Herbicide Mixing Order

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Introduction

Herbicide mixtures are recommended to increase the management of multiple weed species and reduce selection pressure on herbicide-resistant weeds all while reducing the number of applications during a growing season. While herbicide mixtures are effective, the order in which herbicides are added to the spray tank can influence the activity.

Some herbicides may not be compatible for mixing, which can result in a gel, sludge, and/or precipitates that can clog nozzles/screens as well as antagonize the performance of the herbicides (Figure 1). Herbicide labels state language if herbicide(s) have some incompatibility when mixed. However, if no language is present, a jar test can be conducted to determine if herbicides are compatible. The herbicides are mixed in a jar to mimic a spray tank, which is easier to clean compared with a 300-gallon spray tank. After agitating (i.e., shaking) the mixture in the jar, let the jar rest for 30-60 minutes to determine the outcome of the solution. Refer to specific herbicide labels for mixing restrictions.

The first step in mixing herbicides is to fill the spray tank with 50 to 75% of clean water or another carrier such as a nitrogen fertilizer (e.g., urea ammonium nitrate [UAN]). If ammonium sulfate (AMS) is being added to the tank as a water conditioner, then AMS should be added first. Constant agitation of the water carrier as herbicides are added to the tank is important because some formulations are suspended and do not go into solution. Simply mixing with agitation then letting the solution remain stagnant can cause some herbicides to settle out (Figure 2). As a rule of thumb, sufficient agitation is often considered 5-6% of the tank's volume being returned to the tank per minute. If agitation pump cannot work at this output mix in smaller batches or replaced with a more powerful agitation pump.

W.A.M.L.E.G.S. (wettable products, agitate, microencapsulated liquids, emulsifiable concentrates, glyphosate, and surfactants) is the modern acronym for tank-mixing order, often replacing the older acronyms of W.A.L.E.S. (wettable powders, agitate, liquid flowables and suspensions, emulsifiable concentrates, surfactants, solutions and adjuvants) and A.P.P.L.E.S. (ammonium sulfate, powder solubles, dry powders, liquid flowables, emulsifiable concentrates, solutions).

W. Wettable products (i.e. dry herbicide products)

Water-dispersible granule (WG or WDG) and dry flowable (DF) formulations don't dissolve and likely require premixing with a small amount of water (or other carrier) into a slurry to help suspend the herbicide in solution. Consult the label to determine if this necessary, and if so, follow the proper mixing ratio. Constant agitation, even while spraying, is critical to keep these products in solution.

- Example: Atrazine 90DF, Status, Valor SX, and Zidua WG

Water-soluble granule (SG) formulations dissolve into solution and typically don't require premixing with water. Once mixed, constant agitation isn't as critical. Consult the label to be certain.

- Examples: Harmony SG, Express SG

A. Agitate

Agitate the spray mixture until all of the dry ingredients added in the first step have either dissolved or are suspended in the spray mixture. Once this has happened, add anti-foaming agents and buffering agents AMS. If AMS is being added to the tank as a water conditioner, then AMS can be added first. Continue agitating until these additives have dissolved as well.

M. Microencapsulated liquids

These liquid formulations contain a microencapsulated version of the active ingredient that doesn't dissolve and must be continuously agitated to remain in solution. When applied to the soil, the microencapsulated herbicide is released slowly, providing improved crop safety and decreased degradation.

- Example: Warrant (microencapsulated acetochlor)

L. Liquids

Liquid flowables (L or F) and suspension concentrates (SC) are similar. These products readily go into solution but do not dissolve, which requires constant agitation to stay in suspension. Some require premixing with a small amount of water to make a slurry. Check the label to determine whether your product requires premixing.

- Examples: Atrazine 4L, Laudis, Tricor 4F, Spartan 4F, Zidua SC, Valor EZ

Soluble liquids (S or SL) readily dissolve in water, so constant agitation is less critical after the initial mixing.

