

Improving Pesticide Applications with Adjuvants

Robert Bourne, *Bryan County
Extension*

Jim Shrefler, *Southeast District OCES,
Durant*

What are Adjuvants?

■ Definitions

- A material added to a tank mix to aid or modify the action of an agrichemical, or the physical properties of the mixture. (J. Hazen, 2000)
- Any substance in an herbicide formulation or added to the spray tank to modify herbicidal activity or application characteristics. (Weed Science Society of America, 2019)
- Knowledge about adjuvants has improved, so definitions have become more specific

Adjuvants in general

- **Most adjuvants have no pesticidal effect if not used with a pesticide.**
 - **Some can cause plant injury such as leaf burn.**
- **When adjuvants are recommended, it is because they can improve pesticide activity or application characteristics.**
 - **We know this through research!**
- **Some “adjuvants” don’t affect pesticide activity directly**
 - **Example: colorants**

Additional Considerations

- Most pesticide formulations contain at least a small percentage of additives.
 - These are needed to make active ingredient sprayable
- Some special applications require additional adjuvants when mixing.
 - Example: Thorough coverage needed
- Some product labels may caution against adding adjuvants.
 - Can be for various reasons

Common Adjuvants

- Wetting agents
- Emulsifiers
- Invert emulsifiers
- Spreaders
- Stickers
- Penetrants
- Foaming agents
- Thickeners
- Safeners
- Compatibility agents
- Buffers
- Anti-foaming agents



GREVILLIA AG

Grevilla Ag Pty Ltd A.B.N. 36 083 323 817
 PO Box 2510, Brendale QLD 4500
 23 Durston Street, Brendale QLD Australia
 Ph: 07 3205 1788 Fax: 07 3205 4327
 E-mail: admin@grevilliaag.com.au



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Adjuvants can be a little confusing

- **Dozens of manufactures**
 - Many different product names
- **Various types and purposes**
 - What should I use?
 - When is it needed?
- **Some claim very lofty results**
 - Allows reduced rates, reduces regrowth, etc.
 - This was more so a few years back!



Major Categories of Adjuvants

- **Compatibility Agents**
- **Acidifiers & Buffers**
- **Anti-foaming Agents**
- **Spray colorants**
- **Drift Control Agents**
- **Water Conditioners**
- **Surfactants**

Compatibility Agents

- Help to suspend pesticides when combined with other pesticides or fertilizers
- Used mainly when the carrier is a liquid fertilizer



Acidifiers & Buffers

- **Acidifiers are used when water pH is high**
 - Lower pH but do not buffer (stabilize pH)
- **Buffers change the spray mixture pH**
 - Resist change if other ingredients added
- **Proper pH affects pesticide stability in spray mix**

Anti-foaming Agents

- Eliminate excess foam that results when filling and agitating the spray tank
- Used in small amounts
- Add when foaming is observed



Spray colorants / Dyes

- Enables the applicator to see where spray was already applied
- Helps operator to easily detect equipment malfunctions
 - Example: clogged nozzles



Drift Control Agents

- Small spray droplets drift more easily
- Anti-drift agents increase droplet size
- Thickeners are another type
- Drift control agents do not replace good techniques!

