

Ampersand®

Deposition Aid & Sticker & Humectant & Evaporation Reduction Agent & Rain Fastness Agent

Ampersand® is a new and innovative adjuvant scientifically formulated to improve the delivery and efficacy of agricultural chemicals by unleashing the diverse functionality of natural gums. Attune, the makers of Ampersand, are relying on over 100 years of experience developing and commercializing natural gums in the food industry as the foundation for launching unique gum combinations to the agricultural market.

Natural gums are derived from a wide variety of plants and bacteria and as such, provide tremendous diversity in their functionality. In general, gums work by dramatically altering the physical characteristics of water-based solutions. For example, gums can change the thickness of a solution by trapping water. This functionality is commonly used in the food industry to thicken soups and sauces. Gums also provide adhesion characteristics. Think about how pieces of granola bar are held together or how sesame seeds stay on top of a bagel. Film formation is another excellent functional trait of gums. Creating a strong film is how you form that crunchy coating on the outside of a piece of chewing gum or chocolate candy. While these examples are specific to food, it's easy to see how these important gum functionalities can be applied to agricultural tank mix applications.

The objective here at Attune has been to apply this extensive gum knowledge in order to create new and innovative adjuvant technologies by focusing on:

- delivering more spray volume to the target,
- keeping the active ingredient on the target, and
- improving the active ingredient's performance while on the target



Proven Science

We believe it is imperative to understand the forces impacting spray tank ingredients starting at the nozzle and continuing all the way through deposition of droplets. Ultimately, we are most focused on ensuring that the active ingredients are capable of performing as intended. This systematic approach is critical to determining which functional attributes are necessary to improve the performance of an agricultural spray by the inclusion of an adjuvant. Studies focusing on the impact of changing the physical characteristics of tank mix sprays using natural gum combinations and their subsequent effectiveness have been examined. From this research, several opportunities were identified whereby changing the physical characteristics of tank mix solutions improved agricultural spray delivery and active ingredient effectiveness.

Precise Performance

For more than 5 years, Ampersand has been extensively evaluated utilizing laboratory, greenhouse, spray chamber, wind tunnel, field research and commercial demonstration trials. The compilation of this extensive research program demonstrates that Ampersand enhances the precision of pesticide performance by:

- Demonstrating better spray coverage 82% of the time
- Increasing on target spray volume by up to 3 times
- Doubling the absorption potential of actives
- Providing resistance to wash off from rainfall or overhead irrigation

Current Challenges

Droplet Size

- Drops <100 microns are drift prone and will evaporate more readily due to high surface to volume ratios
- Excessive evaporation reduces spray volume and can also make drops more prone to drift

