What Is An Aquatic Herbicide? Money, Time, Luck, Hard Work and Planning

JOHN E. GALLAGHER
Agricultural Chemical Division
Amchem Products, Inc.
Ambler, Pennsylvania

MONEY

In this day and age everything costs something—generally much more than anticipated. Herbicidal development is expensive, and aquatic herbicide development is very expensive. Aquatic herbicides require a research and development team to discover and develop them into the hands of the consumer. The total cost will vary, but for comparison purposes consider your own operational budget where you work with known cost then start multiplying to provide for the unknown and you can get some concept of a company's investment when it gets into the aquatic field.

TIME

Here, too, we deal with a measurable unit, 60 minutes to an hour—24 hours to a day, but at the same time, the only prediction we can make is that it will be long. Development time is made up testing and establishing tolerance and doing analytical work. Because of the unpredictable nature of the work we find ourselves at the end of the year needing more time. We need time for plants to grow, die and grow again so that experiments can be reproduced. You don't write a label on a single experiment.

LUCK

Luck is part of an aquatic product. With all the design and planning that goes into research and development programs, more herbicides are determined by accident than by design. Once the original compound is found, improvements can be made by planning. Luck is having the right man in the right place at the right time. Someone who will see the possibilities and is in a position to move a compound out into development where maximum exposure will develop its potential. In our case, luck was having William W. Allen on hand to recognize the potential of amino triazole. On the other hand, luck was having amino triazole used improperly as a weed control herbicide in cranberries.

HARD WORK

It is just impossible to develope a raw chemical into a saleable aquatic herbicide unless someone does a lot of hard work. Plots have to be put out under a wide range of environmental conditions, under a wide span of growth stages, with different pieces of equipment and through the hands of many applicators.

There is no doubt that plot techniques have improved over the early days of aquatic weed control. Much can be learned from trials under controlled conditions, but the final assay must be made under field conditions and there is no easy way. Aquatic herbicides develop step by step through screening, controlled environmental tests, tank tests, field plot tests and demonstration trials.

PLANNING

It is argued that planning can eliminate the factor of luck, reduce the amount of money and time spent and control the amount of hard work needed to produce an aquatic herbicide. Those of us in research accept this philosophy, but who in research has not run into the unpredictable or uncontrollable factor which suddenly has become the limiting factor in the experiment. Weather is one of our major unpredictable variables. Planning is very important, but you need the organization structure of a research and development and sales force, too, to make your plans work.

A little philosophy is a good thing. Money, time, luck, hard work and planning all go into an aquatic label, but from a more practical point of view let's see if we can be a bit more specific. To do this, I will draw on information presented at various meetings and conferences by individuals directly concerned with the labeling of products for herbicide use.

At one of our earlier meetings, Dr. Thomas McClure of the Pesticide Regulation USDA discussed the mechanics of pesticide registration. The wording on the label is submitted and approved in accordance to a given set of laws—the Federal Insecticide, Fungicide and Rodenticide Act.

The several ammendments such as the Miller Bill and Delaney ammendment have increased the specific protection or information requirements to protect the public so that labels are as meaningful and useful as possible.

In a paper presented at the 1962 NCWCC Meeting in St. Paul, Minn., Dr. Bernard H. Lorant (1) gave the information that is required by law to appear on the label as follows:

"1. The name and address of the manufacturer, registrant or person for whom manufactured."

"2. The name, brand or trade mark under which the product is being sold."

"3. The net weight or the measure of the contents."

"4. An ingredient statement."

"5. Directions for use which may be necessary and if complied with, adequate for the protection of the public."

"6. A warning or caution statement which may be necessary and if complied with, adequate to prevent injury to living man and other vertebrate animals, vegetation and useful invertebrate animals."

"7. In addition, if the product is highly toxic to man either by ingestion, inhalation or skin absorption, it must also carry the skull and cross-bones and word "poison" prominently in red, and a statement of antidote."

INGREDIENT STATEMENT

The first three requirements are readily understood. Item 4 begins to introduce problems, not due to identification, but rather economics and efficiency. Assuming that compound X shows promise as an aquatic herbicide, how do we formulate and why?

Herbicides that are completely water soluble are ideal because they readily lend themselves to liquid and granular formulations. They require no special additives to make them spray or spread easily.

