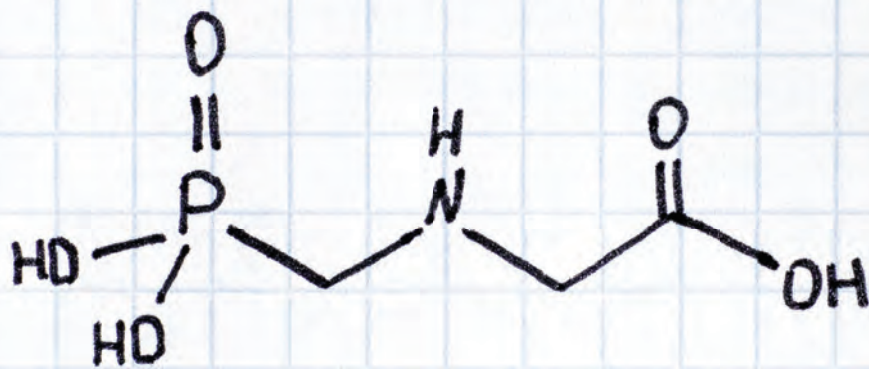


Glyphosate



Understanding glyphosate formulations

By Ramdas Kanissery, Steve Futch, Brent Sellers and Camille McAvoy



Glyphosate is a popular post-emergent herbicide among Florida citrus growers for its broad-spectrum of weed control under trees and in row middles. The use of glyphosate as a “burn-down” application alone, or in combination with other herbicides, is a standard practice in citrus groves.

Various glyphosate-containing product formulations are available on the market to citrus growers. Regardless of the product, the active ingredient that controls the emerged weeds is the same: glyphosate. Nevertheless, the differences among various formulations of glyphosate-based herbicides can be

confusing. This article is intended to help citrus growers better understand their glyphosate products and accomplish the goal of effective weed control.

SALT TYPES

Unlike most herbicides used in citrus production, glyphosate-containing products are formulated as salts. The major variability between glyphosate products is the type of glyphosate salt in the formulation. Another difference is the additives (e.g., surfactants) in the products (Figure 1, page 25).

Chemically, glyphosate is a weak acid which equates to a weak negative charge. When the glyphosate acid is added to a base that has a positive charge, the salt is formed. When it is absorbed, the salt is disassociated at the site of action within the plant tissues. It is only glyphosate acid that binds to the target enzyme and is responsible for herbicidal activities.

Glyphosate products use several forms of glyphosate salts. The major salts in glyphosate products are potassium, isopropylamine, ammonium and trimesium. Potassium refers to the salt form of glyphosate

acid from monopotassium (K). Isopropylamine salt has a “propyl chain” (3-carbon chain) and an amine group. Ammonium salt has one (mono) or two (di) ammonium groups. Trimesium is a short name for trimethyl-sulfonium, which means three methyl groups and sulfur. The information on the salt component of the glyphosate is provided on the product label.

For instance, the Roundup Powermax label states its active ingredient as “Glyphosate, N-(phosphonomethyl) glycine, in the form of its potassium salt.” Similarly, Gly Star Plus states its active ingredient as “Glyphosate, N-(phosphonomethyl) glycine, in the form of isopropylamine salt.” In both products, glyphosate is the common name of the active ingredient, and the rest of the information describes the chemical structure.

Glyphosate salts vary in molecular weight and have differences in the glyphosate acid-to-salt ratio. These changes cause variations in the amounts of active ingredient (glyphosate acid + salt) and acid equivalent

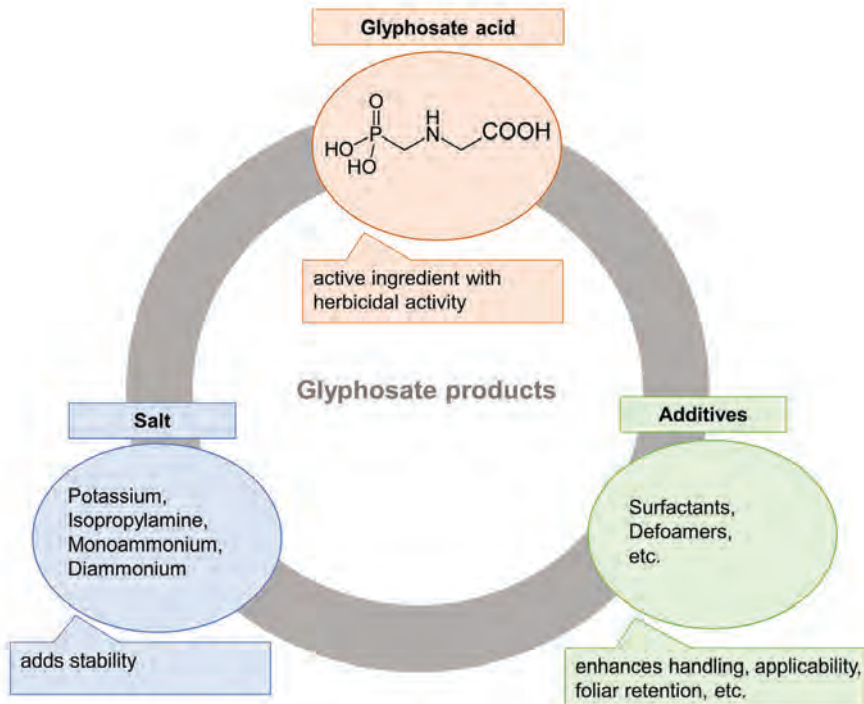


Figure 1. Each glyphosate product consists of the following components: a parent glyphosate acid, salt and inert ingredients like additives.

