Improving the Performance of Microbial Agrosolutions: Enhanced Shelf Life and Optimized Delivery

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In recent years, biological alternatives to chemical crop protection products have become increasingly important as consumers look for food containing fewer chemical residues. Growers need alternative modes of action to control resistant pests or prevent resistance build-up of crop protection products. This demand and the regulatory phase-out of many chemical pesticides globally, provides an opportunity for biological solutions. However, growers often perceive biological products – especially microbial biopesticides - as having a lower and/or inconsistent efficacy compared to chemical ones.

Common causes of efficacy issues are low stability of the product during storage prior to application, insufficient or unevenly distributed active material reaching the target site, and rapid degradation of the biological active on the target. Formulation can help to solve these issues and improve the field efficacy of biological products and thus, increasing the acceptance of these products in the organic and conventional farming market.

Evonik's BREAK-THRU® additives are well known innovative solutions in the crop protection industry. They are used as tank mix adjuvants and as in-can additives for agrochemical formulations. BREAK-THRU® products enhance the performance of synthetic pesticides as spreaders, penetrants, antifoams, dispersants and emulsifiers. In the last years, Evonik has invested strongly to build specific know-how and expertise to handle microbial actives in our agro formulation laboratories. Our BREAK-THRU® product portfolio increases the often limited shelf life of living microbials and optimizes the delivery and efficacy of such actives.

Increased shelf life for microbial biopesticides

The viability of microorganisms depends on several criteria. Besides suitable growth conditions during production and appropriate downstream processing the right formulation and suitable additives help to reduce loss of viability of microbial active ingredients. Additionally, conditions to improve shelf life vary with the type of microorganism. For example, moisture can be a critical factor for the survival of fungal spores. Under dry conditions, they can reduce their metabolism and thus survive in a dormant state. Despite this fundamental ability of fungal spores to stay dormant, many commercial products of fungal spores require cooling during storage and yet have a limited shelf life of not more than 12 months. Examples include the commercially relevant species *Trichoderma harzianum, Coniothyrium minitans, Clonostachys rosea and Metarhizium anisopliae.*

We have prepared low-viscous dispersion concentrates of Trichoderma harzianum spores in various BREAK-THRU® carrier liquids and have tested their viability in an accelerated storage test at 40°C for four weeks in comparison to a commercial WP formulation and the neat spores (see Figure 1). The carrier liquids used were BREAK-THRU® SP 133, BREAK-THRU® S 301 and BREAK-THRU® S 255. BREAK-THRU SP 133 is a biobased and biodegradable polyglycerol ester and approved for organic farming (OMRI and FiBL listed). BREAK-THRU® S 301 is a biodegradable superspreader based on polyether trisiloxane. BREAK-THRU® S 255 is a polysiloxane and can be used as a wetting agent for oil-based formulations, too. As can be seen in Figure 1, only 1-2% of the spores of the commercial WP and the neat spores survived under the test conditions and were able to form colonies on agar plates. When the spores were dispersed in the BREAK-THRU carriers, the survival rate increased to 12% for BREAK-THRU® SP 133 and 30-40% for the polyethersiloxane-based carriers. The dispersion concentrates are easily diluted in water to form the spray solution and the amphiphilic nature of the carriers aids in the uniform suspension of the spores in the tank (see Figure 2).

Targeted delivery

For a microbial product to be effective and economical, it is essential that the organism reaches the target site. Even though a biological active is applied to the site where the pathogen is found, much of the product can be lost by drift, bounce-off and/or run-off as is shown in Figure 3. Many of the principles known for the delivery of chemical pesticides can be applied to microbial products, too. However, the additives used must be biocompatible, i.e. they must not affect viability of the microorganism. Biocompatibility of surfactants is even more important in formulations than it is in tank mixtures where only low concentrations of adjuvants are used. This may be the reason that commercial products of living microorganisms rarely contain surface-active substances. For example, we have found that surfactants like naphthalene sulfonates, sulfosuccinates and some fatty alcohol ethoxylates can interfere with germination of Bacillus amyloliquefaciens spores. However, BREAK-THRU® additives are biocompatible, and provide excellent wetting, deposition, adhesion and retention for foliar applied biopesticides. Due to its super-spreading properties, BREAK-THRU® S 301 provides wetting of the leaf underside, which can protect UV sensitive microbial products. Additionally, BREAK-THRU® SP 133 reduces the number of droplets prone to drift of foliar applied products. For application of biologicals in the soil BREAK-THRU® S 301 and BREAK-THRU® S 255 provide homogenous wetting and distribution of actives with no leaching into deeper soil zones.

