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Adjuvant Safety
Benefits, Risks, and Best Practices

At a Glance: Adjuvants are substances added to pesticide mixtures to enhance the mixtures' performance and effectiveness. Proper use of an adjuvant can improve pesticide action and application while minimizing environmental impacts. However, if mishandled or used incorrectly, adjuvants can potentially harm plants, non-target organisms, or human health. This publication can help pesticide applicators use adjuvants appropriately to maximize benefits and minimize risks.

Figure 1. Phytotoxicity symptoms after pesticide application on coffee leaves. Photo: Andrea Kawabata

Introduction

Adjuvants are supplemental substances like emulsifiers, spreaders, water modifiers, and other compounds that are added to pesticide spray or drench mixtures to enhance their performance and physical properties. Adjuvants are regulated by the U.S. Environmental Protection Agency's Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), but are not considered pesticides. Therefore, regulation of these products is limited to labeling them as inert ingredients in pesticides and establishing tolerances for foods (EPA 2025). However, adjuvants play a critical role in modern agriculture by improving the efficacy and application of pesticides and minimizing environmental impact from pesticide use. Some pesticides have adjuvants pre-mixed into their formulations, while others do not. Adjuvants can also be purchased separately and then tank mixed to improve the effectiveness of pesticide applications. However helpful, adjuvants must be handled and used properly, or they can potentially cause phytotoxicity to plants (Figure 1), result in toxicity to non-target organisms, and pose hazards to human health (Foy and Pritchard 1996).

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Types of Adjuvants and Their Benefits

Adjuvants are categorized based on their function and composition. Some adjuvants have characteristics that fit several different categories, such as surfactant and penetrant. Here are several common types of adjuvants:

- **Water conditioners, buffers, and activators** improve pesticide performance by preventing minerals in water from interfering with pesticide action or by giving the water physical properties that are beneficial to the application. For example, Choice® Weather Master (Loveland Products; Greenville, MS) is a water conditioner that lowers water pH, softens water by binding hardwater cations like calcium and magnesium, and is supplemented with nitrogen, which enhances plant uptake of systemic herbicides, thus ensuring herbicide efficacy. Another example, Alligare® DownForce (Alligare; Opelika, AL), is designed to improve pesticide applications by normalizing droplet size within an ideal range for drift reduction and better canopy penetration.
- **Surfactants** help to reduce surface tension by allowing spray droplets to quickly wet and spread more uniformly across plant surfaces, thereby improving spray coverage. Silwet® L-77 (Momentive; Seoul, South Korea) is an example of an organosilicone-based surfactant that enhances the spreading and coverage of pesticides on the target site surface. MSO® Concentrate with Leci-Tech® (Loveland Products; Greenville, MS), a methylated seed oil, enhances herbicide surface distribution and penetration to improve absorption and efficacy.
- **Spreader stickers** improve the adhesion and spreading of pesticides on plant surfaces. For example, Latron® B-1956 (Innvictis; Boise, ID), a resin-based nonionic surfactant, resists rewetting and removal by rain, making it ideal for use on hairy or waxy foliage. Spreader stickers can improve the efficacy of spray applications on hard-to-wet pests like spider mites, whiteflies, and mealybugs.
- **Penetrants** enhance the uptake of pesticides into plant tissues. Silwet® 408 (Momentive; Seoul, South Korea) is an example of a penetrant that assists the absorption of oil-based pesticides through the plant stomata to help make the product more effective.

Other types of adjuvants are also used with pesticides:

- **Wetting agents** allow wettable powders to mix with water.
- **Emulsifiers** allow petroleum-based pesticides and emulsifiable concentrates to mix with water.
- **Invert emulsifiers** allow water-based pesticides to mix with petroleum carriers.
- **Foaming agents** help reduce drift.
- **Thickeners** reduce drift by increasing droplet size.
- **Safeners** reduce the toxicity of a pesticide formulation by enhancing the plant's ability to quickly break down the pesticide.
- **Compatibility agents** improve the compatibility of fertilizers and pesticides in tank mixes.
- **Anti- and defoaming agents** reduce foaming of pesticide and fertilizer mixtures, especially those that require vigorous agitation (Bessin 2018).

Signal Words and Their Implications

Signal words on pesticide labels indicate the acute toxicity of the product and are categorized as CAUTION, WARNING, or DANGER. When combining pesticides with an adjuvant with a higher-level signal word, it is important to note that some adjuvants can potentially increase the toxicity of the pesticide mixture, pose greater safety concerns, and require additional safety precautions (Wierda et al. 2016). For example, the toxicity of pesticides can be amplified due to increased absorption, greater surface area exposure, and difficulty in washing (Martin et al. 2011) when tank mixing with emulsifying agents, some oil-based surfactants or penetrants, and resin stickers. Products labeled with WARNING and DANGER signal words may require additional personal protective equipment (PPE), such as chemical-resistant gloves, eye protection, and a respirator, compared to products with a CAUTION label (Wierda et al. 2016).

