

Twister[®]

Anti-Evaporant



AN EMULSIFIABLE CONCENTRATED ADJUVANT WETTER-SPREADER, PENETRANT AND ANTI-EVAPORANT

TWISTER is a new-age wetter, spreader, penetrator, and anti-evaporant made from Methylated Seed Oils (MSO) and Silicon surfactants that enhance the uptake and efficacy of agricultural remedies. TWISTER bridges the shortcomings of 'in-can' adjuvants with its unique modes of action.

Modern-day agricultural remedies have complex formulations and contain large amounts of chemicals to ensure safety, efficacy, and storage stability. Although some agricultural formulations contain some "in-can" adjuvants, the concentration is generally limited. TWISTER is an activator adjuvant of which the primary use is to increase the active ingredient uptake. TWISTER influences the physical and chemical properties of the spray solution, including surface tension, volatility and emulsion stability. These properties will, in turn, modify the spray solutions spreading, wetting, retention and penetration.

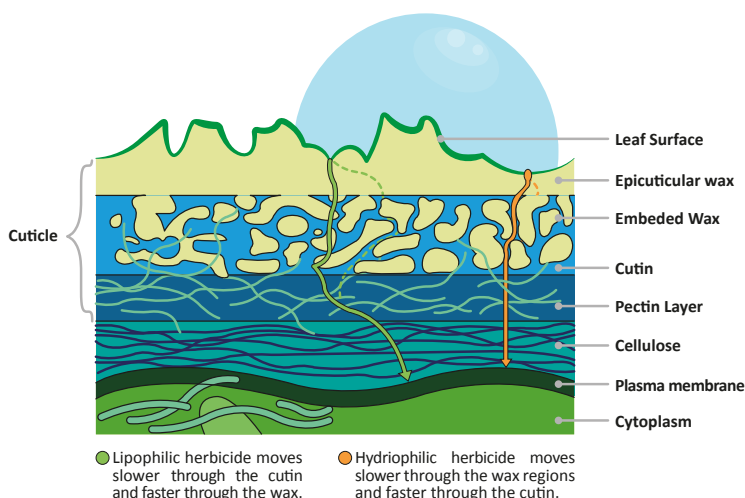


Figure 1: Leaf Cross section showing cuticle composition and herbicidal movement through this barrier.

THE CUTICLE IS THE FIRST BARRIER THAT ANY HERBICIDE OR AGRICULTURAL REMEDY MUST OVERCOME TO BE EFFECTIVE.

The foliar-applied remedy can only perform the desired biological function once it has been transferred from the leaf surface into the plant tissue. The above-ground portions of plants are covered by a continuous noncellular, non-living membrane called the cuticle (Fig. 1). The cuticle is the first barrier that any herbicide or agricultural remedy must overcome to be effective. The plant cuticle comprises water-repelling waxes, less water-repelling cutin, and pectins that can provide pathways for more water-soluble pesticides. The structure of plant cuticles can be likened to a sponge where the sponge matrix corresponds to the cutin and the holes correspond to the embedded wax. The surface of the sponge is also covered with wax (epicuticular wax). The cuticle is extremely diverse and varies greatly between different plant species.



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Waxes are the principal barrier restricting herbicide or remedy movement into plant foliage. The chemical or physical properties of the wax appear to be more important than the thickness in restricting penetration. Surface wax is high in hydrocarbons and other water-repelling molecules. These molecules are less permeable to water, and most herbicides sprays than cuticle membranes with lower amounts of water-restrictive waxes. Not only does the cuticle composition vary between species, but the plant's age has been associated with differences in leaf wax chemistry over time.

Adjuvants are commonly used in agriculture to improve the performance of agricultural remedies. Broadly defined, “an adjuvant is a product that aids or modifies the action of the principal active ingredient, but has no direct active effect”. The use of adjuvants with agricultural remedies generally falls into two categories: (1) formulation adjuvants are present in the container when purchased by the dealer or grower; and (2) spray adjuvants are added along with the formulated product to a carrier such as water. The liquid that is sprayed over the top of a crop, weeds, or insect pest often will contain both formulation and spray adjuvants. Most modern-day agricultural remedies have a complex formulation to stabilize the active. This could lead to space constraints for additional “in can” adjuvants.

