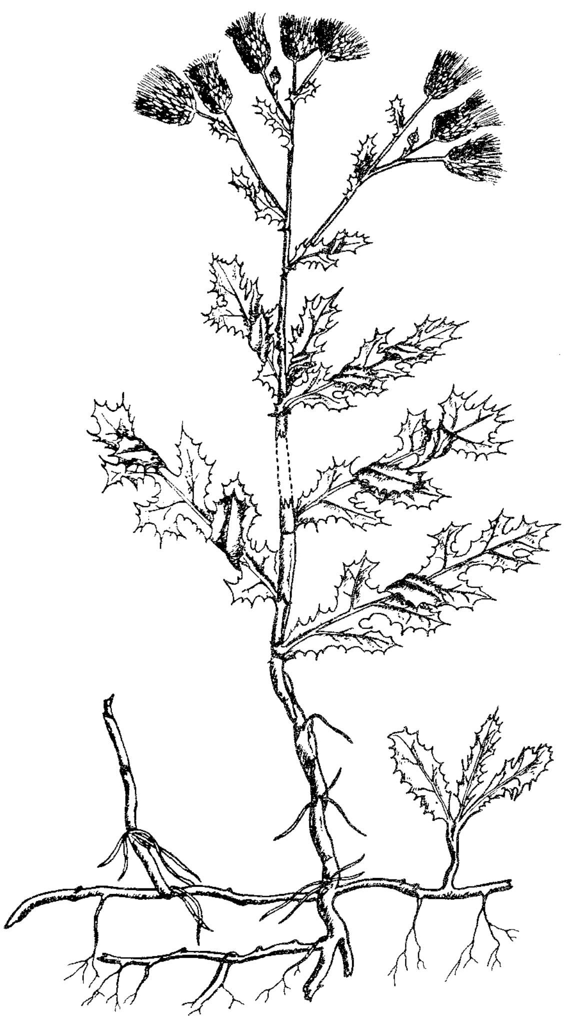

Proceedings

of the 1967 WESTERN WEED CONTROL CONFERENCE

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March 15, 16, 17, 1967

Phoenix, Arizona

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Western Weed Control Conference

Westward Ho Hotel, Phoenix, Arizona

March 15, 16, 17, 1967

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PRESIDENTIAL ADDRESS

Louis A. Jensen[1]

Fellow workers in Weed Science — welcome to the twenty-first meeting of the Western Weed Control Conference! We trust the next two and one-half days will prove to be very profitable to everyone of you. The facilities here are excellent and we hope you are comfortable and happy. We want to thank Fred Arle, Local Arrangements Chairman, and the staff of this hotel for their untiring efforts. If you need or want anything, just contact Fred. An outstanding program has been arranged by the Program Committee under the chairmanship of our vice president, Stan Strew, and we appreciate their efforts.

Certainly we are vitally interested in the future of weed science and the role our conference will play in this important endeavor in the years ahead. In the few minutes allotted to me, I want to bring you a message that reflects the feelings and attitudes of our membership. I wanted every member to have an opportunity to express himself on some basic issues which need some attention. Eighty-one of you took the necessary time and effort to give us the benefit of your thinking. Many of the replies reflect deep feelings and strong convictions. A complete documentation would entail a voluminous report. It includes information which if used, could be of real value to our conference and its members, if you are interested in the ideas and suggestions of western weed scientists.

Here are a few of the highlights. First, let's look at you as respondents.

Total years of experience in the weed work represented is over 1100 years, or an average of 14 years per person. Your employment shows:

Commercial — 33 percent
Federal — 33 percent
State — 31 percent
County — 3 percent

The type of work you are engaged in looks like this in terms of man equivalents: Research workers led with 45 percent; administrative and supervisory represented 18 percent; research and development has 14 percent; Extension workers represent 11 percent; University teaching amounted to 3 percent; with regulatory and sales 2 percent each; and all other types 3 percent.

What are our concerns in the broad field of weed science? Here are just a few:

1. People need to be more aware of the importance of weed science.
2. Our public relations — poor public immage of professional agriculture in the United States.
3. The losses due to weeds.
4. Lack of practical answers for the farmers.
5. The time lag in the use of new methods.
6. Lack of qualified personnel.
7. Universities not turning out enough graduates trained in weed science.
8. Need for research on long-time, ten to twenty year effects, and to measure both positive and negative results.
9. Need to study individual plants more thoroughly.
10. Need for better herbicides.
11. Safe use of herbicides, especially the lack of knowledge on proper use of more potent herbicides.
12. High cost of developing herbicides.
13. Unreasonable FDA restrictions and more demanding requirements for registration.
14. Misconcepts by the public in believing herbicides are as toxic to people, livestock and wild life as insecticides.
15. Labeling is getting too complex and less understandable.
16. Damage to crops from residues persisting in the soil.
17. Those carrying out the regulations do not see the problems of the landowner and applicator.
18. Lack of coordination between agencies and industry on recommendations.
19. Chemicals are getting too much attention and other control measures are being slighted.
20. Not enough credit being given for good applied research.

Some of our concerns for our conference and its future are:

1. Many who would like to attend cannot do so because of a lack of funds and time.
2. We need more participation by conference members.
3. Lack of interest by members in conference affairs.
4. Competition for time and attention from other conferences, mostly the Weed Society of America and to some extent certain state conferences. Even if the time element wasn't serious, there is heavy competition and conflict with the Weed Society of America for papers.
5. The Western Weed Control Conference may die due to competition with the Weed Society of America and state conferences. Some feel we should eliminate this conference.
6. What is the conference — a research meeting or a general conference? Whom does it serve? What does it do that isn't being done by the

[1]Extension Agronomist, Utah State University, Logan, Utah.

Weed Society of America or the state conferences? Maybe we should make it a workshop to just exchange ideas and information among ourselves.

7. One segment may dominate the conference.
8. Too much tendency for meetings to be a place for companies and technicians to discuss their products.
9. The conference is being held at the wrong time.
10. Our meetings are becoming too formal.
11. We meet too often. Every two years would be enough.
12. More attractive programs.
13. Poor visual aids.
14. Proceedings should be available at the time of conference, not six months later.
15. One optimistic person said this: "There is no serious concern. The conference serves a useful purpose and will continue."

What are the major *obstacles* or deterents to the *development* and *introduction* of *new, effective, safe herbicides?*

1. Time and high cost required to get toxilogical and residue data for registration.
2. Unknown policies and standards together with unrealistic interpretation of regulations on residues.
3. Lack of basic information as to function of herbicides in relation to the plant, soil, temperature, moisture and other factors.
4. Shortage of trained personnel.
5. Lack of adequate field testing. For example, no one from the university does field research on control in potatoes in Idaho — their number one crop.
6. Lack of prestige associated with field work.
7. Lack of coordination between agencies.

What are the major *obstacles* or deterents to the *use* of new herbicides by growers and other users after they are developed and introduced:

1. Lack of knowledge of losses due to weeds.
2. High cost to the consumer or user.
3. Growers are reluctant to pay more for newer, more effective herbicides than the less effective old ones. Some won't pay much more than the price of 2, 4-D.
4. The habit of using certain materials. They "would rather fight than switch".
5. Lack of knowledge about the product (how to use them, the cost and possible returns.)
6. Not enough field testing and demonstrations.
7. Lack of basic information on limitations and proper use.
8. Users expecting too much of a herbicide.
9. There are too many herbicides of little or no value.
10. Growers lack confidence in commercial products due to exaggerated claims of effectiveness. Sometimes this is a result of over-selling. There is some distrust of industry.
11. Salesmen sometimes lack knowledge of the product.
12. Slow and ineffective communication between industry, researchers, extension, and growers. There are so many people involved in the process. Universities are often three years behind in their recommendations.
13. Uninformed county agents and lack of informed speakers at growers meetings.
14. Pessimistic attitude of state Extension workers.
15. Fear of harmful residues.
16. Concern about staying within tolerances.
17. Lack of suitable specialized equipment for application.
18. Grower's reluctance to accept new herbicides except through demonstration of effectiveness. (I would say this is probably a good thing).

As to who should be taking major responsibility for field testing of herbicides:

33 percent say industry.
21 percent say ARS.
28 percent say university research.
15 percent say university Extension.

Many believe all four of the above groups have certain responsibilities in field testing. That it should be a joint or cooperative effort.

As to who should be obtaining residue data on herbicides:

49 percent thing industry should.
21 think USDA.
16 think university.
14 think pure food and drug.

There were some very interesting side comments on this question.

Are we over-emphasizing chemicals? Forty-seven percent of those answering the questionnaire feel we should be devoting more effort to aspects of weed science and weed control *other than herbicides.*

Now we want to pass on some of the excellent suggestions for improvement. It is easy to voice concerns and point up problems. But, it takes positive thinking to make worthwhile, practical and useable suggestions for improvement. I will list suggestions in nine different areas of work.

A. SUGGESTIONS TO INDUSTRY RESEARCH

1. Introduce fewer compounds.
2. Develop only highly active herbicides.
3. Test promising new herbicides more thoroughly before releasing to others so there is more likelihood of each one becoming useful.
4. Release all findings on both the weaknesses and the advantages of the compound. Drop those that are questionable.
5. Do more basic work.
6. Do more field testing.
7. More work on control of woody plants.
8. Pay more attention to results on state experiment stations.
9. More publications to universities.

B. SUGGESTIONS TO INDUSTRY SALES

1. Tell the whole truth in advertising and sales contacts. Be completely objective and honest, not over optimistic.
2. Put more emphasis on teaching users safe and proper use of both old and new materials.
3. Keep jobbers and distributors better informed.
4. Better trained salesmen.
5. More demonstrations and less talk.
6. Publish fact, not propaganda.
7. Recommend materials that will do the job regardless of who manufactures them.

C. SUGGESTIONS TO USDA RESEARCH

1. Take responsibility for research on complete weed control programs on a national level.
2. Work on broad principles of weed science.
3. Emphasize basic work on a national level.
4. Establish regional herbicide evaluation centers.
5. More effort on control methods other than chemicals.
6. Do not duplicate university and industry research.
7. Not enough field work. Get out and see the problems.
8. A better balance of basic and applied work.
9. More basic and less applied work.
   (These last three suggestions show the opposite views of different workers)
10. More testing of herbicide mixtures.
11. More work on control of woody plants.
12. Avoid the sensational.

D. SUGGESTIONS TO UNIVERSITY RESEARCH

1. Assume responsibility of research and recommendations of complete weed control programs at state level.
2. Assign more manpower to this area (expand).
3. Do both basic and applied work, recognizing the importance of both. Don't expect Extension to do all the applied research.
4. Expand work on mode of action, soil persistance, side effect, ect.
5. Too basic
6. Be more basic.
   Here again we see the opposing views of different workers on basic and applied research.
7. More work on control of woody plants.

E. SUGGESTIONS TO UNIVERSITY TEACHING

1. Offer more courses at both graduate and undergraduate level in weed science and do more to encourage enrollment.
2. Teach fundamentals, life history, ecology, and include basic and practical.
3. Stress background courses in chemistry, physiology, and biochemistry.
4. Improve quality of instruction. (Some graduate students and research personnel are poor teachers.)
5. Give students more appreciation for the role of industry in weed control.