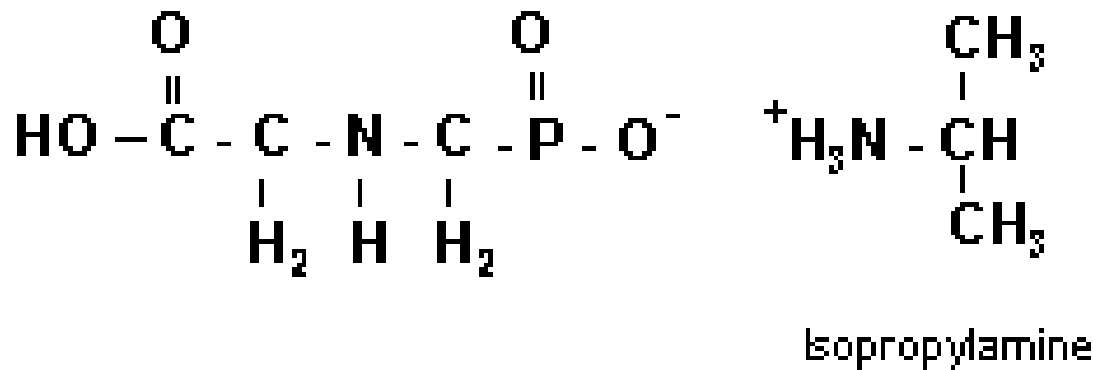


Water Conditioners

- **Modify chemical properties of spray water**
 - **Minerals such as Ca, Mg, Na can reduce herbicide activity**
- **Conditioners make water chemistry more favorable for pesticides**
- **“Neutralize” detrimental effects of minerals on pesticide sprays**

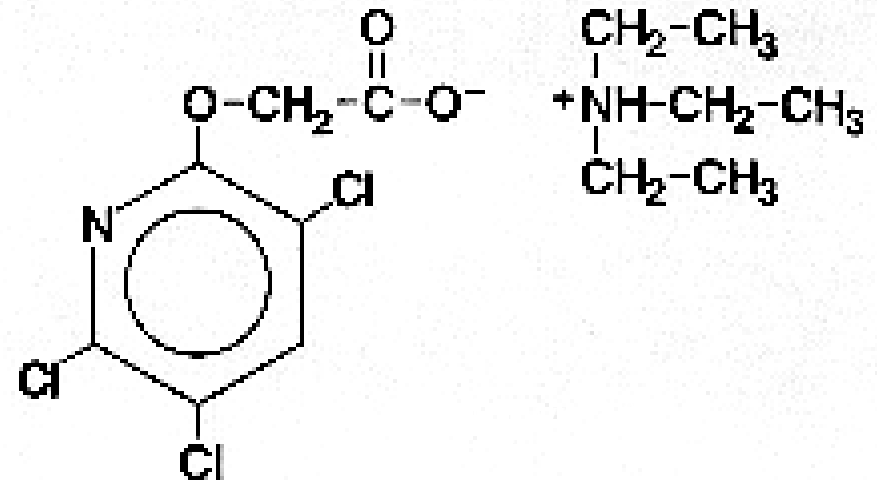


Most herbicides are salts
(have positive and negative parts)

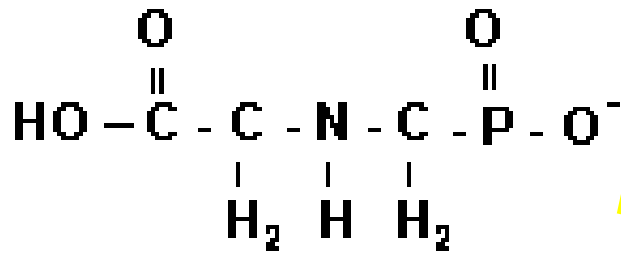


Glyphosate

Triclopyr



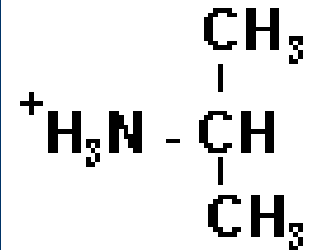
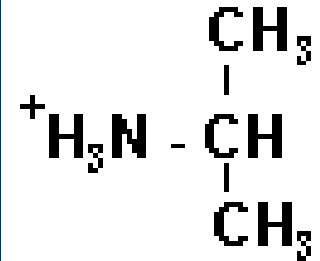
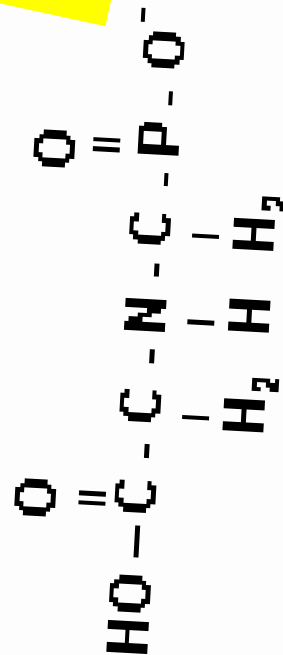
If mineral content is high, minerals can interfere with active Ingredients



