FORMULATING FOR PESTICIDE SAFETY

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Foreward

While it is true that pesticide users and makers are becoming more conscious of the need to respect the hazard potential of the products, it is also true that no legitimate manufacturer or formulator ever designed a product to be unsafe. Without doubt, the primary target is no longer the sole determining factor in modern pesticide technology; efficiency and safety are equally important. It should be noted that the pesticide label is often more informative about hazards, precautions, and medical advice than about how and why to apply the material.

Use Patterns

Pesticides are designed to control or prevent infestations of insects, fungi, weeds, nematodes, animals, and some birds, reptiles, fish, and bacteria. In agriculture, most emphasis is on insecticides, fungicides, and herbicides used in growing a crop. The uses are, broadly, soil-applied and foliar-applied for pest-host zones of activity. The product may be surface-effective or absorbed for systemic action. Due to the nature of the chemical or chemicals comprising the active ingredient, it may be necessary to use a liquid formulation versus a powder suspension or granule. Or, due to the nature of the pest or host plant the formulation and application method may have to be of a particular type. Other considerations may involve compatibility with fertilizers and other pesticides, placement on or in the ground, and proximity to sensitive crops.

Thus, a number of factors must be considered relative to defining the use pattern for a pesticide.

Formulating Alternatives

Not all active ingredients are suitable for formulation as liquids, dry flowables or granules. Conversely, most are suitable for dusts, wettable powders, and wet flowables. The chief pesticide formulations in commerce today are:

1. Emulsifiable concentrates - usually composed of one or more active ingredients solubilized in a solvent containing one or more surfactants and possibly an anti-foam agent. These form oil in water type emulsions. There are, frequently, transport and handling restrictions on EC's.

2. Wettable powders - usually composed on one or more active ingredients which are crystalline at normal temperatures, or sorbed on a carrier, and there may or may not be diluents such as clay. These usually include a surfactant and a dispersing agent and possibly an anti-foam agent.

3. Granule carriers - are usually clay, which may be calcined, or ground corn cobs. These are sized to a specific minimum-maximum sieve range. The active ingredients are usually sprayed on (often

with a solvent solubilizer) or sometimes powders are coated-on with a sticking agent (a technique of last resort).

4. Dry flowable granules - require special equipment and techniques whereby, it is possible to granulate a product which will disperse or solubilize upon dilution in water. Most processes are patented at this time. When poured, the container is free of remnants of the product and no waste is incurred.

5. Wet flowables - can be made from liquid systems or powder suspensions. They include copious surfactant and gel components with a solvent-water carrier. Particles are milled to the micron range.

6. Dusts - usually have low concentrations of active ingredients milled with low bulk density silicates resulting in fine, light powders. Some dusts are electrostatically charged to insure adherence to plants. Dusts are often used for home gardens aerial applications.

The Label Messages

Every pesticide product is registered with the Environmental Protection Agency and all labels are subject to approval for content initially and as amendments become necessary. Therefore, the precautions for proper use, as perceived by EPA, are spelled out in a manner commensurate with the toxicological categories I, II, III and IV. Table 1 shows the relation of these categories to the acute toxicity ranges.

Table 1. Toxicological Categories of Pesticides.

	TOXICITY CATEGORY			
	I	II	III	IV
Oral LD_{50} mg/kg	0 thru 50	51 thru 500	501 thru 5000	>5000
Inhalation LD_{50} mg/L	0 thru 0.2	0.2 thru 2	2 thru 20	>20
Dermal LD_{50} mg/kg	0 thru 200	201 thru 2000	2001 thru 20,000	>20,000
Eye effects	Corrosive; corneal opacity not reversible in 7 days	Corneal opacity reversibility in 7 days, irritation persists 7 days.,	No corneal opacity; irritation gone in 7 days	No irritation.
Skin effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation at 72 hours.

Any one of these acute tests falling in a particular category triggers the classification. Table 2. gives the relation of the toxicity category to the required signal word DANGER, WARNING, or CAUTION.

Table 2. HUMAN HAZARD SIGNAL WORD

Toxicity Category I if for oral, inhalation, or dermal - add	DANGER POISON + skull & crossbones
Toxicity Category II	WARNING
Toxicity Category III	CAUTION
Toxicity Category IV	CAUTION

As a result of the toxicological data, a statement of practical treatment is prominently displayed along with the signal word and "Keep Out of Reach of Children". Directions to where to find additional precautions are given. The following example is taken from a label.

KEEP OUT OF REACH OF CHILDREN
WARNING

Statement of Practical Treatment
If Swallowed, induce vomiting immediately by giving two glasses of water and sticking finger down throat. Never give anything by mouth to an unconscious person. Obtain medical attention immediately.

If Inhaled, Induce coughing
If on Skin, Wash off with soap and water.
If in Eyes, Flush eyes with water.

See back panel for additional precautionary statements.

The Precautionary Statements on the label include Hazards to Humans and Domestic Animals, Environmental Hazards (toxicity to birds, fish, etc.), Physical or Chemical Hazards (keep away from fire, etc.). The appropriate text is elucidated for each subject.

Specific directions for Storage and Disposal of the pesticide and container are given for Storage, Prohibitions, Pesticide Disposal, and Container Disposal.

All of these features of the label relate to safe use of the pesticide. Directions for product use occupy the residual space.

Reducing Use Hazards

In the Hazards to Humans and Domestic Animals label statement, directions are given for use of goggles, face shields, full-length covering, gloves, respirators, etc., as well as cautioning to avoid breathing dust or spray mist and washing-up. These are commensurate with the type pesticide involved and are meant to be useful in insuring operator and handler safety. The manufacturers assume these directions will be followed, since it is their desire that all hazards of use be minimized, where feasible, without sacrificing efficacy.

Safer formulation may be possible through such devices as reducing the concentration of active ingredient or solvent. Some active ingredients are safer as flowables or granules with no loss of performance. However, all users do not have the same application equipment. There are confirmed liquid users who don't allow flowables because of densification problems. There are some users who have excellent agitation in tank sprayers for wettable powders (and some that do not). Also, cost varies with the formulation complexity and most pesticide users are economically astute. Thus, within certain bounds and depending on the hazard involved, industry strives to bring to market pesticides that are as safe as possible. However, the user of these pesticides is obligated to follow label instructions in the handling, storage, and disposal processes and, above all, treat these useful tools with the same respect accorded an automobile or chain saw.