CONTROLLED RELEASE PESTICIDE SYMPOSIUM

1974

PREFACE

The technical reports and notes bound herein were presented at the first Controlled Release Pesticide Symposium conducted under the auspices of the Engineering and Science Division of the Community and Technical College (University of Akron) during the 16th, 17th and 18th of September 1974. In several cases only abstracts were available for enclosure and in two instances, (Nos. 31 and 37) reports have been submitted for publication elsewhere.

A number of individuals have contributed their time and talents in the planning and operation of this symposium. I especially wish to extend my gratitude to Mr. Marvin Phillips, Director of the Institute for Civic Education, Mrs. Linda Petticord and the entire staff at that institute, Professor Michael Bezbatchenko, Chairman of the Engineering and Science Division, Mr. John Krieg of the Health Chem Corp., Mr. George Janes of the Creative Biology Laboratory and Dr. Frank Harris of Wright State University, whose assistance and encouragement is sincerely appreciated. I wish also to thank the Session Chairmen, authors and panelists for their services; and last, but certainly not least, all the attendees for their participation and faith in the future of Controlled Release Pesticide Technology.

Nate Cardarelli
Associate Professor
Engineering & Science Division
September 5, 1974

NOTE

In order to meet an unexpectedly large demand for copies of this Proceedings we are making available this second printing. A few minor alterations have been made and the keynote address added.

I would like to notify all recipients of this document that the next Controlled Release Pesticide Symposium will be held at Wright State University (Dayton, Ohio) during September 1975. Dr. Frank Harris, Department of Chemistry, will chair this meeting.

Nate Cardarelli
Associate Professor
Engineering & Science Division
The University of Akron
February 15, 1975

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Need for Controlled Release Technology in the Use of Agricultural Chemicals

W. C. Shaw 1/

This symposium affords an excellent opportunity to assess the status of an emerging technology that will have a major impact on the effective and safe use of agricultural chemicals. The high level of interest in this important technology is reflected by the more than 40 papers scheduled for presentation, by the 9 panel discussions, and by the attendance of more than 160 scientists. I am honored by your invitation to participate.

A basic goal of our research, regulatory, and education programs is the establishment of high-yielding agroecosystems that include a quality environment. Chemical pest control practices and the use of other agricultural chemicals are fundamental to the success of this concept.

Pests that attack our crops and livestock strike at the base of our Nation's food supply. Pesticides and other agricultural chemicals, including fertilizers, are responsible for about 60 percent of the total production of food, feed, and fiber in the United States.

The farm value of food produced in the United States is more than $20 billion each year. Transporting, packaging, processing, distributing, and selling food adds about $80 billion. This wholesome and safe supply of food is still one of the best bargains the American people buy. Our efficiency in production permits each farm worker to produce enough for 45 other

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1/ Staff Scientist, National Program Staff, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland.
An invitational paper presented at a Symposium on "Controlled Release of Pesticides," The University of Akron, Akron, Ohio, September 16-18, 1974.

persons. This also makes it possible for American families to spend only 16 percent of their income for food, as compared to 56 percent by families in the Soviet Union.

The world's populations of humans, domestic animals, and wildlife cannot survive today in a natural or static environment. Man's survival and his standard of living depend upon his manipulation of the environment. He must produce an ecological balance in agroecosystems that is favorable for production of food crops and livestock, the protection of his natural resources, and all other values in his environment. Pest control is one of the major environmental manipulations necessary for the efficient, safe, and economical production of food crops, and the protection of our health and welfare. Plant diseases, weeds, nematodes, and insects are a threat not only to food and fiber production, but to the health and welfare of Americans and to all components of our environment.

Most Americans have never lived on farms and know little about the vital processes involved in the production of food and fiber. Many overlook the elementary fact that plants are the sole source of energy from which we derive the most abundant supply of high quality and wholesome food known to mankind.

The general public needs to understand the ecological situation in which crops and livestock are produced. They compete in a complex and hostile environment shared by about 50,000 species of fungi, which cause more than 1,500 diseases. About 30,000 species of weeds are distributed throughout the world. More than 1,800 of these cause serious economic losses each year. About 15,000 species of nematodes attack crop plants, and more than 1,500 of these cause damage. More than 10,000 species of pest insects add to the serious losses that occur each year.

In spite of the best control technology that we have been able to develop, the annual losses in potential agricultural production, including crops, livestock, and forests in the United States for the period 1951-1960, were 9 percent due to weeds; 10 percent due to plant diseases; 1 percent due to nematodes; and 13 percent due to insects. Thus, the loss caused by the major classes of pests was 33 percent of potential production.

Farmers spend more than $4 billion each year to control pests. The general public benefits from this annual investment. Because farmers follow effective pest control practices, we also have fewer insects in our homes; less insect transmitted human and animal diseases; less weeds in our lawns, gardens, waterways, and recreation sites; and fewer diseases of flowers and shrubs.

