Proper mixing order for citrus herbicides

By Brent Sellers and Steve Futch

It is common for herbicides to be tank-mixed to control a wider spectrum of weeds with a single pass through the grove. For herbicides to be effective, it is essen-tial that they are properly mixed to ensure uniform coverage and satisfactory weed control. Although tank-mixing saves time and money, spray incompatibility can lead to clogging of spray equipment, product separation, reduced solubility, adverse spray pattern and unsatisfactory weed control.

PHYSICAL AND CHEMICAL INCOMPATIBILITY

Physical incompatibility is the failure of products to mix properly in the spray tank. When this type of incompatibility occurs, the spray solution can become thick or paste-like, separate into layers, or form a cottage cheese-like mixture. This invariably results in mechanical problems by clogging screens, nozzles, lines and valves in the spraying system. The final result is that this spray mix must be brought back into solution to allow spraying to occur or be removed from the tank for disposal — both of which can be difficult and time-consuming.

Chemical incompatibility occurs when mixing one herbicide with another alters the activity of one or both of the chemicals. This type of incompatibility is not observed during the mixing and application process (unless you feel the solution giving off heat or getting extremely cold); rather, the product(s) may not perform as expected. Incompatibility is often known by the pesticide companies and specific instructions for allowable tank-mix partners and mixing order are often provided on the label. However, there are times when incompatibility is found through the experiences of researchers, Extension personnel or growers.

Herbicide labels usually provide instructions for avoiding either physical or chemical incompatibility. When mixing chemicals that do not have specific instructions listed on the herbicide label, you should determine if the products are compatible before mixing them into the spray tank. Do this only when such mixtures are not prohibited on the label; otherwise, you will be making an illegal herbicide application.

JAR TEST

The easiest way to determine if products are compatible is to conduct a compatibility, or "jar" test. A jar test is an easy way to check for either physical or chemical incompatibility of the mixed products. To conduct a jar test, use a small container with a lid and mix proportional amounts of the carrier and products you intend to mix in the spray tank. This process is essentially the same process you would use when mixing a herbicide in your spray tank. First, fill the container one-half to two-thirds full with your carrier (usually fresh water) followed by adding the products in question as stated in the mixing procedures on the label. Shake the container thoroughly after each product is added to simulate tank agitation. Allow the mixture to stand for five to 15 minutes.

If flakes or paste begin to form, or the solution separates into layers, the products are not physically compatible and should not be mixed in that order. It is common for flowable or powder herbicides to settle at the bottom of the container if the mixtures stand for more than 15 minutes. If a product is difficult to resuspend by agitation, you should be aware the products will not likely resuspend in the tank. This may not represent a compatibility problem. These powder or flowable formulations are heavy and will commonly settle out in calm water, but agitation will often bring them back into solution. If the solution gives off excessive heat, or turns excessively cold, a chemical reaction has occurred and the products are not chemically compatible.

Keep in mind, too, that if the products mix well (they're physically compatible), it does not automatically mean that the mixture is chemically compatible. If such a mixture has not been used in the past, spray a small area and note any reduction in weed control or tree damage.

Even if a jar test proves that products can be successfully mixed, proper mixing order is essential so that the herbicides go into solution and work as expected in the field. When mixing into the spray tank, first add the carrier so that the tank is one-half to two-thirds full and begin agitation. Agitation should continue throughout the entire mixing process, because without agitation some products may not disperse correctly (Figure 1). If a label calls for a compatibility agent or water conditioner, add it before including any other product and make sure it is adequately mixed.

Adding products one at a time, begin with those hardest to mix such as wettable powders (WP), dry flowables (DF), or water-dispersible granules (WDG or WG). If an adjuvant such as a defoamer or buffering agent is required by the label, it should be added second. Then add liquid suspensions such as flowables (F), liquids (L) and suspension concentrates (SC). Fourth, emulsifiable concentrates are added. Fifth and finally, the surfactants should be added to the spray solution.

Throughout the entire mixing process, the agitation should be going to ensure all products are being properly mixed. Once all products have been added to the spray tank, then the remaining volume of diluent is added to the tank and all products are thoroughly mixed prior to application. In general, the WALES plan should be followed to ensure proper mixing of your spray solution. The WALES plan is as follows:

1. **W**ettable powders, dry flowables, water dispersible granules
2. **A**gitate and add adjuvants such as defoamers or buffers
3. **L**iquid and soluble products
4. **E**mulsifiable concentrates (EC)
5. **S**urfactants

Figure 1. Some herbicides — especially flowables, aqueous suspensions, water dispersible granules and wettable powders — will not disperse correctly without agitation. This photograph illustrates the effects of adding Alion without agitation.

