWING HERBICIDE APPLICATION

Mike Marshall, Extension Weed Specialist

<table>
<thead>
<tr>
<th>CROP</th>
<th>Corn</th>
<th>Cotton</th>
<th>Grain Sorghum</th>
<th>Peanuts</th>
<th>Soybeans</th>
<th>Sunflower</th>
<th>Tobacco</th>
<th>Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>M = months, D = days, Spring = The spring following application, --- = no information on label</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aatrex</td>
<td>0 D</td>
<td>Spring</td>
<td>0 D</td>
<td>Spring</td>
<td>Spring</td>
<td>Spring</td>
<td>Spring</td>
<td>Spring</td>
</tr>
<tr>
<td>Acuron</td>
<td>0 D</td>
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1Field corn may be planted 4 months after Authority MTZ was applied at 14 oz/A or less; 2Grain sorghum may be planted 12 months after Authority MTZ was applied at 20 oz/A or less; 3Rotation is 7 days when rates of 10 oz/A of Axiom or less have been applied; otherwise, wait 4 months to plant wheat; 4Clearfield corn, sunflower, and wheat; 5Non-Clearfield corn, sunflower, and wheat.
### Crop Replant and Rotation Restrictions Guide for Herbicides (cont)

|M = months, D = days, Spring = The spring following application, --- = no information on label

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1DIREX USE PATTERN 1 = Banded DIREX Preemergence or Postemergence application only; 2DIREX USE PATTERN 2 = Banded DIREX Preemergence and Postemergence or Broadcast DIREX Preemergence (and preplant) or Broadcast DIREX preemergence plus Banded DIREX postemergence applications; 3Xtend cotton/soybean varieties; 4non-Xtend cotton/soybean varieties; 5Reduced tillage production; 6Conventional tillage production; 7A field bioassay must be conducted for crops not listed on the label. To conduct a field bioassay, plant strips of the crop you want to grow the season following herbicide application and monitor for crop safety; 8STS tolerant soybeans only.
### Crop Replant and Rotation Restrictions Guide for Herbicides (cont)

*Goal/GoalTender* | *Corn* | *Cotton* | *Grain Sorghum* | *Peanuts* | *Soybeans* | *Sunflower* | *Tobacco* | *Wheat*
--- | --- | --- | --- | --- | --- | --- | --- | ---
Goal/GoalTender | 10 M | 7 D | 10 M | 60 D | 7 D | 60 D | 60 D | 10 M
Gramoxone SL | 0 D | 0 D | 0 D | 0 D | 0 D | 0 D | 0 D | 0 D
Guardsman Max | 0 D | Spring | 0 D | Spring | Spring | Spring | 24 M | Spring
Halex GT | 0 D | 10 M | 0 D | 10 M | 10 M | 10 M | 10 M | 120 D
Harmony Extra | 21 D | 21 D | 21 D | 45 D | 14 D | 45 D | 45 D | 0 D
Harmony GT/XP | 0 D | 7 D | 0 D | 45 D | 0 D | 45 D | 45 D | 0 D
Hornet WDG | 0 D | 18 M | 12 M | 18 M | 10.5 M | 18 M | 18 M | 4 M
Huskie | 9 M | Spring | 4 M | Spring | 4 M | 9 M | Spring | 1 M
Impact | 0 D | 9 M | 9 M | 9 M | 9 M | 9 M | 18 M | 3 M
ImpactZ | 0 D | 9 M | 9 M | 9 M | 9 M | 9 M | 18 M | 9 M
Instigate | 0 D | 10 M | 10 M | 18 M | 10 M | 10 M | 18 M | 4 M
Interline | 0 D | 0 D | 180 D | 180 D | 0 D | 180 D | 180 D | 70 D
Intro | -- | -- | -- | -- | -- | -- | -- | --
Keystone NXT | 0 D | Spring | Spring | Spring | Spring | Spring | Spring | 4 M
Kerb 50-W | 1.0 lb/A | -- | 90 D | -- | -- | -- | -- | 365 D
| 2.0 lb/A | -- | 90 D | -- | -- | -- | -- | 365 D
| 3.0 lb/A | -- | 120 D | -- | -- | -- | -- | 365 D
Laudis | 0 D | 10 M | 10 M | 18 M | 8 M | 18 M | 18 M | 4 M
Layby Pro | -- | 0-0.6 lb ai | 4 M | 4 M | 4 M | 4 M | 4 M | 3 M
| 0.6-1.0 lb ai | 4 M | 4 M | 4 M | 8 M | 8 M | 12 M | 8 M | 4 M
| 1.01-1.6 lb ai | 4 M | 4 M | 4 M | 12 M | 8 M | 12 M | 8 M | 8 M
| 1.61-2.2 lb ai | 8 M | 8 M | 8 M | 12 M | 12 M | 12 M | 12 M | 12 M
Leadoff | 0 D | 1 M | 10 M | 10 M | 1 M | 10 M | 10 M | 3 M
Liberty 280 SL | 0 D | 0 D | 180 D | 180 D | 0 D | 180 D | 180 D | 70 D
Linex/Lorox | 0 D | 0 D | 0 D | 4 M | 0 D | 4 M | 4 M | 4 M
Lumax/Lexar | 0 D | Spring | Spring | Spring | Spring | Spring | 18 M | 18 M | 4.5 M
Marksman | 0 D | Spring | 0 D | Spring | Spring | Spring | 24 M | 10 M
MCPA | None | None | None | None | None | None | None | None
Micro-Tech | None | None | None | None | None | None | None | None
MSMA | None | None | None | None | None | None | None | None
NIT-IT | 0 D | 10 M | 18 M | 18 M | 15 D | 10 M | 18 M | 8 M
Nimble | 21 D | 21 D | 21 D | 45 D | 14 D | 45 D | 45 D | 0 D
Optill | 85 M | 18 M | 18 M | 4 M | 0.1 M | 18 M | 9.5 M | 4 M
Option | 7 D | 60 D | 60 D | 60 D | 14 D | 60 D | 60 D | 60 D
Osprey | 12 M | 90 D | 10 M | 90 D | 90 D | 30 D | 10 M | 7 D
Outlook | 0 D | Spring | Spring | 0 D | 0 D | Spring | Spring | 4 M
Parallel PCS | 12 M | 12 M | 12 M | 12 M | 12 M | 12 M | 12 M | 4.5 M
Parazone | 0 D | 0 D | 0 D | 0 D | 0 D | 0 D | 0 D | 0 D
Peak | 1 M | 10 M | 1 M | 10 M | 10 M | 22 M | 18 M | 0 D
Poast/Poast Plus | 30 D | 0 D | 30 D | 0 D | 0 D | 30 D | 0 D | 30 D
PowerFlex/HL | 9 M | 9 M | 9 M | 9 M | 5 M | 9 M | 12 M | 30 D
Prefix | 10 M | 1 M | 18 M | 10 M | 0 M | 18 M | 18 M | 4.5 M
Princep | 0 D | Spring | Spring | Spring | Spring | Spring | 24 M | Spring
Prowl/Prowl H2O | Spring | 0 D | 10 M | 0 D | 0 D | 0 D | 0 D | 4 M