Risks Associated with Adjuvants

Handlers should always read adjuvant and pesticide labels thoroughly prior to use and follow all label directions. This is especially important because while adjuvants offer advantages, their mishandling, misuse, or overuse when used alone, or in combination with other products, can lead to significant risks such as phytotoxicity to plants, toxicity to non-target organisms, human health issues, and negative environmental impacts (Janssens 2017). Incorrect use of adjuvants and pesticides can kill sensitive plants. Organosilicone surfactants have been linked to harm in pollinators like bees (Mullin et al. 2016), and some adjuvants, such as alcohol ethoxylate and nonylphenol, can persist in groundwater and sewage, potentially impacting the environment (Petrovic and Barcelo 2000). Workers contacting pesticide mixes with adjuvants on plant materials can experience skin irritation and rashes, be afflicted with respiratory illness (Cox and Zeiss 2022), and be exposed to other problems. Also, pesticide adjuvants can potentially have adverse interactions, such as the creation of heat, precipitation of solids out of the mixture, gelling, solidification, neutralizing effects on other adjuvants, or reducing/eliminating efficacy of the

pesticide (Santos et al. 2021; Stanford Environmental Health and Safety 2020).

Should an accident happen, be sure to have the product label and Safety Data Sheet available as these include information about PPE and product hazards, as well as first aid instructions.

General Safety Precautions

The following precautions may help to ensure worker and handler safety, the efficacy of applications, and protection of plants and non-target species:

- **Safety Data Sheets (SDSs):** The Occupational Safety and Health Administration's Hazard Communication Standard (OSHA 2025) requires employers to educate and train workers on dangerous chemicals at the workplace and requires SDSs to be readily available to all workers. This is especially important during transportation, storage, and in case of emergencies as a product's SDS has more in-depth information about first aid and exposure response than the product label.
- **Product label(s):** Before use, carefully read the product label and be sure that you understand it. During and after adjuvant and pesticide use, continue to follow all product label instructions. An adjuvant label typically provides information on compatible pesticides, rate, storage, handling, PPE, first aid, and other safety measures.
- **Personal protective equipment (PPE):** Review all product labels of the pesticide(s) and adjuvant(s) to be tank mixed and use the highest level of PPE required by the products. Wearing more protection than the label requires is acceptable, but wearing less than the label requires is not legal and could lead to health issues for the handler (Sprague 2021). If using a respirator by choice or as required by the label, the wearer must first be medically approved to wear a respirator, trained to use one, and respirator fit tested.
- **Label rates:** Follow the label instructions for the rate per acre or the percentage of product or active ingredient to carrier in the mix. Over-application of an adjuvant not only wastes product and money, but also may cause phytotoxicity to the crop, potentially resulting in reduced marketable yield or, under extreme circumstances, total loss. Under-application can render the spray application less effective or ineffective thereby costing the operation time, product, and money to re-apply. Under-application may also increase the occurrence of resistance to the pesticide(s) with which the adjuvant is tank mixed.
- **Environmental considerations:** Follow the pesticide and adjuvant label instructions, which generally state to avoid spraying during windy conditions and aim for days where wind is below the limit stated on the product labels to prevent drift. Suggested wind speeds to avoid drift issues are generally 3–10 miles per hour. Weather gauges or even a hand-held anemometer can help determine wind speed. A study by Hock (2022) suggests that calm weather can reduce pesticide drift by up to 40 percent. Additional factors that may be listed on the product labels and should be considered before application include forecasts for rain, temperature, and humidity, as well as temperature inversions. Some adjuvants help to reduce drift (foaming agents and thickeners) or prevent rain from washing the product off the target site (spreader stickers).
- **Proper storage:** Storage directions for adjuvants should be included on the label. Adjuvants should be kept secure in labeled containers and away from children and pets. Improper storage can lead to accidental poisonings, corrosion of storage racks, and a reduction in product performance.
- **Access to documents:** Be sure that the product labels and SDSs are readily available, and follow the federal Worker Protection Standard (WPS) as well as OSHA Hazard Communication guidance. The SDS will contain information about PPE, first aid, and product hazards.
- **Resources for growers:** Consult with your local Extension Agent or your state Department of Agriculture and Biosecurity's Pesticides Branch if you need assistance when handling and applying pesticides and adjuvants. The University of Hawai'i at Mānoa's College of Tropical Agriculture and Human Resilience (UHM CTAHR) provides study packets on pesticide use through its **Extension Pesticide Program** website. Browse CTAHR Extension publications under the category **Pesticide Risk Reduction Education (PRRE)** to download additional pesticide-related articles on topics such as pesticide safety, recordkeeping, WPS, respirator fit testing, sprayer calibration, compatibility and jar tests, and calculating rates for applications.

Conclusion

Adjuvants are supplemental additives in tank mixes that are used to enhance pesticide efficiency. There are many benefits to using adjuvants, but their inclusion can also increase risks if adjuvants are not handled and used properly. By adhering to product label guidelines and safety recommendations while also following best practices, pesticide applicators can maximize the advantages of using adjuvants while safeguarding against production and financial risks of the operation and harm to the crop, human health, and the environment.

Disclaimer

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