

**VINEGAR:
AN ALTERNATIVE TO GLYPHOSATE?**

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INTRODUCTION

Glyphosate is the chemical name of world's most widely used and best-selling herbicide. It is used in more than 130 countries on agricultural crops, orchards, nurseries, greenhouses, lawns, landscapes, rights-of-way, etc.. Over 100 million pounds are applied to U.S. farms and lawns every year, according to the EPA. In the home and garden sector, it is the second most-used pesticide, with over 5 million pounds used per year. In golf courses and turfgrass maintenance, 5-8 million pounds of glyphosate are used each year. One landscape maintenance industry survey¹ attested that glyphosate may account for up to 90% of pesticide applications in landscape beds.

Glyphosate was patented by Monsanto under the trade name 'RoundUp' in 1974. Glyphosate is now widely available from many manufacturers under numerous trade names after patent protection ended in 2000: RoundUp, KleenUp, Accord, Imitator, Eraser, Pronto, Rodeo, etc.. There are over 750 products containing glyphosate for sale in the U.S.², according to the National Pesticide Information Center.

Glyphosate [*N*-(phosphonomethyl) glycine, a.k.a. the isopropylamine salt of glyphosate] is a non-selective, post-emergent, broad-spectrum systemic herbicide. When applied to growing plants, it is absorbed by foliage and translocated to the roots, where it blocks the production of a specific enzyme pathway needed for plant growth. Wilting and death occur within ~7-10 days. After application, glyphosate binds tightly to soil particles, becoming immobilized so it can no longer harm plants. Due to no residual soil activity, a crop can be seeded or transplanted into the soil soon after application. It is ultimately broken down in the soil by microorganisms into ammonium and carbon dioxide.

As a non-selective herbicide, glyphosate will kill most plants it contacts. Accordingly, it can be used for vegetation cleanup prior to all types of planting, e.g. field/bed/turfgrass preparation or renovation. It can be spot sprayed for general weed control or sprayed directly over top of specific crops at certain times of year (e.g. over Christmas trees/conifers in the fall). No other herbicide works as well on perennial grasses as glyphosate does, particularly late in the season.

TOXICITY

Because glyphosate does not leach through soil and has low mammalian toxicity, it has been considered to be very safe toxicologically and environmentally, with hundreds of studies showing the active ingredient to be less acutely toxic than common table salt or aspirin. The EPA does not consider glyphosate to be a human carcinogen. However, much of glyphosate's touted low-toxicity is based only upon studies of the active ingredient, not the other inert ingredients in a formulation. Different glyphosate products vary in the type of active ingredient salt and the manufacturer proprietary compounds included in the formulated products. Proprietary compounds are listed on the label as inert ingredients and used for handling convenience, for easier mixing with other pesticides, and/or for aiding movement of the active ingredient from the leaf surface into the plant tissue (e.g. surfactants). RoundUp, for example, is 41% glyphosate and 59% inert ingredients. Products range from 0.5% RTU formulations (KleenUp, etc.) to concentrates of 53.8% active glyphosate. The EPA is currently conducting a standard registration review of glyphosate and has set a deadline of 2015 for determining future use limits.

VIALE ALTERNATIVES TO GLYPHOSATE?

Due to environmental, regulatory action, and increasing consumer concerns, green industry professionals as well as homeowners are seeking viable alternatives to glyphosate. Alternative, non-chemical, natural, organic herbicides are available commercially. These products mimic natural plant based chemicals; they generally have low toxicity and break down rapidly in the environment. They can be used selectively to control weeds by spraying, painting or drenching. However, they tend to be expensive, have no residual activity, and may have quality differences from batch to batch.

Commercially available alternative products rarely generate 100% weed control. They perform better on broadleaf weeds than grassy weeds. They are best used in conjunction with optimizing cultural practices such as improving soil health, turf/plant nutrition, irrigation, cultivar selection, proper mowing, and seeding/plant establishment and overseeding. Avoiding conditions that favor weeds (compacted soils, overwatering, excessive or ill-timed nitrogen applications) and adjusting soil pH to favor desirable plants over weeds increased effectiveness. Most alternative herbicide products are not chemicals, so they are exempt from EPA pesticide registration. As a result, many have little or no ecotoxicity or worker exposure data available. Several can be harmful to people/pets during mixing and application, owing to inhalation, skin or eye contact, or spray mist. Some have unpleasant smells or have an allergenic effect. For example, corn gluten meal should not be used by anyone with corn allergies.

Alternative herbicides fall into 7 product categories: Natural acids (vinegar + citric acids), Herbicidal soaps, Iron-based herbicides, Salt-based herbicides, phytotoxic oils (clove, peppermint, pine, citronella), corn gluten, and combination products (including ingredients from multiple categories). This fact sheet concentrates specifically on acetic acid (vinegar) products.