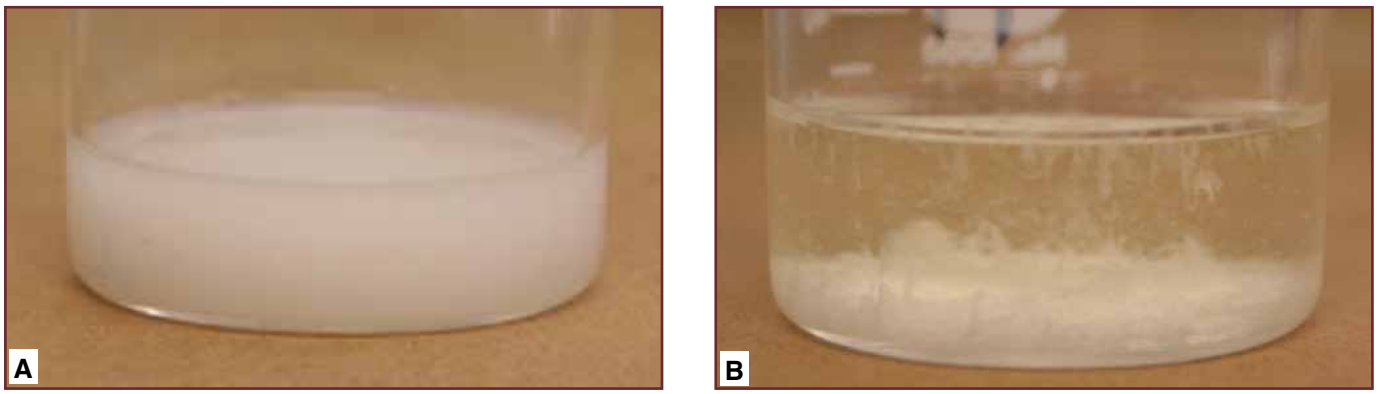

Figure 2. The proper mixing order with the WALES sequencinig method was followed for A; it was not followed for B.

To demonstrate, Figure 2 shows the importance of the WALES method. In Figure 2A, the WALES method was followed: water was added to the jar, followed by ammonium sulfate, Alion and finally Roundup Powermax. Note that with agitation after adding each product, the result is a cloudy mixture, representing complete mixing of all products in the solution. In Figure 2B, the WALES method was not followed: water was added to the jar followed by ammonium sulfate, then Roundup Powermax, and Alion was added last. In this case, the herbicide mixture would not even mix with vigorous agitation after adding Alion.

From the table at right, the more commonly used herbicides are identified as to the formulation type to aid in the mixing order as mentioned above in the WALES mixing order.

In a few cases, some liquid products may contain a surfactant or adjuvant and if so should be added as the last of the flowables or liquids. Examples of these types of liquid products that contain surfactants include many of the glyphosate products.

Most tank-mixing incompatibilities can be overcome simply by using the WALES method and following the mixing instructions on the herbicide label. When tank-mixes are allowed on the label, following the proper tank-mixing order will help ensure satisfactory weed control and will help avoid mechanical problems in the field.

Finally, the WALES mixing order is applicable to mixing of all pesticides. Remember to follow all label instructions and the label is the law.

Brent Sellers is a University of Florida associate professor at the Range Cattle Research and Education Center at Ona. Steve Futch is a multi-county Extension agent at the Citrus Research and Education Center in Lake Alfred.

Table 1. Listing of commonly used herbicides as to their formulation type.

Dry Materials/Wettable Powders (WP or W), Dry Flowables (DF), Water Dispersible Granules (WDG)	
Bromacil	Hyvar X
Simazine	Caliber 90 WDG, Simazine 90 DF
Saflufenacil	Treevix
Water Dispersible Granules (WDG) or Dry Flowables (DF)	
Bromacil + Diuron	Krovar I DF
Diuron	Direx 80 DF, Karmex DF
Norflurazon	Solicam 80 DF
Flowables (F)/Liquids (L)	
Diuron	Diuron 4L
Indaziflam	Alion
Paraquat	Gramoxone Inteon, Gramoxone SL
Pendimethalin	Prowl H2O
Glyphosate	Roundup, Roundup WeatherMax, Roundup PowerMax, Touchdown HiTech
Glyphosate + 2, 4-D	Landmaster II
Simazine	Princep 4L, Simazine 4L
Emulsifiable Concentrates (EC or E)	
Carfentrazone-ethyl	Aim EC
Fluazfop	Fusilade DX 2E
Sethoxydim	Poast Plus 1.0 EC

FROSTPROOF growers supply

Now Featuring Economy Tree Wraps

- Made from a thinner, lighter, more flexible version of our original corrugated Sprout Saver II
- Contains a high concentration of UV stabilizers that block and absorb sun's harmful rays
- Secure with twist ties or staples
- Available in standard sizes 8" x 14" and 8" x 18." Can be custom made to any size needed.

14-inch Economy Wraps		18-inch Economy Wraps	
1 - 2,499	$0.27	1 - 2,499	$0.34
2,500 - 4,999	$0.26	2,500 - 4,999	$0.33
5,000 - 9,999	$0.25	5,000 - 9,999	$0.32
10,000 - 14,999	$0.24	10,000 - 14,999	$0.31
15,000+	$0.23	15,000+	$0.30

• Tree-T-Pees • Ground Cover • Deer Nets • Budding Tape • Hand Tools • Tensiometers • Flagging Tape • Safety Supplies • PH Testers • Shade Cloth • Bug Lenses • Field Boxes

Toll free: 800-635-3621 **www.frostproof.com** **support@frostproof.com**