1. A field bioassay must be conducted for crops not listed on the label. To conduct a field bioassay, plant strips of the crop you want to grow the season following herbicide application and monitor for crop safety; 2. Crop rotation intervals are based on the cumulative amount of DIURON in LAYBY PRO applied to a site in the preceding 12 months; 3. Use the longer interval within the ranges listed for crops grown on coarse textured soils with organic matter less than 2.0%.
## Crop Replant and Rotation Restrictions Guide for Herbicides (cont)

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*Application rates above 0.4 oz/A; follow the 18-month rotation interval for grain sorghum, non-STS tolerant soybeans, and field corn; Application rates 0.2 to 0.4 oz/A; follow the 4-month rotation interval for grain sorghum; Application rates 0.2 to 0.5 oz/A; follow the 6-month rotation interval for planting STS tolerant soybeans; Application rates 0.2 to 0.4 oz/A; no waiting interval for wheat; Application rates 0.5 oz/A; following the 4-month rotation interval for wheat; Use the longer interval within the ranges listed for replanting soybeans (i.e., 2 months for coarse textured soils with organic matter less than 2.0% and a 1 month for coarse textured soils with organic matter greater than or equal to 2.0%); Cotton may be planted after 12 months where SONIC was applied at rates of 5 oz/A or less and meet the following conditions: medium/fine soils; pH<7.2; and rainfall or irrigation exceed 15 inches after application.
## Crop Replant and Rotation Restrictions Guide for Herbicides (cont)

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<th>Cotton</th>
<th>Grain</th>
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<td>0 D</td>
<td>Spring</td>
<td>Spring</td>
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<tr>
<td>WideMatch</td>
<td>0 D</td>
<td>18 M</td>
<td>12 M</td>
<td>10.5 M</td>
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<td>Xtendimax/Fexapan</td>
<td>Up to 33 fl oz/A</td>
<td>15-45 D</td>
<td>0 D D/15-45 D</td>
<td>30 D</td>
<td>0 D</td>
<td>0 D</td>
<td>15-28 D</td>
<td>120 D</td>
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<td>34-88 fl oz/A</td>
<td>120 D</td>
<td>0 D D/120 D</td>
<td>120 D</td>
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<td>0 D D/120 D</td>
<td>120 D</td>
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<tr>
<td>Yukon</td>
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<td>2 M</td>
<td>6 M</td>
<td>9 M</td>
<td>18 M</td>
<td>----</td>
<td>2 M</td>
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<td>18 M</td>
<td>12 M</td>
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<td>10.5 M</td>
<td>0 D</td>
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<td>4 M</td>
<td>18 M</td>
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<tr>
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<td>Zidua PRO</td>
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<td>30 D</td>
<td>18 M</td>
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<td>4 M</td>
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</tr>
</tbody>
</table>

\*For **corn**: Plant a minimum of 14 days (minimum or strip-till) or 30 days after VALOR SX (conventional tillage system); \*For **cotton**: After Valor SX (2.0 oz/A or less) application, conduct strip till operation a minimum of 7 days before planting (regardless of crop residue levels). After conducting strip-till operation, apply Valor SX herbicide a minimum of 28 days before planting (<30% crop residue levels) or 21 days before planting (>30% crop residue levels); \*For coarse textured soils with less than 2% organic matter; \*All other soil types; \*Xtend cotton or soybean varieties only; \*Non-Xtend soybean and cotton varieties.