What You’ll Learn...

- Many factors can influence the performance of glyphosate, the active ingredient in Roundup® brand agricultural herbicides. Understanding these factors can help to maximize efficacy of the herbicide.
- Using the full labeled rate of Roundup agricultural herbicides for the weeds and their size, while considering environmental conditions at application, is important to maximize product performance.
- Weeds need to be actively growing for best results with a Roundup agricultural herbicide.

Roundup® Agricultural Herbicides

Glyphosate is the only active ingredient in Roundup PowerMAX®, Roundup PowerMAX® II, and Roundup WeatherMAX® agricultural herbicides. The products are foliar applied for broad-spectrum control of weeds in crop and non-crop situations. Understanding the factors that can influence the performance of glyphosate can help to maximize product efficacy.

Use the Full Labeled Rate

The rate of Roundup agricultural herbicides should be determined by the size and type of weed species, and by the largest or most tough-to-control weeds in the field or spray situation. In general, the bigger the weed species, the higher the rate needed for control. Annual weeds are best controlled when they are in an early growth stage, actively growing, and less than four inches tall. Perennial weeds are often controlled better when they are taller and in later growth stages. In most situations, a minimum rate of 32 fl oz/acre can provide good weed control. Always refer to the product label for rate recommendations for particular weed species.

Larger and older annual weeds can be more difficult to control. More mature or hardened-off annual weeds may require 44 fl oz/acre even if they are smaller in size. Environmental stress, such as dry weather, can cause weeds to be short for their age, requiring a higher rate for good control. Perennial weeds may require 64 fl oz/acre or more for effective control. Check the herbicide label for application restrictions, and use full rates to help achieve complete control of existing weeds.

Weed species can also differ in their sensitivity to glyphosate. Certain weed species can have natural tolerance to glyphosate, while others are resistant and control is unlikely, regardless of the application rate. Tank-mixing herbicides with different and effective modes of actions and other weed resistance management practices in these situations can help to provide more consistent control of tolerant or resistant weeds. Using lower than labeled rates can lead to poor weed control and potentially select for resistant weeds. Always use the full, labeled rate of Roundup agricultural herbicides for best results.

Spray Additives and Tank Mixtures

Surfactant. Adding surfactants can increase spray solution spreading on leaves, improving plant uptake and translocation of glyphosate. Roundup agricultural herbicides have surfactant already included in the formulation. However, depending on the situation, additional non-ionic surfactant can be added to Roundup PowerMAX and Roundup PowerMAX II herbicides to help control weeds. In general, the addition of crop oil concentrates (COC) and methylated seed oils (MSO) is not recommended. Follow recommendations on the product label for using additional surfactant and other additives.

Ammonium Sulfate (AMS). AMS is often recommended for use with Roundup agricultural herbicides to condition hard water, as well as to make it easier for glyphosate to penetrate into the plant for better weed control. AMS also helps to reduce any possible antagonism when residual herbicides and other products are added to the tank.

AMS should be added to the water in the spray tank and thoroughly mixed before adding any herbicides. Dry spray-grade AMS should be added at 8.5 to 17 pounds (1 to 2% by weight) per 100 gallons of spray solution. Liquid AMS products are generally added at 2.5 to 5 gallons per 100 gallons of spray solution. When using liquid AMS products, the recommended rate should deliver an equivalent amount of AMS as provided by a dry AMS product. The higher rates should be used in spring burndown, tank mixes with residual herbicides, or when targeting tough-to-control weeds. The lower rates should be used for in-crop applications to reduce the potential for cosmetic leaf burn of the crop, especially under high temperature conditions.

Tank Mix Partner. Labels for Roundup agricultural herbicides include approved tank mix partners. Avoid tank mixtures with other herbicides that can reduce the efficacy of glyphosate (through antagonism) or tank mix recommendations that encourage application rates...
below the label recommendations. Tank mixing Roundup® brand agricultural herbicides with insecticides, fungicides, and nutrients or foliar fertilizers is generally not recommended.

**Water Quality and Spray Volume**

Hard water contains large amounts of dissolved salts or cations that can antagonize glyphosate. AMS can be used to reduce the antagonistic effects of hard water. Clean water should also be used with Roundup agricultural herbicides, since glyphosate can bind and be deactivated by soil, organic matter, and clay particles in dirty water.

For most situations, spray volumes of 10 to 15 gallons per acre (GPA) allows adequate coverage of weeds. Higher volumes (15-20 GPA) can be beneficial in situations with dense weed infestations, well developed crop canopies, or large weeds. Recommended rates of Roundup agricultural herbicides can be applied in up to 40 gallons of water per acre as a broadcast spray. The spray volume should be increased within the recommended range to ensure complete coverage of weeds. Coverage can also be improved by choosing the proper nozzles, adjusting the boom height, and spraying at an appropriate ground speed.

As spray volume decreases, there can be an increased risk of spray drift and insufficient weed coverage. Relatively small spray droplets are required for uniform coverage at spray volumes less than 10 GPA, and small droplets can increase the likelihood of spray drift. Nozzle selection for glyphosate application should be based primarily on managing droplet size and drift potential rather than optimizing spray coverage.

**Environmental and Other Considerations**

Weeds need to be actively growing for good absorption and translocation of glyphosate. Environmental conditions can affect absorption and translocation. Dry weather causes weeds to have thickened cuticles, which are harder for herbicides to penetrate. Dry weather can also increase dust particles that can bind with glyphosate, making it less available for absorption into the plant. Using higher rates and AMS can help to improve efficacy when applying Roundup agricultural herbicides on stressed plants.

Cold weather can be a stress to plants. It can take glyphosate longer to work on plants when applied during or after cold weather. When applied in the fall after a frost, green leaves must be firmly attached to the plant stem to absorb and translocate glyphosate. Weed control will decrease when the herbicide is applied to dessicated plant tissue. For optimum control, application of the herbicide to new plant growth is needed after a frost.

Translocation requires actively growing weeds with a good plumbing system, the xylem and phloem. Mechanical damage from tillage, planting, spray, or harvesting equipment can compromise the plumbing. Tillage, that injures but does not kill the weeds, can make them appear shorter because much of the plant is below the soil surface. Planters and drills can cause the same effect. Lack of weed control in wheel tracks can be due to a restricted plant plumbing system and/or the presence of dust. Stem boring insects can also damage the plumbing, restricting translocation. When weeds injured by stem boring insects have been sprayed with a Roundup agricultural herbicide, the portion of the plant above the insect damage should die. Below the insect damage, the weed often remains green and may regrow. Giant ragweed and marestail are two examples of weeds where this has been noticed. Tillage should be delayed for at least one day after treating annual weeds and three days after treating perennial weeds to allow for good translocation of glyphosate in the plant.

When re-treatment of a Roundup agricultural herbicide is necessary, allow time for weeds to recover and resume growth. Use the right rate, considering weeds are older, taller, and will probably be even more difficult to control. If wheel tracks were the problem, avoid the previous tracks. Weeds need to be actively growing for the best results when using a Roundup agricultural herbicide.

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