Pros and cons of pesticide combinations

By Eileen Buss

I sat in on an interesting discussion at the National Entomological Society of America meeting in Reno, Nev., in mid-November. The room had some of the "greats" in insecticide toxicology and pesticide resistance, product manufacturers, and other entomologists like myself. There were talks on the uses, advantages and disadvantages of simultaneous pesticide combinations in integrated pest management strategies. I'd like to share some of the highlights.

First of all, the terminology is confusing and certain words mean different things to different people. Let me define a few terms according to the Insecticide Resistance Action Committee (IRAC) before I go too far:

• **Pesticide combinations:** applications of two or more compounds to the same pests at the same time. Specific examples are tank mixes and premixes.

• **Tank mix:** a mixture of two or more products (they don't just have to be insecticides) on-site or on a mix/load pad by an applicator. Each product is often applied at a high labeled rate. Sometimes a "tank mix" may be thought of as mixing one product with water in a tank, but that is not how I'm using the term in this article.

• **Premix:** a commercial product containing two or more active ingredients. At least one active ingredient is usually applied at a lower rate than if used alone. This "premix" category is different from the use of something like water-soluble packaging of a single insecticide.

Why would anyone use a combination of products, rather than just applying one product at a time? There can be pros and cons, either way. The most common reason to combine pesticides is to kill more pests with one application. Many of the newer insecticides have fewer target pests (are "narrow-spectrum") and may have different routes of entry (contact vs. plant systemic). So if you apply two or more at one time, then you have a more "broad-spectrum" treatment.

Other benefits may include reducing transportation costs by saving on fuel (if you kill most pests initially, there may be fewer call-backs), reducing the amount of packaging, decreasing possible turf injury from repeated traffic or soil compaction, and decreasing the spread of disease or pests on equipment. Client satisfaction (at least in agriculture) tends to be higher when mixtures are used, and mixtures may be less expensive than do-it-yourself tank mixes.

Another reason to use a mixture or pesticide combination is to slow down the development of resistance in some pests. However, this is not the typical motivation of applicators, and I would appeal to you to weigh the pros and cons of this when choosing your pesticide inventory. I was amazed that in agriculture, a lot of insecticide mixtures have been used over the last 50-plus years (e.g., abamectin (Avid) plus thiamethoxam (Meridian) on pears against psyllids and aphids). The list was so long, I couldn't write down all of the combinations.

Pest control technician pouring a bag of pesticide into a tank

Photo by Eileen Buss

Mixing products is not as easy as it sounds. With any kind of mixture, there are some things to watch out for. It is possible to get **"antagonism"** between compounds, which means that the mixture is less effective than when the single products are used alone. There is also the risk of plant damage or **"phytotoxicity,"** which is more likely to occur when mixtures are applied to stressed plants (e.g., drought-stress), but separate applications of the compounds would not hurt a plant. And, **"physical incompatibility"** can happen if two compounds or formulations react to each other or physically can't combine (an issue of compatible solubility). The result could be a big glob of goo in your spray tank.

Some cautions to follow include:

• Avoid mixing insecticides that have the same **"mode of action"** or are in the same chemical class. From a resistance management perspective, if an insect is resistant to one insecticide (e.g., bifenthrin), then what good would it do to add another pyrethroid (e.g., permethrin, deltamethrin, lambda-cyhalothrin, etc.) to the mix? There could be **cross-resistance** within the same chemical class or even across other classes, so you would only be exerting the same selection pressure to the pest. For example, carbamates and organophosphates act essentially the same way on an insect, and pyrethroids and DDT similarly have some cross-resistance. Hopefully, you remember that a mode of action is how an insecticide acts (e.g., interferes with the sodium channel) at its target site (e.g., the nervous system) within the insect.

• Another caution is to avoid using the same mode of action (single product or mixture) against the same generation or life stage of the target pest. This may be easier said than done in the southeastern United States, especially Florida and the Caribbean, where we have overlapping life stages of pests nearly year-round. Ideally, one treatment could be used to knock out most of one pest generation; then, if needed, you could come back to treat the next generation or whenever damage reoccurs. Similarly, if a treatment of some product doesn't work the first time, don't keep applying it again in the hopes that attempt No. 2 or No. 3 might be more worthwhile. Doing the same thing over and over again when you know it doesn't work is insanity (and arguably unethical if you're getting paid for the job). Be aware that treating with a brand name product, and at the same time with a generic product at the highest labeled rates equals a 2X application, which is illegal. Again, the goal is to reduce selection pressure and use products wisely, not nuke everything. Modes of action can be determined by finding the Group number on a product label or by looking up the active ingredients on the IRAC website (http://www.irac-online.org).