+Mg+

Glyphosate

Glyphosate



Water Conditioners

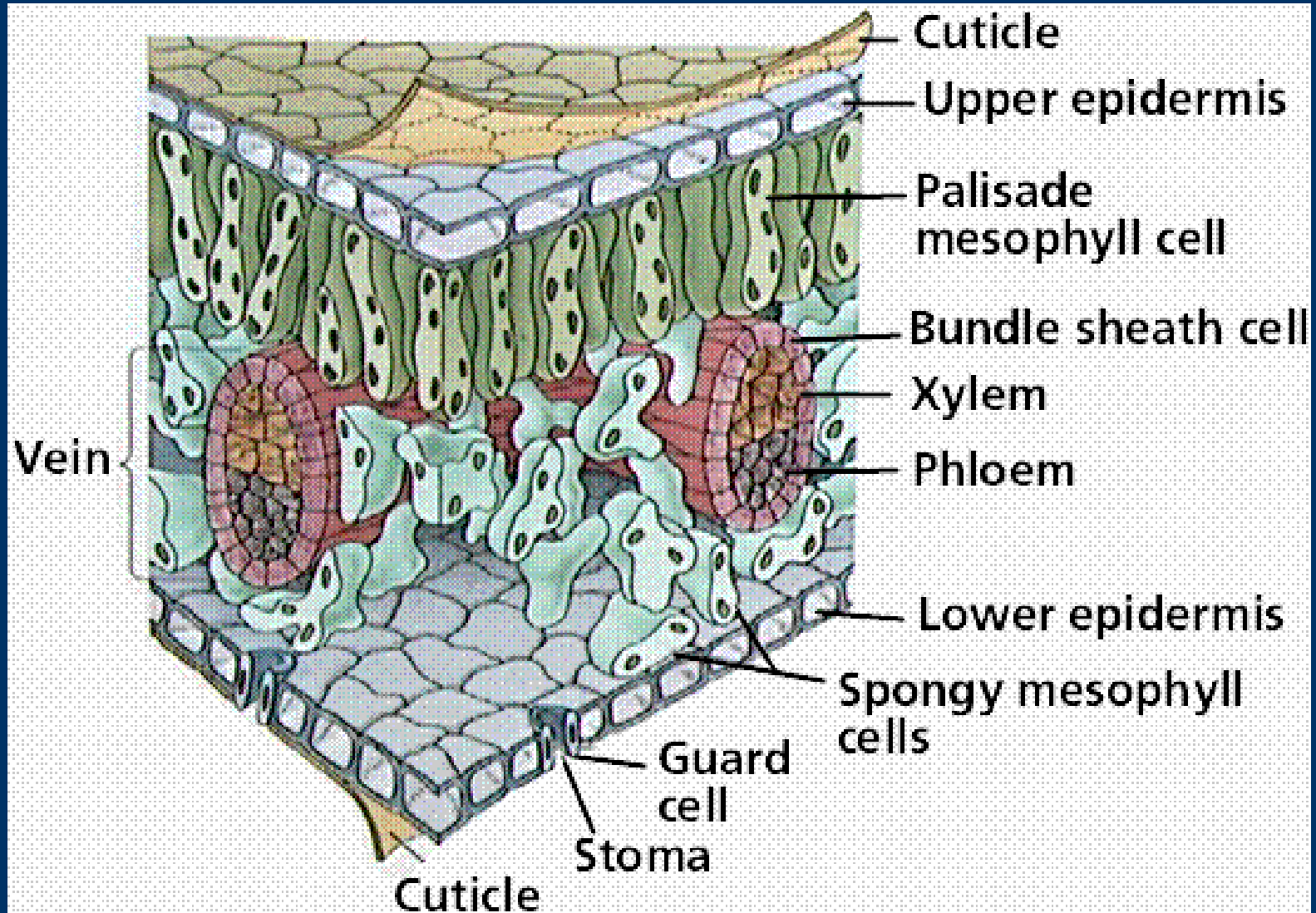
- **Most common is Ammonium sulfate**
 - Use a spray grade source
 - Add to tank before adding herbicide
- **Can speed up herbicide action**
- **Can be corrosive to sprayer parts**
 - Clean thoroughly after use



