The outcome will directly affect you and your program. As best you can, be alert to pending legislation. Be aware of pressure groups. Resolve to handle all chemicals carefully and condemn those who do not. Through intelligent cooperation with all concerned, a solution—short of rigid and largely unnecessary new laws—will be found.

# Development, Labeling, Distribution of Turfgrass Pesticide Chemicals*

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I wonder what thoughts the title of this paper brings to each of you. To business executives it probably creates visions of new uses for chemical products and the economic implications involved. To salesmen it may raise expectations for new lines of persuasion to complement those that may have lost their freshness. To technologists it could recall memories of endless laboratory and field testing. To theoretical scientists it may give hopes of a new "breakthrough" in the scientific field. To the consumer, it may give a feeling of satisfaction to know a new potent chemical is available. Or, it also may bring confusion as to availability and proper use for this material. At any rate, it is a subject that is much broader than the simple title may imply.

When invited to present this topic, I thought of the extremely broad subject and could hardly visualize discussing this topic in 30 minutes. Then I considered the part Velsicol Chemical Corporation has had in the turfgrass chemical control program. As you know, chlordane and heptachlor have wide acceptance of usage in the various insect control programs. Also, chlordane has gained acceptance as a pre-emergence application for crabgrass control. Just at this time we are evaluating other chemicals for use in the Turfgrass Pesticide Chemical Control Programs such as a fungicide for the control of various diseases of turf and also some selective herbicides. Hence, with products now being used as well as others being evaluated in the Turfgrass Control Programs, I believe you can realize we have faced this topic various times and I speak from experiences in the various steps necessary in placing a new product on the market.

First, let us look at the subject in relation to the broader aspects of the producing and consuming public with which a pesticide is ultimately concerned. Turfgrass pesticides must be used under a variety of soils and climate and management practices that are constantly changing. As a result, the circumstances under which a turfgrass pesticide is used are never the same from state to state or even from one town to another and even within a given area. The control of the pests has to be attempted under these diverse conditions.

Furthermore, living things have great powers to adapt to environmental change and the agricultural environment is changing both naturally and through the efforts of man. Thus,

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when a new pesticide is applied, it is introduced into a situation that is living and changing and may even be changed as result of the application.

### Agency Responsibilities

Let us now consider the responsibilities of the various agencies concerned with the development and use of a new turfgrass pesticide. Various Federal Experiment Stations, State Experiment Stations, and other institutions which may or may not be privately owned, contribute to the knowledge of a pesticide through both testing and research. However, I propose to refer to the responsibilities of the chemical industry and of Federal or State Government Offices that are vitally concerned.

Industry's essential objectives are to develop new pesticides and to get them legally on the market with as little delay as possible. Since industry develops new pesticides for sale, it has the primary interest in securing the information required by law for registering such products for sale. This would entail responsibility for securing physical and chemical properties of the pesticide, procuring reliable data on the toxicity to various pests, plants, warm-blooded animals, including the applicator, fish or wildlife as well as to provide the essential information for pharmacological purposes. To carry out these responsibilities, industry must undertake the synthesis of new chemical compounds and the study of their evaluation in tests to determine the performance under field conditions similar to those for which their use will be recommended. Individual companies may vary in whole or in part in discharging these responsibilities but usually they supply samples of the candidate pesticide to Federal or State Experiment Stations for evaluation.

Possibly the easiest way to show the progress or development of a new pesticide is to follow the outline to show the steps in development and marketing of a chemical. Each stage of development, such as biology, chemistry or toxicology, is being evaluated simultaneously. However, for the ease of following the stages of development we will follow each individually up to marketing.

### BIOLOGY

From various evaluation studies it is necessary to compile data to determine the pests against which the chemical is effective. Also to establish the correct dosage to apply as well as the proper timing of applications. It is necessary to determine the effects of temperature, light, rain, soil type and fertility on the effectiveness of the candidate material. As indicated in the outline, initial screening tests will give an indication of the possible pests that may be controlled. This is followed by laboratory or small plot tests to establish the dosage needed to give effective control. Finally, large scale or field tests are used to secure information on the control obtained under similar application methods as will be used by the ultimate consumer when the chemical is marketed. The last step before placing a material on the market is to secure label registration from the U.S. Department of Agriculture as well as individual states that have Pesticide Laws. Naturally, all information obtained from the entire outline is necessary in securing the label registration. All the claims we make on a label must be carefully worded since they must be the truth in the language the consumer understands.

