



SOIL

Herbicide Surfactants and Adjuvants no. 0.559

by P. Miller and P. Westra ¹

Quick Facts...

Adjuvants and surfactants are materials added to spray solutions to improve the performance of crop protection compounds (herbicides).

Based on chemical composition, surfactants can be divided into the following five groupings:

1. non-ionic surfactants (NIS)
2. crop oil concentrates (COC)
3. nitrogen-surfactant blends
4. esterified seed oils
5. organo-silicones

Not all oils are created equal with respect to surfactant performance and they should be evaluated carefully before using.

Adjuvants and surfactants are spray solution additives, and are considered to be any product added to an herbicide solution to improve the performance of the spray mixture.

Examples of adjuvants include compatibility agents (used to aid mixing two or more herbicides in a common spray solution), drift retardants (used to decrease the potential for herbicide drift), suspension aids (used to aid mixing and suspending herbicide formulations in solution), spray buffers (used to change the spray solution acidity), and surfactants.

Surfactants (surface active agents) are a type of adjuvant designed to improve the dispersing/emulsifying, absorbing, spreading, sticking and/or pest-penetrating properties of the spray mixture. Pure water will stand as a droplet, with a small area of contact with the waxy leaf surface. Water droplets containing a surfactant will spread in a thin layer over a waxy leaf surface.

Because postemergence herbicide effectiveness is greatly influenced by plant factors such as age, size and the growing conditions encountered before application, herbicide performance can vary. A way to minimize the variations in postemergence herbicide performance is to use an adjuvant or surfactant in the spray solution. Adjuvants, specifically surfactants, generally improve the effectiveness of postemergence herbicides. Typically, surfactants are not added to herbicides that are soil applied (pre-emergence).

The surfactants listed below are categorized into groups or classes based on their chemical composition and how they work. Generally, five surfactant classes are recognized. Table 1 lists their general usage.

Surfactant Class Definitions

Nonionic surfactants are comprised of linear or nonyl-phenol alcohols and/or fatty acids. This class of surfactant reduces surface tension and improves spreading, sticking and herbicide uptake.

Crop oil concentrates are composed of a blend of paraffinic-based petroleum oil and surfactants. This surfactant class reduces surface tension and improves herbicide uptake and leaf surface spreading.

Nitrogen-surfactant blends consist of premix combinations of various forms of nitrogen and surfactants. They generally are used with herbicides recommending the addition of ammonium sulfate or 28 percent nitrogen. These surfactants reduce surface tension and improve leaf surface spreading.

Esterified seed oils are produced by reacting fatty acids from seed oils (corn, soybean, sunflower, canola) with an alcohol to form esters. The methyl or ethyl esters produced by this reaction are combined with surfactants/emulsifiers to form an esterified seed oil. These surfactants reduce surface tension and improve herbicide uptake by improving herbicide distribution on the leaf surface.

**Colorado
State**
University
Cooperative
Extension

© Colorado State University
Cooperative Extension. 12/96.
Reviewed 10/98.

www.colostate.edu/Depts/CoopExt

Table 1: Surfactant classes and their general usage.

Surfactant Class	General Usage
nonionic surfactants (NIS)	all purpose
crop oil concentrates (COC)	used primarily with grass herbicides
nitrogen-surfactant blends	used primarily with broadleaf herbicides
esterified seed oils	all purpose
organo-silicones	all purpose

Organo-silicones are usually silicone/surfactant blends of silicone to nonionic or other surfactants; a few within this classification are composed entirely of silicone. These surfactants provide a tremendous reduction in surface tension and spread more than conventional surfactants. In addition, this class of surfactant provides improved effectiveness through maximum rainfastness.

The addition of oils as surfactants in spray solutions is a relatively common practice, depending on the type of herbicide and the weeds involved. As such, it is important to note that not all oils provide the same surfactant effectiveness. In general, three types of oils are commonly referred to as surfactants: vegetable seed oils, crop oil concentrates, and esterified seed oils.

Vegetable seed oils are a blend of vegetable oil (cottonseed, soybean) and surfactants. These surfactants exhibit good crop tolerance but do not have good spreading, sticking or pest-penetrating properties.

Crop oil concentrates are a blend of paraffinic oil (petroleum based) and surfactants. These surfactants exhibit good spreading and penetrating properties but crop tolerance may be a problem.

Esterified seed oils are comprised of a methyl or ethyl ester of a vegetable seed oil (sunflower, soybean, corn, canola) combined with a surfactant/emulsifier. These spray solution additives have good spreading and pest-penetrating properties and convey good crop tolerance. However, these additives generally are more expensive than vegetable seed oils or crop oil concentrates.