USING ALTERNATIVE HERBICIDES

Alternative herbicides are generally considered contact herbicides, not systemic. They generally work by burning plant foliage, but only foliage that is contacted by the product (although

chelated iron products claim weed kill down to the root). They only kill weeds that have emerged and have no residual activity on those emerging after application. Most are fast acting (15 minutes) when temperature is high (>85 °F), and particularly if humidity is low. Small, immature, recently germinated weeds -- in the cotyledon/first true leaf stage -- are most readily killed. Annual weeds—e.g. sorrel, mustard, lambsquarter, etc. – die quickly subsequent to proper application; grassy weeds (crabgrass, etc.) are not controlled as well. Larger weeds and perennial weeds may wilt/discolor soon after spraying, but may begin to re-grow a week or so later since root systems are not killed. These weeds require multiple treatments for acceptable control.

Commercially, alternative herbicides are best used in conjunction with optimizing cultural practices such as improving soil health, turf/plant nutrition, irrigation, cultivar selection, proper mowing height, and seeding/plant establishment and overseeding. Alternative herbicides may not be regarded as long term single application herbicides like glyphosate, but as short term “burn-down” products. An initial germination treatment followed by spot treatments later in the season is necessary to minimize persisting perennial weeds. A single application once (or twice) a year is not sufficient to keep “trim” areas (pavement, sidewalk cracks, skin surfaces on playing fields, etc) weed free. Moreover, the cost of alternative products may be higher compared to glyphosate: higher per application and more applications per year, resulting in higher labor expenses. Alternative herbicides also require higher volumes of water, higher volume pumps and larger nozzles on sprayers.

Ways to improve effectiveness when using alternative herbicides include:

- Thorough spray coverage (to runoff); A large, flat nozzle (ie. 8006) is preferable in turfgrass production
- Add the high label amount of surfactant/adjuvant to improve control;
- Treat when weeds are small (2-5 leaves)
- Repeat applications for larger weeds are necessary in most instances.
- Lower concentrations at high spray volumes (i.e. 10% concentration in 70 gallons per acre) appear to be more effective than high concentrations at low spray volumes (i.e.20% concentration in 35 gallons per acre)

From an economical perspective, alternative herbicides cost more than chemical herbicides due to the concentrations and number of applications required. For example, a lawn study³ in NY found that acetic acid herbicides were more than three times more costly on a square foot basis than glyphosate. Another study⁴, by the U. Mass Transportation Center, showed that glyphosate cost ~\$20/mile to control weeds along roadways. They also found that alternative materials (Citric Acid, Acetic Acid, Clove Oil, Scythe®, etc) varied in cost from \$360 to \$2400 per mile.

ACETIC ACID

Acetic acid, commonly known as vinegar, but also known as ethanoic acid, affects the cell membranes of a plant, causing rapid breakdown/desiccation of foliage tissue on contact. Herbicidal vinegar is stronger than household vinegar: the acetic acid concentration for herbicidal use is 10 -20%, compared to 5% acetic acid. Acetic acids of 8% or less inert ingredient are exempt from registration by the EPA as a pesticide under EPA Minimum Risk Pesticide, FIFRA 25 (b). Most states require registration for use of acetic acid as a pesticide. **In Maryland, a product must be registered by the [state chemist](#) to use it as a pesticide.** In sufficient quantities, acetic acid results in quick burn down of the plant, especially in bright sunlight. Products are non-selective, foliar sprays that kill most broad-

leaved weeds. Applications require a surfactant; yucca extract is sometimes added as a natural sticking agent.

PROs:

- Excellent control when contacting very small annual broadleaf weeds
- Rapid kill rate (Over 90% of treated plants should die within 24 hours).
- Acetic acid products break down quickly in the environment
- Most useful for managing weeds in gravel and on patios/sidewalks.
- These contact herbicides fit into an integrated pest management program; although weeds require monitoring for best control timing.
- Non selective, but mainly kill broadleaf weeds. Burns back grasses temporarily.