Surfactants

- **Surfactant = Surface Active Agent**
- **May do any of these:**
 - **Emulsify - allow unlike materials to mix**
 - **Water & oil**
 - **Disperse materials in spray mixture**
 - **Spread material on surface**
 - **Help wet plant surfaces**

Why use surfactants? Pesticides may not enter plant tissues easily.



Surfactants Reduce Droplet Surface Tension





**No
Surfactant**



Surfactant

Surfactant Product Types

- Follow pesticide label recommendations!
- Product types include
 - Emulsifiers
 - Wetting Agents / Spreaders
 - Crop oil concentrates
 - Silicone surfactants
 - Stickers



A Few Examples on Using Surfactants

2,4-D / Amine 4

[Herbicide]

For selective control of many broadleaf weeds in certain crops, orchard floors, fallow cropland, forests, grass pastures, rangeland, Conservation Reserve Program acres, ornamental turfgrass (including turfgrass grown for sod or seed), non-cropland and aquatic areas. Also for control of trees by injection.

Active Ingredient:

2,4-Dichlorophenoxyacetic acid,	
dimethylamine salt	46.3%
Other Ingredients	53.7%
Total	100.0%
2,4-dichlorophenoxyacetic acid - 38.4% - 3.8 lb/gal	

Keep Out of Reach of Children
DANGER PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

First Aid

If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

If swallowed: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.

If on skin or clothing: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

If inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For information on this product, contact the National Pesticide Information Center, 1-800-858-7378, Monday-Friday, 7:30 AM-3:30 PM PST. You may also contact the National Poison Control Center, 1-800-222-1222, day or night, for emergency medical treatment information.

Note to Physician: Probable mucosal damage may contraindicate the use of gastric lavage.

Refer to label booklet for Directions for Use.

Notice: Read the entire label. Use only according to label directions. **Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies at end of label booklet. If terms are unacceptable, return at once unopened.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

EPA Reg. No. 33270-21

Produced for
United Suppliers, Inc.
30473 260th St.
Eldora, IA 50627

EPA Est. _____
Net Contents _____

11-17-14

2,4-D / Amine 4

2,4-D can be applied with liquid nitrogen fertilizers.

When applying this way, compatibility aids (agents) may be needed.

Mixing with Liquid Nitrogen Fertilizer

This product may be combined with liquid nitrogen fertilizer suitable for foliar application for broadleaf weed control and fertilization of corn, small grains or pastures in a single operation. Use 2,4-D/Amine 4 Herbicide in accordance with directions for these crops provided in this label. Use liquid fertilizer at rates specified by the supplier or Extension Service Specialist. Test for mixing compatibility as described above before mixing in spray tank. A compatibility aid, such as Unite or Complex, may be needed in some situations. Compatibility is best with liquid fertilizer solutions containing only nitrogen. Mixing with N-P-K solutions may not be satisfactory, even with the addition of a compatibility aid. Pre-mixing 1 part 2,4-D/Amine 4 Herbicide with up to 4 parts water may help in situations when mixing difficulty occurs.

Fill the tank about half full with the liquid fertilizer, then add the required amount of 2,4-D/Amine 4 Herbicide with agitation. Maintain agitation and complete filling the tank with liquid fertilizer. Apply immediately and continue agitation in spray tank during application. Do not store the spray mixture. Application during very cold weather (near freezing) is not advisable.

