RESIDUES IN PERSPECTIVE

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In today's era of concern over the use of chemicals and how this affects our "quality of life" it is well to examine the problems associated with chemical residues. By being well informed, we should be able to examine the problem rationally. I will restrict my comments to pesticide chemical residues as they relate to tolerances.

When a pesticide chemical is applied to a crop, a certain concentration of the chemical remains on the crop for a variable length of time, depending on many factors. Disappearance of the chemical is speeded or slowed by such things as the nature of the chemical (e.g., organophosphorus compounds generally degrade more rapidly than organochlorine compounds under similar conditions), environmental temperature and humidity, whether the chemical remains on the surface or is absorbed by the plant, whether the chemical is metabolized by the plant or undergoes non-metabolic degradation, and the formulation containing the pesticide. In some cases, a metabolite may be more toxic than the parent compound and becomes important also. The concentration of the chemical (and any toxic metabolites) remaining at any given time is referred to as the "residue" on that crop.

The alfalfa industry is probably more aware of problems associated with pesticide residues than are most agricultural industries. I am sure that you remember the problems of the early and mid-sixties associated with organo-chloride residues in the milk of cattle fed contaminated alfalfa. Because of the excellence of alfalfa as feed for dairy cattle, the possibility of pesticide residues in milk will no doubt continue to be your major residue concern. Pesticides which are to be registered for use on alfalfa will be carefully evaluated as to their potential for causing residues in milk or in the edible tissues of food animals.

With the creation of the new Environmental Protection Agency (EPA) in 1970, the responsibility for the regulation of pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was transferred from the USDA to the EPA. When a pesticide registration petition is submitted to EPA, the petition must be supported by data to show that the product would be effective for the intended purpose that the label warnings and cautions are adequate when followed to protect humans, fish and wildlife, and that the directed use of the product would not result in illegal residues on food or feed, or significant adverse effects on the environment. If the use of a pesticide is known to or seems likely to result in a residue when the crop or a portion of the crop is marketed for use as food or animal feed, it is necessary to obtain a "tolerance" for such residue. Otherwise, such food and feed will be deemed adulterated and subject to seizure by the regulatory agencies. This allowable tolerance (maximum residue concentration) is set by the EPA at the time the pesticide is approved for registration. Therefore, a legal residue may result only when the pesticide is used in accordance with its registration and label instructions. The federal regulatory agencies have had authority only over goods which move in interstate commerce. State regulatory agencies have generally adopted the federal pesticide regulations so that they could control goods moving within the state. The Federal Environmental Pesticide Control Act of 1972 which was recently signed into law will reportedly substantially increase the authority of EPA in controlling pesticides moving only within a state as well as the use of all pesticides.

New toxicology guidelines for evaluating the safety of pesticide chemical residue tolerances were recently proposed by the EPA (Federal Register, vol. 37, no. 183, 20 Sept. '72). These will likely be adopted largely as proposed and will require a very thorough toxicological investigation of any hazard to man or animals who consume the residues in their food as well as evaluation of any environmental impact. Depending on the toxicology data and the amount of residue which can be expected to result, a classification of "negligible" or "non-negligible" residues will be made. A support for the residue's being classed as negligible is a very large safety factor. This safety factor is obtained by dividing the quantity of the substances that produces no effect in the diet of the most sensitive laboratory animal tested by the quantity of the substance expected in the diet of man on a mg/kg daily, body weight basis. Residues classed as

non-negligible receive much more scrutiny and prolonged additional toxicological testing. These tests include tests for carcinogenicity, teratogenicity, and mutagenicity. One should keep in mind that, in any case, the tolerance will be set at the lowest level that is reasonable. The fact that permitting greater residues than necessary might encourage carelessness in pesticide use is of constant concern. Therefore, the pesticide with the lowest tolerance is not necessarily the most toxic.