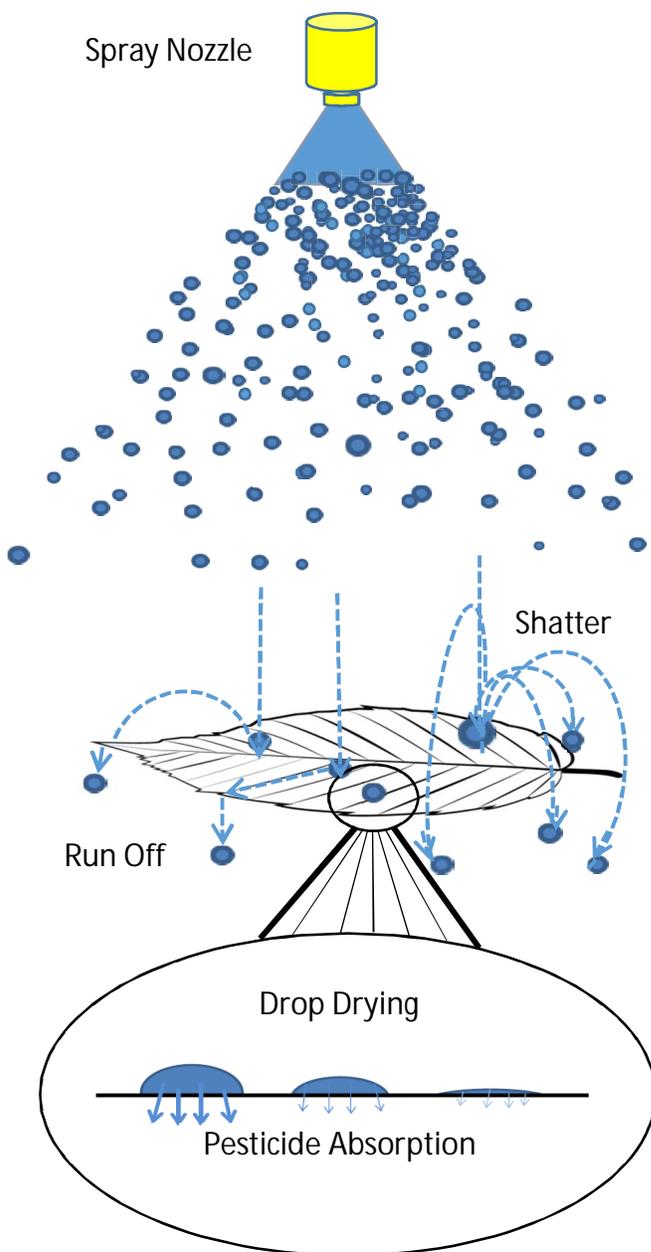
Target Contact

Spray Drops are prone to:

- Bounce off
- Run off
- Shatter into smaller drops

Residence Time

- Absorption stops when the drop dries up.
- Spray residues are prone to washoff by overhead irrigation and rainfall



Attune Solutions

Droplet Size

- Increase the viscosity of the solution to reduce the formation of small drops
- Reduce evaporation to increase spray volume to the target

Target Contact

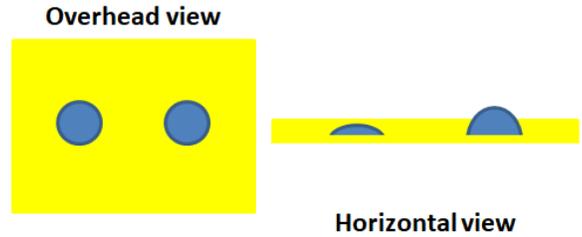
- create an internal matrix that increases strength of the drop to reduce shatter
- provide adhesive characteristics to adhere drops to the plant surface

Residence Time

- Increase water binding which slows water loss due to evaporation resulting in an increase in systemic pesticide absorption.
- Create a film as protection from washoff.

Better spray coverage 82% of the time

Attune compared the relative spray coverage of herbicides mixed with Ampersand to those mixed with competitive deposition aids. Water sensitive deposition cards were sprayed in a track spray chamber, allowed to dry, digitally scanned, and analyzed using Media Cybernetics ImagePro software. Coverage was measured as the percent of the card covered by drops. In greater than 80% of 112 head to head comparisons, Ampersand provided greater coverage than the leading adjuvant deposition aids.

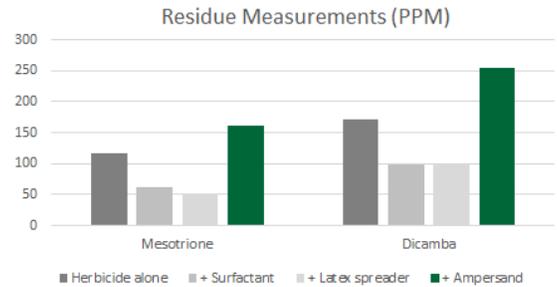


Up to 3 times more spray volume

Ampersand delivers more spray volume than competitive adjuvants by:

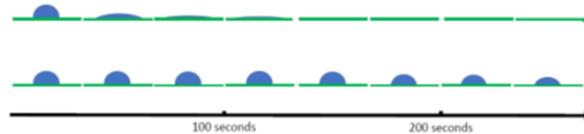
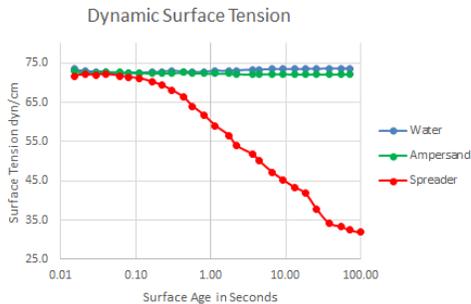
- 1) reducing small drops being formed at the nozzle,
- 2) reducing evaporation as drops travel to the plant, and
- 3) reducing the loss due to drop bouncing, shattering and runoff.

