



Understanding Herbicide Adjuvants

What You'll Learn...

- Adjuvants can help to improve post-emergence herbicide performance and modify spray solution characteristics.
- Herbicide product labels outline specific instructions for the use of adjuvants.
- Adjuvants must be properly matched to each herbicide formulation and tank mixture for optimum effectiveness and crop safety.

The Function of Adjuvants

Adjuvants play an important role in herbicide formulations and spray mixtures to help herbicide performance either by improving herbicide activity or ease of application. Herbicide labels are the most important source of information for adjuvant recommendations that cover diverse use situations and tank mixtures. Adjuvants are specific for each product as researched and developed by the herbicide manufacturers.

- Adjuvants include spreaders, stickers, wetting agents, penetrants, stabilizing agents, compatibility agents, buffering agents, anti-foam agents, and others.¹
- Adjuvants can be classified into two main groups: Activators and utility modifiers (or special purpose adjuvants).
 - » Activator adjuvants, such as surfactants, crop oil concentrates (COC), and nitrogen (N) are normally used to help improve the performance of herbicides by increasing herbicide retention or penetration on or into leaf surfaces, improving rainfastness, or to decrease photodegradation of herbicides.²
 - » Utility modifiers, such as buffering, antifoam, and drift control agents, typically modify the characteristics of the spray solution and product compatibility.

Since herbicide spray adjuvants impact how much herbicide enters the plant, they can impact weed control and crop safety; therefore, it is important to follow the label requirements for each herbicide. Each herbicide product has adjuvant requirements that are specified on the product label. The label will provide guidance and adjuvant options to address tank mixtures, environmental conditions, or weed species characteristics. Some herbicide products, such as Roundup PowerMAX® 3 Herbicide, are formulated with sufficient adjuvants in the herbicide formulation and may not need additional adjuvants added to the spray mixture. Some products have specific recommendations for spray adjuvants that the user must add to the spray mixture. The user should pay particular attention to label instructions for each tank-mix product because label recommendations for adjuvants may differ for each product. Each herbicide manufacturer may have supplemental labels or fact sheets that provide additional guidance for the use of adjuvants for specific application situations, weed species, crops, or tank mixtures. There is a diverse array of adjuvant products and brands. The user must understand the composition and function of each product, while considering expected environmental conditions at the time of herbicide application, to properly match the adjuvant to individual herbicides or tank mixtures. Comprehensive information on commercially available adjuvants can be found at <http://siu-weeds.com/adjuvants/index-adj.html>.

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Table 1. Adjuvant recommendations for Bayer herbicides.

Herbicide	Adjuvant Recommendations
Axiom® DF herbicide	Balance® Flexx herbicide, Corvus® herbicide, and Degree Xtra® herbicide are restricted use pesticides. No additional adjuvant required. If tank-mixing follow the adjuvant recommendations for the tank-mix partner.
Balance® Flexx herbicide	
Corvus® herbicide	
Degree Xtra® herbicide	
Harness® herbicide	
Harness® Xtra herbicide	
Harness® Xtra 5.6L herbicide	
TripleFLEX® II herbicide	
Varro® herbicide	
Warrant® herbicide	
Wolverine® herbicide	
Wolverine® Advanced herbicide	
Autumn™ Super 51 WDG herbicide	External adjuvant and a nitrogen fertilizer source are required. External adjuvant: Crop Oil Concentrate (COC), Methylated Seed Oil (MSO), or equivalent oil blend at 1% v/v (1 gallon per 100 gallons of final spray volume). Nitrogen fertilizer: 1.5-2 qt/A of 28 or 32% UAN or Spray Grade AMS at 1.5lb/A to 3.0 lb/A
Capreno® herbicide	External adjuvant and a nitrogen fertilizer source are required to achieve optimum weed control when weeds are present at time of application. External adjuvant: The use of nonionic surfactants or refined vegetable oils will result in unacceptable or erratic weed control. Use: Crop Oil Concentrate (COC) which contains at least 80% crop oil and 10% emulsifier Rate: 1 gallon per 100 gallons of water (1% v/v) *HSOC may be substituted for COC MSO (0.5% v/v) may be substituted for COC when plants are growing under adverse conditions such as drought stress, low humidity, etc. Nitrogen fertilizer: 1.5 qt/A UAN or AMS at 1.5lb/A (or 8.5 lb/100 gallons with a minimum of 1.5lb/A). Use UAN under conditions of low relative humidity for greater weed control.
DiFlexx® herbicide	To improve post emergence weed control particularly in dry growing conditions use one of the following: Nonionic Surfactant: 0.25% v/v or 1 qt/100 gallons COC: 1.0% v/v or 1 gal/100 gallons MSO: 1.0% v/v or 1 gal/100 gallons
DiFlexx® DUO herbicide	External surfactant required to achieve optimum weed control when applied postemergence or when applied preplant or preemergence if weeds are present. MSO at 1% v/v or 1 gal/100 gallons COC at 1% v/v or 1 gal/100 gallons HSOC may be used with DiFlexx® DUO herbicide as an alternative to COC surfactants. Use recommended rates with an HSOC product containing 25-50% surfactant wt/wt in a minimum of 50% oil wt/wt. If tank-mixing, see label for adjuvant alternatives.
Harness® MAX	Postemergence in corn use either COC or NIS. A nitrogen-based adjuvant (AMS or UAN) may also be added to increase weed control consistency. The use of nitrogen-based adjuvants will increase the risk of temporary crop injury. Do not include AMS or UAN when making postemergence applications of this product to yellow popcorn. COC at 1.0% v/v COC NIS at 0.25% v/v
Huskie® herbicide	AMS, UAN, or NIS may help optimize herbicide activity in challenging spring conditions where Huskie® herbicide is applied alone. When tank-mixing use additives according to the label for the tank-mix partner as additional additives may cause unacceptable crop response. AMS: 0.5- 1 lb/A UAN: 1-2 qt/A NIS (with 80% concentration): 0.25-0.5% v/v (1-2 qt/100 gallons).