It is when you are faced with the insoluble, the highly volatile, or the too-readily-mobile compound that difficulties develope. Now you need special additives, solubilizers, emulsifiers and oils which will stabilize formulations. For dry granular formulations, when you have a compound which cannot be formulated on clay carriers, your formulation difficulties increase greatly.

The label requires a statement of the name and percentage of the active ingredient and the percentage of inert ingredients or the name of each active ingredient together with the percentage of total inert ingredients.

Formulations although principally a chemist's problem are developed within a specific framework made up of effectiveness, safety, cost and handling ease. Why does one choose a liquid over a granular or wettable powder? Which formulation has proven more effective in killing weeds and has the highest crop safety? Which formulation has greater adaptability for use under a wider range of conditions? Which formulation is safe under most conditions; safe to user, public and fish and game population? Which formulations are best at minimum cost? Which formulations are easy to use—which are preferred by the user?

All the questions must be considered by the manufacturer in developing the formulation which must be recorded on the label. The basic chemical quite often governs the choice of additives, but we are cost-conscious as well as safety-minded and the choice is generally a compromise. The most efficient, least costly safe formulation is selected.

Associated with the ingredient statement is item 7—the poison sticker. If any component of the formulation is more toxic than the following specifications the sticker is needed: LD50 of 50 milligrams per kilogram of body weight by oral ingestion, 200 milligrams per kilogram of body weight by inhalation or skin absorption. This preliminary test must be run by the manufacturer before even the most limited use label is approved.

The question of the poison sticker with its skull and cross-bones quite often comes up for rediscussion. Even now there is considerable agitation to have the sticker part of the cigarette label. The purpose of the sticker is to warn the user of highly toxic chemicals which can cause death within a short time after exposure. To label every potential hazard will defeat this purpose. Let us keep the sign meaningful and label only those truly hazardous compounds.

WARNING STATEMENT

Item 6, an equally important component of the label, one requiring a considerable amount of research to cover the many eventualities which can and do arise, is the warning or caution statement.

Because of the many different environmental conditions associated with aquatic weed control, it is quite possible that a warning or caution statement could exceed the directions for use in terms of label space. The Federal and state agencies make an effort to help protect the user from personal harm and damage claims.

The following are taken from labels in use, and I list a number of them to show you the wide range of cautions to look for.

1. Avoid prolonged breathing of spray mist.
2. Avoid skin contact.
3. Wash hands after using.
4. Keep away from children and domestic animals.
5. Avoid contamination of feed and food stuffs.
6. Keep livestock off treated areas.
7. Do not use for purposes other than recommended on this label.
8. Do not use *more* than is recommended.
9. ----------should be used in the spring.
10. Do not store in contact with fertilizer, seeds, insecticides or fungicides.

11. Destroy by burning.
12. Do not apply where water will be used for irrigation, drinking or other domestic purposes.
13. Do not apply to root zone of valuable trees or plants.
14. *Important*—application as directed will result in the loss of soil productivity for at least one year or possibly longer depending on soil type and rainfall.

The above are a few of the many precautions that appear on labels. A lot are simple, common-sense suggestions that everyone engaged in the handling of pesticides should observe. Others are there for specific reasons and these become self-evident when ignored.

How do we determine the need for these warning statements? Generally, as a result of test programs. It is surprising how often the unexpected shows up in test programs. The variables of weather, excessive amounts—one decimal point on a slide rule can raise the application rate ten-fold—and incompatability with other compounds which will show up in trials of mixed compounds. The first consumer usage quite often shows up additional limits. Actually, the Pesticide Review Board can and do make suggestions based on experience with similar compounds. Cautions are on the label to prevent accidents and payment of unnecessary damage claims.

DIRECTIONS FOR USE

Directions for use which may be necessary, and if complied with, adequate for the protection of the public. Safety of the public is a prime consideration, particularly in aquatics, but performance is also very important—it is still necessary to kill the weeds. Supporting data is closely scrutinized.

It's obvious that effective weed control is contingent on "application according to directions." The user can expect results if he follows directions. He must be informed through the label of the specific weeds controlled, rate of application needed and time of application as well as the necessity of repeat applications. He must also be informed if special equipment or additives are necessary and of specific volumes of carrier should that be critical to the success of his efforts.

Directions for use represent several years of work and expense of product development: the company's research program, the several state and Federal research test programs and the many repeated field tests which cover a wide range of treatment dates, environmental conditions, plant species, application rates, application volumes, additives and special equipment. In any extensive test program failures occur. These must be explained if possible so they can be avoided by label directions and cautions.

