COMPATIBILITY IN THE SPRAY TANK

By understanding a few basic principles, the chemical operator can apply a large number of chemical combinations simultaneously

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There is a great economic and performance benefit in being able to spray a mixture of chemicals at the same time. The beneficial results have at times been astounding, and once the art has been mastered the chemical operator will never go back to the old-fashioned notion that chemicals must be sprayed one at a time.

For economic reasons the farmers of this country have been spraying mixtures for years, but turf has been sadly neglected for the obvious reason that phytotoxicity might be encountered on fine turfgrass. This need not be if one has a thorough but simple understanding of the nature of the chemicals one is spraying.

I divide all chemicals into two categories: *solubles* and *insolubles*. Of course, water is the substrate. I go one step further and make the dogmatic statement that *insolubles cannot burn grass*. If they are insoluble in water, how can they possibly diffuse into the plant in toxic concentration? Or, how can they possibly be so concentrated as to produce reverse osmosis and have water move out of the plant and cause desiccation? In my 35 years of experience in the turf field, I have never encountered phytotoxicity with insolubles at the time of spraying.

I will admit that there are insoluble pre-emergent weed killers that could be sprayed on fine turfgrass and could, over a period of time, release a soluble chemical that could be toxic to a particular species of grass. But these precautions are clearly outlined on the label. For example, there are certain pre-emergent crabgrass killers that are not to be used on bentgrass or *Poa annua* greens.

Taking this exception into consideration, and following the rule of not exceeding the recommended application rate because EPA has warned applicators not to do so, one can mix any number of insoluble chemicals in the spray tank without incurring phytotoxicity.

Fortunately, the majority of pesticides are insolubles. This allows the pest control operator considerable latitude on what he can mix in the spray tank. On the other hand, *soluble* chemicals must be handled intelligently to avoid phytotoxicity. One must carefully follow the rules and guidelines that I am about to propose in order to avoid burning.

Soluble chemicals can be divided into two general classes: *ionic* and *nonionic*. The ionic solubles are usually referred to as salts, and can be further subdivided into cations and anions. The cation, which is positively charged, is always accompanied by an anion, negatively charged. They are always found together, neutralizing each other. But it is customary to single out the nature of the active ingredient and ignore the ionic charge of the inert ingredient. For example, 2,4-D can be formulated in various salts, such as dimethylamine and diethanolamine. The 2,4-D acid is considered anionic, and the cation is the inert portion whose function is to solubilize 2,4-D in water. Another example is cadmium fungicide, which occurs as soluble salts, such as chloride or succinate. The active ingredient cadmium is cationic, and the inert anion is ignored.

Compatibility Test

Incompatibility results when an active cation is tank-mixed with an active anion. An example of such incompatibility would be the tank mixing of Caddy (cationic) fungicide with 2,4-D (anionic) herbicide. This is clearly visible when a little 2,4-D and Caddy are added to water in a glass jar. Instead of being a clear solution, the water will become milky, followed by the precipitation of a gum of the cadmium salt of 2,4-D.

Fortunately for the pest control operator, all the soluble post-emergent herbicides on the market are anionic. Therefore, they are compatible and can be tank-mixed without incurring precipitation. When trying new soluble pesticides for possible tank mixing, simply test them in a glass jar as previously described. If they can be mixed with water and still result in a clear solution, they can be safely tank-mixed.

It has been previously stated that all soluble post-emergent herbicides are anionic and compatible. There are only six cationic pesticides on the market at the present time, and two of them, Diquat and Paraquat, because they are general grass and weedkillers and are never tank mixed with other pesticides. The other six, strangely enough, are all fungicides: PMAS and Calo-Clor, two mercuries; Caddy and Cadminate, two cadmiums, and Subdue and Previcure (propamocarb), two *Pythium*-control chemicals. Again, I emphasize that if two or more soluble pesticides are tank mixed, test them in a glass jar of water to assure yourself of their compatibility. Once you are satisfied that they are compatible, you can add any number of insolubles to that mixture without incurring phytotoxicity.

EPA uses signal letters to inform applicators whether a product is soluble or insoluble.

S = solution
SP = soluble powder
EC = emulsifiable concentrate
WP = wettable powder
F = flowable

S, *SP* and *EC* are classified as solubles, *WP* and *F* are insolubles.