### CHEMISTRY

The outline for chemistry has been divided into three studies in the devel-

opment of a turfgrass pesticide until marketed. Possibly these divisions could be called Production, Formulation and Analytical.

**A. Formulation**—A proper formulation is necessary since this often determines the success or failure of a pesticide. Various types of formulations are emulsifiable concentrate, wettable powder, dust or granular. The formulation must be easy to use, designed to get the chemical to the site of action in the most efficient form, and must be economical.

The chemical must be stable in storage for periods of a year or longer and must not be affected by extremes in temperature from below 0°F. to above 100°F. The formulation must not separate nor block during this storage period since many formulations have separated or hardened, such as a chunk of concrete six months later.

Containers and container weights must be determined in this development program. This would include the size and type of container, whether glass, stainless steel, plain iron or resin-lined. Those of you that have not had the experience of being unable to get two pounds of material in a five-pound container have not adequately investigated bulk density of the new product.

The chemical properties of the new product must be developed and placed in the technical literature at the time the product is introduced to the market.

**B. Production**—The first laboratory prepared sample is very small such as one or two grams or less. If this sample shows promise in the preliminary screening evaluation tests, then slightly larger samples must be prepared until the product is ready to be moved into the pilot plant. Process development is necessary to find how the product can be made most economically—first in the pilot plant and finally in the large scale plant. This process development should begin as as soon as a new pesticide shows promise in order to supply quantities of the product for development purposes and operating data for the design of large scale plant.

Engineering is necessary for the design, erection and initial operation of the most economical plant. The Chemical Engineering Department prepares a report at this stage which furnishes rough estimates of costs and return on investment at estimated sales prices and volumes.

Concurrent with the later stages of research and the engineering and erecting of suitable production facilities, a market development must be considered. This market study would determine the possible markets as well as the potential for each market. All of this survey is necessary to provide the Chemical Engineers with enough information as to the possible size of the production plant to produce the necessary quantity of the new pesticide.

**C. Analytical**—If a pesticide is to be used on food crops it is necessary to develop a chemical analysis method to establish the possible residues on the raw agricultural crop harvested. These residues are not as important when the pesticide is applied to turfgrass, however, a chemical cannot be developed for a specific use but must be included in various control programs to provide sufficient production to insure economical use. If no residues are found, then the product may be registered on a "no-residue" basis under the Federal Insecticide, Fungicide and Rodenticide Act.

When residues are found to occur on food crops, a tolerance must be

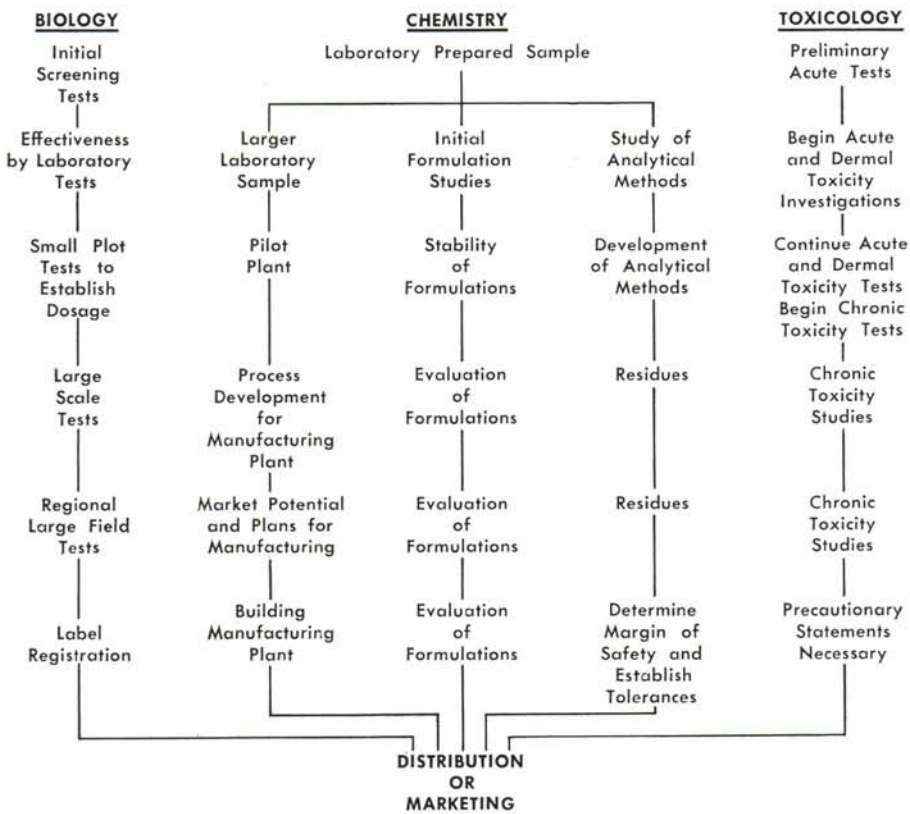
established by a petition to the U.S. Department of Agriculture and the Food and Drug Administration. The USDA decides if the product is useful and renders an opinion as to the correctness of the residue data. The Food and Drug Administration then examines the amount of residues found and if not considered harmful at the levels found will publish the tolerance. The USDA will then register an appropriate label for the pesticide.