Although this is said of most areas of weed research, we at least will agree that the aquatic environment is more complex than many terrestrial situations. Our problem is not simply one of killing weeds. Any number of the following limits can be placed on the chemical offered as a solution to the aquatic problem.

We are asked for compounds that kill the weeds, but

1. don't kill fish or wildlife;
2. don't contaminate water used for domestic purposes, stock watering or for irrigation;
3. retain the herbicide in the placement area so that downstream water users will not be effected;
4. don't cause a build-up of decaying vegetation;
5. leave the desired vegetation, particularly the susceptible attractive ones growing along the water edge;
6. work equally well in static or running water;
7. don't restrict use to a specific time period;
8. don't stain or discolor boats or docks.

The above "don't" philosophy constitutes a normal difficulty and expense which can be worked out in time. As of now, solutions to all of these restrictions would permit only a very limited use label. The question in all our minds is what toxicological and residue data is actually needed to permit the labeling of compounds with no restrictions.

This can best be illustrated by a hypothetical example.

Assuming a new herbicide proven effective on water hyacinth with all of the biological performance data in the LD50 established, what additional information is needed?

I. For waters not involved in irrigation, drinking or other domestic uses,
   1. eye, dermal and inhalation studies;
   2. limited sub-acute feeding trials;
   3. TLM on fish species native to the area.
   (Time involved — 2-3 months)

II. For waters used in irrigation, but not for drinking or domestic purposes:
   1. All of the information in Section I;
   2. Determination of residue in crops to be irrigated;
   3. Establishment of a no-residue or tolerance if needed.

Requirements for the establishment of a tolerance:
   1. Two year feeding studies in two species of animals;
   2. Reproduction studies over three generations for two species of animals;
   3. Development of acceptable analytical methods;

III. For potable waters
   No set requirements, but all of the above plus no-residue situations.

SUMMARY

To summarize, let me repeat what was said at the beginning. Money, time, luck, hard work and planning go into a label. There is no inexpensive way to produce an aquatic herbicide. The immediate future does not indicate the introduction of many new aquatic herbicides; in fact, the reverse may be true since the requirements for labeling will become much more strict and demanding.

To illustrate, let me quote from the *Federal Register* (2). George P. Larrick, in what constitutes an answer to a notice of proposal to amend tolerances of dieldrin and aldrin, writes of an advisory committee recommendations, "In the expectation that there will be continued use of aldrin and dieldrin indefinitely, from which food contamination would occur and for which tolerances are therefore needed, the Committee recommends that additional studies be conducted. These studies may include: (a) definitive investigations of carcinogenicity in two animal species; (b) establishment of no-effect levels in two animal species; (c) study of the metabolic fate of aldrin and of dieldrin in the human as well as in experimental animals; (d) epidemiological studies in men, including groups occupationally exposed to the pesticides, with correlations of exposures and fat storage; (e) further attemps to estimate the maximal predicted human exposure.

The above represents one expenditure of close to ½ million dollars. There is no reason to assume that similar requirements will not be imposed for compounds to be used in potable water.

The interest of the Fish & Wildlife Division is of prime importance in the development and use of aquatic herbicides. In a paper presented at the American Chemical Society meetings in California, March 4, 1964, Dykstra (3) lists among the findings and recommendations of the President's Science Advisory Committee — Changes in Pesticide Registration procedures: "Fish and Wildlife Service biologists are also currently working with the Pesticides-Wildlife Committee of

the National Agricultural Chemicals Association to develop procedures whereby certain species of fish and wildlife will be used by chemical companies in determining the toxic effects of new pesticides at an early stage in their development. They will include avian species that are readily available such as pheasants, quail, and mallard ducks, as well as warm- and cold-water fishes such as bluegill and trout. These will be used in addition to the common laboratory animals now accepted as standards. It is expected that data from such tests will be required in the future at the time requests for registration of new products are made to the Department of Agriculture."

Aquatic herbicides will be developed, but not too rapidly.

1. Lorant, Bernard H. 1962. Labelling to meet state registration requirement. Proc. NCWCC 19:55-58.
2. Larrick, George P. 1965. Aldrin and dieldrin; notice of proposal to amend tolerance. Federal Register 30:7249-50.
3. Dykstra, Walter W. 1964. Chemicals in the wildlife environment. N.A.C. News 22(5):3-5.