Research trials were conducted in which plants were sprayed with a herbicide, herbicide + Ampersand, and herbicide + competitive adjuvants. Leaf discs were cut from treated plants and analyzed for herbicide residues. Herbicide sprays using Ampersand had up to 3 times more herbicide residues than competitive adjuvants.



Double the absorption potential

Many active ingredients today are systemic or translaminar which implies that they must be absorbed into the plant for optimum effectiveness. The absorption of most active ingredients stops when drop residues dry on the leaf surface. Consequently, drop evaporation rate plays a significant role in determining the amount of active ingredient that is absorbed into the plant. Drop evaporation is heavily influenced by environmental conditions like temperature and relative humidity as well as droplet characteristics like size and the contact angle of a drop on a leaf. Surface tension of the droplet will dictate how high the contact angle is: higher surface tension = higher contact angle. Sprays with high contact angles will have minimal spread which can increase the amount of time active ingredients have for absorption by as much as 50%. Most competitive deposition aids contain surfactants which quickly reduce a drop's surface tension causing the drop to spread and thereby accelerating evaporation.



Ampersand employs two modes of action to increase the amount of time for active ingredient absorption. First, Ampersand is designed to produce droplets with higher contact angles which minimize spread and maximize droplet volumes. Second, Ampersand uses humectants to further reduce droplet evaporation rates which in turn increases the time available for the active ingredient to be absorbed into the leaf.

Four fold increase in wash off protection

Attune evaluated wash off resistance by spraying leaves with a herbicide mixed with either Ampersand or a competitive spreader/sticker adjuvant. After the leaves were allowed to dry, half of the leaves were exposed to 0.25 inches of simulated rainfall. Leaf discs were cut out and residue levels were determined by chemical analysis. In >70% of the head to head evaluations, Ampersand provided higher levels of resistance to wash off than the competitive standard.

Treatment	Average % Wash Off Resistance*
Pesticide	23.1%
+ Sticker	92.5%
+ Ampersand	98.8%

Smarter Agriculture

Smarter Agriculture involves getting the most out of every input the farmer employs. And in doing so, ensuring the safety of the workers directly exposed to the ingredients. In that light, Ampersand has been developed using only food grade ingredients that have been extensively tested to have the lowest toxicity rating, Category IV. No signal words are required for labeling this product and no special PPE or handling is required. Attune believes Ampersand can be a valuable component of an innovative farming approach.

Directions for Use:

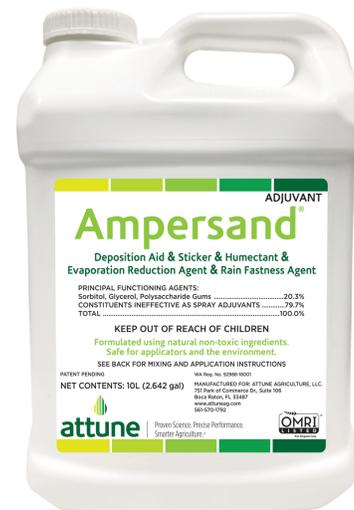
The suggested use rates are 1 pint to 2 quarts of Ampersand per 100 gallons of spray volume (1.25 liters – 5 liters per 1000 liters of spray volume). For improved spray deposition, use 1 pint to 1 quart of Ampersand per 100 gallons (1.25 liters – 2.5 liters per 1000 liters of spray volume). For wash-off prevention, use 1 to 2 quarts of Ampersand per 100 gallons (2.5 liters – 5 liters per 1000 liters of spray volume).

Mixing

Water should be the first ingredient added to the mix tank. It is recommended that half of the amount of water to be used in the final spray volume should be added and agitated or circulated through the tank. Ampersand should then be added to the spray tank with agitation to disperse the adjuvant throughout the tank. Allow Ampersand to circulate through the tank for at least 5 minutes to ensure complete dispersion of the adjuvant. Active or other ingredients should then be added as per label recommendations with agitation. Finally, after all ingredients are thoroughly dispersed, the remaining quantity of water should be added to the spray tank and agitated to complete the tank mix formulation.

Storage

For best results, store containers above 52F. Storage at lower temperatures will result in a thicker solution that may require longer mixing time. Do not allow to freeze.



Proven Science. Precise Performance.
Smarter Agriculture.®

Ampersand® is a registered trademark of Attune Agriculture, LLC
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