The use of fertilizers, pesticides, other agricultural chemicals, and biological methods of pest control has played a major role in increasing farming efficiency. Only 5 percent of the population of the United States is engaged in agriculture, as compared to 39 percent of the population in the Soviet Union.

The use of pest management systems, including integrated chemical and biological pest control practices, are only a part of the technological package that has brought about this unusual productivity on American farms.

The total technology includes: (1) genetically improved high yielding and high quality pest resistant varieties of crops; (2) improved crop and livestock management practices; (3) better plant and animal nutrition; (4) improved farm equipment and mechanization practices; (5) improved irrigation equipment, principles, and practices; and (6) efficient control of diseases, insects, nematodes, weeds, parasites, and other pests. The integration of these production inputs into compatible and efficient agroecosystems has created an agricultural revolution with far-reaching benefits.

Role of Pest Control in Food Production

In 1973, of the $4 billion farmers spent to control pests, about $2 billion was for pesticides. In addition to the use of pesticides, the farmer's defense against damage to food crops and livestock by pests includes the use of multiple pest-resistant high yielding varieties; effective seedbed preparation and seeding methods; optimum plant populations; proper fertilizer and irrigation practices; timely and appropriate cultivations; sound crop rotation, crop diversification, and field sanitation; and other effective biological and chemical methods of control. All of these practices cause ecological changes that require benefit/risk evaluations to determine those practices that best serve the public interest.

In some instances, chemicals are the only means available to control weeds, insects, nematodes, and diseases. In some instances, pest-resistant crop varieties and other nonchemical methods are the only practical means of control. However, chemical and nonchemical methods of control are usually most effective, and the public interest is best served when these are combined in an integrated pest-management systems approach that includes other good crop production practices.

The use of pesticides has accounted for at least 20 percent of the increase in farm output since 1940. They are also responsible for $4 billion of the annual saving in production resources. We should also consider the consequences of the complete withdrawal of pesticides now used in agricultural production. Total output of crops and livestock combined would be reduced immediately by at least 30 percent. The price of farm products would skyrocket. Increases of 50 to 75 percent could be expected. Farm exports would be eliminated. The number of agricultural workers currently on farms would have to be doubled. Instead of spending 16 percent of family income on food, we would be forced to devote 30 to 40 percent of our income and perhaps even more to provide current food needs. Without increasing the amount of land in farm crops, we could not provide food for more than 40 percent of our current population.

Now, of course, no thoughtful person would propose a complete ban on the use of agricultural chemicals. Currently we have about 6 percent excess production capacity. Any combination of factors that caused a 10 percent reduction in production would cause serious and untenable economic consequences. However, the overall importance of pesticides emphasizes the significance of cancelling individual uses that go to make up a part of an integrated system. Decisions to cancel individual pesticides or pesticide uses must be made by the same analytical and scientific criteria initially used in deciding to register them for crop and livestock production.

Need for Controlled-Release Technology for Agricultural Chemicals

We are entering an era of increasing intensity in the use of chemicals in agriculture as we search for more efficient forms of energy. Pesticides and other agricultural chemicals are essential to crop and livestock production and protection. They can be used to reduce the man-hour requirements, machine-hours, and machine-horsepower requirements in crop and animal production. In effect, agricultural chemicals are additional production and protection tools or sources of energy for increasing farming efficiency and reducing horsepower and energy requirements on farms.

One of the most important objectives in the development of controlled release agricultural chemicals is to achieve specificity, selectivity, and accuracy in placing them in the exact amount, in the exact place, at the appropriate time, with optimum residual activity on the target organism, with minimal effects on non-target organisms, and without causing harmful effects in the environment. The development of controlled-release technology represents a significant advancement in achieving these objectives.

Much has been written about the excessive persistence of pesticides and the potential harm they may cause in the environment. Actually, only a few of the total number of agricultural chemicals have excessive persistence. The greatest limitation in the current use of agricultural chemicals is the lack of optimum residual activity for most of them. Controlled-release technology provides new opportunities for tailoring the residual activity of chemicals to meet actual needs.

In the control of most agricultural pests, it would be desirable for pesticides to provide residual control for about one growing season, without leaving harmful residues in the soil that could be absorbed and translocated in crops grown the next season. Very few of the current herbicides, nematicides, fungicides, and insecticides provide optimum residual pest control.

Many of them have only short periods of residual activity. As a result, the initial applications of pesticides are usually at higher dosages than needed, and repeated applications are often necessary. This is an inherently wasteful, expensive, and at times an environmentally undesirable practice.

The development of controlled release technology, through the use of polymers, copolymers, microencapsulation, granulation, and other formulation techniques, offers many opportunities for developing pesticide formulations with the desired initial and residual activities for optimum pest control with minimum environmental impact.

