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Fruit Diseases

Using Adjuvants in Apple Disease Management

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Fruit appearance is of premium importance to fresh market apple production. To protect the appearance of apples, growers apply fungicides to prevent disease. Increasingly, fruit growers are interested in using adjuvants to improve disease management, similar to how adjuvants have improved weed management.

However, most studies have found that fungicide-adjuvant interactions are more complex and the results are not always consistent. This publication aims to help fruit growers understand what adjuvants are, what they can do, and when they can be safely used — all important factors to consider before adding adjuvants to a disease management strategy.

Active Ingredient	
fenbuconazole: a-[2-(4-chlorophenyl)ethyl]-a-phenyl-1H-1,2,4-triazole-propanenitrile	23.5%
Other Ingredients	76.5%
Total	100.0%

Figure 1. *Most modern fungicides have the surfactants built into the product.*

Under some conditions, the use of additives or adjuvants may improve the performance of **Merivon**. However, all varieties and cultivars have not been tested with possible tank mix combinations. Local conditions can also influence crop tolerance and may not match those under which BASF has conducted testing. Physical incompatibility, reduced disease control, or crop injury may result from mixing **Merivon** with other products. Therefore, before using any tank mix (fungicides, insecticides, herbicides, liquid fertilizers, biological control products, adjuvants, and additives), test the combination on a small portion of the crop to be treated to ensure that a phytotoxic response will not occur as a result of application.

Figure 2. *The label is a history lesson: Be sure to read and follow to prevent injury from occurring.*

What Are Adjuvants?

Adjuvants are a diverse group of chemicals that can be added to a spray tank to improve how a pesticide performs or how it is applied. Manufacturers have promoted adjuvants by claiming that they increase pesticide activity/efficacy, improve how well a pesticide "sticks" to the plant's surface (adsorption), and reduce weathering and **photodegradation** (the process whereby sunlight breaks down a pesticide).

Adjuvants include anti-flocculants, buffers, crop oils, defoamers, emulsifiers, fertilizers, penetrants, and surfactants, to name but a few. It is important to note that many recently released pesticides are prepackaged with adjuvants (called additives), which are listed as "inert ingredients" on product labels (Figure 1).

The propriety nature of many companies' inert ingredients reflects why certain pesticide formulations are more effective than others in controlling certain pests, despite equal amounts of the same active ingredient. Labels also state that applicators must take care when using certain adjuvants with some fungicides to prevent **phytotoxicity** or **chemical damage** that can result in fruit russetting, plant injury, and even plant death (Figure 2, page 1).

Incorporating adjuvants with fungicides may potentially improve disease control by increasing the fungicide's penetration, by improving the fungicide's dispersion (spread), or by extending the fungicide's persistence on the plant.

Surfactants (or surface-active agents) are adjuvants that are used to improve the spray quality of pesticides. Some surfactants (called spreaders) are wetting agents that reduce the amount of beading on the leaf surface, thereby improving fungicide coverage (Figure 3). A common surfactant spreader used in apple production is Regulaid®, which improves the coverage of streptomycin and growth regulators.

Surfactants that help fungicides adhere or "stick" to plant surfaces are called **stickers**. A sticker improves how the fungicide **adsorbs** to the leaf surface, thereby improving persistence (stick) or adhesion. Stickers also can decrease the rate at which rain can wash off the fungicide or sunlight can break down the fungicide (**photodegradation**).

Surfactants are the most important and widely used of all adjuvants. They have the potential to reduce the amount of active ingredient applicators must spray. They could also improve spray performance by improving how that spray is delivered and if it adheres (sticks) to the plant surface, or if it is absorbed by the plant.

Penetrants are adjuvants that increase the ability of a pesticide to permeate or pass into a living organism (**absorb** — not to be confused with adsorb). Applicators most commonly use penetrants with herbicides. Researchers have found that some penetrants improve disease management in apples (Deford and Beckerman, 2009; Abbott and Beckerman, 2014, 2016) (Figure 4).