Roundup Original

SPECIMEN LABEL

Monsanto

Roundup[®] Original

HERBICIDE

Complete Directions for Use

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS (EXCEPT AS SPECIFIED FOR INDIVIDUAL ROUNDUP READY[®] CROPS), DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

Not all products recommended on this label are registered for use in California. Check the registration status of each product in California before using.

Read the entire label before using this product.

Use only according to label instructions.

It is a violation of Federal law to use this product in any manner inconsistent with its labeling

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. THIS COMPANY DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

1.0 INGREDIENTS

ACTIVE INGREDIENT:

*Glyphosate, N-(phosphonomethyl)glycine,
in the form of its isopropylamine salt 41.0%

OTHER INGREDIENTS: 59.0%

100.0%

* Contains 480 grams per litre or 4 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt. Equivalent to 356 grams per litre or 3 pounds per U.S. gallon of the acid, glyphosate.

No license granted under any non-U.S. patent(s).

EPA Reg. # 524-445

2004-1

21154B4-1/CG

2.0 IMPORTANT PHONE NUMBERS

1. FOR PRODUCT INFORMATION OR ASSISTANCE IN USING THIS PRODUCT, CALL TOLL-FREE,

1-800-332-3111.

2. IN CASE OF AN EMERGENCY INVOLVING THIS HERBICIDE PRODUCT, OR FOR MEDICAL ASSISTANCE, CALL COLLECT, DAY OR NIGHT,

(314)-694-4000.



From Roundup Original label – Surfactants, wetting agents and ammonium sulfate may be used in spray mixtures

6.4 Surfactants

Nonionic surfactants (NIS) or wetting agents that are labeled for use with herbicides may be added to the spray solution. Do not reduce rates of this herbicide when adding surfactants. Read and carefully observe cautionary statements and other information appearing on the additives label. When adding additional surfactant, use 0.5 percent surfactant concentration (2 quarts per 100 gallons of spray solution) when using surfactants that contain at least 70 percent active surfactant, or a 1 percent surfactant concentration (4 quarts per 100 gallons of spray solution) for those surfactants containing less than 70 percent active surfactant.

6.5 Ammonium Sulfate

The addition of 1 to 2 percent dry ammonium sulfate by weight or 8.5 to 17 pounds per 100 gallons of water may increase the performance of this product, particularly under hard water conditions, drought conditions or when tank mixed with certain residual herbicides, on annual and perennial weeds. The equivalent rate of ammonium sulfate in a liquid formulation may also be used. Ensure that dry ammonium sulfate is completely dissolved in the spray tank before adding herbicides or surfactants. Thoroughly rinse the spray system with clean water after use to reduce corrosion. NOTE: When using ammonium sulfate, apply this product at rates recommended in this label. Lower rates will result in reduced performance. The use of ammonium sulfate as an additive does not preclude the need for additional surfactant.

From Roundup Original label – Colorants or Dyes and Drift reduction additives may be used.

6.6 Colorants or Dyes

Agriculturally approved colorants or marking dyes may be added to this product. Colorants or dyes used in spray solutions of this product may reduce performance, especially at lower rates or dilutions. Use colorants or dyes according to the manufacturer's recommendations.

6.7 Drift Reduction Additives

Drift reduction additives may be used with all equipment types, except wiper applicators, sponge bars and Controlled Droplet Applicator (CDA) equipment. When a drift reduction additive is used, read and carefully observe the cautionary statements and all other information appearing on the additive label. The use of drift reduction additives can affect spray coverage which may result in reduced performance.

Remedy Ultra

>Remedy Ultra can be applied in oil, water or liquid fertilizer.

>Remedy Ultra can be mixed with:

- surfactants
- drift control agents
- deposition aids
- other herbicides

>The order of mixing ingredients is important

Specimen Label



Dow AgroSciences

Remedy[®] Ultra

SPECIALTY HERBICIDE

®Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

For the control of woody plants and broadleaf weeds on rangeland, permanent grass pastures, and conservation reserve program (CRP) acres (including fence rows and non-irrigation ditch banks within these areas).