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Herbicide	Adjuvant Recommendations
Huskie® Complete herbicide	Huskie® Complete herbicide is a restricted use pesticide. AMS: 0.5-1.0 lb/A UAN: 1pt/A to 1 qt/A
Huskie® FX herbicide	To improve weed control, especially in challenging growing conditions AMS: 0.5 to 1.0 lb/A NIS: 0.35 to 0.5% v/v (1 to 2 qt/100 gallons) UAN: 1-2 qt/A *Watchout with additives due to risk for crop response if Huskie® FX herbicide is applied in a tank mixture. Follow label for tank-mix partner for required adjuvants.
Laudis® herbicide	Requires external surfactant and nitrogen fertilizer source to achieve optimum weed control. MSO based products are preferred with Laudis® herbicide particularly when used alone or tank-mixed with atrazine. MSO: 1% v/v (1 gal MSO/100 gallons water) HSOC may be used with Laudis® herbicide as an alternative to MSO surfactants. NIS or refined vegetable oils will result in unacceptable or erratic weed control. Fertilizer: AMS (1.5 lb/A or 8.5lb per 100 gal) or UAN (1.5qt/A). Use UAN under conditions of low relative humidity for greater weed control.
Olympus® 70% Water Dispersible Granular herbicide	NIS required at 0.25 to 0.5% v/v
Osprey® herbicide	Adjuvants required. NIS plus ammonium nitrogen fertilizer (UAN or AMS). NIS: 0.5% v/v (2 qt/ 100 gallons) UAN: 1-2 qt/A AMS: 1.5-3lb/A Basic blend adjuvant (pre-mix of NIS or MSO and a nitrogen source): 1% v/v or 0.8 -1.6 pt/A MSO: 1.3-1.5 pt/A *substituting MSO for NIS may induce greater crop response. Do not use ammonium nitrogen source if using MSO.
Rimfire® Max herbicide	Adjuvant required. MSO: 1.3-1.5 pt/A Basic Blend: 1- 1.25% v/v and at least 0.8 pt/A NIS plus ammonium nitrogen fertilizer (UAN or AMS): NIS at 0.25 to 0.5% v/v or 1-2 qts/100 gallons. UAN at 1-2 qt/ac or AMS at 1.5-3 lbs/A
Roundup PowerMAX® herbicide	Extra surfactant is generally not recommended. AMS could increase the performance of this product on annual and perennial weeds, particularly under hard water conditions, drought conditions or when tank-mixed with certain residual herbicides. Rate: 1 to 2% dry AMS or equivalent rate of liquid formulation.
Roundup PowerMAX® II herbicide	Do not add buffering or pH adjusting agents to the spray solution when either Roundup PowerMAX® herbicide, Roundup PowerMAX® II herbicide, or Roundup PowerMAX® 3 herbicide is the only pesticide product being applied.
Roundup PowerMAX® 3 herbicide	Do not add additional surfactant or additives containing surfactant to this product for preharvest application to cotton or any postemergence (in-crop) application to Roundup Ready® cotton and Roundup Ready® Flex cotton.
Roundup WeatherMAX® herbicide	Extra surfactant is generally not recommended. AMS could increase the performance of this product on annual and perennial weeds, particularly under hard water conditions, drought conditions or when tank-mixed with certain residual herbicides. Rate: 1 to 2% dry AMS or equivalent rate of liquid formulation.
RT 3® herbicide	Extra surfactant is generally not recommended. AMS could increase the performance of this product on annual and perennial weeds, particularly under hard water conditions, drought conditions or when tank-mixed with certain residual herbicides. Rate: 1 to 2% dry AMS or equivalent rate of liquid formulation.