Proof of efficacy in greenhouse trials

The increase of efficacy of biological control agents by using BREAK-THRU® additives has been demonstrated in greenhouse and field trials. Figure 4 shows the results of a greenhouse trial (GLP) to control white fly (*Bemisia tabaci*) in tomato. The biological product used was Naturalis® which is an oil dispersion of spores of the mycoinsecticide *Beauveria bassiana*. Naturalis® has been applied in two rates: the full rate of 2.0 L/ha without adjuvants and the reduced rate of 1.25 L/ha alone and in combination with adjuvants. By using BREAK-THRU® S 301 as a tank mix adjuvant at a very low rate of 0.15 L/ha the overall efficacy was improved to the level of the full application rate. However, no increase of efficacy was found upon using a pinene-based adjuvant at a rate of 0.55 L/ha. No phytotoxicity was found using both adjuvants.

Conclusion

Biocompatible BREAK-THRU® additives allow for physically stable solid and liquid microbial formulations. BREAK-THRU® carrier liquids enhance the shelf life of microbials in liquid formulations without the need of cold storage or transport. Additionally, they enhance the performance of microbial agricultural solutions, which has been demonstrated in greenhouse and field trials.

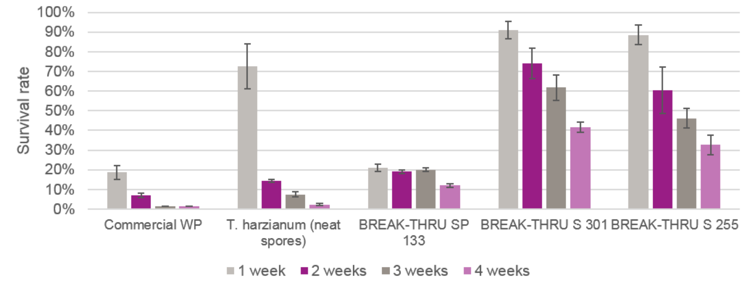

Figure 1: Survival rate of Trichoderma harzianum *spores (20 wt.%) in the liquid carriers BREAK-THRU® SP 133, BREAK-THRU® S 301 and BREAK-THRU® S 255 in comparison to the neat spores and a commercial WP formulation at 40°C*

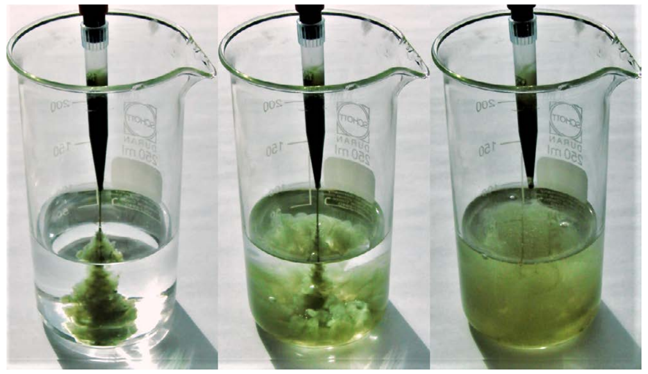

Figure 2: Dilution of Trichoderma harzianum *spores (10 wt.%) dispersed in the liquid carrier BREAK-THRU® S 301 in water*

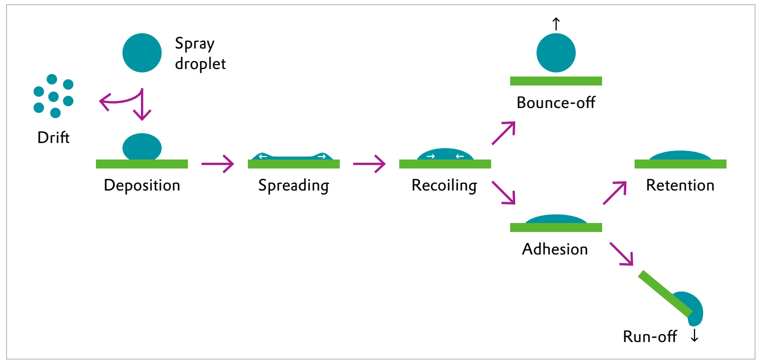

Figure 3: Targeted delivery of microbial spray solutions: BREAK-THRU® additives enhance deposition, adhesion and retention.

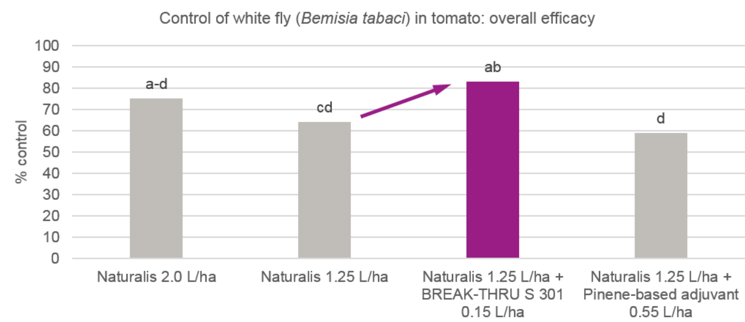

Figure 4: Results of a greenhouse trial (GLP) with the mycoinsecticide Naturalis® (Beauveria bassiana) *on white fly* (Bemisia tabaci) *in tomato*