F. SUGGESTIONS FOR UNIVERSITY EXTENSION

1. Be responsible for applied research at the county or district level with more uniform trials throughout the state.
2. Stay out of early stage compound testing and give formal field plot research back to university research.
3. Upgrade Extension's capabilities in weed science. County Extension agents and farm advisors should be better informed.
4. Established area or multi-county weed specialists.
5. More emphasis on training the dealers in cooperation with industry since they supply so much information to the users of herbicides.
6. More cooperation between Extension and research.
7. Careful observation of weed control practices of successful farmers who *do not solicit* our advice.
8. More emphasis on weed projects and training in 4-H Clubs and FFA to help encourage weed science careers.

G. SUGGESTIONS FOR STATE DEPARTMENT OF AGRICULTURE REGULATORY

1. Make a complete survey or inventory of noxious weeds and enforce the law regarding their control.

2. Serious need for more men that are better qualified and trained with authority to enforce the regulations.
3. Police spray operators more carefully.
4. Be less political, avoid political appointments.
5. Closer cooperation with other agencies.
6. Spend more time in the field and see what the farmers are doing.

H. SUGGESTIONS FOR COUNTY OR DISTRICT WEED DEPARTMENTS

1. There is a serious need to increase wages to get and keep more capable and qualified men.
2. Concentrate more on noxious weeds on roads and right of ways.
3. Keep up to date on new materials and change to them rather than holding on to outdated ones that are less effective.
4. Look for the best chemicals not just the cheapest.
5. Be models of careful handling and safe application methods to avoid damage and criticism.
6. Keep closer contact with University Extension.

Now, last but not least, here are some fine suggestions for improving the "Western Weed Control Conference" or the "Western Weed Science Conference".

1. Change the date.
2. Meet at more central locations of the west.
3. Hold a summer conference occasionally so we can go into the field.
4. Eliminate evening programs.
5. Better use of visuals — paper content good, but most need improved delivery.
6. Allow more time for submitting papers.
7. Send programs out earlier.
8. Be less formal. Informal project committee periods are very helpful.
9. Design program to serve purposes not served by Weed Society of America or individual state conferences
10. Include a section for invitational papers by nationally recognized authorities on a specific subject of great interest.
11. Separate sessions for technical and practical but not concurrently so individual can attend either or both.
12. Expand present sections and break down into subject matter groups.
13. Separate into two groups
    (a) applied research and development group
    (b) basic research group
14. Be a working group only.
15. Allow reporting on some uncompleted research, but avoid papers on work so preliminary that conclusions aren't possible.
16. More active participation from those in education aspects.
17. More attendance and participation by other groups such as sales people, county agents, growers, public and private organizations.
18. Eliminate research progress report and only publish papers given at the conference.
19. Hold a period, at the end of the conference to discuss improvements and solutions to problems that come up during the conference.

In conclusion I want to thank you for your frank comments and suggestions. Some of them are pretty pointed. Please don't take offense, but "if the shoe fits, wear it". Completed questionaires will still be accepted. I have some extra blanks for you who didn't receive one.

I hope each of us separately and our conference as a group, can recognize the important problems we face and put many of these suggestions into action. By so doing we wtill greatly improve our conference and the accomplishments in weed science.

CHANGING ROLE OF THE EXPERIMENT STATIONS IN DEVELOPMENT OF NEW HERBICIDES

Harold P. Alley[1]

I am sure that most of you in attendance have either heard or reviewed the papers that were presented at the Weed Society of America meetings in St. Louis in 1966 and are published in Weeds 14(4) October, 1966. This symposium carried the title very similar to this one with only the two words *testing* and *development* in the two titles being of any significance.

If we can assume that testing of herbicides is preliminary work to show its potential and real character and development is taking the compound from there to make a herbicide more usable by going through the natural evolutions of growth to where the full potential and limitations are unfolded and expanded to maturity, I feel we can intelligently discuss the Experiment Stations' role in developing a new herbicide.

It would be quite easy to assume that the role of the Experiment Stations, since our introduction into the modern era of endeavor after World War II has not changed. This would be an easy way out, I truly feel there have been changes and there are going to be more. If we are laboring in a profession that is as important to the economy of world agriculture and the world food supply, as has been dramatized, there has to be changes.

[1]Associate Professor — Weed Control, University of Wyoming, Laramie.

We cannot be content if we want to enjoy equal prestige of related fields.

Changes yes — but we still have our obligations. In 1887 the Hatch Act was passed setting up Agricultural Experiment Stations in all of the states in association with the land-grant colleges for experimentation in agricultural practices. Thus relatively early in our development, the responsibility for agricultural experimentation was placed by federal mandate and state acceptance in the Federal Department of Agriculture and the State Experiment Stations. The responsibility of the Experiment Stations is still experimentation in agricultural practices.

The symposium which was presented at the Weed Society of America meetings raised many questions and caused much comment. I have attempted to analyze these papers, and through the solicitation of help from several administrators, throughout the WWCC, come up with the feelings within our conference.

First I think it logical to consider a few of the criteria which are foremost in discussions that might attribute to the feelings that the role of the Experiment Stations is changing.

"Testing so-called unknown materials to identify potential herbicides is clearly incompatible with the teaching and research role of a university" is a direct quote from R. J. Aldrich's paper as found in weeds 14(4) 1966. This statement was directed to many of our administrators, those directly responsible for herbicide research, of the WWCC. The majority indicated that research necessary to identify herbicides was compatible — others answered a blunt no. Those that stated that the practice was compatible, stipulate that they reserved the right to concern themselves only with compounds which may be of some value in their overall program or more specifically when faced with a specific problem for which there were no chemicals of demonstrated usefulness available. Even in this case the manufacturers were expected to show evidence of potential usefulness before acceptance for testing and development. The author would have to assume from the questionnaires received that the testing of unknowns is compatible but is not necessarily practiced.

Probably the most significant development, over the past twenty years, which could be responsible for a change in Experiment Station activity, is the rapid development of a large arsenal of herbicides for use in practically every major crop and on practically every major weed species. We certainly do not have all the answers and are always alert to better practices and better herbicides. However, early in the development of modern weed control researchers were anxious to evaluate any compound in hopes of solving or even alleviating some of their immediate problems. Compounds were requested that even had to be formulated — dissolved in acetone etc. before they could be put into the evaluation program. Some of the first herbicides introduced are finding new uses — we only have to consider the ureas and arsenicals to know this is true. The Agricultural Research Service is directing more time to determining the full potential of the whys of the older established compounds and expanding relatively less of their energies on screening new herbicides. This is not a changing role — it is only meeting our obligations. If this is considered a changing role in the development of new herbicides then possibly the change is here.

Chemical companies must provide technical information when providing the chemical. It is definitely the Experiment Stations' responsibility after certain parameters have been established — either by industry or other stations, to develop this compound for potentials under their local conditions. When one considers the magnitude of research that must go into only one compound to determine with the least amount of accuracy the rates of application as effected by soil types and climatic conditions, the soil residual, selectivity, leachability, toxicity and many other areas that must be determined, we can see why possible screening programs are slowing down.

There is concern pertaining to the areas of basic and applied research: (1) There is not due recognition for applied research, (2) stations are directing their energies toward more basic research, (3) monies available are mainly for basic studies. (4) promotions are based on basic research, and (5) recommendations among states, are frequently the same therefore, all states need not have done testing of herbicides, are a few hotly contested items when the changing role of Experiment Stations are discussed.

Many of these thoughts are not new and the older researchers have been confronted with these dilemas for some time. If we read Dr. Stanley B. Freeborns, Assistant Dean, College of Agriculture, University of California, article entitled "How Experiment Stations Help Develop New Pesticides" in Agricultural Chemicals — 1948, we come across the statement "It seems that the only way out of the labyrinth of endless replication of empirical trials is along the lines of basic research that will establish the possibility of fixing 'tailor-made' insecticides, fungicides and herbicides. If we capitalize on our best opportunities for progress, the time has arrived for us to develop a division of labor that will lead us out of the confusion that we have erected for ourselves."

What is the feeling of our administrators in the WWCC. Responses to the questionnaire ranged from — (1) applied research is our basis for continued existence to (2) Experiment Station research should as much as possible be directed toward more basic aspects. The majority agreed that applied research was their responsibility with the research being problem oriented whether it was basic or applied and that there should be a balance. Also that applied research is necessary and justifiable but there was an undertone that this could be done by Extension.

There seems to be a strong feeling that sources of support and earmarking of federal funds for basic research put pressure on researchers to build programs which will attract this support and stations orient their programs in this direction. This means that legislative and congressional leaders are directing research rather than the professionals who have much more working knowledge of the overall picture and are aware of what direction research should move rather than through political pressure.

The question concerning applied research lacking in scientific prestige with publication of only basic research, a major emphasis for promotion, received considerable comment. The response was very interesting, diverse in opinion, and possibly encouraging to some researchers. Of course depending upon at which institution you are employed and whether you are adept at basic or applied research. Most of our administrators stated that applied research was not lacking in scientific prestige and was given equal value in promotion. Some of the comments are as follows: 1) it is unfortunate that we have permitted ourselves to accept a wedge in the term research and have separated it into applied and basic. Whenever we genuinely are in search of the truth of new information, it is research whether it has an immediate application or whether it is only accumulating knowledge for knowledge sake at that time, 2) a major publication is never lacking in prestige and use to someone or it should not be published. Accomplishment is a better criterion for promotion, 3) is not a major basis for promotion, good research is, 4) there is a definite quality difference in favor of basic research. Applied takes relatively little creativity.

It may be enlightening to know that most of our administrators feel as they do, however, this is not universal when we consider the other scientists who are members of the college promotion boards.

The statement and I quote "recommendations among states are frequently the same, therefore, all states need not have done testing of herbicides" has been heard. Here is where I would really like to bring out what I feel is the real difference between *testing* and *developing*. I will agree that preliminary screening may not be necessary in every state. Neither do I believe that one state or even the research people at Beltsville can do all the testing. I feel that the general parameters, rates and potential areas of use, can be set by any group — this group being specifically industry. From this point it is the responsibility of Experiment Stations to develop this herbicide to its fullest under local conditions.

Programs of other states should not be looked upon as duplications but as a complementary. Climatic conditions within any one state vary so much that few materials can be used statewide without a complete working knowledge of respective conditions. Herbicides that make the grade from experimental compounds to commercial products are those whose effect, among other things, are highly repeatable, however, there is no substitute for one's own experience and data when irate farmers and ranches have failures or crop damages.

In summary I would like to say that there are many opinions—it is not a question of what the changing role may be, but how can we work together—how can we complement each other through our experience and responsibilities. There has been little effort to organize within states a procedure which might be a policy for systematically evaluating herbicides in general.

Where states have taken an energetic role and responsibility—commercial concerns have relied upon individuals within Experiment Stations. Where this was not done the only recourse was to go to the field themselves.