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Herbicide	Adjuvant Recommendations
Warrant® Ultra herbicide	<p>No adjuvants are needed unless Warrant Ultra® herbicide is being used to burndown emerged weeds. For postemergence applications add one of the following except in tank mix products prohibiting spray additives:</p> <ol style="list-style-type: none"> 1. NIS containing at least 75% surface active agent at 0.25 to 0.5% v/v (1-2 qts/100 gal) 2. COC (nonphytotoxic containing at least 15-20% approved emulsifier) at 0.5-1% v/v (0.5 to 1 gal/100 gal). *COC can improve weed control but may reduce crop tolerance. 3. MSO (nonphytotoxic containing at least 60% methylated seed oil). *Poor performance may result from the use of MSO products containing less than 60% methylated seed oil. MSO can improve weed control but may reduce crop tolerance.
Wolverine™ PowerPak herbicide	AMS: 0.5-1 lb/acre or UAN may be utilized at 1-2 qt/acre
XtendiMax® herbicide with VaporGrip® technology	XtendiMax® herbicide with VaporGrip® Technology is a restricted use pesticide and must be used with VaporGrip® Xtra Agent (or an equivalent volatility reduction adjuvant). For approved tank-mix products (including VRAs and DRAs), nozzles and other important label information visit XtendiMaxApplicationRequirements.com . Do Not tank mix with AMS.

Assumptions unless otherwise stated: AMS and UAN are spray-grade quality, NIS at 80% concentration, MSO at least 80% methylated seed oil and 10% emulsifier.

For additional information, contact your local Bayer representative.



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Types of Adjuvants

There are several adjuvants that can be used with herbicides such as surfactants, oil concentrates, ammonium N fertilizers, spreader-stickers, wetting agents, and penetrants.^{1,2,3} Nonionic surfactants (NIS) are good dispersing agents to help improve plant coverage and penetration of foliar-applied herbicides with low toxicity to crop. Oil concentrates help improve herbicide penetration into leaf surfaces and reduce surface tension. Crop oil concentrates (COC) are derived from petroleum. Methylated seed oils (MSO) function like other oil concentrates but are derived from seed oils.² High surfactant oil concentrates (HSOC) are emulsifiable oil-based products containing 25-50% surfactant (wt/wt) in a minimum of 50% oil (wt/wt). HSOC oil concentrates may be MSO or COC based. COC, MSO, and HSOC, may increase the risk of crop injury more than surfactants.³ Ammonium N fertilizer products, used at recommended rates, can act as adjuvants to help improve the performance of certain herbicides especially under hard water conditions, drought, or in tank mixtures. Spray-grade ammonium sulfate (AMS) or urea ammonium nitrate (UAN) are common N fertilizer adjuvants. N fertilizer solutions are generally recommended in conjunction with NIS or COC. Blended adjuvants contain specific combinations of special purpose and/or activator adjuvants that serve multiple functions.²

Sources:

- ¹ Jordan, T, Johnson, B., and Nice, G. 2011. Adjuvants used with herbicides: Factors to consider. Purdue University. <https://extension.entm.purdue.edu/pestcrop/2011/issue25/index.html#adjuvant>.
 - ² Curran, W.S. and Lingenfelter, D.D. 2009. Adjuvants for enhancing herbicide performance. Agronomy Facts 37. Penn State Extension. <https://extension.psu.edu/>.
 - ³ Hartzler, R. 2013. (Re) learning to accept herbicide injury to crops. Iowa State University, <https://www.extension.iastate.edu/>.
- Hartzler, B. 2001. Role of spray adjuvants with postemergence herbicides. Iowa State University Weed Science Online <https://crops.extension.iastate.edu/encyclopedia/role-spray-adjuvants-postemergence-herbicides>.

Web sources verified 6/29/21.

Legal statements

XtendiMax® herbicide with VaporGrip® Technology is part of the Roundup Ready® Xtend Crop System, is a restricted use pesticide and must be used with VaporGrip® Xtra Agent (or an equivalent volatility reduction adjuvant). For approved tank-mix products (including VRAs and DRAs), nozzles and other important label information visit XtendiMaxApplicationRequirements.com.

ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Roundup Technology® includes glyphosate-based herbicide technologies.

Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.

Balance® Flexx, Corvus®, Degree Xtra®, Huskie® Complete and XtendiMax® are restricted use pesticides. Not all products are registered in all states and may be subject to use restrictions. The distribution, sale, or use of an unregistered pesticide is a violation of federal and/or state law and is strictly prohibited. Check with your local dealer or representative for the product registration status in your state. Tank mixtures: The applicable labeling for each product must be in the possession of the user at the time of application. Follow applicable use instructions, including application rates, precautions and restrictions of each product used in the tank mixture. Not all tank mix product formulations have been tested for compatibility or performance other than specifically listed by brand name. Always predetermine the compatibility of tank mixtures by mixing small proportional quantities in advance. Autumn™, Axiom®, Balance®, Bayer, Bayer Cross, Capreno®, Corvus®, Degree Xtra®, DiFlexx®, Harness®, Huskie®, Laudis®, Olympus®, Osprey®, Rimfire®, Roundup PowerMAX®, Roundup Ready®, Roundup Technology®, Roundup WeatherMAX®, RT 3®, TripleFLEX®, VaporGrip®, Varro®, Warrant®, Wolverine® and XtendiMax® are trademarks of Bayer Group. All other trademarks are the property of their respective owners. For additional product information call toll-free 1-866-99-BAYER (1-866-992-2937) or visit our website at www.BayerCropScience.us. Bayer CropScience LP, 800 North Lindbergh Boulevard, St. Louis, MO 63167. ©2021 Bayer Group. All rights reserved. 1034_S3