Improved controlled-release technology is badly needed to improve the effectiveness and safety of most agricultural chemicals, such as antibiotics, antiparasitic agents, attractants, biologics, chemotherapeutics, defoliants, desiccants, fumigants, fungicides, herbicides, insecticides, nematicides, plant and animal growth regulators, plant and animal nutrients, repellents, seed protectants, and soil conditioners.

In 1973, about 50 million acres of corn, or more than 76 percent of the total corn acreage planted, were treated with herbicides for the control of weeds. About half of this acreage was treated preemergence with soil-applied herbicides. The preemergence technique of weed control was discovered in 1947 when 2,4-D was used as a preemergence soil-applied herbicide for weed control in corn.

Currently, however, 2,4-D is not widely used as a preemergence herbicide for weed control in corn for two reasons: (1) it often moves downward in the soil, causing injury to emerging seedlings, if rain occurs after the preemergence application is made, but before the corn emerges, and (2) it provides residual weed control for only about four to six weeks. Thus, it has been replaced by soil-applied herbicides that cause less initial injury and give longer residual weed control.

If a controlled-release formulation of 2,4-D could be developed that would reduce its downward movement in the soil and thus eliminate injury to emerging crop seedlings, and if its residual activity could be increased, the use of this chemical for preemergence weed control could be greatly increased. Its greater use would also effectively supplement other herbicides that are currently used. Controlled-release technology would also expand the use and improve the effectiveness and safety of many of the current herbicides.

There is a critical need for controlled-release formulations of volatile soil fumigants that give multiple pest control, such as plant pathogens, insects, nematodes, and weeds. A controlled-release formulation of a volatile pesticide, such as methyl bromide, that would maintain temporary toxic concentrations in the soil for 24 hours without the use of a gas tight cover would have a revolutionary impact on the control of soilborne pests.

Controlled-release formulations of fungicide seed treatments with residual activity that protects seedlings against attack by soilborne pathogens are badly needed. Foliage-applied, controlled-release formulations for control of diseases of tree fruits and vegetables would provide badly needed residual pest protection for these crops.

Weed seeds, nematodes, plant pathogens, and insects are widely distributed on croplands by irrigation water. Conventional pesticides have not been as effective as desired in controlling aquatic pests. Controlled release formulations offer unique opportunities for improving the chemical control of pests in aquatic sites. The increased effectiveness of controlled release formulations for mosquito control illustrates the unusual opportunities for improved pest control in aquatic ecosystems.

Recently, a polymeric microencapsulated formulation of methyl parathion was developed and introduced by scientists of the Penwalt Corporation. 2/ This formulation has clearly shown increased insecticidal activity, as well as increased residual control of several insects. In addition, the polymeric microencapsulated formulation of methyl parathion is less than one five hundredth as toxic by skin absorption and about one-fortieth to one-one hundredth as toxic by ingestion as conventional methyl parathion formulations. This innovative formulation was developed to improve the residual performance of methyl parathion for the control of insects and at the same time to increase the safety of this chemical to applicators and the environment. This is a striking example of what can be achieved through the development of controlled-release formulations of pesticides.

These are but a few examples of how controlled release technology could significantly improve the effectiveness and safety of pest control. Many of the agricultural chemicals introduced in the 1950's and 1960's can be substantially improved in effectiveness and safety through controlled-release technology. Chemical developers and manufacturers need to make careful assessments to determine the advantages of improving many of these pesticides through controlled-release and other formulation technology as compared to the cost of developing new agricultural chemicals.

2/ Ivy, E. E. Pencap M: An Improved Methyl Parathion Formulation, Penwalt Corporation, King of Prussia, Pennsylvania. In Press 1974.

Research is the Key to Improved Pest Control Systems

Primary objectives of our pest control research program in the Agricultural Research Service are to protect our supply of food, feed, and fiber; to reduce losses caused by pests; and to reduce other risks to our health, welfare, and environment. We are achieving these objectives by developing efficient and safe methods of controlling insects, diseases, weeds, and nematodes that are compatible with efficient agroecosystems and a quality environment. The development of controlled-release formulations of agricultural chemicals directly supports these objectives.

Initial emphasis is on basic research to extend our knowledge of the taxonomy, biology, ecology, physiology, pathology, metabolism, and nutrition of pests, host plants, and host-parasite relationships.

We are emphasizing mission-oriented research to develop safer and more effective pesticide use patterns, formulations, and methods of application. We need to expand basic research to support the development of controlled-release technology. Controlled-release formulations have performed well in aquatic pest control experiments, but soil-applied treatments for control of weeds and other pests have given erratic results. Fundamental research is needed to determine the causes of failure and to improve performance.

We are developing improved methods for detecting, measuring, and eliminating or minimizing residues in plants, animals, soils, air, and water. Expanded cooperative investigations on the toxicity, pathology, and metabolism of pesticides, and the behavior and fate of their residues in plants, animals, soil, air, and water are providing answers that will enable us to insure a greater degree of safety and effectiveness in pesticide use patterns and controlled-release formulations.