Why Should You Select a Specific Surfactant Type?

The active ingredient is the agent in an herbicide formulation that has a specific effect on a weed. Select a surfactant that will best complement the action of the active ingredient and formulation type chosen for the specific application conditions. Consider the following points:

What are the environmental conditions before herbicide application?

- Conditions not ideal for plant growth (hot and dry) do not favor optimum herbicidal activity.
- If an herbicide must be applied under less than ideal conditions, a surfactant (crop oil concentrate, esterified seed oil or organo-silicate) may greatly improve performance.

What environmental conditions are likely to follow herbicide application?

- Not all surfactants are equal with respect to degree of rainfastness.
- Surfactant classes providing rapid rainfastness include esterified seed oils, organo-silicates and most nitrogen-surfactant blends.

What are the leaf-surface characteristics of the plant(s) to be protected or controlled?

- Thick and waxy leaf surfaces, hairy or narrow-leafed (grasses) plants are generally less susceptible to herbicide phytotoxicity than broad-leafed plants with little or no hair.
- The addition of a surfactant may greatly improve herbicide performance where the leaf surface is thick and waxy, hairy or narrow-leafed.
- In addition to improving the herbicidal activity on undesired plants, surfactants also can enhance the potential for increased phytotoxicity on desirable plants. In order to achieve performance and lessen the potential for unwanted crop injury (phytotoxicity), always read and follow the herbicide label instructions on surfactant selection and use.

What cost concerns are there?

- Surfactant costs vary widely. In general, non-ionic surfactants and crop oil concentrates are the least expensive of the surfactant classes, followed by nitrogen-surfactant blends, esterified seed oils and organo-silicates.

Table 2: Surfactant class, chemical composition, and a list of herbicides commonly used with each class of surfactant.

Surfactant Class	Composition	Commonly Used With*
non-ionic surfactant (NIS)	linear or nonyl-phenol alcohols and/or fatty acids	Assure II, Fusilade 2000, Fusion and Gramoxone Extra
crop oil concentrates (COC)	parafinic oil (80 - 90 %) + surfactants (20 - 10 %)	atrazine, Assure II, Fusilade 2000, Fusion, Laddock, Poast Poast Plus and Select
nitrogen-surfactant blends	surfactant + some nitrogen form (ammonium sulfate or 28% N)	Roundup, Classic, Pinnacle and Pursuit
esterified seed oils	fatty acids from seed oils reacted with an alcohol to form esters	Accent, Beacon, and Pursuit
organo-silicates	composed entirely of silicone, blends of silicone with non-ionic or other surfactants	Basagran, Blazer, Cobra, Galaxy, Reflex, Storm and/or Tornado

*Including but not limited to these herbicides. Users must read and follow the label on the product container. No endorsement is intended, nor is any criticism implied, of similar products not mentioned.

Table 3: Surfactant class, selected product within a surfactant class and product manufacturer.

Surfactant Class	Product Name*	Manufacturer
non-ionic surfactant (NIS)	Activator 90	United Ag Products
	Penetrate II	Wilfarm
	Triton Ag 98	Rhone-Poulenc
	X-77	United Ag Products
crop oil concentrates (COC)	Agri-Dex (99:1)	Helena
	Crop Oil Plus (83:17)	Wilfarm
	Prime Oil (83:15)	Terra
nitrogen-surfactant blends	Cayuse Plus (surfactant + AMS)	Wilfarm
	Chaser (surfactant + 28% N)	Terra
	Dispatch (surfactant + 28% N)	United Ag Products
	Patrol (surfactant + 28% N)	Helena
esterified seed oils	Hasten	Wilfarm
	Meth-Oil	Terra
	MSO	United Ag Products
	Sun-it II	Cyanamid
organo-silicates	Sylgard 309 (straight silicone)	Wilfarm
	Silwet L-77 (straight silicone)	United Ag Products
	Kinetic (silicone/surfactant blend)	Helena
	Herbex (silicone/surfactant blend)	American Colloid

*Including but not limited to these surfactants. No endorsement is intended, nor is any criticism implied, of similar products not mentioned.

¹P. Miller, Colorado State University post-doctoral research fellow, and P. Westra, Cooperative Extensionweed specialist and professor; bioagricultural sciences and pest management.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Milan A. Rewerts, Director of Cooperative Extension, Colorado State University, Fort Collins, Colorado. Cooperative Extension programs are available to all without discrimination. No endorsement of products mentioned is intended nor is criticism implied of products not mentioned.