

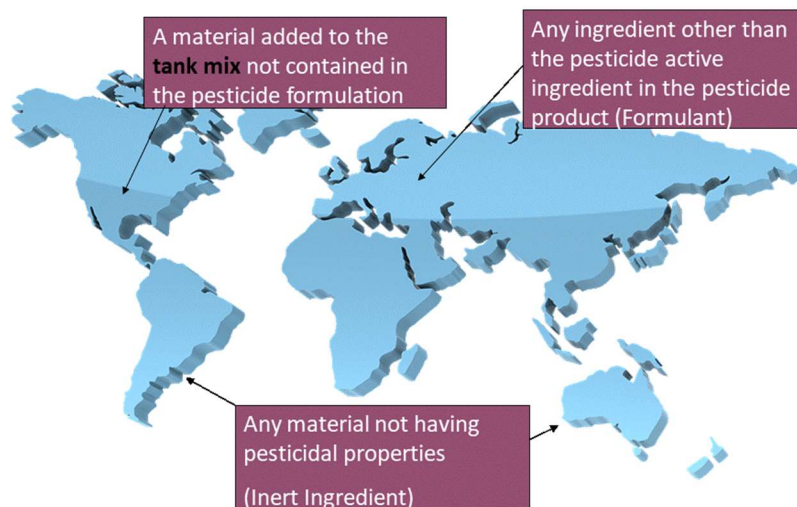
Do we have too many Adjuvants in Agriculture?

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Merriam - Webster dictionary defines an “adjuvant as: an ingredient (as in a prescription or a solution) that modifies the action of the principle ingredient”. This definition could be an acceptable definition but the question about the term “adjuvant” still is somewhat ambiguous. Even if you limit the application of the term to agricultural uses and practices, the term adjuvant can be defined based on a variety of applications: an additive in an agrichemical formulation, an additive to a spray solution of crop protection products, an additive in fertilizer or micronutrient formulations and many more. Not only have we seen different definitions for different functions but different parts of the world use different definitions. In Figure 1 below the definition for a tank added adjuvant varies per the world region.

Figure 1



For the purpose of this article I will focus on adjuvants as used in a spray solution of crop protection products.

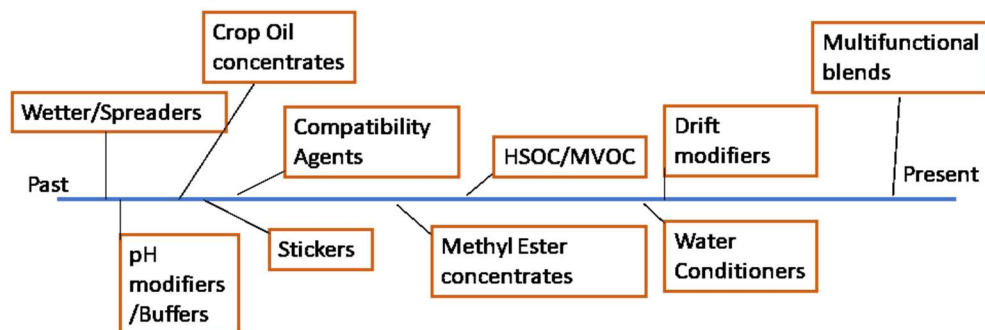
Although the above purpose limits the scope somewhat one still finds many different types of adjuvants. The first distinguishing characteristic is blended vs component adjuvants. Blended adjuvants are those adjuvants containing two or more components which may or may not act as functional agents but are mixed together to form the adjuvant. An example of this type of adjuvant would be a crop oil concentrate where oil and surfactant are mixed together to form the final product. On the other side adjuvants can also be single components. Various surfactant companies and inert producers provide single component adjuvants such as the polysorbate ester ethoxylates and alkylamine ethoxylates are single component adjuvants.

With these definitions and understanding in place, it is easy to see how the [Adjuvant Compendium](#)¹ authored by Bryan Young in 2016 found over 779 adjuvants from 38 distinctly different companies just in the United States. This compares to 76 entries from 22 companies in the first publication in 1992. I would refer the reader of this article to the Adjuvant Compendium for Dr. Young’s view on the growth of the adjuvants over this period.