Experiment stations make great conrtibutions as a partner in complementing industry. Commercial concerns must provide technical information when providing the chemical. They must give a better understanding of how successful a chemical has been rather than claim it will solve all problems. Because of this claim sometimes being made there has been a degree of mistrust by Experiment Stations and Extension as well as consumers being sold a bill of goods.

Conversely to this is the fantastic pressure on commercial concerns for "do everything compounds." Companies over greedy try to solve everyone's problems, in this competitive nature they have ignored the basic tenants and principles of cooperation.

Some Experiment Stations have jealously guarded their responsibility in recommendations and development of materials—extension has been ignored—extension agents, county agents and many others have gone on their own to find solution as no one was assisting them on the firing line.

The proper approach is that industry is the prime discoverer and tester of new materials. The Experiment Stations' responsibility is to take the materials and establish parameters—whether the chemical has a place in crops or sites within the state and areas where industry says it is most suited. Experiment Stations must work out the details of residual, tolerance, selectivity, toxicity, etc. Then the herbicide is given to extension for controlled field trials in cooperation with county agents. These three entities must work together—research—extension—industry. All concerned must realize that it may take a minimum of three years to adequately develop a compound.

Many industrial concerns are not willing to accept the above mentioned challenge. Three years after a compound has been found to have potentials—is much too long for them to work out the many aspects of its real potential and limitations.

The Experiment Stations are going to have to be looked to for recommendations within their states—the Extension as the educational arm. With the tremendous pressure for full evaluation of the many compounds now available and the possibility of many new ones, besides the potential of mixing two or more compounds we cannot afford to spend time monitoring and checking new chemicals that are being sold within our own locals without proper development.

The accomplishments of State, Federal and industrial weed scientists are often cited by agricultural leaders as an outstanding example of the progress that can result from a well-balanced, cooperative and coordinated team effort. Are we going to lose what prestige we have gained by minor differences of opinion of what each entity's role is? I think not.

We have gone through a period of metamorphis. The key to the future will certainly be characterized by the discovery, development and utilization of more efficient forms of energy. Thus our progress in the future will be determined by the discovery and development of more selective, more specific, better translocated, safer and more economical herbicides. We must have information and understand the fundamentals of the effect of herbicides on the total environment.

The herbicide field is becoming large and very competitive. The Experiment Stations are, in many instances, understaffed. They do not enjoy the rank and file of our closely allied friends in Entomology and Pathology. We have all experienced growing pains. We are not going to be separate sections within our college. We have a very ambitious and obligatory program ahead of us. If we are to progress we must have a well-balanced, cooperative and coordinated team effort.

If we gain nothing else from this symposium than realizing the needs for standard guidelines or policies that states can follow, we can have accomplished the first item on an agenda that could alleviate the uneasy feelings that apparently exist in the Weed Control field.

We were the first of the four weed control conferences organized, why can't we be first again.

QUESTIONAIRE AND SUMMARY "CHANGING ROLE OF EXPERIMENT STATIONS IN THE DEVELOPMENT OF NEW HERBICIDES"

Harold P. Alley

The following questions were submitted to Heads of Departments, who are responsible for direction of herbicidal research, in the eleven Western states. The response is summarized below with little or no editing of the responses submitted.

1. Is it compatible with the teaching and research role of your station to test unknown materials to identify herbicides? Is there a charge?

A majority indicated that research necessary to identify herbicides was compatible—others answered a specifically no. Those that agreed that the practice was compatible, stipulated that they reserved the right to concern themselves only with compounds which they thought may be of some value to their overall program. Other requests were made for such materials and test them only when they were faced with a specific problem for which there were no chemicals of demonstrated usefulness available—even in this case the manufacturers were expected to show evidence of potential usefulness before products were accepted.

Charges for testing was about a 50-50 proposition. Charges were definitely made if the research was in addition to the regular schedule of work. Costs were usually by grants based upon time involved, detail required and direct-overhead costs.

2. What is your reaction to applied research oriented to problems faced by the agriculture and homeowners of your state?

Response ranged from "This is our basis of continued existence" to "Experiment station research should as much as possible be directed toward more basic aspects." These responses were the extreme. The majority agreed that applied research was their responsibility with the research being problem oriented whether it be basic or applied and that there should be a balance. Applied research is necessary and justifiable but there was an undertone that this could be done by Extension personnel.

3. Recommendations among states are frequently the same. There are strong feelings that all states need not have done the testing of herbicides. What are your reactions to the above statement?

The parameters or general rates can be set by any group. Programs of other states compliments other than duplicates local programs. Climatic conditions within states are so great that few materials and methods can be used statewide. Herbicides that make the grade from an experimental compound to a commercial product are those whose effect (among other things) is highly repeatable. There is no substitute for one's own experience and data under local conditions when irate farmers and ranchers have failure or damages.

4. There seems to be a strong feeling that the sources of support and cost of research are movng experiment station programs in the direction of increased basic research and concentration of effort. Has this support prompted your program to be oriented in the direction of basic research?

Definitely has a bearing on the activity and has to be considered a factor because of the availability of funds for basic research. However, most stations are endeavoring to keep a balance between basic and applied research. Again there is a minority that would like to go strictly to basic work.

5. Has the increasing ear-marking of federal funds for specific projects with emphasis on basic research put your individual researchers under increasing pressure to build programs which will attract grant support?

The ear-marking of funds seems to have considerable influence upon the type of research. Some stations report there is pressure to orient or organize research in a direction which will qualify their projects for federal funds. This means that legislative and congressional leaders are directing research rather than the professionals who have much more working knowledge of the overall picture and are aware of what direction which research should move rather than through political pressure.

6. With the need for more elaborate, refined, and exexpensive equipment where do monies come from to meet these needs?

Primarily from grants with limited sources from state funds. The obtaining of sufficient monies is of major concern.

7. Is your station looking to other states, with more elaborate and expanded facilities for certain aspects of herbicide testing? Do you base state recommendations on other stations' research and testing?

Most stations take advantage of work from other states especially for preliminary screening and specific basic work that does not include all the variables of field testing. Information is exchanged, but materials used in any significant amount should be verified by local station.

8. If your station has handled extensive routine testing in the past, do you contemplate a reduction in this type of work in the future?

Only one state indicated that they had ever conducted an extensive routine testing program. The others had never had an extensive program other than for very pressing problems. Indications were that this type of testing may even be reduced from what it is now.

9. Should the experiment stations rely upon the pesticide industry and U.S.D.A. to contribute more than they do at the present time, to the testing of herbicides?

Very strong feeling that the pesticide industry should contribute more to the testing of herbicides than they now do—this means technical, residual, selectivity, etc. Experiment stations should not rely upon the industries data unless they expand their program and give more critical data.

10. Should local problems be solved by the experiment station or should they rely upon the industry to come up with solutions?

Whole heartedly a cooperative venture between the two with a very few feeling it is a responsibility of industry in particular situations.

11. Is applied research lacking in scientific prestige with publications of only basic research a major emphasis for promotion?

The response was very interesting and possibly encouraging to some researchers. Most administrators stated that applied research was not lacking in scientific prestige and was given equal value in promotions. Some of the responses are as follows: (1) it is unfortunate that we have permitted ourselves to accept a wedge in the term research and have separated it into applied and basic. Whenever we genuinely are in search of the truth of new information, it is research whether it has an immediate application or whether it is only accumulating knowledge for knowledge sake at that time. Nevertheless there is an obligation to continue publishing our applied research, and if it is well done scientific prestige is bound to follow; (2) a major publication is never lacking in prestige and use to someone or it should not be published. Accomplishment is really a better criterion for promotion; (3) is not a major basis for promotion, good research is; (4) no, but there sometimes is a consistent quality difference in favor of basic research. Testing takes relatively little creativity;

It is interesting to note that our administrators feel as they do, however, this feeling is not universal, especially when we consider the variety of people from other colleges that are on the promotion committees.

12. What percent of the annual budget for herbicide research comes from grants including National Science Foundation, Institute of Health and Federal grants as compared to legislative appropriations?

Appropriations from sources other than from the state, averaged approximately ⅓ of the total received for herbicide research. The range was from 0 to 60 percent.

13. What is your stations' feeling on field testing of herbicides?

Feeling was generally that the stations should field test herbicides but be selective as to the ones tested, that they have some potential for solving existing problems. There seemed to be a tendency for more of this type of work to be done by extension personnel and popular area of activity for branch station agronomists.

14. The remark has been made that "Universities and Experiment Stations are not doing a proper job of testing herbicides and must take a more active position." What is your feeling?

The University and Experiment Stations generally feel that they have done a good job, however, there is always room for improvement. There seems to be a feeling that less emphasis by institutions in the future with the primary responsibility being industry. This testing has been a subsidy for companies and more support is needed to maintain the present level of testing by University and Experiment Stations.

15. Weed control is a relatively young and rapidly growing field with predicted herbicide sales of $450 million by 1975. This amount of sales will equal the combined sales of insecticides and fungicides. Do you feel that your station will be prepared for such growth to be able to advise what chemical or chemicals best fit the agricultural weed control probems?

A majority felt that they would not be able to unless better organizations were established in the states, and even then, they would never be able to provide detailed answers to specific questions about all compounds. Advice could be given but categorical recommendations, no. Many crops, especially horticultural and irrigated crops are not receiving adequate attention.

16. Does your station contemplate increasing staff members, in weed control, in the next five years?

Majority stated that they contemplated an increase but would be very fortunate if this came about.

17. When considering an individual for promotion and salary increase do you put equal emphasis on basic and applied research publications?

The response to this question followed very closely the answers submitted for question 11. Both basic and applied research publications are considered along with other media. Consideration is not given to whether the individual's job is in basic or applied but depends on what contribution he is making to society. However, there were responses indicating that basic research is given more weight.

18. With the increased importance of Weed Control to the overall agriculture problem, why are the Experiment Stations understaffed when compared to Entomology, etc. Is there a possibility at your instituion of having a Weed Science section such as we have in Entomology, Pathology, etc.

There seems to be no hopes for Weed Science sections with the present assignments being satisfactory. Weed control does not enjoy the financial and political support by farmers and industry that the other entities do. Possibly the Entomology and Pathology being established when the Colleges of Agriculture were still young and rapidly expanding contributes to their higher esteem.

THE CHANGING ROLE OF THE EXTENSION SERVICE IN THE DEVELOPMENT OF NEW HERBICIDES

Eugene Heikes[1]

I am pleased to have the opportunity to discuss the assigned topic because I think Extension has a definite role in the development of herbicides. We at Colorado State University have given this considerable thought during the past year in an attempt to formulate a policy on relationships between Experiment Station, Extension Service and Industry personnel in the development of herbicides. As yet, a definite policy has not been established, but I would like to review some of the thinking that has gone into this study.

Historically the Colorado Agricultural Experiment Station has been responsible for the development of new information through basic and applied research and the primary responsibility of the Colorado Extension Service has been to carry out educational programs with farmers and others, utilizing information resulting from research. As agriculture becomes more complex there is need to define areas of responsibility and methods for carrying out programs of work for which both are responsible. Now, in the recent years, industry has also become an active partner in both research and extension programs related to herbicides.