E. Emulsifiable concentrates

These products are oil-based, and as the saying goes, "you can't mix oil and water." That is, unless the product contains an emulsifier. The emulsifier keeps the oil-based herbicides suspended in the water and can be seen by the white, cloudy appearance when mixing. An example of a nonemulsified mixture would be shaking an oil and vinegar salad dressing where over time, the two liquids become separated. An example of an emulsified solution would be mayonnaise, where the water and oil stay in suspension due to the egg yolk acting as the emulsifier.

- Examples: 2,4-D ester (solventless ester formulation), Dual, Maestro 2EC, and Harness (non-encapsulated acetochlor)

G. Glyphosate

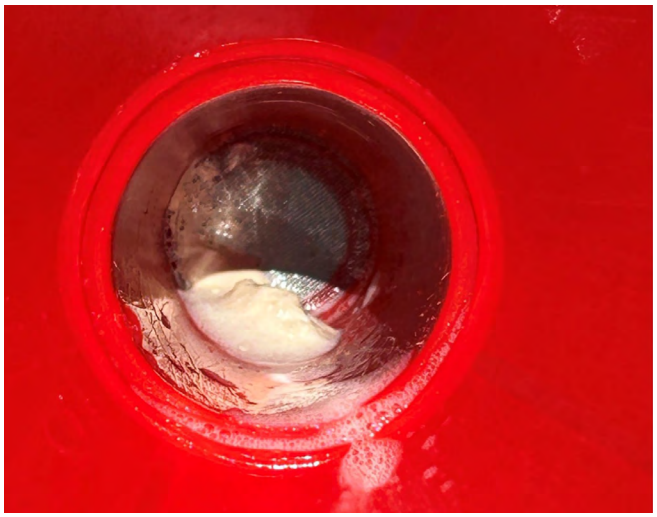
Even though glyphosate products are soluble liquids (SL), it is usually recommended to add as the final herbicide.

S. Surfactants

Non-ionic surfactants, crop oil concentrates, methylated seed oils, and other surfactants should be added last.

If you are unsure of the formulation of the herbicides being mixed, the tradename usually denotes the formulation (Figure 3). If the tradename does not denote the formulation or you want more specific details, the label will always state the formulation (Figure 4).

Disclaimer: Tradenames used in this publication are used solely for examples, not for product endorsement. Similarly, no mention of a tradename does not imply non-endorsement.



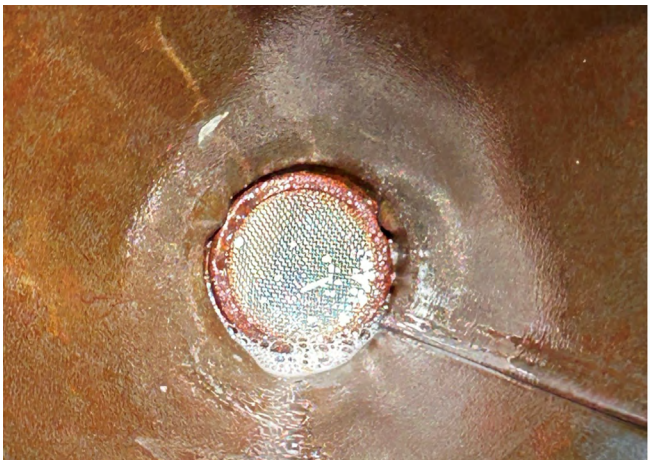


Figure 1. Gel/sledge (A) and precipitation (B) from herbicides mixed incorrectly can clog nozzles that affect spray pattern and output.

Figure 2. Comparison of two herbicide mixtures. The bottle on the left has been constantly agitated while the bottle on the right was stagnant for 1 hour. The herbicide mixture on the left would be more effective as the active ingredient is homogeneously mixed with the water carrier while the mixture on the left would not be effective as there is little active ingredient suspended in the water carrier.

Figure 3. Command 3ME; the “3” is regarding the active ingredient formulation of 3 lbs per gallon and the “ME” denotes the herbicide is formulated as a microencapsulation (Courtesy: FMC Corporation, Philadelphia, PA).

Figure 4. Atrazine 90DF; the “90” is regarding 90% active ingredient and the “DF” denotes the herbicide is formulated as a dry flowable (Courtesy: Drexel Chemical Company, Memphis, TN).

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