Another source from ASTM International Committee E-35.22² Standards (ASTM E1519-16) has seen phenomenal growth in adjuvant terminology over the years. What started in 1991 as a task force to

investigate definitions for common adjuvants, today incorporates fifty-seven (57) definitions of adjuvants. Listed below in Figure 2 is an estimated timeline for the introduction of various adjuvants over the course of time.

Figure 2 – Representative timeline for various common adjuvant introductions



As illustrated above adjuvants have arisen out of specific marketplace needs. Simple wetter spreader adjuvants were commonplace in the late 1970s. Compatibility agents were demanded for fertilizer mixtures in the tank mix with pre-emergent herbicides in the 1980s. The introduction of methyl ester concentrates for use with the sulfonyl ureas was developed in the mid-1990s. In the early 2010 era, the market saw crop oil concentrates be modified to develop the HSOC (High Surfactant Oil Concentrates) in use today. With the increasing demands for multicomponent crop protection products today, complex multifunctional adjuvants are being developed. For more than 45 years, the industry has always found new answers to new needs and questions.

Adjuvants have been developed for many years to answer problems in the application of pesticides. It has been found over time that certain active ingredient pest control agents perform better in the presence of tank mix adjuvants. In some cases, the adjuvant was specifically designed for the active ingredients as is the case for: Clethodim and Sethoxydim – methyl esters plus acidifier, Glufosinate – alkyl ether sulfate, and alkylamine ethoxylates with Glyphosate. Table 1 below illustrates some of the common modes of action for adjuvants of a few specific crop protection products.

Table 1 – Adjuvants developed for specific crop protection products

Crop Protection Product	Desired adjuvant functionality
Glyphosate	wetting, penetration, water conditioning
Sethoxydim	penetration
Atrazine (Post uses)	wetting, compatibility
Paraquat	wetting, penetration, sticker
Glufosinate	wetting, penetration, water conditioning
Imazapyr	penetration
Acifluorfen	wetting, penetration
Sulfonyl urea herbicide	wetting, pH buffering
Fluazifop	Wetting, penetration
Pyraclostrobin	penetration

Today we are seeing more tank mixed active ingredients than ever in the past. As these mixes are developed combination adjuvants are being developed. Adjuvants which have multiple functioning agents are not trivial and can lead to new chemistries being needed to make a commercially viable product. Combination adjuvants are increasingly more difficult to develop and the chemistry is more complex. Adjuvants which are offered as Spreader Stickers generally have emulsions within the adjuvant itself. Some drift control products may incorporate the drift agent along with a crop oil microemulsion or an organosilicon super wetter. Water conditioning agents frequently combine multiple actions in the formulation and achieving the solubility of the various components is difficult. Microemulsion technology, nanoparticle technology, structured surfactant systems, colloidal suspensions of micronutrients and sunscreens are some of the new developments currently being evaluated in the adjuvant market.

So, the question remains, do we have too many adjuvants?

As new combinations and demands are placed on the crop protection market it will be important to evaluate the current adjuvant products for effectiveness in these situations. Should the need however arise new adjuvants will be developed to answer these needs. In the near term, continued work in the area of drift mitigation and vapor suppression will lead to new adjuvants. Longer term issues such as: increasing use of biological materials as both adjuvants and active ingredients, tank mix cleanout to ensure safe levels of residue in the spray tank and mixtures of micronutrient formulations with crop protection formulations; will lead to new adjuvant technologies. The industry has responded in the past and will continue to respond to the needs of the growers. So, NO we do not have too many adjuvants!

1. *Young, Bryan G, Matthews Joseph L., Whitford, Fred; Compendium of Herbicide Adjuvants; Purdue Extension and Southern Illinois University at Carbondale; 2016, 13th edition.*
2. *ASTM International Committee E-35 on Pesticides, Antimicrobials, and Alternative Control Agents; E1519-16 Standard Terminology Relating to Agricultural Tank Mix Adjuvants; September 2016.*