GROUP	4	HERBICIDE
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Active Ingredient:

Triclopyr: 2-[(3,5,6-trichloro-2-pyridinyl)oxy]
acetic acid, butoxyethyl ester

60

Other Ingredients.....

39

Total

100.00%

Acid Equivalent: triclopyr – 43.46% - 4 lb/gal



Mixing Order for Tank Mixes: Add one-half of the needed water to the mixing tank and start agitation. Add different materials in the order indicated below, allowing time for complete dispersion and mixing after addition of each product.

1. Water soluble herbicide (if used)
2. Premix of oil, emulsifier, Remedy Ultra and other oil-soluble herbicide (if used); see below

Add the remaining water. During the final filling of the tank, add a drift control and deposition aid cleared for application to growing crops (if used), plus an agricultural surfactant (if a water dilution rather than an oil-water emulsion spray is used). Maintain continuous agitation of the spray mixture during mixing, final filling and throughout application to ensure spray uniformity.

Premixing: Prepare a premix of oil, emulsifier (if oil-water emulsion), and Remedy Ultra plus other oil-soluble herbicide (if used), e.g., 2,4-D ester.

Note: Do not allow water or mixtures containing water to get into the premix or Remedy Ultra since a thick "invert" (water in oil) emulsion may form that will be difficult to break. Such an emulsion may also be formed if the premix or Remedy Ultra is put into the mixing tank before the addition of water.

Mixing with Liquid Fertilizer for Broadleaf Weed Control

Remedy Ultra may be tank mixed with liquid nitrogen fertilizer and foliarly applied for weed control and fertilization of grass pastures. Use Remedy Ultra in accordance with recommendations for grass pastures as given on this label. Apply at rates recommended by supplier or Extension Service Specialist. **Note:** Remedy Ultra is not recommended for use with liquid fertilizer on woody plants (brush). Foliage burn caused by liquid fertilizer may reduce herbicide effectiveness on woody plants. Test for mixing compatibility using desired procedure and spray mix proportions in clear glass jar before mixing in spray tank. A compatibility aid such as Unite or Compex may be needed in some situations. **Compatibility is best with straight liquid nitrogen fertilizer solutions. Mixing with N-P-K solutions or suspensions may not be satisfactory even with the addition of compatibility aid.** Premixing Remedy Ultra with 1 to 4 parts water may help in difficult situations.

Fill in the spray tank about half full with the liquid fertilizer, then add the herbicide with agitation and complete filling the tank with fertilizer. Apply immediately and continue agitation in the spray tank during application. **Do not store liquid fertilizer spray mixtures.** Application during very cold weather (near freezing) is not advisable. The likelihood of mixing or compatibility problems with liquid fertilizer increases under cold conditions.

Note: Do not use spray equipment for other applications to land planted, or to be planted, to susceptible crops or desirable plants **unless** it has been determined that all phytotoxic herbicide residue has been removed by thoroughly cleaning the equipment.

Low volume basal bark applications of Remedy Ultra can be applied in oil

Low Volume Basal Bark Treatment

To control susceptible woody plants such as mesquite, huisache, red maple, red and white oak, birches and aspen with stems less than 6 inches in basal diameter, mix 20 to 30 gallons of Remedy Ultra in enough oil to make 100 gallons of spray mixture. Apply with a backpack or knapsack sprayer using low pressure and a solid cone or flat fan nozzle. Spray the basal parts of brush and tree trunks to a height of 12 to 15 inches from the ground in a manner which thoroughly wets the lower stem, including the root collar area, but not to the point of runoff. Herbicide concentration should vary with size and susceptibility of species treated. Apply anytime, including the winter months, except when snow or water prevent spraying to the ground line or when stem surfaces are saturated with water.

