NCASI Fact Sheet

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Herbicide Tank Mixtures – Potential Interactions

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Introduction

The toxicity of chemical mixtures can be described in one of three ways: additive, antagonistic, or synergistic. When mixture effects are equal to the sum of effects of each individual component, mixture toxicity is said to be additive. When mixture effects are greater than expected based on the sum of effects of each individual component, mixture toxicity is said to be synergistic. When mixture effects are less than expected based on the sum of effects of each individual component, mixture toxicity is said to be antagonistic.

Concerns are sometimes expressed about potential toxicity of forestry herbicide tank mixtures, which may contain 2 or more herbicides plus a surfactant and other inert (non-herbicidal) ingredients (e.g. defoamers). However, any effects of mixtures with additive toxicity are readily predictable based on the toxicities of individual components. This predictability allows EPA, applicators, and land managers to identify and implement mitigation measures to minimize risk of adverse effects. And when mixture effects are antagonistic, mitigation measures based on assumptions of additive effects are more than sufficiently protective. Synergistic mixtures could be problematic because effects may not be predictable and may exceed expectations, but there is considerable evidence that synergistic effects of herbicide mixtures are not an issue in actual practice.

Synergism is Rare

In studies examining hundreds of pesticide mixtures, synergistic effects were observed with only a small fraction of mixtures. For example, in a review of the toxicity of 194 different mixtures of pesticides, only 7% showed any evidence of synergistic interactions (Cedargreen 2014). The National Research Council (NRC 2013 113) considered interactions among pesticides and surfactants or other inert ingredients and concluded that "there is a low probability that synergists associated with pesticide formulations enhance the toxicity of pesticide active ingredients." Tatum et al. (2012) used water fleas and minnows to evaluate aquatic toxicity of 23 different forest herbicide mixtures at environmentally relevant concentrations using commercial formulations. They reported that the few herbicide mixtures showing any effects at all exhibited primarily antagonistic or simple additive toxicity. Only a few mixtures (one with water fleas, three with minnows) showed evidence of synergistic toxicity and the degree of synergism was slight.

Synergism is Associated with Just a Few Specific Substances

In studies of synergism in pesticide mixtures, synergistic interactions have typically been associated with only a few specific types of substances. For example, among the 7% of pesticide mixtures that Cedargreen (2014) identified as having synergistic interaction, 95% contained either a specific type of insecticide or a specific type of fungicide, neither of which will be found in forestry herbicide tank mixtures. Similarly, the NRC (2013 112-114) identified a few specific components of pesticide formulations and a few specific types of pesticides that are primarily responsible for synergistic interactions in pesticide mixtures. None of them will be found in forest herbicide tank mixtures.

Synergism Happens in the Lab, Not in the Field

Synergistic interactions typically occur only at high exposure concentrations seen in the laboratory and not at lower exposure concentrations found after actual applications of pesticide mixtures (Levine and Borgert 2018 128, NRC 2013 114). Interactions at low concentrations "are not likely to occur or, if they occur, will be minimal and probably not detectable" (NRC 2013 114). In a notice explaining revisions in its policy on label claims for tank mixing, USEPA (1982) reported that "…years of reviewing compatibility and residue data for tank mixes and records of actual field experience have shown that as a practical matter [synergism] is not likely to occur."

Conclusion

Although synergistic interactions among pesticides in a mixture and between pesticides and inert ingredients in a formulation can and do occur, synergism is rare, is associated with only a few specific types of pesticides and inert ingredients, and typically occurs only at exposure levels that exceed environmentally relevant concentrations. There is no evidence that synergism occurs to any meaningful degree among components of herbicide tank mixtures used in forestry.

References

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For More Information

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