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It is possible to encounter all three forms of a single pesticide: *EC, WP* and *F.* Wettable powders and flowables are safer to use but slower acting than emulsifiable concentrates. Because the aromatic solvents used in preparing *ECs* are notoriously phytotoxic, *ECs* used with low gallonage spray invite phytotoxicity.

> Never tank mix emulsifiable insecticide concentrates with other chemicals, but insecticides can be tank mixed with each other for better control.

Phytotoxicity will occur when the aromatic solvent sits on the grass blade. In addition, the insecticides, according to the labels, must be sprayed with large volumes of water (10 to 30 gallons), sometimes followed by heavy watering to move them down to the grubs. Wettable powder and flowable formulations will not burn but still require watering in for grub control. Insects are rapidly developing strains that are resistant to insecticides. Repeated use of the same insecticide invites the development of resistant strains. Dr. Roscoe Randell at the University of Illinois recently reported that he obtained good insect control by mixing half rates of Dursban EC and Sevin-F; when he used full rates of each separately, he obtained only moderate control.

This permits the tank-mixing of a tremendous variety of chemicals, and it allows the applicator to spray four or more chemicals simultaneously.

> All insolubles can be tank mixed without incurring phytotoxicity, provided the products are sprayed at recommended rates.

Where money is no object, broad spectrum control is a must. The applicator should not rely on only one chemical to control a target disease. Note how pathologists at the various agricultural colleges are mixing different pesticides in an attempt to achieve better control in their experimental plots.

With the advent of systemic fungicides, the broad spectrum mixture has assumed more importance because of the longer residual control attainable with the addition of a systemic to one or two contact fungicides in the spray tank.

Before the development of systemics, it was accepted that contact fungicides did their job on the grass blade and in the thatch and were dissipated within 2 to 3 days. A good contact fungicide, which will kill germinating spores at a few parts per million, is usually sprayed on the grass blade at about 5,000 practices. It doesn't take more than 3 days to get down to a dilution below the effective 5 parts per million.

In hot, humid weather accompanied by sporadic showers, an applicator had to spray twice a week or the grass would go unprotected the latter part of the week. Systemics have changed all this because they hydrolyze in the soil to knock down the fungus population. They act not only in the soil but also within the grass blade by diffusion through the root system, thereby giving extended protection.

I maintain that the ideal fungicide tank mix is a three-way combination of soluble contact—insoluble contact—insoluble

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> Only one soluble chemical can be tank mixed with one or more insolubles. If two soluble chemicals are tank mixed with or without insolubles, avoid phytotoxicity by cutting the rate of each soluble in half.

systemic chemicals. For years I have even recommended mixing two soluble contacts, each at half rate, to get broader coverage than the single soluble at full rate.

All the insolubles can be tank-mixed, and they can be tank mixed with one of the solubles. If the solubles are tank-mixed, cut the dosage in proportion to the number of chemicals added. If three solubles are tank-mixed, cut the dosages to one-third of the recommended rate of each soluble component.

> Soluble fertilizers and trace elements can be added individually or mixed, provided the amount will not exceed 2 ounce solid per gallon of tank spray mix in hot weather, or 4 ounces per gallon in warm weather. Six ounces per gallon can be used in cool weather.

Hot weather is considered to be temperatures in the 90s, warm weather as temperature in the 80s and cool weather as temperatures in the 70s. Some soluble fertilizers have a greater burn potential than others. The nitrates, sulfates and phosphates are truly inorganic soluble salts, whereas urea is truly an organic soluble. It must hydrolyze and oxidize before it is available to the plant. It has less burn potential than the soluble salts. Formolene is a solution of urea and methylol urea possessing less burn potential than straight urea. Finally, two ureaform polymers are categorized as insolubles. They are Fluf and Nitroform, which contain a mixture of soluble methylene ureas and insoluble methylene urea polymers. They are considered very safe and can be used at rates higher than the rates referred to previously.

