

Plant Health Management Issues of Public Concern: Focus on Pesticides

The three papers that follow are based on presentations for a symposium at the annual meeting of the American Phytopathological Society in San Diego, California, 13–17 November 1988.

Pesticides—There Will Be Change

EARL C. SPURRIER, Vice President for State Affairs, National Agricultural Chemicals Association, Washington, DC

Pesticides are a category of chemicals used to combat a broad spectrum of bacteria, fungi, insects, weeds, rodents, and other pathological or detrimental biological species that have a potential adverse effect on humans or animal populations. Crop protection chemicals, on the other hand, are used specifically to assist in the production of food, feed, and fiber. They have no other purpose. This paper will deal exclusively with those pesticides that are used for crop protection.

Benefits to Society

Crop protection chemicals, namely, herbicides, insecticides, fungicides, bactericides, and, in some cases, plant growth regulators, offer benefits to producers of food, feed, and fiber as well as to the general public. Many benefits are never recognized. Increased crop yields are generally noted as the paramount benefit of chemical use, helping make the United States and its agriculture the breadbasket of the world. But, because our domestic production technology, with the use of chemicals, has historically produced grain surpluses, the surpluses have become the target of adverse public opinion, and other tangible benefits of crop protection chemicals have not been given proper recognition.

Crop protection chemicals, per se, do not increase yields in crops. When applied properly, however, they do suppress or prevent excessive competition by weeds and damage by pests that interfere with the plant's ability to use sunlight, nutrients, and water. Cultivated,

tree, and pasture crops are a tremendous resource that can readily convert solar energy through photosynthesis to carbohydrates and ultimately to production of food, feed, and fiber. Crop protection chemicals, although classified as pesticides, are in fact solar-energy enhancers by their actions in the crop production environment.

Farm benefits from the use of pesticides are many. Chemical weed control programs can prevent contamination of feed grains and hay with noxious weed seeds and foreign material; such contamination results in excessive price discounts (dockage) and allows the spread of weed seeds from area to area when these farm products are sold or transported. Also, off-flavors in milk and other dairy products and the death of farm animals from ingesting noxious or poisonous vegetation can be avoided.

Significant improvements in crop production and harvesting efficiency are gained if crops are free from weeds, diseases, and insects. For example, a cotton picker or cotton stripper cannot operate in a weedy cotton field. A grain combine will lose as much as 625 kg/ha (10 bu/acre) of the crop in the field if the crop is lodged because of damage by stalk borer or root-infesting insects or if weed growth is heavy at harvest time.

Operators of farm equipment are safer when weed and insect control technology is effectively used. Clogging of equipment by weeds and debris exposes the operator to extreme danger when the equipment must be unclogged by hand. Controlling allergenic weeds, such as ragweed and poison ivy, and curbing roadside weeds and brush with herbicides to improve traffic visibility offer significant health and safety benefits to the public as well to the farmer.

Clean, high-quality crops free from insects and disease ship and store better and deteriorate less than damaged crops. The value of food crops damaged by insects or disease is significantly reduced at the point of sale. Fruit and vegetables that are of poor quality or diseased or

insect-infested cost more to market, raising prices at the consumer level as much as 50%. Low costs for processing and distributing foods are attributable, in part, to improvements gained from the use of properly applied chemicals. Incidentally, food costs in the United States amount to only about 16% of a citizen's disposable income—the lowest proportion in the world.

The Chemical Revolution

Since the time of the Roman Empire, when sulfur was first used to control mildew in grapes, the need for pest control has constantly increased. The chemical revolution in agriculture started after World War II. The relocation of farm workers to urban and city areas left a deficient farm work force. Mechanization took over. Farms increased in size, but too few workers were left to weed or cultivate by hand. Chemical developments, especially selective herbicides, began filling this void. As farm equipment became larger and more sophisticated, dependence on chemical weed control became part of normal production technology. Also, forms of chemical pest control to assure insect and disease reduction were adopted.