HOW TWISTER WORKS

Surfactants are very unique molecules that consist of a hydrophilic head (water-loving) and a hydrophobic tail (water-hating). Surfactants are part of our everyday lives. Shampoos, conditioners, washing powder, toothpaste, etc., all use these special molecules called surfactants. The word surfactant is derived from the word surface active molecule. Figure 2 illustrates the general molecular arrangement of a simple surfactant molecule. Considering the molecule contains both water-loving and water-hating groups on the same molecular backbone, the only place these molecules are truly “happy” is at the interface (the point between different phases). This concept is well illustrated in Figure 3 and one can see how half of the molecules are dissolved inside the water, and the other half is dissolved in the oil.

In order to make a droplet spread evenly over the leaf's surface, the surface tension of the water droplet is lowered. Surface tension is a characteristic of all liquids, and surface tension occurs due to the unique force a water molecule experiences on the surface. In Figure 4, one can see that the water molecule in the bulk phase is attracted to similar water molecules in all directions. Still, the water molecule on the top of the surface only experience an attraction to the side and downwards as there are no water molecules above it (they are air molecules). The attraction on the surface of a liquid, such as water, has a single layer of molecules under extreme tension. The stronger the attraction between similar molecules, the higher the surface tension of the liquid.

Although water has a high surface tension, this can be manipulated. The structuring of surfactants on the surface of liquids allows scientists to accurately manipulate the surface tension by replacing water-to-water interaction with surfactant-to-surfactant interaction that has a lower attraction.

The use of surfactant lowers the surface tension and also creates an affinity to the leaf surface. The use of special methylated seed oils creates a surfactant from plant origin. These surfactants have an affinity to the plant that increases the stomatal penetration. With the low penetration, Twister allows for rapid stomatal penetration, as seen in Figure 5.

Seed oil derivatives have an interesting contribution to the complimenting mechanisms that make Twister unique. The structuring of the emulsion inside the droplet reduces the evaporation rate. A spray droplet of a tank mix is a complex emulsion the farmer applies to a target to deliver the active ingredient. As a spray droplet evaporates, the oil emulsion droplets are forced closer together (Figure 6 T.1min). The emulsion droplets then coalesce to form larger oil droplets (Figure 6 T.6min). The larger oil droplets are less dense than water and form an oil layer at the top of the droplet (Figure 6 T.10min). This reduces the surface area on top of the droplet where water evaporation can transpire and consequently reduces the tempo of evaporation. This increases the active contact time with the leaf surface and increases absorption into the leaf through the cuticle. Furthermore, oils possess the ability to penetrate the cuticle and could be related to a transfer of actives into plants. MSO surfactants disrupt or dissolve the epicuticular waxes to increase the solubility of pesticides within the lipophilic cuticle, and to increase cell membrane permeability.

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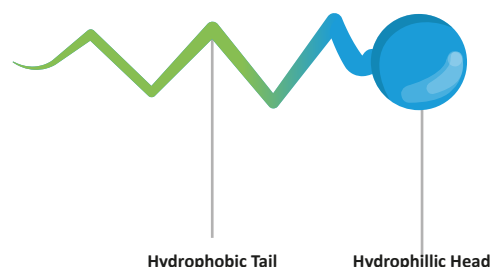


Figure 2: Basic makeup of a surfactant, for a molecule to be surface active it needs to have a hydrophilic (water-loving) and a hydrophobic (water-hating) part.

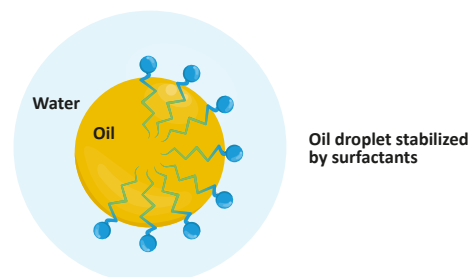


Figure 3: Packing and stabilization of an emulsion (oil in water) droplet at the surface interface between the water and oil part.

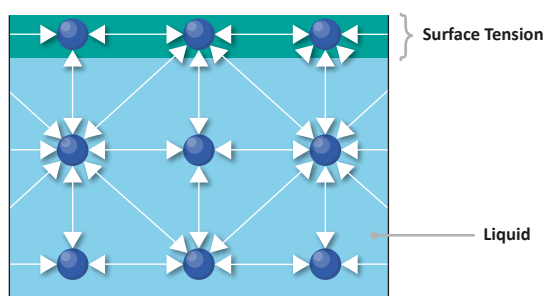


Figure 4: Interactive forces and attractions between molecules in three dimensions. At the surface, there is no outward pull; thus, the molecules on the surface experience a strong inward pull to create surface tension.