For over 10 years, all pest control recommendations published by Colorado State University have been developed in cooperation with and approved by the Colorado Agricultural Chemicals Clearing Committee. This committee consists of an over-all clearing committee representing the University, the State Department of Agriculture, and government agencies. The main committee is subdivided into three sub-committees, one for herbicides, one for insecticides, and one for fungicides. This committee meets annually to discuss and approve or disapprove recommendations for the coming year.

Before the clearing committee meets, recommendations are discussed with the corresponding sub-committees of the Colorado Agricultural Chemicals Association, an association of industry representatives. Experiment Station and Extension personnel involved with herbicides, insecticides and fungicides meet with corresponding sub-committees in the CACA to discuss research findings and proposed changes in recommenda-

[1]Extension Weed Specialist, Colorado State University, Fort Collins, Colorado.

tions for the coming year. This gives industry a chance to make suggestions in regard to availability of specific pesticides, current registrations and labels, and indicate research needs. Following this meeting, the respective Extension Specialist discusses recommendations with Experiment Station people and tentative recommendations are prepared for presentation to the Colorado Agricultural Clearing Committee. If they are approved by the clearing committee, a letter of approval is given by the Committee Chairman who is the Commissioner of Agriculture. In general, this procedure has worked quite satisfactorily and has stimulated understanding and cooperation, and the three interested groups—Experiment Station, Extension Service and Industry.

In recent years, there has been some criticism from both grower groups and industry, mainly centered around the fact that the recommendations are sometimes somewhat of a "laundry list" with no indication as to which chemicals are the most effective in Colorado, or in certain regions of the state. We have also received some comments from chemical manufacturers that they are not clear as to how they can have an independent evaluation of their product by the University under state conditions. This criticism has been more with respect to insecticides than herbicides. It should also be pointed out that the University recommends only agricultural chemicals registered by the U.S. Department of Agriculture and does not include experimental or non-registered chemicals.

Frequently a registered chemical that has performed excellently in a particular environment does not respond the same in a different locality. For this reason, it is not possible for herbicides or other agricultural chemicals to receive automatic state endorsement for the control of a particular pest simply because it is registered by the USDA. Usually new products need extensive field testing in all possible situations before they can be recommended for use in a state or region. Because of this situation, it was decided that the Experiment Station and Extension Service at Colorado State University, develop a policy statement covering field testing and development of pesticides.

To get further information on what other states are doing in this regard, all other State Experiment Stations were asked to indicate their policy regarding the problem. A short questionnaire was developed and mailed to the directors of 49 other State Experiment Stations. Replies were received from 39. This represented an 80% response. There were 11 states which indicated that all their pesticide recommendations were based on their own field testing. There were 34 states which indicated that some of their chemical recommendations were based on field tests carried out in the state, other than by the manufacturer. In no case did a state indicate that they did no field testing of pesticides which were recommended for use in the state. In states in which some or all of the recommendations were based on independent testing, 35 indicated that the Experiment Station did the testing; 25 indicated that the Extension Service did some of the testing; 3 indicated that the State Department of Agriculture did some of the testing, and 21 indicated that some of the testing was done by the Agricultural Research Service of the USDA. Four states indicated that some of their recommendations were based on tests conducted by Experiment Stations in other states. Seventeen of the responding states indicated that their recommendations were usually specific to regions within the state, and 13 indicated that all of their recommendations were blanket recommendations applying to any part of the state.

Several states sent policy statements regarding the testing of agricultural chemicals. There was considerable variation in the forms of these policy statements. The replies concerning policies can be summarized as follows:

1. Four universities appeared to have no fixed policy regarding the testing of materials under local conditions.
2. Twenty make tests if they, as a university, decide that the testing is desirable or necessary.
3. Eight make tests by arrangement between the company and the university at the request of the company.
4. Two universities do no testing.
5. One university does testing if it fits in with "pertinent research projects."

Ten universities indicated that they charged a fee for testing a chemical material and twenty-five indicated that no fee was charged. Only four universities gave the fee which they charged. The figure varied between $100 and $300 per test. One university indicated that they did field testing of chemicals at the actual cost of testing. There were four who charged the cost of testing plus an overhead, and there were five who charged a fixed fee.

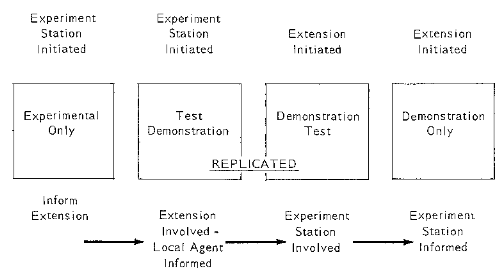
It is evident from this survey that there is no uniform policy among states in the development of herbicides or the way recommendations are made.

Having been in Extension for quite a few years, I have heard many comments on the need for more applied, practical-type research. In some cases, Experiment Station Research is becoming less concerned with solving today's farm problems and more emphasis is being put on basic research, on subjects somewhat remote from the questions that come to County Agents. However, this is not always a valid argument because I'm sure we will all agree there is much more information available than is being put to use, which emphasizes the need for stepped-up educational programs. The immediate problem facing real advancement and progress in weed control is not development of new herbicides or new methods of weed control through research, but greater acceptance and use of information already available. We all know there is definite need for more research and the development of better and more economical herbicides, but there is also need for evaluation of complete weed control programs, synchronized with other farming operations such as proper use of fertilizers; correlation with specific soil types; combinations of insecticides, herbicides, and fungicides; proper irrigation practices; crop rotations; harvesting, etc. We in Extension, Research, and Industry are responsible for considering *all* aspects of an integrated program when developing a herbicide. The use of herbicides should be considered as one of the effective tools a farmer may use in the growing and marketing of a crop. It is up to us to show him how this tool can best fit into his overall operations. Whether "X" chemical will kill "X" weed is of little interest to a farmer unless he knows how this chemical responds with respect to other crops he may grow, how it moves in the soil, what its residue characteristics are, and whether its use will make him money. We all know there is need for more and better more sophisticated herbicides, but there is also need for this information being tied in with complete farming operations.

I mentioned the trend toward basic research by State Experiment Stations. This does not mean that the need for applied research has lessened; in fact, many Extension people think the need for practical, applied-type research is greater today than it has ever been. The question is, who should do it? In some states, this responsibility is being moved from Experiment Stations to the Extension Service. There is also a tendency for industry through their development and sales representatives to do field testing and what we think of as applied research. The critical thing is that many State Extension Services are not geared up to carry out this type of program adequately; they do not have sufficient funds or personnel to adequately field test herbicides, and fungicides. In some states, with inadequate financing and neither the Experiment Station nor Extension Service being able to accept this resposibility to the extent that appears necessary, industry has moved in and is doing rather extensive field testing. In some cases testing is conducted in cooperation with the universities, and in some cases independently. Industry has also recognized the importance of demonstrations as a means of breaking down prejudices and selling products. What this means is that in many situations involving pesticides, farmers are turning more to industry for information and less to State Extension Services and Experiment Stations.

I am not saying this is right or wrong; there is certainly no need for duplication, but I think it points out the need for cooperation. It is important that Extension, Research and Industry people work together. Each have certain advantages that can help the other. For example: numbered, unregistered chemicals should be tested on Experiment Stations whenever possible where the testing can be done under close supervision and better control. After the material has been registered and looks promising for certain usages, it should be field tested under as many variable conditions as possible. Here the County Agent and the Extension Specialist in cooperation with Industry can work together.

The following block diagram shows a line of responsibilities in developing herbicides or other projects from the experimental phase to demonstration and acceptance by farmers. Industry has a place in all four steps but probably more so in the last two.



We in Extension should take the initiative in any applied research that is done off Experiment Stations. We should work closely with Industry. Both can benefit from the information obtained. There is no need for both Extension and Industry to establish field demonstrations; however, the Experiment Station should be involved and kept informed at all times. But there should be a 3-way partnership.

In establishing ground rules for mutual understanding, of work relations between Experiment Station, Extension and Industry personnel, the following procedure for initiating the evaluation of a herbicide is suggested.

1. A company wishing to have a pesticide tested in a state or area should discuss this with the proper Experiment Station and Extension personnel and present his thinking in writing. Chemicals of a non-registered nature should be confined to Experiment Stations. If the product is registered and has been tested in other states, testing for local results may be done entirely by the Extension Specialist and County Agents. However, chemicals which are tested in this manner will depend on available resources of either the Experiment Station or Extension Service.

2. Herbicides should be evaluated for at least two years under field conditions before being considered for recommendations. This length of time varies by states; in Colorado we do not recommend a new herbicide until it has been

tested and looked at under local conditions for two years.

3. Acceptance of a particular herbicide into the testing and evaluation program should not constitute a guarantee that the chemical will be recommended. Here it should be emphasized that testing does not mean endorsement of a product.
4. The Experiment Station or Extension Service (which ever does the testing) should furnish an annual progress report to the industry involved, regardless of whether the herbicide is recommended or not.
5. Industries wishing to do specific testing or evaluation of a numbered compound should do so by contract with the appropriate university or associated USDA personnel.

SUMMARY

In summary, there is no established uniform policy among states in regard to development of new herbicides by Experiment Stations, Extension Services or industry. In recent years, there has been a trend to more basic research and less applied research by Experiment Stations. In some states, the applied research is being conducted by the Extension Service, but in many states, there is inadequate financing and personnel in Extension to do this adequately. As a result, Industry has taken over part of the applied research phase and in some cases, farmers are turning more to Industry for practical information than to either Experiment Stations or Extension. There is apparent need for continued cooperation between Experiment Stations, Extension and Industry.

THE CHANGING ROLE OF INDUSTRY IN THE DEVELOPMENT OF NEW HERBICIDES

Donald H. Ford[1]

As a representative of industry, it is indeed a pleasure to speak to you today. For me personally, it is a distinct honor.

Before examining the changing role of industry in the development of new herbicidal compounds, I would like to consider some of the trends evident in applied agriculture and agricultural research in the United States.

American agriculture has taken giant strides of progress as it has evolved through the last hundred-plus years since the establishment of the land grant colleges. Today we can no longer consider agriculture as farming but rather as big business—big business as evidenced by a gross capital expenditure by farmers of 4.9 billion dollars in 1964. As rural America shrinks, the remaining farmers are being transformed into managers and capitalists. Not only has farm population decreased 46 percent since 1949 but farm employment has also dropped 35 percent in the same period. The farm now claims less than 10 percent of the nation's total labor force. The famous statement of the late Sir Winston Churchill can be applied appropriately to our agricultural enterprise: "Never have so many owed so much to so few."

The many businesses that provide goods and services to the farm, the farm operation itself, and the industries that take the raw agricultural commodities through processing, packaging, marketing, and the distribution to the consumer—all these give a broad spectrum of integrated activty that has provided us with an abundant supply of food and fiber and a basic national strength (a strength without which we could not have become the leading nation in the world). This American agricultural productivity has not come about by chance but rather, as we all know, through the sound programs and hard work of agricultural workers. We, in all phases of agricultural research, development, and extension, can and should take pride in our accomplishments. But despite these successes, our problems are increasing, not diminishing. On the one hand, we have a rapidly increasing population which demands food of higher quality and greater quantity—and this from a dwindling supply of farm land. On the other hand, we must cope with decreased understanding of farm problems and decreased appreciation of the need and benefits of agricultural research by city dwellers and by politicians elected to represent them.