(glyphosate acid alone) in the formulations. Also, different glyphosate salts may have different water solubility. Thus, different glyphosate salts are

purported to have variable effects on stability in formulation, absorption and translocation within the weed. However, research communities



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Table 1. Selected glyphosate products and the product use rates for equivalent amounts of glyphosate acid per acre

Glyphosate product	Salt form of glyphosate acid	Active ingredient per gallon product	Acid equivalent per gallon product	Product use rate to achieve 0.75 acid equivalent/acre
Durango DMA	dimethylamine	5.07 lbs.	4 lbs.	24 oz.
Gly Star Original	isopropylamine	4 lbs.	3 lbs.	32 oz.
Gly Star Plus	isopropylamine	4 lbs.	3 lbs.	32 oz.
Gly Star 5	isopropylamine	5.4 lbs.	4 lbs.	24 oz.
Gly-4 Plus	isopropylamine	4 lbs.	3 lbs.	32 oz.
Glyphos	isopropylamine	4 lbs.	3 lbs.	32 oz.
Roundup Original	isopropylamine	4 lbs.	3 lbs.	32 oz.
Roundup Ultra	isopropylamine	4 lbs.	3 lbs.	32 oz.
Roundup Original Max	potassium	5.5 lbs.	4.5 lbs.	21.3 oz.
Roundup PowerMax	potassium	5.5 lbs.	4.5 lbs.	21.3 oz.
Roundup UltraMax	isopropylamine	5 lbs.	3.7 lbs.	26 oz.
Roundup UltraMax II	potassium	5.5 lbs.	4.5 lbs.	21.3 oz.
Roundup WeatherMax	potassium	5.5 lbs.	4.5 lbs.	21.3 oz.
Touchdown	diammonium	3.7 lbs.	3 lbs.	32 oz.
Touchdown HiTech	potassium	6.2 lbs.	5 lbs.	19.2 oz.

have yet to find a noteworthy effect of glyphosate salt on weed-control efficacy. Most reports suggested that differences in weed control are inconsistent and do not support a single superior glyphosate-salt formulation.

Since the acid component of the material is what binds at the active site within the plant, glyphosate rates are often referred to in terms of pounds (lbs.) acid equivalent (a.e.) per acre

instead of lbs. active ingredient (a.i.) per acre. A compiled list of several glyphosate products and the product use rates for equivalent amounts of glyphosate acid per acre is presented in Table 1.

OTHER INGREDIENTS

Other components (e.g., adjuvants, surfactants, carrier solvents, etc.) are contained within the formulation of

glyphosate products. These inert materials are components that improve the handling, safety and solubility of products. They promote the dispersion, emulsifying, absorbing, spreading, sticking or penetration of the spray droplets. They can also facilitate movement of glyphosate into plants. Differences in performance among glyphosate products could be attributed to these components.

While many products have a built-in surfactant, the type of surfactants used in the formulated product may be dependent upon the manufacturer. Consequently, even if the active ingredient is identical between two products, a significant difference in the performance may solely be dependent upon the inert materials. In general, it is difficult to statistically separate these differences with replicated field studies.

Adding an appropriate surfactant is helpful while using a glyphosate product without a built-in surfactant system. Such glyphosate formulations are usually utilized in aquatic situations. Make sure to read the herbicide product label to see requirements and specifications for additional surfactants. For products where the addition of a surfactant is suggested, consider adding a high-quality, non-ionic surfactant at rates of 0.25 to 1.0 percent volume per volume (0.32 to 1.28 ounces of surfactant per gallon



Glyphosate product comparison

Let's compare two glyphosate-based products with different salt forms. Roundup PowerMax has 5.5 pounds (lbs.) active ingredient (a.i.) per gallon of the glyphosate potassium salt, which is equivalent to 4.5 lbs. acid equivalent (a.e.) per gallon of the acid. This information can be easily located on the herbicide label in the ingredient statement section. Roundup Original has 4 lbs. a.i. per gallon of glyphosate as the isopropylamine salt, which is equivalent to 3 lbs. a.e. per gallon of glyphosate acid.

When comparing on an a.e. basis, one product is 50 percent more concentrated than the other (as in 4.5 lbs. a.e. vs. 3 lbs. a.e.). In order to achieve a comparable application rate in the grove (for a.e. per acre), based on this example, growers need to apply 50 percent less of the 4.5 lbs. a.e. product (Roundup PowerMax) to get the same amount of glyphosate acid.

of spray solution) depending on the label specifications.

FURTHER CONSIDERATIONS

If the water source for spray mix is “hard,” or in other words, if it contains large amounts of dissolved salts like calcium (Ca), magnesium (Mg), iron and aluminum, glyphosate activity could be reduced. These salts, particularly Ca and Mg, will displace the potassium, isopropylamine or other

Ammonium sulfate prevents antagonistic salts from interacting with glyphosate.

salt components in the glyphosate-salt complex in the formulated product. The glyphosate activity will be reduced as weeds absorb less glyphosate bound with Ca or Mg salts than the formulated salt of glyphosate.

To prevent this, most glyphosate product labels suggest adding ammonium sulfate (AMS) during the preparation of herbicide tank mix. AMS prevents antagonistic salts from interacting with glyphosate. The negatively charged sulfate portion of AMS will bind with the positively charged Ca and/or Mg. AMS should always be added to the water *prior to adding glyphosate product* to avoid the potential formation of less active glyphosate-salt complexes with antagonistic cations. 🍊

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