Adding Nutrients

Iron and magnesium, elements necessary for chlorophyll can be sprayed as sulfate salts, but due to their ease of hydrolysis they are not as effective as they are in chelated forms. It goes without saying that N, P and K are also necessary for chlorophyll production. Of these three, too much reliance is placed on the semiannual granular feedings to provide adequate amounts of slow-release N and K. The slow release of nitrogen in granular feedings leaves a lot to be desired, and I know of no insoluble salt of potassium. Nitrogen and potassium deficiencies are real. In an attempt to supply adequate amounts of nitrogen, the tendency is to add large amounts at infrequent intervals, which results in lush growth, particularly in the absence of potassium (which provides turgidity or hard growth).

What a great opportunity the chemical spray operator has to add nitrogen, potassium, iron and magnesium to the spray tank in small increments every time he sprays.

I have witnessed better disease control when these elements are added to a fungicide program because they help the grass grow out of stress. The same result is witnessed when post-emergent herbicides are used that have a narrow safety factor

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and have a tendency to slow down the metabolism of desirable grasses.

Alternative Spray Programs

The accompanying chart of alternative spray programs, entitled "Some Fungicide Combinations," illustrates the diversity of chemicals used. An excellent article written by Dr. Patricia Sanders of Penn State, explains very clearly the proper use of various systemic fungicides...

"The broad spectrum systemic fungicides that control other turf diseases fall into three groups according to their mode of action; the benzimidazoles (Tersan 1991, 26019, Vorlan), and the sterol inhibitors (Banner, Bayleton, Rubigan). Any fungus that is resistant to one of the benzimidazole fungicides will be resistant to them all. The same is true within the dicarboxymide and sterol inhibitor groups of fungicides. Therefore, for resistance management, broad-spectrum systemic fungicides must be mixed or alternated BETWEEN but not WITHIN groups. Systemic fungicides may also be mixed or alternated with any contact fungicide that will give the disease control desired."

Solubility and formulation

Solubles: EC, S, SP		Insolubles: WP, F		Soluble-Insoluble combinations (Treat as solubles)
FUNGICIDES				
PMAS		Tersan 75	Bayleton	Calo-Clor
Caddy		Tersan LSR	Fore	
Subdue		Tersan SP	Maneb	
BANOL		Spotrete	Zineb	
ALLIETTE		Bromosan	Captain	
BANNER		Spectrol	Daconill 2787	
RUBIGAN EC		3336	Dyrene	
		1991	Fungo	
		RUBIGAN WP	RP26019	
		SCOTTS FUNGICIDES I, II, III		
INSECTICIDES				
Dursban	Malathion	Oftanol		
Diazinon	Proxol	Diazinon		
Chlordane	Dylox	Dursban		
Sevin	Triumph	Sevin		
		Malathion		
HERBICIDES				
2,4-D	MCPA	Dacthal		
MCPP	DSMA	Tupersan		
Dicamba	MSMA	Balan		
ACCLAIM	AMA	SURFLAN		
	Betasan-EC			
FERTILIZERS				
urea		Nitroform (Powder Blue)		
ammonium nitrate		IBDU		
ammonium phosphate		Fluf (flowable ureaform)		
ammonium sulfate				
potassium nitrate				
muriate of potash				
Formolene				
Cleary's Water Soluble N-P-K's				

Some fungicide combinations

	Soluble contact		Insoluble contact		Insoluble systemic
	1 oz. Caddy	+	3 oz. Spotrete-F	+	1 oz. 3336-F
or	1 oz. Caddy	+	3 oz. Daconil	+	1 oz. RP26019
or	1 oz. Caddy	+	2 oz. Dyrene	+	1 oz. Bayleton
or	½ oz. Caddy	+	1 oz. Tersan SP 2 oz. Daconil	+	½ oz. 1991 ½ oz. Bayleton
or	½ oz. Caddy	+	1.5 oz. Daconil 1.5 oz. Spotrete	+	⅓ oz. Bayleton ⅔ oz. 3336-F

Suggested fertilizer combinations added with fungicides:
1 oz. urea + ½ oz. chelated iron + ½ oz. chelated magnesium + 1 oz. potassium sulfate
6 oz. Cleary's (N-P-K) + 4 oz. Trugreen (Mg + Iron + Potash)
8 oz. Fluf (ureaform) + 1 oz. potassium sulfate + 1 oz. chelated iron + 1 oz. epsom salts (magnesium)

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