Formulated Products Used in Everyday Life
What is a formulation?

A formulation is a way to deliver an active ingredient to a specific target site in a usable form.
Active Ingredients

In agriculture, an active ingredient (AI) is a molecule that has good biological activity against pests, weeds, or diseases that impact the end user.

- Herbicides
- Insecticides
- Fungicides

![Durango DMA](image1)
![Delegate WG](image2)
![Glyphosate DMA](image3)
![Spinetoram](image4)
![PropiMax EC](image5)
![Quelex](image6)
![Propiconazole](image7)
![Arylex™ active](image8)
![Florasulam](image9)
Formulation Types

Liquid Forms
- Soluble Liquids (SL)
- Suspension Concentrates (SC)
- Emulsifiable Concentrates (EC)

Solid Forms
- Wettable Powders (WP)
- Water dispersible Granules (WDG or WG)
Water Dispersible Granule (WG)

- Active ingredient is blended with inerts then mixture is granulated to form granules (WG).
- Various granulation processes may be used.
- When added to water, the granules break apart and form a suspension for application.
How do WG’s work?

Water Dispersible Granule (magnified)

Water + oil (adjuvant) or CP product

agitation

Pores

Break down into primary particles, allowing for easy pass through screens and nozzles.

What will occur to WG?

Pores becomes clogged and unable to let water in to break apart the granule leading to undispersed granules.
Tank Mixing Basics

Definition:

- **Tank mix**: process of mixing several crop protection products into one mixture to be used for application

**Why are tank mixtures used?**
- Convenience
- Control of broader spectrum of pests (insects, weeds, or fungus)
- Enhancement of active ingredient
  - Adjuvant
Tank Mixing: Recommendations

Parameters to consider when combining more than one crop protection product into water for purposes of application:

- Amount of water initially in application tank (i.e. initial water volume)
- Order of addition of crop protection products
- Rate of addition of crop protection products
- Water quality (pH, water hardness, etc.)
- Temperature of crop protection products
- Temperature of water
- Total water volume (GPA=gallons/acre, or L/ha=liters/hectare)
Tank Mixing Basics: Order of Addition Recommendation

Below is the recommended order of addition of crop protection products:

1. **Water**
2. **Water soluble packets** → Example: FirstRate® herbicide
3. **Dry formulation types** (WG, WP, SG) → Example: Sonic® herbicide, Surveil® herbicide, Quelex™ herbicide, PowerFlex® HL herbicide
4. **Water Conditioners** → Example: AMS or AMS solutions
5. **Heterogeneous Liquid formulation types** (SC, CS, OD, SE) → Example: Instinct® II nitrogen stabilizer, Goldsky® herbicide, Opensky® herbicide
6. **Homogeneous Liquid formulation types** (EC, SL) → Example: Durango® DMA herbicide, Lorsban® 4E insecticide, and any adjuvants
7. **Micronutrients**
8. **Remaining Water**
# Tank Mixture Example #1

<table>
<thead>
<tr>
<th><strong>Product Name</strong></th>
<th><strong>Use Rate</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Initial Water (50%)</td>
<td>12 gal/acre</td>
</tr>
<tr>
<td>2. Water Dispersible (WG) #1</td>
<td>6 oz./acre</td>
</tr>
<tr>
<td>3. Water Dispersible (WG) #2</td>
<td>4 oz./acre</td>
</tr>
<tr>
<td>4. AMS solution</td>
<td>15.4 oz./acre</td>
</tr>
<tr>
<td>5. Soluble Liquid (SL) #1</td>
<td>1.33 pt./acre</td>
</tr>
<tr>
<td>6. Soluble Liquid (SL) #2</td>
<td>48 oz./acre</td>
</tr>
<tr>
<td>7. Adjuvant</td>
<td>4 oz./acre</td>
</tr>
<tr>
<td>8. Remaining water</td>
<td></td>
</tr>
</tbody>
</table>

**Always follow product label/use guides/other materials for all registered uses, use rates, and product recommendations.**
Tank Mixture Example #1

1. 50% of total water volume (12 gal/acre)
2. Addition of WG #1 (6 oz./acre)
3. Addition of WG#2 (4 oz./acre)
4. Addition of AMS solution (15.4 oz/acre)
5. Addition of SL#1 (1.33 pt/acre)
6. Addition of SL#2 (48 oz./acre)
7. Addition of adjuvant (4 oz./acre)

Tank mix of WG#1 + WG #2 after dispersion of granules

8. Final Tank Mix Solution after addition of remaining water
Tank Mixture Example #1

1. 50% of total water volume (12 gal/acre)

2. Addition of WG #1 (6 oz./acre)

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8. Final Tank Mix Solution after addition of remaining water
## Tank Mixture Example #2: Order of Addition

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<tr>
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<tbody>
<tr>
<td>1. Initial Water (50%)</td>
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<tr>
<td>2. Micronutrient Solution</td>
<td>5 gal./acre</td>
</tr>
<tr>
<td>3. Suspension Concentrate (SC)</td>
<td>1.0 lb./acre</td>
</tr>
<tr>
<td>4. Suspo-emulsion (SE)</td>
<td>3 qts./acre</td>
</tr>
<tr>
<td>5. Soluble Liquid (SL)</td>
<td>8 fl oz./acre</td>
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<td>6. Remaining water</td>
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Tank Mix Example #2: Order of Addition

1. 50% of total water volume
2. Micronutrient Solution (5 gal./acre)
3. SC (1lb./acre)
4. SE (3 qts/acre)
5. SL (8 oz./acre)
6. Final Tank Mix Solution after addition of remaining water
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Tank Mix Example #2: Order to Addition

1. 50% of total water volume
2. SC (1 lb./acre)
3. Compatibility Agent (0.75% v/v)
4. SE (3 qts/acre) + SL (8 oz./acre)
5. Micronutrient Solution (5 gal./acre) + remaining water

Result from No. 50 screen.
Tank Mixing Basics: Summary

• Rate of addition of formulations to tank is a key parameter for tank mix compatibility.
  ▪ Adding crop protection products too quickly or even simultaneously may cause incompatibility.

• Temperature of liquid products affects their ability to be pumped into application equipment.

• Temperature of water used for the dilution of crop protection products in application equipment affects the dispersion of formulations.
  ▪ Dry formulations may take longer to disperse (break apart) if cold water is used for dilution.
  ▪ Heterogeneous liquid formulations should be agitated well prior to addition to cold water.

• Total water volume decreases, chances of incompatibility increases!

• Perform a jar test for all tank mixtures, especially when in doubt!
Questions