The all too familiar population projections suggest a world population of approximately 4 billion humans by 1975 and about 6 billion by the turn of the century. The most optimistic of the population prophets hope that the world's population can be stabilized at something between 6 and 10 billion early in the next millenium. In short, whether or not we ever achieve a "Great Society," we are sure to have a big society—a big, hungry society. And our question becomes, how are we going to feed them? The answer here logically lies in the expansion of agricultural research aimed at improving the productivity of the land currently under cultivation and developing technology to bring additional land under cultivation. What will be the source of the research needed to solve these problems? Tax-supported agricultural research has been the pioneer in introducing the Federal government to research needs and opportunties. But agricultural research support by the Federal government is now dwarfed by the many other research activities in which the government is engaged.

One set of figures can give some insight into the emphasis shift and increased research participation by the Federal government. In 1938 agricultural research

[1]California Research Station, Eli Lilly and Company, Fresno, Califronia.

made up about 40 percent of all federally supported research and development. At this time, the Department of Agriculture was the largest single agency supporting research. Today agricultural research is a far larger, more diverse, and more compehensive enterprise than it was in 1938; and yet it is less than 1.6 pecent of federally supported research and development. So, despite its growth, it is only 1/25 as important as part of the Federal research program as it was in 1938.

A major contribution toward over-all agricultural research progress is the rapid growth in the industrial sector. It has recently been estimated that 50 percent of all agricultural research is now conducted by industry. While certainly there is no indication that total government dollars for agricultural science is likely to decrease, it may well be past its "grand period of growth." However, there is every indication that agriculture's new ally, industry, will continue to make substantial commitments toward agricultural technology for some time to come.

What is the role of industry in the development of new herbicides? In a paper entitled "Principles of Weed Control Research" presented at the recent California Weed Control Conference, Dr. Boysie Day set forth the goals of industrial herbicide research as follows:

1. The discovery and development of new herbicides.
2. The development of new uses of these herbicides
3. The exploitation of the herbicide products
4. The maintenance of limited interest and activity in basic research.

These activities have and will continue to contribute the major program in industrial herbicide research. However, it is obvious to those of us in the field that industry is taking an increasingly sophisticated and aggressive approach to herbicide discovery and development. The emphasis in totally random screening and dependence on university and experiment station facilities for primary testing of candidate herbicides is rapidly diminishing. In exploring this change in industry's approach, let's examine an Eli Lilly-Elanco Products Company research project — our most successful one — the herbicide TREFLAN . Our research program in this area consisted of a rather general screening program to observe the activity of chemicals on plants. In this routine testing, we found a compound with some activity. It was certainly not a promising material by present-day standards. The compound was a rather complex double-ring molecule which showed some non-selective burning on plants. Fortunately, we were too naive in those early days to drop this relatively unpromising lead. From the initial observation, one of our chemists sent various intermediates — much simpler compounds — to us for testing. They were also active, showing nonselective, postemergence burning of plants. Still nothing remarkable. Next he made some more complex analogs of these simple compounds. And these showed a completely different type of activity — and a high degree of activity — as selective preemergence herbicides. Considerable testing and follow-up chemistry showed the trifluoromethyl analog to be the most active — hence, trifluralin or TREFLAN . The compound didn't come from the storeroom shelf. It came from the laboratory of a competent chemist — a chemist who followed closely every scrap of biological data provided him and he used it to guide his synthesis program.

This new herbicide still had many more hurdles to make. It was a great greenhouse performer but almost failed in the field. This was because we hadn't yet learned to incorporate it into the soil. We could have given up there. Fortunately, Dr. Stan Parka, who had just joined the company, salvaged the product. He ran an experiment incorporating TREFLAN and, thus, obtained the first excellent field results with the compound. With these initial results, many activities went into motion. There was greatly expanded laboratory and field testing, studies on appropriate formulations, development of analytical methods for both formulations and for residues in plant or animal tissue, preparation of radioactive material for tracer studies, development of chemical manufacturing technology, toxicology tests of all types, and the vast array of other data required for label registration.

We have attempted at various times to analyze the reasons for our success with TREFLAN . We'd like to apply it to other projects. Unfortunately, we can't extract out some major success elixir. We find only a reliable screening program, competent chemical support, an imaginative field testing program, and a sound development and sales program. A really significant feature throughout this and all our projects is the freedom at all points to inquire and experiment. Without this freedom and with a highly regimented atmosphere, we could easily have lost a very effective and needed herbicide — TREFLAN.

Extensive testing efforts are not unique with Lilly-Elanco; many companies who entered the field before us have similar research programs. Other firms are now establishing new and elaborate research facilities. Why is this? Why are companies investing in agricultural research? The obvious answer is that we expect to get a return on an investment. We expect agricultural problems to be around for a long time, and we'd like to help solve them. But these increased activities also reflect efforts to meet the more vigorous requirements for proof of safety and efficacy by the U. S. Department of Agriculture and Food and Drug Administration. They also represent efforts to plan for tomorrow — to obtain more specialized, more sophisticated products — products which inevitably require a stronger research base.

As a representative of Eli Lilly-Elanco Products Company, I would like to give you some of our goals in herbicide research:

1. We want to continue to broaden our product line to meet expanding needs. If cotton acreage is reduced, we hope to have products for the substitute crops.
2. We want to continue to develop products with unique properties and of real significance to agriculture.
3. We must look at large acreage crops since they are of great economic importance and receive strong support from the user and the universities. We can't do much work on a clearance for a herbicide for 2,000 acres of garlic because the return will not pay for the investment even though garlic is very important to garlic producers. With many of the minor crops, we need to work closely in a cooperative program with universities and experiment stations and develop the needed data for registration.
4. We must provide adequate data to the university or experiment station regarding the biological activity of a compound and not expect them to do our screening work for us. They now have more compounds from chemical companies than they can properly and adequately test without being asked to evaluate inactive materials.
5. We recognize that herbicide research is somewhat of a gamble, but we don't wish to gamble needlessly. Specifically, we don't want to gamble with our or the university's or experiment station's reputation. We must develop data fully before a product is turned over for sale — not just enough information to obtain Federal registration. Throughout testing of candidate herbicides at our regional research stations and close, cooperative testing with local agricultural research and extension workers in secondary testing of the compounds appear to be the answer. We need an unbiased and impartial evaluation of these compounds for eventual recommendations to the users.
6. We all recognize that as industry develops greater capability for research, the land grant institutions are freed for studies of more basic nature. Actually, to develop products nowadays requires that we in industry also engage in activities that can only be construed as "basic" research. Moreover, as we develop skills along these lines, we become convinced that we can capitalize directly in recognizing opportunities to convert "nonapplied" research into applied channels. Some people believe that successful basic research will solve problems automatically if the results are simply available. Others think of basic research as "useless" research. We believe basic research is *potentially* useful research. Actually, we believe we must find ways to mobilize efforts on the more broadly defined problems and support a higher proportion of research for which the application is uncertain or at least not obvious. We must probe in new areas — we must be on the cutting edge of research if we are to prosper. We will continue to invest in sound basic programs.
7. We recognize and need the state agricultural experiment stations, extension service, and Federal agencies as vital and important links in a good, sound agricultural service program. Industry and the state and Federal organizations must continue to work together to insure thorough and efficient development and introduction of new herbicides.

REGISTRATION OF HERBICIDES FOR AQUATIC SITES

Robert B. Balcom[1]

Ladies and Gentlemen of the Western Weed Control Conference. It is a pleasure to again have the opportunity to meet with you and to discuss an important phase of our weed control problems.

In early Western Weed Control Conferences the principal topic was how to control weeds, emphasizing especially the kinds of chemicals available and the research needed to develop new ones. And now we find that only about one-half of the papers pertain specifically to weed control, which of course, is desirable, but it proves how complicated our art is becoming. Registration of pesticides was unheard of. In the first Western Weed Control Conference, which was held 29 years ago in Denver, and at which I was privileged to be one of the 23 present, there were five chemicals mentioned: sodium chlorate, carbon disulphide, borax, arsenic, and sinox or dinitrocresol.

The proceedings of the Conference included a letter dated March 17, 1938, from Secretary of Agriculture Henry A. Wallace to Congressman Marvin Jones. It stated in part, "The Department has been engaged for a limited period on a weed research program. This work has not been carried far enough to warrant final conclusions. The available evidence indicates, however, that in most areas, the most feasible methods of weed control are cultivation and cropping practices which fit in as part of the regular farm operations. * * * The only general effective method, other than that involving cultivation and cropping, is the use of chemicals, principally carbon bisulphide and sodium chlorate."

Then six years later something happened which

[1]Agronomist, U.S. Bureau of Reclamation, Washington, D.C.

shortly thereafter revolutionized weed control thinking and methods — the discovery of the effects of comparatively large amounts of the growth regulator, 2,4-D. And as you know, many other weed control compounds have followed.

Great claims were made for many of these new herbicides and about the only deleterious effects cited, especially for phenoxy compounds, were those caused by spray drift to crops and ornamental plants. Eventually their widespread use and often improper application by inexperienced workers began to show some harmful effects to certain desirable organisms such as fish and wild animals and some became suspect for humans as well.

As has been shown so often, our practical experience in the application and use of these chemical tools had gotten beyond our knowledge of how and why they work and their possible effect upon our total environment — knowledge which can be obtained only through basic research.

While the registration of pesticides in general began in 1947, very few herbicides were included and then they were registered for performance only. However, it was becoming increasingly apparent that a closer look must be given to possible residues and their effects on humans and animals. Hearings began in 1950 to obtain data. Finally the Miller Amendment to the Food, Drug, and Cosmetic Act was passed in 1955 to establish tolerances based on the evidence presented in the 1950 hearings. In order to get a pesticide registered for a particular use, it was now necessary to show that such use would not only give effective control, but also that it would not constitute a health hazard. The applicant for the registration of a label must give valid proof that the residues do not exceed the designated tolerance if one has been established.

Only a few herbicides have been registered for use in or near water and most of those carry on their labels the precaution that the water must not be contaminated or must not be used for a certain length of time. In addition, the Federal Committee on Pest Control reviews all proposed pesticide programs of each Government agency and, as it should be, will not approve the programs unless satisfied that the chemicals will be safe to use.

In many cases herbicides shown to be effective for the control of weeds in or near water have not been registered for this use, not so much because they are known to be harmful but because sufficient studies have not been made or the proper data gathered to show that they are not harmful when properly used. Evidently the manufacturers of such herbicides do not feel that the potential market is sufficient to warrant the extra expense to add this use to their labels.

Aquatic vegitation growing in irrigation, industrial, and municipal water supply reservoirs, and waterweeds in lakes, ponds, streams, irrigation canals, and drains constitute a real problem in all parts of the country. Likewise major operation costs and maintenance problems as well as large water losses are caused by undesirable vegitation infesting the banks of these reservoirs and waterways. The Defense Department, Tennessee Valley Authority, Bureau of Reclamation, Bureau of Indian Affairs, Fish and Wildlife Service, and other Federal agencies as well as State, local, and private organizations are all affected by these pests. The many people who now take advantage of water areas for recreational purposes, soon learn that water weeds impair boating, fishing, and swimming and increase mosquito production. Also, resorts may be handicapped by disagreeable odors when certain algae are involved.