## TOXICOLOGY

The first preliminary acute tests are made on rats or other laboratory animals to determine the range of toxicity to warm-blooded animals. If the pesticide shows promise then long term animal feeding studies are run concurrently with the large scale biology field studies. The compound is added in various dosage levels to the diets of rats and perhaps other animals. The effects on the animals are carefully noted and compared at various dietary levels.

During the course of the experiments, periodic examinations are made of the blood and general condition of the animals along with organ function tests. Periodically during the feeding tests, small groups of the animals are sacrificed and detailed examinations of their tissues are made. At the termination of the experiments the

**DEVELOPMENT, LABELING AND DISTRIBUTION OF TURFGRASS PESTICIDE CHEMICALS**



remainder are sacrificed and carefully examined.

By applying appropriate safety factors to these long-term studies, it is possible to estimate the amount of the residue which will be safe in human food.

After the toxicity studies are completed and the results fully evaluated the necessary precautionary statements that may be necessary on labels for safe use of the pesticide are established.

Finally you may be interested in the possible cost in developing a pesticide through all of these research programs which involves three or more years. The outline gives an estimated cost for the development of a new pesticide. It is difficult to give an accurate estimate of the total costs for development but it is commonly agreed that it will vary from $775,000 to over $3,000,000.

**ESTIMATED COSTS FOR DEVELOPMENT OF A NEW PESTICIDE CHEMICAL**

| | | Estimated Cost in Thousands of Dollars |
|---|---|---|
| 1. | Synthesis 100 - 1500 Compounds | $ 50 - $ 150 |
| 2. | Preliminary Screening | |
| 3. | Market Analysis | |
| 4. | Select about 10 Most Promising Compounds | 50 - 150 |
| 5. | Prepare 50 - 500 Grams Each | |
| 6. | Secondary Screening | |
| 7. | Acute Toxicology | |
| 8. | Phytotoxicity Testing | |
| 9. | Patent Applications | |
| 10. | Select 1-3 Compounds, prepare 25 - 100 Pounds | 75 - 300 |
| 11. | Analytical Methods Development | |
| 12. | Biological Performance Field Tests | |
| 13. | State Chronic Toxicity Studies | |
| 14. | Flavor and Quality Studies | |
| 15. | Residue Analysis | |
| 16. | Formulation Studies | |
| 17. | Experimental Label Registration | |
| 18. | Pilot Plant Production - 1 Compound | 100 - 500 |
| 19. | Advanced Field Testing and Comparisons | |
| 20. | Residue Analysis | |
| 21. | Conclude Toxicology Studies | |
| 22. | Process Studies and Plant Design | |
| 23. | Petitions for Tolerances | |
| 24. | Label Registration | |
| 25. | Build Full Scale Manufacturing Facilities | 500 - 2,000 |
| 26. | Packaging Chemical | |
| 27. | Labeling Chemical | |
| 28. | Sales Literature | |
| 29. | Recommendations | |
| 30. | Market Expansion | |
| | **Total Costs . . . . $775,000—$3,100,000** | |