Why, if such elaborate precautions are taken before a pesticide is registered, do illegal residues occur? Many reasons come to mind, but most include some form of improper application such as from drift, incorrect application rate, application of a chemical not registered for use on the crop, or other failure of the applicator to follow label instructions. In an area of intense agriculture such as this where crops with greatly varying needs for pesticides are grown side by side, contamination by drift is a considerable problem. With the enforcement of the new restrictions on pesticides, and their use on pesticide applicators which are contained in the recently passed California State Senate Bill 1021 and the Federal Environmental Pesticide Control Act of 1972, pesticide misuse will become less frequent in the future. Illegal residues will perhaps then result largely from pesticide accidents or some unpredictable occurrence such as happened in the upper San Joaquin and the Sacramento Valleys this past spring following treatment of alfalfa with Guthion® (azinphosmethyl).

To briefly review this problem, following the application of Guthion in accordance with the label instructions for control of the Egyptian alfalfa weevil, residues in alfalfa hay in excess of tolerance were detected by the State Department of Agriculture. Further sampling and testing showed that the occurrence of excessive residues was widespread in the first cutting of alfalfa throughout the area. The State Department of Agriculture reported that these over-tolerance concentrations ranged from 5.6 ppm to 172 ppm, with an average of 28 ppm. Eventually, some 33,000 tons of hay were found to contain residues in excess of tolerance. Both ground and air applications of the pesticides were used. This is an insignificant part of the yearly total alfalfa production in California (estimated to be near 7 million tons in 1972), although this may not be of great solace to the individuals whose crops were affected. Fortunately, the excessive residues were detected before the hay was fed to dairy or other food animals. The troubling thing is that we do not know why this occurred, and so cannot predict when or if it may occur again

University of California researchers investigated possible implication of the buffer which was used by many of the applicators for the first time this year. It was found to have no significant affect on the degradation of Guthion on alfalfa. State Dept. of Agriculture chemists could find no detectable differences between this year's formulation of Guthion and those used in past years. The most plausible explanation for the excessive residues seems to be the result of a slowing of degradation caused by the unusual cool and often cloudy weather which prevailed during the time, and a lack of growth-dilution after treatment caused by the fact that the pesticide was applied quite late in the growth of the alfalfa. Investigation is continuing, however.

The proficiency of the analytical chemists and those who cooperate to develop the analytical equipment can be given much of the credit for the current residue controversy. During recent years, the concentration of pesticides which could be reliably detected has decreased from parts per million (ppm) to parts per billion (ppb), and in some cases parts per trillion (ppt). Consider that if we were speaking of water 1 ppm would be equivalent to one teaspoon in 1250 gallons and that 1 ppb is 1/1000th of that amount. These are very small amounts. And, if the past is any guide, what is an undetectable (once known as "zero") residue today may not remain so tomorrow. Costs of obtaining a reliable analysis predictably increases geometrically as the detectable concentration grows smaller and smaller. Once detected, the significance of these minute residues must be evaluated by competent highly trained scientists, another increasingly expensive venture.

I believe that we can safely predict that residues will continue to be a problem so long as pesticide chemicals are used. The occurrence of illegal residues will likely decrease in frequency but will be more expensive to resolve. As analytical methodology becomes even more sophisticated and obtaining reliable results even more costly, it will become urgent for those who use pesticides to be able to obtain reliable analyses for their own protection. Standardized sampling techniques and proper handling from sampling until delivery to the analytical laboratory will be very important. Some sort of certifi-

cation and/or licensing or private pesticide residue analytical laboratories will likely be needed if a suitable system is to be developed.

Another urgent need is for education of the public. In my opinion, education of a person so that he can competently make his own decision regarding the hazard of a chemical is much better than overly protective legislation designed to protect him from his ignorance. Also, we are more likely to follow a regulation if we understand why it is needed. Industry, government agencies, and universities are cooperating in efforts to increase the knowledge of the public about pesticides, but each of us must assist if the attempt is to be truly successul.