

## APPENDIX R: Adjuvants and Surfactants Addressed by Bakke (2003A)

The following surfactants have been reviewed in risk assessments and may be used to help herbicides adhere to target plants (Bakke, 2003a). The effects of using these ingredients, along with other inerts and metabolites, have been disclosed in the Invasive Plant FEIS (2005a). Most surfactants do not have adverse effects of concern. At certain rates, NPE (Nonylphenol Polyethoxylate) surfactants have been shown to have adverse effects on human health and aquatic ecosystem elements so some limitations on their use have been included in the PDC.

- **Surfactants**

There are several different basic chemistries of surfactants. Examples of each<sup>1</sup>:

Ethoxylated fatty amines (Cationic)

Entry™ II (Monsanto Company)

POEA - Roundup® has 15 percent POEA

Alkylphenol ethoxylate-based surfactants (non-ionic)

R-11® Spreader Activator (Wilbur-Ellis Company)

Activator 90 (Loveland Industries)

X-77® (Loveland Industries)

Latron AG-98™ (N) (Dow AgroSciences LLC)

Latron AG-98™ (Dow AgroSciences LLC)

Cide-kick®, Cide-kick® II™ (Brewer International)

These surfactants usually include an alcohol as a solvent (isopropanol (X-77®, AG-98™), butanol (R-11®, AG-98™ (N)), glycol (AG-98™ (N), Activator 90), a silicone defoamer (polydimethylsiloxane), and water.

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<sup>1</sup> The use of product names is for illustrative purposes only and is not intended as a recommendation for use or an endorsement of these products by the USDA Forest Service.

### Alcohol ethoxylate-based surfactants (non-ionic)

Activator N.F. (Loveland Industries)

### Silicone-Based Surfactants

Also known as organosilicones, these are increasing in popularity because of their superior spreading ability. This class contains a polysiloxane chain. Some of these are a blend of non-ionic surfactants (NIS) and silicone while others are entirely silicone. The combination of NIS and a silicone surfactant can increase absorption into a plant so that the time between application and rainfall can be shortened. Examples:

Sylgard<sup>®</sup> 309 (Wilbur-Ellis Company) –silicones

Freeway<sup>®</sup> (Loveland Industries) –silicone blend

Dyne-Amic<sup>®</sup> (Helena Chemical Company) - silicone blend

Silwet L-77<sup>®</sup> (Loveland and Helena) - silicones

Blends normally include an alcohol ethoxylate, a defoamer, and propylene glycol.

### Oils

Adjuvants that are primarily oil-based have been gaining in popularity especially for the control of grassy weeds. Oil additives function to increase herbicide absorption through plant tissues and increase spray retention. They are especially useful in applications of herbicides to woody brush or tree stems to allow for penetration through the bark. Oil adjuvants are made up of either petroleum, vegetable, or methylated vegetable or seed oils plus an emulsifier for dispersion in water.

*Vegetable Oils:* The methylated seed oils are formed from common seed oils, such as canola, soybean, or cotton. They act to increase penetration of the herbicide. These are comparable in performance to crop oil concentrates. In addition, silicone-seed oil blends are also available that take advantage of the spreading ability of the silicones and the penetrating characteristics of the seed oils.

The U.S. Food and Drug Administration (FDA) considers methyl and ethyl esters of fatty acids produced from edible fats and oils to be food grade additives (CFR 172.225). Because of the lack of exact ingredient statements on these surfactants, it is not always clear whether the oils that are used in them meet the U.S. FDA standard.

MSO<sup>®</sup> Concentrate Methylated Seed Oil (Loveland Industries)

Hasten<sup>®</sup> (Wilbur-Ellis Company)

The surfactant in Pathfinder<sup>™</sup> II (a triclopyr formulation)

Improved JLB Oil Plus (Brewer International)

Cide-Kick and Cide-Kick II (Brewer International)

Blends of vegetable oils and silicone-based surfactants

Syl-tac<sup>™</sup> (Wilbur-Ellis Company)

Phase<sup>™</sup> (Loveland Industries)

*Crop Oils and Crop Oil Concentrates:* These are normally derivatives of paraffin-based petroleum oil. Crop oils are generally 95 to 98 percent oil with 1 to 2 percent surfactant/emulsifier. Crop oils also promote the penetration of a pesticide spray. Traditional crop oils are more commonly used in insect and disease control than with herbicides. Crop oil concentrates are a blend of crop oils (80 to 85 percent) and a nonionic surfactant (15 to 20 percent). The purpose of the nonionic surfactant in this mixture is to emulsify the oil in the spray solution and lower the surface tension of the overall spray solution.

kerosene (found in the triclopyr formulation Garlon 4),

Agri-dex<sup>®</sup> (Helena Chemical Co. or Setre Chemical Co.)

Red-Top Mor-Act<sup>®</sup> (Wilbur-Ellis Company)

- **Special Purpose or Utility Adjuvants**

The special purpose or utility adjuvants are used to offset or correct certain conditions associated with mixing and application such as impurities in the spray solution, extreme pH levels, and drift. These adjuvants include acidifiers, buffering agents, water conditioners, anti-foaming agents, compatibility agents, and drift control agents.

The pH of most solutions is not high or low enough for important herbicide breakdown in the spray tank. pH reducing adjuvants (example LI-700<sup>®</sup>) are sometimes recommended for use with herbicides because of greater absorption of weak acid type herbicides when the spray solution is acidic.

LI-700<sup>®</sup> Surfactant Penetrant Acidifier – (Loveland Industries)