The Science of Formulation Chemistry

The real technology that often determines the effectiveness of a product occurs several years prior to the first date of its sale

BY TERRY GOUGE



ever before has there been such a high level of interest in the technologies used by manufacturers to produce products that control insects, weeds and diseases for the golf course industry. Indeed, golf course superintendents are now presented with formulation options that offer the following benefits that lead to optimized performance:

fullest potential. It is this optimization process that can make the difference between a product simply being applied to the pest site versus interacting within the full environment to control the intended pest as quickly and completely as possible.

Most formulation chemists agree: It is fairly simple to produce a basic formulation that "looks good in the bottle" and is relatively stable as it sits on the shelf. All formulators use the same basic processing equipment to measure, mix and mill the active ingredients with the inert ingredients that constitute a particular formulation type. However, the real technology that often determines the effectiveness of a product occurs several years prior to the first date of sale. At that time a basic manufacturer decides to produce a specific formulation type (i.e., suspension concentrate, water dispersible granule, emulsifiable concentrate, oil in water dispersion), which will exhibit the exact properties required to address a specific market objective.

enhanced safety;

simplified tank-mixing and application procedures;

controlled or directed release to the target pest;

active ingredients with particle-size ranges from nano to macro; and

formulations containing pre-measured adjuvants proven to increase the activity of the active ingredient.

Basic manufacturers produce or internally certify the quality of each of their own high-purity active ingredients. They also invest millions of dollars to secure the latest equipment and instrumentation for the chemist to optimize the formulation to its

Basic manufacturers can easily spend hundreds of work days and several hundredthousand dollars optimizing each formula-Continued on page 46

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tion with the designed properties to make the active ingredient as efficacious as possible. Unlike the active ingredient, a proprietary formulation technology is rarely applied for patent protection but is instead maintained by the basic manufacturer as strictly confidential, without expiration.

One way to explain how formulation technology can benefit the end-user was demonstrated during a spray application study conducted by researchers at The Ohio State University. In this study it was discovered that up to 90 percent of the pesticidal spray droplets applied to soybean leaves was lost due to simple runoff. In similar tests at Bayer Environmental Science, high-speed photography was used to clearly demonstrate how droplets of non-optimized formulations can strike the waxy leaf cuticle and simply fall off, becoming unavailable for plant protection.

To prevent this droplet repulsion phe-



nomenon, the formulation chemist can incorporate special surface active agents (surfactants) into a formulation that effectively reduce the droplet's dynamic surface tension and thus dramatically reduce droplet runoff. If necessary, other well-researched additives are incorporated into the formulation to allow:

maximum leaf contact (droplet spreading);

rapid cuticle penetration and uptake to improve efficacy and rainfastness;

and quicker activity resulting in reduced pest damage.

Additional studies are conducted to measure the particle size and shape of the active ingredient as it dries and binds to the leaf surface. This is carried out by scanning electron and florescence microscopy, along with direct biological assays that correlate surface characteristics with field performance.

For soil-applied granules or fertilizer formulations, the chemist may incorporate specially designed emulsifiers that allow rapid granule release with small amounts of rainfall or soil moisture. Should longer residual activity be required, the chemist may encapsulate the granule in a polymer coating that allows for slower or sustained release of the active. An optimized formulation must deliver the active ingredient to the target in the physical form and at the threshold level and timing required to control the pest. We continue to enhance the performance of our older active ingredients in much the same way we work with newer active ingredients in our pipeline. Often previously optimized formulations must be altered to add specific characteristics to better control a specific pest, to add tankmixing properties with fertilizers or other pesticides or simply to make the product safer to end-users.

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For the formulation chemist, an optimized formulation is never truly achieved. ■

Editor's note: Terry Gouge, the author of this story, is manager of formulations development for Bayer Environmental Science.

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