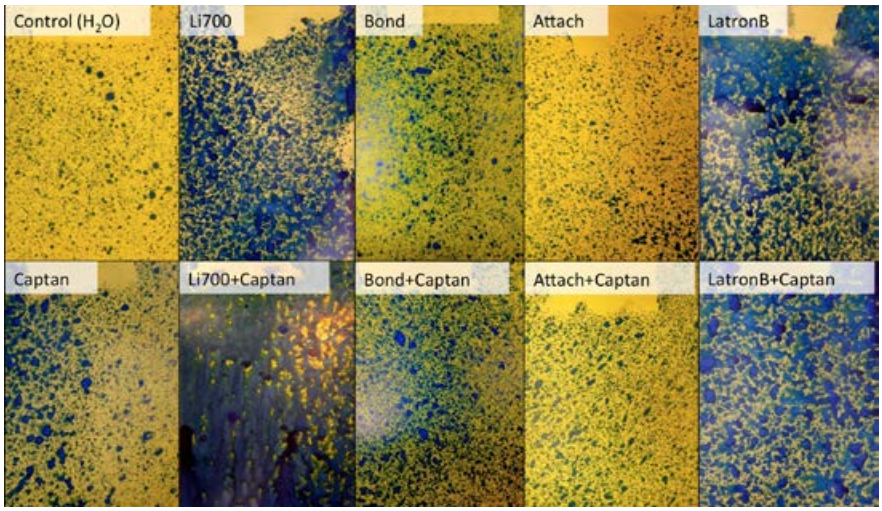

Figure 3. *Surfactants can improve the spread and solubility of fungicides. Photo by Chelsi Abbott.*

A non-polymer containing spray adjuvant approved for use with registered pesticide products may be added to spray solutions according to manufacturer's use instructions to achieve optimum disease control.

Figure 4. *Some labels encourage applicators to use specific types of adjuvants.*

Figure 5. *Russetting can result from using a surfactant by itself or from combining surfactants with various fungicides, particularly under poor drying conditions. Photo by Janna Beckerman.*

Other fungicide-surfactant combinations resulted in inconsistent to poor results with other penetrants and even phytotoxicity (Abbott and Beckerman, 2015) (Figure 5).

While it might seem like a good idea to get a fungicide to penetrate into a plant, the reality is that many older fungicides like captan or copper are extremely toxic if they get into the plant — this could result in plant damage and even widespread crop loss.

Acidifiers are surfactants that lower the pH (acidify) of a spray tank solution. This is particularly important for a fungicide like captan, which has a half-life of 20 minutes if the water has a pH greater than 8 (alkaline). In other words, captan breaks down and is considered ineffective in 40 minutes in high-pH conditions. An acidifier will improve captan performance if the tank water has a pH of 8 or greater.

However, with a fungicide like copper, an acidifier could make the copper phytotoxic, which could damage the plant (particularly flowers and fruit) or even kill it. This is but one example of the care applicators must take to choose the right adjuvant-pesticide combination.

As always, carefully read product labels before adding any adjuvant to a mixture and take care when mixing pesticides — the adjuvant you include to improve the performance of one pesticide may result in phytotoxicity when mixed with another product. Examples of this include combinations of captan with Merivon®, Aliette® with copper fungicides, and captan with any oil (Figure 6). This is why some fungicide labels prohibit the use of some adjuvants because of the increased potential for phytotoxicity or plant damage (Figure 2).

Combining adjuvants with many fungicides has the potential to improve disease management by reducing fungicide rates and extending the interval between applications. This can reduce pesticide use, and, ultimately, increase a grower's net return in apple production. Before widespread use in any orchard, carefully evaluate adjuvant-fungicide combinations in small test plots and be aware that different apple varieties will respond in different ways.

Figure 6. *Captan can become phytotoxic when mixed with oil or other adjuvants. Photo by Janna Beckerman.*

For additional information about the ways adjuvants modify pesticide performance, see *Adjuvants and the Power of the Spray Droplet: Improving the Performance of Pesticide Applications* (Purdue Extension publication PPP-107), available from the Education Store, www.edustore.purdue.edu.

Literature Cited

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Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Individuals using such products assume responsibility for their use in accordance with current directions of the manufacturer.

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