Dr. F. L. Timmons, Leader, Weed Investigations, Aquatic and Noncrop Areas, Crops Research Division, Agricultural Research Service, USDA, gave an excellent summary of the waterweed problem, the costs and losses involved, the herbicides available for control, and the research needed, in his paper, "Herbicides in Aquatic Weed Control," which he presented at the Sixteenth Annual Meeting of the Southern Weed Control Conference.

Through his investigations, he has found that herbicides, the modern weed control tools, are saving the irrigation water users in the 17 Western States alone, many millions of dollars annually as compared to the outmoded methods previously employed. In fact, we can thank Dr. Timmons and the ARS scientists who have worked with him for the development of many of these money saving methods.

We cannot afford to go back to such tedious time and money consuming methods just because the effective herbicides we have been using, some now for about 20 years, have not been registered, if there is a possibility that we can show they can be used safely.

This was the topic of discussion at a recent joint meeting of the weed committees of the Department of the Interior and Agriculture and representatives of the Defense and the Health, Education, and Welfare Departments in Washington, D.C. Dr. John L. Buckley, Director and Environmental Quality Adviser of the Office of Ecology suggested that an Ad Hoc Committee be appointed to determine what would be needed to ascertain whether some of the most useful of these herbicides could be registered.

The Ad Hoc Committee was appointed with me as chairman and with representation from the Corps of Engineers, Department of the Army; Office of Science Adviser, Bureau of Reclamation, Bureau of Sport Fisheries and Wildlife, Federal Water Pollution Administration, all of the Department of the Interior; the Pesticide Regulation Division, Department of Agriculture; Public Health Service and Food and Drug Administration, both of the Department of Health, Education and Welfare; and the Tennessee Valley Authority, with exofficio members and advisers from the Corps Protection

Branch, Department of Agriculture.

There were many questions to be considered by our committee:

What is the present situation concerning the use of herbicides in and around water? What herbicides are registered for use in aquatic sites? What limitations are imposed in their use?

What herbicides have been shown to be effective for aquatic weed control, but cannot be utilized at present because of lack of adequate information or lack of registration? What specific additional information is required in order to be able to use them?

What herbicide treatments now being used in aquatic and ditchbank weed control programs are considered by Federal Committee on Pest Control, Public Health Service, Federal Water Pollution Control Administration, or other regulatory agencies to be "suspect" because of inadequate information on their "safety"? If additional information is required, what specifically is required?

What is the feasibility of establishing water standards of quality or tolerances that would provide for use of herbicides in and around water?

What research, regulatory, or legislative actions are required to insure continued usage of safe herbicides for control of aquatic and ditchbank weeds?

It was decided that we should first investigate certain of the phenoxy compounds because of their widespread use and effectiveness.

However, to complicate matters it has been determined that it is not enough to request registration of 2,4-D, 2,4,5-T or Silvex merely as an amine or ester because different amines and esters affect desirable organisms differently. For example, some are many times more toxic to fish than others.

Time prevents giving all of the details of the requirements for registration but, in general, a manufacturer or other applicant must include the proposed use on his labeling. It must also include adequate directions for that use such as the kind of aquatic sites intended to be treated, kind of weeds to be controlled, dosage, method and time of application, and the subsequent use of both the treated aquatic site and the water involved. He must also supply data to support the efficiency of each of these items.

Safety data also are required which may be harder to supply because sufficient tests may not have been made. This includes toxicity hazards to humans during transport and application; toxicity hazards to animals and fish during application; as well as toxicity to humans, fish, and desirable vegetation after application. Residue data must be furnished for both raw and finished water in reservoirs and in irrigation canals and laterals. If you would like further details on registration, they can be obtained from the Pesticides Regulation Division of the Department of Agriculture, Washington, D.C.

A three-man Registration Task Force was appointed within the Ad Hoc Committee to prepare proposed labels. The members are representatives of the Pesticide Regulation Division, Department of Agriculture; the Bureau of Sport Fisheries and Wildlife, Department of the Interior; and the Food and Drug Administration, Department of Health, Education, and Welfare. As an adviser to the Committee, Dr. Timmons furnished much of the herbicide use information for the Task Force which then perpared labels for four 2,4-D formulations.

These consist of a 2,4-D granular ester for use in ponds, lakes, and tidal embayments, and an ester of 2,4-D for the control of emersed weeds on ponds, lakes, marshes, canals, streams, bayous, and other bodies of water. The other two labels are for an amine of 2,4-D and a low volatile ester, both for use on the banks and margins of irrigation canals, drainage ditches, ponds, lakes, and reservoirs. We do not know for certain just how much additional information will be needed to have these registrations approved. We may find it necessary to substitute other formulations. We learn that there is more information available than we thought at first, and that it may be just a matter of getting it all together in the proper place. If anyone has any information or suggestions which will fit into and help complete our jigsaw puzzle, we will appreciate receiving it.

At a meeting of the Registration Task Force on March 1, it was decided that probably some toxicity and residue data will have to be obtained before the registration can be approved. It is probable that the toxicity and residue data required to register the 2,4-D formulations intended for use on ditchbanks or the margins of other bodies of water, will be the easiest to obtain because the residues should be negligible. Some toxicologists believe that if the level of 2,4-D in potable water does not exceed 0.1 parts per million (ppm) of 2,4-D, it is safe for humans.

There is research underway or planned which should give us the answers to some of the questions we need answered on safety. We hope that positive findings will be made in the near future and that these or similar registrations can be approved. In time, we hope to include other hebicides needed for aquatic weed control or marginal weeds.

In any event, the Committee will continue to follow its original policy that it will be just as concerned in learning which herbicides are not safe to use in aquatic sites as in knowing which ones can safely be applied.

PROGRESS OF REGULATORY WEED CONTROL IN NEVADA

Philip Martinelli[1]

The 1915 Legislature established the State Board of Stock Commissioners. Their primary concern at that time was with the livestock industry of the state.

In 1920 a Plant Quarantine was established to control the alfalfa weevil; this was the beginning of the Division of Plant Industry. This was also the beginning of weed control work in the State of Nevada. In 1929 the Legislature formally created the Division of Plant Industry and passed the first weed law.

Up until 1929 puncture vine control was carried out on a sporadic basis within various counties. In 1929 with the passing of the weed law, weed control work was carried on in the following counties: Clark, Douglas, Lyon and Washoe.

A weed survey of the state in 1929 and 1930 showed that certain noxious weeds had gained a firmer footing than had been anticipated. The weeds which had been declared noxious at this time were: Puncture vine (Tribulus terristris), white top (Lepidium draba) and Canada thistle (Cirsium arvenses).

The material used by those counties doing weed control work at this time was calcium chlorate. The counties purchased the material and the cost was then divided among the individual ranchers involved. Cost of weed control even at that time ranged from $80.00 to $100.00 per acre, depending upon local conditions. Results of control with calcium chlorate were reported as being variable.

In the early 1930s, in addition to the previously mentioned chemical control, flooding and cultivation were tried. Several hundred acres of land were dyked and flooded in cooperation with the Bureau of Reclamation. The control of white top was not satisfactory. This area was and still is used as a community pasture.

In the early thirties Clark and Washoe Counties had a full time weed supervisor who worked in cooperation with the State Department of Agriculture. A portion of their duties was to organize control programs involving noxious weeds. On small infestations the property owner usually took care of the problem; however, on larger acreages assistance was available through the AAA and county funds.

In the forties a sudden increase was shown in the control of noxious weeds throughout the state.

Ranchers realized that the presence of noxious weeds on their lands not only reduces the quantity and quality of the products grown, but also reduces the negotiable value of their land. Many loan agencies were making weed surveys on the lands applying for a loan. If the land was badly infested with noxious weeds the loan was either refused or substantially reduced.

About this time several counties organized control programs on Russian knapweed and white top. These programs were carried out in cooperation with the land owner, county commissioners and the AAA. In one county after two years of work the land owners failed to meet their obligations and the project was dropped. In another county the program worked the opposite way; the county didn't come up with the necessary funds and the individual ranchers carried on the program of their own volition.

In 1947 legislation was introduced authorizing the formation of weed control districts. This legislation was not enatced. However, an amendment to the weed law pertaining to weed districts was passed by the 1949 Legislature.

The first weed district was established in Lyon County in 1951 and is known as the Walker River Weed District. The noxious weeds controlled by this district are Canada thistle, Russian knapweed, puncture vine and white top.

The second district formed was in Douglas County in 1955. The weeds under control in this county are the same as those previously mentioned except for the addition of diffused knapweed and yellow star thistle.

Douglas County has a cooperative agreement with Alpine County, its neighboring county in California, which is the major source of its irrigation water. The weed district sprays noxious weeds in Alpine County and in turn is reimbursed by them. At the present time this weed district is the most active one of the three we have in the state. They are operating three spray rigs and have a full time weed supervisor.

The last weed district formed to date was in 1957 in Humboldt County and is confined to only one area of the county known as Paradise Valley. This district is the smallest of the three districts and the only weeds they are concerned with are Russian knapweed and white top.

The State Department of Agriculture has surveyed and mapped all of the farming areas of the above weed distritcs. Maps and descriptions of the infestations were made and distributed to the weed districts.

In addition to the above three weed districts two of the largest counties, Clark and Washoe, maintain a full time agriculturist as previously mentioned. The supervisors in these two counties bring together the various cooperators. In many instances the counties stand all of the costs, while in special situations the cost is paid for by the cooperators including: cities, railroads and individuals.

The State Department of Agriculture for the past 17 years has been carrying on a program in cooperation with the State Highway Department, counties and agencies within the state not having a weed district or full time help. The Highway Department and other subdivisions furnish the materials used and the State

[1]Nevada Department of Agriculture, Reno, Nevada.

Department absorbs the cost of labor and equipment. The spraying of noxious weeds is confined to the right-of-ways belonging to the state or counties and only to the noxious weeds mentioned in our regulations. This work is in addition to the spraying that is done by each of the six highway districts in the state. Their primary concern is with weeds obstructing their road signs or road shoulders.

Our noxious weed law provides for abatement procedures against property owners not willing to comply with requests to control noxious weeds on their premises. Through public relation efforts the Department has not found it necessary to enforce abatement proceedings in order to have land owners comply with control recommendations in cooperation with organized programs.

In early 1960 the Walker River Weed District, under the authority of the noxious weed law, and with the approval of the Department, developed a regulation providing for the inspection of all hay and whole feeds moving into the district for feed purposes. Point of origin or terminal inspection is required to determine freedom from designated noxious weeds.

To give you some comparison of the value of weed districts in our state during the past three to four years there has been an increase of movement of alfalfa hay and small grains to our neighboring state of California. In the last two years approximately 100 loads of the above two crops have been rejected for noxious weds. Out of these 100 loads only 1 load was from an area which has a weed district.