• The last caution I heard at the meeting was that premixes should not be used unless all components within the product are needed. Say that an insecticide premix is used on residential turf in June in north-central Florida. Which pests might be present at that time that could be killed by both a pyrethroid and a neonicotinoid, without even doing any monitoring? Maybe grubs, mole cricket nymphs, chinch bugs, twolined spittlebugs (in North Florida)… But, how often are multiple pests really present and causing damage? So, is it even necessary to use two insecticides if one can

effectively do the job? How would you justify the treatment or ever know without doing any monitoring? It reminds me of when my kids get sick. I have to wait 10 to 14 days to make sure the virus has run its course before taking them to the doctor to get an antibiotic, because by then, the infection has become bacterial and is treatable.

ADVANTAGES AND DISADVANTAGES OF TANK MIXES AND PREMIXES

The advantages and disadvantages of tank mixes and premixes were thoroughly discussed at this meeting. For example, commercial premixes have the advantages of being convenient to use, the active ingredient rates are unchangeable, the component rates and formulations are optimized during development, no mixing or stability issues should exist, and at least one component is usually applied at a lower-than-labeled rate.

Some disadvantages include the inability of an applicator to change the active ingredients, all target pests should be present at the same time, and premixes may have been designed for specific pests or regions of the United States, but could be used outside of the optimal treatment zone. From an economic standpoint, premixes may be created by manufacturers as part of a post-patent marketing plan to obtain a licensing extension.

Some advantages of tank mixtures include giving the applicator some flexibility to provide treatments that fit the pest control need at that time, and they help to reduce any excess pesticide inventory that might exist. However, the flip side is that creating a tank mixture is less convenient, it's potentially hazardous to people who are not trained to properly mix products, "homemade" tank mixes may not be as stable as a premix, and the products being combined tend to be mixed at the highest labeled rates.

According to the Insecticide Resistance Action Committee, or IRAC, which is a highly-regarded committee of pesticide experts (pesticide manufacturers must pay dues to belong to this group), there are some requirements for a mixture to be considered effective. First, all toxins should persist the same length of time where the mixture is applied. Complete coverage of the treated plant is essential. There should be no cross-resistance between the toxins. In effect, both compounds should each be able to kill the target pest, which is called **"redundant killing."** As turfgrass managers, we are not chemists, and don't know if only one of the compounds in the mix is doing all the heavy lifting or if there is really a benefit to having both compounds in the mix.

Whether or not mixtures are useful in pesticide resistance management is controversial among applicators, researchers and regulators. Some say that the use of mixtures in resistance management is not supported by either computer models or field experiments, although lab tests can make mixtures appear to work. It is possible that a mixture could incompletely kill multiple life stages of a pest, instead of killing everything it was intended to kill. That means that some bugs still survive, lay eggs, and pass on their resistance genes to the next generation.

I asked someone at this meeting if they thought it might be possible to restore the use of a product when resistance levels were really high (like bifenthrin and chinch bugs in parts of Florida), and they pessimistically said that it was too late. I hope that's not true. They also said that resistance management should start BEFORE field failures occur. So the time is NOW to determine how to delay resistance development in the neonicotinoids like Arena (clothianidin), Meridian (thiamethoxam) and Merit (imidacloprid).

Okay, so I also had the question of what a resistance management strategy should look like. Should each pest generation only be exposed to one active ingredient? Should all of a species' populations be treated with the same compound at the same time, or should each infested site be treated differently? In lawn care, that is what we do – each lawn is treated differently, often by different companies, thereby creating a **"mosaic"** effect, unless a whole neighborhood is under the management of one pest management company. If property 1 is treated with bifenthrin (Talstar) and neighboring property 2 is treated with clothianidin (Arena), then what happens next? Any surviving insects on either property may find each other, mate, and have offspring that can better survive an application of either compound applied alone or mixed together. Almost sounds like a cliff-hanger — we can't predict how fast resistance will develop to another compound in this common type of scenario.

So, what does this all mean? Be good product stewards and help us develop a functional resistance management plan for turf. Implement integrated pest management, or IPM. Avoid treating turfgrass unless you absolutely have to – this is admittedly challenging for a route-based business. Just because you treat green grass and it stays green after an application does not mean that a product worked; it may mean that no pests were present and causing damage at the time of application. Overuse of products like this is one route to developing product failures down the road. There is obviously no "one size fits all" pest management strategy, so we need to work together to determine what the useful options are.

For more information, visit the Insecticide Resistance Action Committee website at: http://www.irac-online.org

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