A broad spectrum of crop protection chemicals was introduced into the market starting in the 1950s. Chlorinated hydrocarbons, organophosphates, carbamates, triazines, phenoxy, acetamides, and many other newly synthesized chemical compounds were deployed. Numerous patented pesticide products generated from intensive research and development programs were registered with the United States Department of Agriculture and later with the Environmental Protection Agency (EPA) for crop use. Foreign-based companies saw an expanding market in the United States. They also gained a presence with their technology and expertise. Farm equipment companies developed new and larger equipment. Farmers wanted the new technology. An entire new industry came into its own. Food and fiber

Presented 15 November 1988 for the symposium "Plant Health Management Issues of Public Concern: Focus on Pesticides" at the annual meeting of the American Phytopathological Society, San Diego, California.

Accepted for publication 27 July 1989 (submitted for electronic processing).

products from this chemical revolution began to become part of export trade—a favorable shift in the U.S. trade balance—as beef, cotton, fruit, and feed grains were sent overseas. Agricultural technology was also exported. The United States became committed to help feed the world.

Opportunities for Change

Pest control science developed rapidly. Crop protection technology with pesticides advanced faster than the ability to investigate all of the consequences and environmental impacts of pesticides. Problems recognized today were foreseen by only a few people in the 1950s. Now that the consequences of some of the problems have been realized, they must be addressed. The integrity of the nation's food supply must be preserved. Future problems must be assessed by facts and sound science, not by perceptions, emotions, and speculation. Problem recognition and setting of priorities for problem solving within economic capabilities are major steps.

Problems with pest resistance have encouraged scientists and practitioners to develop alternative pest control products, change spray schedules, and impose integrated pest management schemes to manage field programs more efficiently and effectively. Such changes have increased the useful product life of many chemicals. Pest resistance will continually present problems, however. Populations of insects, fungi, bacteria, herbaceous plants, and other organisms that build resistance to certain pesticides will continue to arise through selection and perhaps mutation. Possibly, wide-scale deployment of some classes of pesticides may have accelerated the selection process.

Persistence of pesticides in the environment is now being addressed. Industry is synthesizing "softer" compounds, more easily and rapidly biodegradable. They should not persist in the environment unless longer persistence is necessary for a particular problem and judged to be inconsequential relative to environmental safety.

Application technology has not paralleled chemical advances. The principles of sprayer application, utilizing hydraulic pressure to force liquid spray materials through nozzle tips, are essentially the same as they were 70 years ago. Researchers are now cognizant of these deficiencies, however, and are beginning to address application concepts designed to prevent off-target movement or drift and to improve coverage of the pesticide for the pest targeted for control. Product formulations are constantly being improved with drift-retarding additives to reduce or prevent off-target movement.

Exposure of workers is being reduced through improvements in closed systems for transferring chemicals, protection

regulations, education, applicator licensing and certification, and the recognition that potential exposure to chemicals is greater for mixers, loaders, and applicators than for the average worker. The worker can reduce potential exposure, and thereby risk, by wearing chemical-resistant gloves, using appropriate protective equipment, and washing hands and body parts with soap and water immediately after a transfer or exposure. Education is the key to reduced exposure.

Misuse is perhaps the biggest problem for the pesticide industry and for responsible users of pesticides. Even though use of a pesticide in a manner inconsistent with its label is illegal, the incidents of misuse continue, and some are prominently reported in the media. The worker, the public, and the environment are exposed when a product is misused, whether intentionally or accidentally. Education and regulatory enforcement must be increased to reduce product abuse.

That certain pesticides contaminate groundwater is now recognized. Opportunities and needs for research and monitoring exist in this highly publicized subject area. Analytical and prediction methodologies for detecting and predicting movement of chemicals in water have become highly sophisticated and computerized. Years ago, detection in the range of parts per million was the most sensitive available, but now scientists can detect some chemicals at concentrations of parts per quadrillion (10^{-15} g/g). Imposing health-based standards for judging the toxicological significance of such detections and providing triggers that initiate voluntary or regulatory management actions are required to prevent further contamination of groundwater.

Residues in food of chemicals used to control pests are being perceived by the general public as unacceptable. This is most unfortunate, because the U.S. Food and Drug Administration (FDA) pesticide residue tolerance system has been in place for over 40 years and has been simulated worldwide. The system works. For example, as part of its pesticide residue monitoring program, the California Department of Food and Agriculture recently analyzed over 7,000 samples of agricultural produce and found that 79.8% had no detectable residues, 18.7% had residues within legal tolerances, 0.3% had residues over tolerances, and 1.2% contained residues of pesticides with no established tolerances. Even when pesticides are detected, the 100-fold safety factor built into the tolerance system ensures that the food is safe. FDA's monitoring data are similar. Former FDA Commissioner Frank Young has repeatedly testified at federal hearings in Washington, D.C., that chemical residues found in food pose no special concern; to him, microbial food

contamination is much more critical. Our food system is the best in the world.