The outlook in the field of weed control is for increasing weed problems and control procedures. The increasing weed problem is being brought about by our methods of more rapid transportation and movement of products and farm implements. In spite of an effective roadside weed control program, increasing numbers of Johnson grass and yellow star thistle infestations are being found on state highway right-of-ways.

I think many of our weeds need some form of birth control.

DAMAGE FROM MISUSE OF PICLORAM IN IDAHO

Robert E. Higgins

The scientific chemical revolution has placed in our hands tools which have miraculous powers. The magicians of the Arabian nights or Merlin of King Arthur's day would really have had a majic touch if they could have had materials at their command which could literally wipe out acres of vegetation with infinitesimal amounts.

[1]Extension Agronomist, University of Idaho, Boise, Idaho

With the development of such toxic chemicals, use patterns have to be developed. As each new chemical was introduced numerous instances of injury from misuse occurred. We learned by experience that promiscuous use caused trouble. The careless use of 2,4-D showed us what a hormone type chemical could do by drift, volatility, use in the wrong place and so forth. People learned to use 2,4-D quite safely. When picloram came along we thought it to be another chemical similar to 2,4-D but more toxic. Some experts said that to release such a chemical to the ordinary user would be like giving a 3-year-old a 12-gauge shot gun instead of a popgun. They weren't ready for it. Even though they were instructed about how to use Tordon and what precautions to take they couldn't comprehend the phytotoxicity of this new chemical and they couldn't realize the devastating effect it could have in crops such as potatoes, beans, peas and sugar beets. As a result, they went ahead and used it similar to the way they had used 2,4-D and other related chemicals. They didn't read the label. The sales people didn't tell them what they were getting; often the retail salesman set a container on the counter and said this will kill your thistle, and so it did.

We don't want to give the impression that the manufacturer was careless in introducing Tordon nor that his representatives were careless. But, sales people and others who were inexperienced, relatively uninformed, and who wouldn't believe, did contribute to one of the biggest herbicide fandangos we have ever had.

In Idaho great effort has been made to teach people the need for and how to use all pesticide chemicals carefully. All county extension agents, county weed control supervisors and chemical sales people were informed on the hazards of misusing picloram and also on ways and means for proper use.

In spite of these warnings and directions for use and even distant rumors of unusual damage, various segments of agriculture proceeded to use picloram in such a way that injury symptoms showed up in many crops. Sometimes it was difficult or impossible to determine where the materials came from. Before tordon we had occasional damage from other chemicals, but not such a steady run of incidents which formed a pattern. For this reason we have felt that the damage and symptoms can be credited to this specific chemical although we realize that herbicides such as TBA, Banvel D and even 2,4-D and its related materials could cause similar symptoms.

The most serious damage occurred in our potato crop. In some commercial fields picloram was used for spot treatment. Before the next crop was planted soil was moved around in the field resulting in large areas other than the treated area with enough tordon to prevent potato production, or at least enough to cause serious symptoms. Other fields were damaged by applying picloram to irrigation ditches during the growing season.

In the seed producing areas similar type misuse occurred, resulting not only in loss of seed crop, but in loss because the tubers produced for seed accumulated enough residue that fields planted from this seed carrying enough tordon to show symptoms causing serious concern. Certified seed lots in Oceanside, California plantings (where each seed lot for Idaho certified seed growers is tested) called attention to this chemical. Twenty-seven lots exhibited chemical injury; two lots had enough injury to cause rejection. The remaining lots showed from ½ percent to 3 percent damaged plants. Of these seed lots 7 came from fields where picloram was applied for spot treatment in the field while the crop was growing; 5 lots were contaminated from irrigation water; and 14 lots were exposed to drift from roadside application.

Several lots of this seed were planted in various areas of the state. The resulting fields had symptoms varying from mild to severe. Actually, only one or two fields were considered to be a total loss. Other fields outgrew the symptoms when the plants were rooted in the soil and no longer growing from the contaminated seed piece.

This year, from the same araes, when the Oceanside plots were examined there were only single plants exhibiting symptoms and these from only one or two grower's lots. Apparently these areas not only learned by experience, but also from a concentrated educational program conducted during the year.

However, seed lots from other areas showed serious damage this year. It took one year for them to get in on the show. Now they are concerned and undoubtedly there will be a stronger educational effort on the safe use of chemicals in these newly affected areas.

Because of similar misuse injury symptoms also showed up in bean and sugar beet fields. Leaky booms, grazing after application, contaminated shoes and other practices contributed to the picloram injury.

Besides these cases, there have been instances where symptoms showed up in spots and streaks in the field. These were credited to the movement of Tordon by livestock because they either fed on Tordon treated areas, were fed straw of hay which had Tordon on it, or straw from treated areas had been used for bedding in corrals, feed lots, or barns and was then hauled and spread in the field. Tordon moves with soil, with water, with livestock, and with treated vegetation. Read and follow the label.

The following color slides show what has happened to potatoes, beans, sugar beets, and alfalfa because of misuse of this material. Either the chemical was sprayed in a crop field when it should not have been, or it was used at a higher rate than it should have been, or it was used in an irrigation ditch during the growing season, or it was applied when conditions for drift were present.

IDAHO'S AGRICULTURAL CHEMICAL COORDINATE COMMITTEE

Stanley I. Trenhaile[1]

The use of chemicals, including insecticides, herbicides, etc., in the production of agricultural commodities presents potential problems to and conflicts among major agricultural industries within the state of Idaho. A conference of Idaho industry representatives and the University of Idaho Extension Service was held in Pocatello on September 15, 1965, to study existing problems and conflicts and determine if these are serious enough to warrant action by interested industry groups. Idaho's potato, sugarbeet, wheat, bean, milk and livestock feeder industries from central and eastern Idaho were represented.

Active discussion revealed several serious conflicts and problems. The use of registered chemicals required for the production of one crop in a rotation may jeopardize the produce of crops following because of FDA tolerance requirements on the second crop. The utilization of crop by-products in livestock feeding may result in residues in milk and meat. Certain insects such as the alfalfa weevil cannot be economically controlled while producing residue-free alfalfa hay. Contamination of neighboring crops or destruction of beneficial insects or plants by improper selection or application of insecticides and herbicides were some of the many other problems considered.

In addition, growers have been given different and often conflicting control recommendations for each crop they grow. These conflcts may result in unacceptable residues occurring on agricultural commodities produced in Idaho.

At the close of the Pocatello conference it was propsed that a planning committee be selected to enlist the administrators and representatives of all Idaho's agricultural industries in similar meetings. The purpose of these meetings will be: 1. *to discuss and develop effective use of agricultural chemicals where serious problems or conflicts exist;* 2. *to determine methods of preventing illegal residues or misuses which might be detrimental to any segment of the agricultural community.* A planning committee was appointed to meet with the Commissioner and the Extension Entomologist.

The planning committee met in Boise on September 22, 1965. The state was divided into five regions on the basis of similar areas of agricultural production with similar problems and conflicts in agricultural

[1]Commissioner, Idaho Department of Agriculture, Boise, Idaho.

chemical usage. Representatives of each industry or agricultural commodity will be designated by their state organizations to meet and review the agricultural chemical situation in their region.

The planning committee agreed that a state committee elected from participants of each regional meeting was necessary to exchange accomplishments between regions and serve as a stimulus to the regional groups. An important function of this committee would be to coordinate control recommendations issued to growers by various agricultural industries and the Extension Service.

The name proposed for this committee was "The Idaho Agricultural Chemical Coordination Committee."

Infractions of agricultural chemical use must be prevented before someone, an industry, or Idaho's agriculture becomes involved in financial loss or nationally involved in adverse publicity. Understanding the situation and through compromise, Idaho will continue to produce an abundance of high quality commodities.

The Idaho Agricultural Chemical Coordinating Committee has now held its second annual meeting. Reports from the Regions show that local interest and sound thinking prevails and the State Committee has been able to develop a few general recommendations.

EMPHASIZING SAFE USE OF HERBICIDES[1]

A. D. Worsham[2]

I consider it a distinct honor and pleasure to be invited to present a paper on safe use of herbicides at the Western Weed Conference. However, it is with some misgivings that I have traveled approximately 2,000 miles to tell members of the Conference how not to use herbicides. It is suspected that with the diversity of crops in some of the Western states, early herbicide usage, and with weed workers in the Western states having a formal organization 10 years older than our Southern Weed Conference, you probably learned how not to use herbicides before we did and have been carrying on effective educational programs.

Extension specialists, herbicide manufacturers, and other agricultural leaders have been emphasizing proper use of pesticides for many years. With tremendous increased herbicide usage in all areas and an increasing number of chemicals being marketed, perhaps there is a need for even more emphasis on proper use.

Since becoming an Extension Weeds Specialist in 1960, I have been aware of many of the more common mistakes growers make in applying herbicides. We gradually collected slides of these errors and sometimes the drastic results of the msitakes in terms of crop injury. We emphasized to growers the necessity of proper use of herbicides in all meetings and publications.

When extension received funds from the appropriations for the national expanded educational program in pesticides, a Pesticide Education Committee at North Carolina State University was formed. Members represented the areas of entomology, plant pathology, weed control, and information.

As a member of this committee, I finally had time and funds to formalize the previous years' experiences into a slide set with script. Incorporated into the slide set were the results of questionnaires sent to county extension personnel in the state in 1963 and 1965. A part of these surveys asked for information on instances of herbicide injuries to crops.

It appeared that along with the rapidly increasing use of herbicides, there was also an increasing incidence of crop injuries through carelessness and misuse of the chemicals. *However, there was no alarming trend in herbicide misuse or evidence of unknown dangers being exposed.* Needed information was obtained on the problem areas so increased educational efforts could be initiated.

It is probably to be expected that when a new highly technical practice such as chemical weed control increases 10-to-100 fold in a period of 5 to 6 years, misuse and carelessness will occur. The important fact is that nearly all the types of misuse could easily be prevented. Increased educational efforts by public agencies and industry can help, but complete freedom from accidents and carelessness will probably never be attained just as we have never been able to prevent automobile accidents. Also, in final usage, no one can look over the shoulder of every consumer to see that he reads the label and uses the chemical properly.

Actually, we have a very good safety record as far as proper herbicide use is concerned when we consider the phenomenal rise of chemical weed control in a relatively short period of time. Table 1 gives the estimated increase in usage of herbicides in North Carolina. The situation is probably very similar for other states and the United States as a whole.

Table 1. Estimated Increase in use of Herbicides On Certain Crops in North Carolina

	% of Acreage Treated					
Crop	1957*	1961*	1963*	1964**	1965*	1966**
Corn	7	22	43	48	55	58
Cotton	1	12	38	50	70	—***
Peanuts	0.2	12	49	60	78	80
Soybeans	0	½	6	10	15	15
Small Grain	3	7	8	9	11	12
Grain Sorghum	5	14	15	17	18	20
Pastures	1	17	18	15	15	15
Hay Crops	½	4	5	5	5	5
Vegetables	—	—	—	—	3	10
Fruits	—	—	—	—	2	10
Ornamentals	—	—	—	—	5	15

*Estimated by county extension workers in state.
**Estimated by extension weed control specialists.
***Probably 75-80% of the cotton planted was treated. Much cotton was lost due to extremely unfavorable weather and probably 95% of the cotton harvested was treated.