Poast

SPECIMEN LABEL

Micro Flo

Poast[®]

Herbicide

ACTIVE INGREDIENT:

Sethoxydim: 2-[1-(ethoxyimino)butyl]-5-[2-(ethythio)propyl]-3-hydroxy-2-cyclohexen-1-one* 18.0%

INERT INGREDIENTS: 82.0%

TOTAL 100.0%

Equivalent to 1.5 pounds of sethoxydim per gallon

EPA REG. # 7969-58-51036

EPA EST. # 34313-TX-01

AD120299

Manufactured By

MICRO FLO COMPANY LLC

P.O. BOX 772099

MEMPHIS, TENNESSEE 38117-2099

**KEEP OUT OF REACH OF CHILDREN
WARNING/AVISO**



ADDITIVES

To achieve consistent weed control, always use one of the following additives: Dash HC, Sundance HC, methylated/modified seed oil, or crop oil concentrate. In addition, urea ammonium nitrate or ammonium sulfate is recommended for use on alfalfa, beans, cotton, flax, peanuts, peas, potatoes, soybeans, POAST Protected™ field corn, sugarbeets, and sunflowers to enhance activity on certain grass species.

See Table 4. Additive Rates Per Acre for more information. However, when used in many vegetable crops under the following conditions, POAST plus adjuvants should be used with caution due to potential crop leaf injury: when the temperature exceeds 90°F and the relative humidity is 60% or greater, or anytime the temperature exceeds 100°F, regardless of the humidity.

Because most nitrogen solutions are mildly corrosive to galvanized, mild steel, and brass spray equipment, rinse the entire spray system with water soon after use. UAN and AMS are not recommended in the Pacific Northwest and are not registered in California. Consult a MICRO FLO COMPANY, LLC representative or local agricultural authority for more information on the use of additives.

Dash HC, Sundance HC, Crop Oil Concentrate, or Methylated Seed Oils

A crop oil concentrate must contain either a petroleum or vegetable oil base and must meet all of the following criteria:

1. be nonphytotoxic,
2. contain only EPA-exempt ingredients,
3. provide good mixing quality in the jar test, and
4. be successful in local experience.

The exact composition of suitable products will vary; however, vegetable and petroleum oil concentrates should contain emulsifiers to provide good mixing quality. Highly refined vegetable oils have proven more satisfactory than unrefined vegetable oils. For more information, see Compatibility Test for Mix Components. For most crops, Dash® HC or Sundance® HC spray adjuvant may be substituted for crop oil concentrate or methylated seed oil; however, for some crops and tank mixes, Dash HC, Sundance HC and MSO are not recommended. (See Crop-Specific Information for more information.)

Nitrogen source Urea Ammonium Nitrate (UAN): (Commonly referred to as 28%, 30%, or 32% nitrogen solution), UAN may be used in addition to Dash HC, Sundance HC, or crop oil concentrate to improve weed control. DO NOT use brass or aluminum nozzles when spraying UAN.

Nitrogen source Urea Ammonium Nitrate (UAN): (Commonly referred to as 28%, 30%, or 32% nitrogen solution), UAN may be used in addition to Dash HC, Sundance HC, or crop oil concentrate to improve weed control. DO NOT use brass or aluminum nozzles when spraying UAN.

Ammonium Sulfate as a Water Conditioner to Improve Glyphosate Efficacy

Water is a universal solvent that serves as the primary carrier for pesticide applications. The quality of the water used as a carrier can have a large influence on the performance of herbicides such as glyphosate. Dissolved cations such as calcium, magnesium, zinc, iron, and manganese form complexes with glyphosate that reduce its efficacy.

Ammonium sulfate (AMS) conditions water by reacting with the dissolved cations to form insoluble sulfates that will not react with glyphosate. Spray grade AMS should be added to the spray tank and thoroughly mixed before adding glyphosate.

Final Points

- **Use only those adjuvants that are needed**
 - **If it's not broken, no need to fix it**
- **Follow Pesticide label recommendations**
 - **Products often contain the adjuvants that are needed**
 - **Sometimes adjuvant use can be detrimental**
- **What's needed with one pesticide product is not needed with all**

Botanical Garden in Santo Domingo, Dominican Republic