Product	Superficial Tension	Spreading Index - mm
Water	72	1
Nonil Fenol	32	9
Fatty Alcohol	31	10
Conventional Oil	33	7
Trisiloxane	21,9	55
Evapoguard	23	43

Table 1: Superficial surface tension spreading ability of water compared to different surfactants.

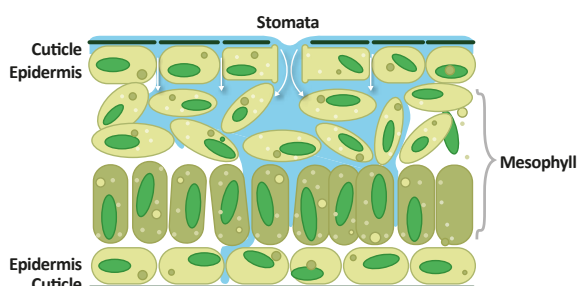


Figure 5: Penetration of the stomata of a spray mixture containing Evapoguard, where the active is now freely available for absorption and translocation through the mesophyll.

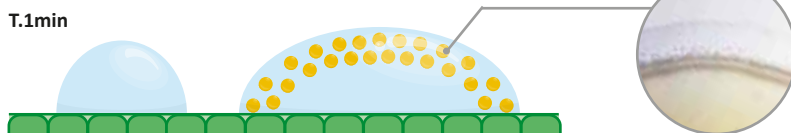
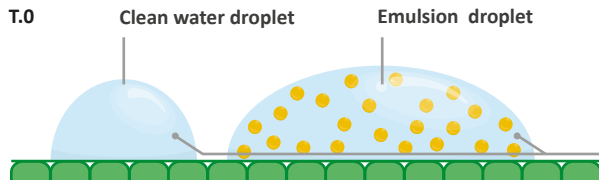
water and form an oil layer at the top of the droplet (Fig 7 T.10min). This reduces the surface area on top of the droplet where water evaporation can transpire and consequently reduces the tempo of evaporation. This increases the active contact time with the leaf surface and increases absorption into the leaf through the cuticle. Furthermore, oils possess the ability to penetrate the cuticle and could be related to a transfer of actives into plants. MSO surfactants disrupt or dissolve the epicuticular waxes, to increase the solubility of pesticides within the lipophilic cuticle and to increase cell membrane permeability.

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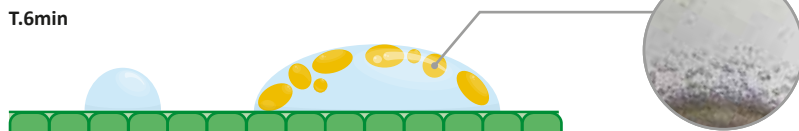
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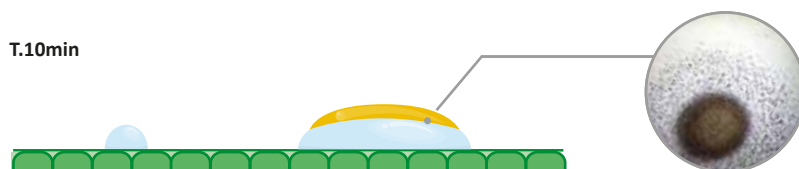
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Water mass reduces due to evaporation. Volume reduces and forces oil droplets closer to one another.



Emulsion droplets start to coalesce and form larger oil droplets.



The oil concentration increases at the surface as the water evaporates. Due to the density difference between water and oil, the oil layer covers the remainder of the water, preventing water loss and increasing contact time.

COMPETITIVE EDGE

TWISTER is a specialized adjuvant designed to increase the efficacy of agricultural herbicides and pesticides. The unique formulation of silicone surfactants with modified seed oil enables a spray mixture to reduce environmental conditions such as temperature, wind, humidity, and time of the day when spray applications are made. The extraordinary wetting-spreading and penetration effect through the cuticle and stomata and anti-evaporation properties increase active ingredient uptake within plants leading to increased product performance.

Independent research done by Orsmond Aviation, testing the effects of adjuvants on spray quality and efficacy of aerial and ground application of agricultural remedies, has shown the benefits of TWISTER on application quality. TWISTER has shown through research that it increases mean droplet size, overall target droplet count, and droplets/cm² over water and our competitors (Graph 1-4). This increase in spray quality improves the deposition of the active ingredient on the target, hence increasing the available amount of active ingredient coverage. Combining the increase in spray quality and coverage with the superior wetting-spreading, penetration, and anti-evaporation effects of TWISTER ensures better utilization of actives in a spray mixture and increased efficacy of active ingredients