CONS:

- No residual activity. Will kill or damage any plants they touch.
- Weeds must be small (timing is important – within 2 weeks of germination)
- Roots are not killed; repeat applications are needed for larger weeds and perennial weeds
- Good spray coverage is essential (70 GPA+)
- Sharp vinegar odor may be unpleasant
- Spray equipment must be cleaned after application, particularly metal equipment. Avoid using spray equipment with metal working parts such as metal spray lines or metal nozzles.
- Spray drift may damage desirable plants.
- Do not apply to reactive metals such as aluminum, tin, iron, and items such as fencing or lawn furniture. Avoid spraying the material onto masonry sidewalks and structures. If the product contacts these surfaces, staining, mottling, etching, or other harm to the finishes or surfaces may occur.
- Do not apply more frequently than every two weeks
- Treatments must be delayed 24-48 hours or more after rain
- Severe eye irritation, burns, and possible irreversible damage potential. Vinegars with acetic acid concentrations of 11% or greater can burn the skin and cause severe eye injury, including blindness.
- Severe skin irritation and possible allergic sensitization
- Prolonged or repeated exposure may cause dermatitis, chronic bronchitis, and erosion of teeth

RESEARCH SUMMARY

Research has found that 5-10% acetic acid herbicide products can give viable control of very small, young weeds that have only 1-2 leaves (or within 2 weeks of germination). Larger weeds (with >3-4 leaves) are likely to survive treatment, but using higher (20%) concentrations⁵ of

acetic acid and increasing the application volume (from 20 to 100 gpa) can improve weed control^{6,7}. Total crabgrass and grass weed control in a 2006 USDA-ARS study occurred with 20% acetic acid applied at 100 gpa, resulting in weed control that ranged from 28 to 45%⁵. Multiple applications improve long term control. Broadleaf and annual weeds tend to be more susceptible than grassy weeds and perennial weeds, which show initial signs of damage but generally recover⁸. Nonetheless, using acetic acid on weeds with tap roots (dandelions, Canada thistle), may only result in top kill unless the weed is very young.

Studies have found that properly applied acetic acid appears to have promising results at controlling the following weeds: broadleaf plantain⁹, carpetweed⁵, common chickweed¹⁰, cutleaf evening primrose¹¹, ground ivy⁹, oriental mustard¹², pale smartweed¹⁰, tumble pigweed⁵, spiny amaranth⁵, lambsquarters¹³, velvetleaf⁹, and recently germinated crabgrass¹⁴. Although the overall cost is higher than traditional herbicides, careful weed monitoring and spot applications as part of an IPM program could reduce material cost.

COMMERCIALY AVAILABLE ACETIC ACID PRODUCTS

Check with your state to determine if a product is registered to be used as a pesticide.

Bradfield Natural Horticultural Vinegar - 20% vinegar (acetic acid) + yucca extract. (Bradfield Organics) NOT OMRI Listed

Burn-out – 25% acetic acid (St. Gabriel Laboratories).

Grotek Elimaweed Weed And Grass Killer - 7.15% acetic acid (GREENSTAR PLANT PRODUCTS)

Maestro Gro's Organic Vinegar. 20% acetic acid (Ag Organics/Nature's Wisdom)
1 gal % 15.79

Natural Weed Control- 0.2% citric acid, 8% acetic acid + water. (Nature's Wisdom/Ag Organics).

Soil Mender 10% Vinegar - 10% acetic acid (made from grain alcohol and not from glacial acetic acid), orange oil, molasses, and a natural surfactant.

Vinagreen Natural Non Selective Herbicide- 20% acetic acid (CMC Chemical) **Registered in Maryland**

Weed Pharm Fast Acting Weed And Grass Killer - 20% vinegar (acetic acid) (PharmSolutions) (Signal word: Danger)

COMBINATION PRODUCTS

Alldown- 23% Acetic Acid, 14% Citric acid (BioLynceus Biological Solutions) (OMRI organic listed)

Alldown Green Chemistry Herbicide. 5% Citric Acid 0.2% Garlic, + Acetic Acid, Yucca Extracts and water. (SummerSet Products) (OMRI listed organic)

Bioganic Safety Brands Weed & Grass Killer - 10% acetic acid, 2% eugenol (clove oil), 2% thyme oil, 1% Sodium Lauryl Sulfate. (Bioganic Safety Brands, Inc.,) Product is fragrant.

Black Jack Twenty-one - 21% acetic acid, Yucca Extract, Olive Oil, Garlic Oil, Citrus Oil and Molasses used as sticking, wetting and emulsifying agents. (Maestro-Gro).

Burn Out II Weed and Grass Killer RTU 4% Clove oil, 3% Sodium laurel sulfate, + vinegar, lecithin & citric acid. (St. Gabriel Labs) (OMRI® listed).

Burn Out II Weed and Grass Killer Concentrate (St. Gabriel Labs) 12% Clove oil, 8% Sodium laurel sulfate, + vinegar, lecithin & citric acid. (St. Gabriel Labs)

Summerset Alldown® Organic Herbicide. 23% Acetic Acid, 14% Citric acid, with 0.02% garlic juice extract.

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