

SURFACTANTS AND HERBICIDES

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Surfactants are used as additives to herbicidal sprays to enhance the effect of herbicides on the target species. In this article, I will try to cover some of the fundamental facts about surfactants with practical application to herbicidal sprays such as: what are surfactants, types of surfactants, what are the advantages of surfactants, which ones should be used, how much should be used, etc.

WHAT IS A SURFACTANT? A material which improves the emulsifying, dispersing, spreading, wetting or other surface modifying properties of liquids. A typical surfactant molecule is made of two parts, a non-polar tail and a polar head. Based on net electrical charge on the polar part, surfactants are classified in four groups, cationic or positively charged, anionic or negatively charged and amphoteric which have both acidic and basic moieties in the polar part.

HOW DOES A SURFACTANT WORK? The main function of surfactants in a herbicide solution is to reduce surface tension. Surface tension is a force with dimensions by dynes/cm that is a measure of work required to increase the area of a surface by one square centimeter. Reduction in surface tension increases the wetting ability of a surface (could be a leaf surface) by reducing contact angle. The angle formed by a droplet in contact with a solid surface, measured from within the droplet is called contact angle. Contact angle without a surfactant is shown in Figure 1A in which surface tension is higher and the drop is round in shape. When the surfactant is added to a solution surface, tension is reduced and the droplet becomes flatter as shown in Figure 1B. The additional advantages of surfactants are described later in this article.

HOW MUCH TO USE? As I have indicated earlier, surfactants are only additives to herbicide solutions and they do not contain any herbicidal properties. It is quite normal to believe the old saying "If a small amount is good, then more will be better," however, in case of surfactants, it is not so. Figure 2 indicates that initially, an increase in surfactant concentration reduces the surface tension which reduces the contact angle, and since reduced contact angle is a function of surface tension, consequently wetting is increased. After surfactant concentration reaches a certain limit, there is no further reduction in surface tension which a minimum contact angle and maximum wetting is obtained at this concentration. The surfactant concentration is called "Critical Micelle Concentration" (CMC). At CMC, the liquid surface is covered with a monomolecular layer of surfactant and if additional surfactant is added, there is no surface available to accommodate additional surfactant molecules and they start going below the surface and start micelle for-

mation. Therefore, there is no further reduction in surface tension. Adding surfactant beyond CMC will not benefit the herbicidal effect and will increase costs unnecessarily. CMC varies from surfactant to surfactant but the general range will be 0.1 to 0.25% (v/v). Therefore, surfactants should be added to herbicide sprays in this range. Most effective surfactants have low CMC, lower surface tension and contact angle of CMC.

Advantages of Surfactants in Herbicidal Sprays

- 1. SMALLER DROPLETS:** Herbicide sprays containing surfactants produce smaller droplets which spread more uniformly on plant surfaces. This uniformity of spread improves the efficacy of herbicides.
- 2. SURFACTANTS IMPROVE THE WETTING OF LEAVES:** Surfactants improve wetting of the leaf surface and herbicides are absorbed through a larger area which means more herbicide is entering the plant and producing better results.
- 3. SURFACTANTS IMPROVE SPREADING OF DROP ON THE LEAF:** Without a surfactant in the herbicidal spray, the drop is close to round in shape and easily rolls off the leaf surface. Surfactants tend to flatten the drop and it does not fall easily from the target surface.
- 4. SURFACTANTS REDUCE THE RATE OF EVAPORATION:** Reduction in rate of evaporation caused by surfactants allows herbicide spray droplets to remain in liquid form for longer periods of time. Since herbicides are absorbed in liquid form, the absorption is greatly enhanced.
- 5. SURFACTANTS DISSOLVE THE WAXES:** Most of the leaf surfaces are covered with wax. Surfactants dissolve the cuticle wax and enhance foliar retention and penetration of herbicidal sprays.
- 6. SURFACTANTS IMPROVE THE TRANSLOCATION OF HERBICIDES IN PLANTS:** Surfactants are absorbed by the plant along with herbicides and they increase the movement of herbicides within the plant.

There are many surfactants and surfactant-like materials available on the market today. It is wise to select a proper surfactant. Most of the time surfactants are identified by their trade names for a particular herbicide by the manufacturer of the herbicide. But if this type of information is not available, then the selection could be made on the basis of CMC, surface tension and contact angle values at CMC, and their phytotoxic effect on the plant. Manufacturers of surfactants should be able to provide this information. A good surfactant should have a lower CMC, very low surface tension and contact angle at CMC and should not have any phytotoxic effect on the plant. In Figure 2, both surfactant A and B have approximately the same CMC, but surfactant B has lower surface tension and will produce a smaller contact angle which means higher wetting ability. Therefore, surfactant B is considered more effective than surfactant A. Non-ionic surfactants are most commonly used as additives with herbicidal sprays. ■

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