Changes in Technology

The chemical industry, keeping pace with environmental concerns and rapid changes in technology, is constantly upgrading its products to make them more efficacious and compatible with societal needs. New formulations are being developed and marketed. These include dry-flowables, granulars, slow-release microprills, soybean oil and water bases instead of organic solvents, less toxic inert ingredients, and dye-based formulations that include markers to improve applicator coverage. Biological pesticides, now being researched and marketed, are specific for particular pests, cause no direct harm to beneficial insects, and pose negligible risk of environmental damage.

Although the application of biotechnology will result in new products, a decade may elapse before a major product is available for commercial utilization. Conventional chemistry will remain the standard-bearer for pest control for some time to come. Recombinant DNA research and testing will have many regulatory and patent-protection barriers to overcome before any meaningful progress can be made. Specific products for specialized crops or uses will be the first approved for field testing. After the first bioengineered products are registered, on-the-farm field evaluation and acceptance of these products by the farm community will be essential. Pricing of bioengineered products must be relative to benefits derived for successful market penetration. Growers, if they see performance and environmental advantages, may accept these new products readily only if the products meet a need not already being satisfied by conventional chemicals and application techniques.

The incorporation, through cell biology, of resistant genes into crop varieties to gain chemical, insect, or disease resistance is being tested. Chemical companies are buying seed companies in order to exploit the concept. Only by marketing to growers seeds from resistant seed stock developed by this process can a company enjoy the benefits of this technology. The resistant crop variety must be adaptable to a wide area of use to provide sufficient market volume or be of such specialized use to justify the higher cost for introduction and continued production.

Pheromones, trapping, and pest monitoring are changing pest management strategies significantly. Economic threshold evaluation and trap-baiting are used to determine when and what pest management chemical, if any, is required. Placement of pheromones to reduce reproduction of certain insects has reduced the need for chemical control

in some instances.

Higher biological activity and lower rates of use per unit area for active pest control ingredients are now feasible. Several new products, requiring only grams vs. kilograms per hectare of older products, have been introduced into the marketplace. At the same time, the newer products that have higher biological activity will require an attitude change by the grower regarding application accuracy; sloppiness during application cannot be tolerated.

Biodegradable packaging (to reduce waste disposal problems) and bulk or minibulk handling will become standard approaches. In some cases, biodegradable cornstarch plastic packaging could be utilized. Water-soluble plastic containers or pouches that can be put into the spray tank are a possible means of reducing worker exposure and eliminating container disposal problems.

Use of rinsates, container disposal, and recycling options and programs are being developed to reduce the chemical dis-

posal load in landfills and to assure the possibility of rinsates being applied to the field as part of the spray application. Recycling plastic or metal containers for resource recovery has great promise.

Regulatory Changes

Federal and state regulations will significantly affect availability and use of crop protection products. The reregistration of older products mandated by the new amendments to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requires an upgrading of data bases for older products. Failure to reregister products will cause their removal from the marketplace.

Groundwater protection strategies developed by the EPA will produce health-based standards and result in guidelines for groundwater protection. The EPA will seek implementation of such strategies within states by state governments. More than 20 states have comprehensive groundwater legislation.

Eventually, all 50 states will have such plans.

Food safety issues, based on public perception, have reached a high level of concern. Publication of several reports and books on the subject will encourage introduction of federal legislation on food safety. The negligible risk concept or the one-in-a-million probability of contracting cancer from ingestion of chemical residues will be of profound concern as new regulations regarding food tolerances are being considered.

In summary, the crop protection chemicals industry is changing along with the nation's agricultural system and, in part, in response to legislative and regulatory pressures being brought by Congress and the states. The change is not only in product identification but also in philosophy. The industry is more environmentally conscious than it once was. It is more than willing to play its role to maintain the integrity of the nation's supply of air, water, soil, and food.