[1]Invitational paper.

[2]Extension Associate Professor of Crop Science, Agronomy Specialist (Weed Control), North Carolina State University, Raleigh, North Carolina.

Table 2. Herbicide Injuries to Crops in North Carolina in 1965 (Reported by County Extension Workers)

Crop	Chemical Involved	Number Injuries Reported	Acres	Cause or Reason for Injury	Estimated Loss
Tobacco	Tordon	74	45	Spray drift	$60,000
	Atrazine	7	48	Used by Mistake	19,000
	Atrazine	68	52	Residue from poor application	1,400
	Atrazine	30	20	Residue from granular	1,500
	Atrazine	9	25	Contaminated sprayer	2,600
	Caparol	1	12	Contaminated sprayer	3,600
	2,4-D	2	9	Used by mistake	5,400
	2,4-D	13	17	Vapor drift	1,500
	2,4-D	5	3	Spray drift	150
	2,4-D	26	35	Drift (unspecified)	6,500
	2,4-D	8	17	Contaminated sprayer	1,650
	Fenac	1	1	Soil residue after 4 years	500
	Treflan	2	0.1	Residue from poor application	150
Cotton	2,4-D	46	417	Contaminated sprayers	21,000
	2,4-D	16	320	Vapor drift	750
	2,4-D	16	40	Spray drift	650
	2,4-D	85	700	Drift (unspecified)	20,500
	2,4-D	2	2	Applied by mistake	100
	Tordon	5	10	Spray drift	2,000
	Karmex	15	300	Unexplained injury	1,900
	Karmex	4	45	Applied too late or excess rate	550
	Treflan	6	5	Poor application	160
	Treflan	26	175	Characteristic stunting	None
	DSMA	3	75	Applied too early	?
Peanuts	Atrazine	6	92	Residues, poor application and contaminated equipment	2,250
	Atrazine	3	3	Used by mistake	?
	Karmex	1	0.3	Residue from poor application	450
	Tordon	3	6	Spray drift	500
	Vernam	15	60	Excess rate	300
	Dyanap	6	30	Used too late	100
Corn	2,4-D	99	753	Excess rate or applied over top too late	2,925
	Treflan	3	4	Residues from poor application	130
	Nitrogen solution plus 2,4-D	28	160	Sprayed over top	None
Small Grain	Diphenamid	1	3	Residue	None
	Atrazine	3	2	Residues from poor application	20
	Simazine	4	1	Residues from poor application	50
Soybeans	2,4-DB	8	200	Excess rate or too early	?
Tomatoes	Atrazine	9	9	Resdues from poor application	475
	Atrazine	2	2	Erosion on slope	500
	2,4-D	2	1	Spray drift	100
	2,4-D	2	1	Contaminated sprayer	600
Home Gardens	2,4-D	5	2	Vapor drift	200
	2,4-D	6	3	Spray drift	100
Grapes	2,4-D	2	7	Drift (unspecified)	None
Beans	2,4-D	1	5	Drift (unspecified)	300
Pasture (seeding)	Atrazine	30	80	Residue from granular	900
Peaches	Atrazine	1	1	Applied by mistake	250

A summary of herbicide misuse as reported in the 1965 weed control questionnaire to county extension workers is given in Table 2.

One has reservations about publishing data of this kind for they supply excellent source material for those who wish to quote pesticide literature out of context. However, we have made every effort to keep this aspect in proper perspective with the benefits and savings to farmers and consumers through adequate and efficient weed control through increased use of herbicides. The presentations and slide set have been well received by other extension workers, other educational agencies, and industry especially has made use of the slides in helping us in our educational efforts.

Although such a listing as this makes injuries and misuse appear alarming, again let us emphasize that when compared to savings resulting from proper use, *these losses are insignificant.* Farmers in North Carolina save at least $30 million each year in losses from weeds and cost of control through herbicide use. Potential savings are much greater with increased herbicide use.

Nearly all of the mistakes with herbicides could have been avoided. Let's take a closer look at the common problems and how to avoid them:

1. Most instances of herbicide drift could have been prevented by using a non-volatile formulation and/or using low pressure and nozzles which give a course spray. The witchweed control program in North Carolina has shown that 2,4-D can be safely applied to thousands of acres each year with present ground equipment in diversified crop areas. We believe that if all herbicide applications were made with the whirlchamber hollow-cone nozzle drift would be reduced to a minimum.

   The significant injuries caused by picloram were caused by an aerial applicator's error one year and has not occurred since.
2. The injuries from residues of atrazine, simazine, and diuron indicate that carelessness was the cause — not residual problems from proper use. Spot residues from poor application can be prevented by not stopping sprayers in the field, spilling chemicals, having good agitation in the tank, having proper nozzles, and by not over-lapping spray swaths.
3. Injuries from contaminated equipment are the result of carelessness. Growers should have separate sprayers for application of phenoxy herbicides and need to better clean sprayers which have had other herbicides in them if they have to be used on other crops.
4. Many of the other instances of misuse are the result of plain carelessness — not calibrating sprayers, not reading and following label directions, and mix-ups of chemical containers on the farm.

Let it be emphasized again that the misuse of herbicides leading to crop injuries are insignificant when compared to savings from proper use. However, the instances of misuse year after year, mainly involving the same types of errors do indicate that continued educational efforts are needed as herbicide usage continues to increase. Other states may have somewhat different problems due to different crops and herbicides, but it is suspected that most of the general categories of misuse and carelessness are the same.

INTRODUCTION TO THE PANEL ON PESTICIDE SAFETY AS IT RELATES TO HERBICIDES

J. Blair Bailey[1]

Gentlemen, I'm sure that most of you are attending this conference to further your knowledge of herbicides as well as to meet and talk with others who have similar interests.

Probably the first thing you want to know about any herbicide is whether it is effective. If it isn't under your conditions of use, you generally are not interested in any further information about the material. On the other hand, if it does prove effective and useful, you then must concern yourself with other matters, such as residues, and the legal aspects of selling, buying, and using the product under your local conditions.

Uppermost in your considerations should be the problem of safety. Manufacturers of pesticides are required, by the federal government (through the USDA), and by other regulations in many states, to establish the effectiveness of their products and to prove that they can be used safely if label directions are followed. It is at this point that confusion arises. Many people have a very narrow concept of what "safety" and "safe use" mean. They associate the term safety exclusively with human safety and, conversely, with human poisoning. However, there is considerably more to it than that.

"Pesticide safety", as we know and use the term here today, is a very broad concept that includes, but is not limited to, the toxicity of the compound and the possible hazards that exposure to the chemical may present to humans.

Pesticide safety also demands a thorough knowledge of:

1. Toxicity and possible hazard to livestock, honey bees, and fish and other wildlife.
2. Proper protective clothing and other required safety devices to be worn.
3. Drift, and how to minimize or prevent it.
4. Proper storage and disposal procedures.
5. Incompatibility and possible potentiation when certain chemicals are combined.
6. Residues in plants to be used as foods or feeds.
7. Water pollution.

[1]Pesticide Safety Specialist and Entomologist, University of California, Berkeley, California.

8. Soil contamination — that is, how long the herbicide persists in the soil, whether it will accumulate under your conditions, and whether it will adversely affect crops grown in the soil in the future.

Gentlemen, we do have some problems caused by herbicides. Humans and livestock have been poisoned, and in some cases have died. There are a number of documented cases of "fish-kills". In numerous cases, herbicides have drifted onto non-target crops, and legal action has been taken. Illegal residues have been found in crops taken up from soil, contaminated by treatment during the previous year.

I have asked the members of this panel to present, briefly, information pertaining to certain aspects of pesticide safety, as it relates specifically to herbicides.

As prerequisite to all other information pertaining to pesticides, you must know what type of category of chemical you are dealing with. I have asked Eugene Heikes, of Colorado State University to outline the classification of herbicides.

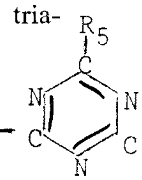
CLASSIFICATION OF HERBICIDES BY CHEMICAL TYPES

Eugene Heikes[1]

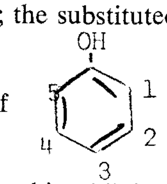
The topic assigned to me is one we can go many ways on; I am sure you have all seen classifications of herbicides based on chemical structure, whether the application is to foilage or soil, whether the herbicide is selective or non-selective, etc. But they all have one basic purpose; that is, to enable better understanding of the chemical properties and other information on proper usage. At present, there are over 100 basic chemicals that can be used for weed control. This does not include formulations. There are two general types of herbicides, these are: inorganic and organic chemicals. The inorganics (non-carbon compounds) have a history beginning in about 1900 and include ammonium sulfamate, ammonium sulfate, ammonium thiocyanate, calcium cyanamide and others. Until about 1945, when 2,4-D first became available, the inorganics along with various oils and waste products of the petroleum were the only chemical tools the weed scientists had to work with.

The organics (compounds containing carbon) which have developed mainly since 1945 are generally divided into two classes — those which contain nitrogen and those which do not; the organics which do not contain nitrogen, include the phenoxyacetic acid compounds (2,4-D and its relatives), the phenoxypropionic acids (silvex and its relatives), the phenoxybutyric acids, the phenoxyethyl derivatives such as sesone, the phenylacetic acids (amiben, etc.,) the benzoic acids such as dicamba and TBA, and the halogenated aliphatic acids such as Dalapon and TCA.

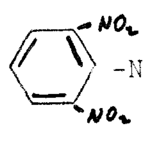
The organics that contain nitrogen include the amides, which include those whose general structure is $\begin{matrix}R_1\\R_2\end{matrix}\!>N\!-\!\overset{O}{\overset{\|}{C}}\!-\!R_3$ such as Randox and Diphenamid; maleic hydrazide; the substituted ureas which include those whose general structure is $\begin{matrix}R_1\\R_2\end{matrix}\!>N\!-\!\overset{O}{\overset{\|}{C}}\!-\!N\!<\!\begin{matrix}R_3\\R_4\end{matrix}$ (such as Monuron, Diuron, Neburon and Linuron); the carbamates whose generalized structure is $\begin{matrix}R_1\\R_2\end{matrix}\!>N\!-\!\overset{O}{\overset{\|}{C}}\!-\!OR_3$, and which includes chloropropham and propham (CIPC and IPC); the thiolcarbamates of the general structure of $\begin{matrix}R_1\\R_2\end{matrix}\!>N\!-\!\overset{O}{\overset{\|}{C}}\!-\!S\!-\!R_3$ such as Avadex and Tillam; the dithio carbamates with the general structure of $\begin{matrix}R_1\\R_2\end{matrix}\!>N\!-\!\overset{S}{\overset{\|}{C}}\!-\!S\!-\!R_3$ such as CDEC: the triazines with the generalized structure of $\begin{matrix}R_1\\R_2\end{matrix}\!>N\!-$



$-N\!<\!\begin{matrix}R_3\\R_4\end{matrix}$ such as simazine and atrazine; the substituted phenols with the generalized structure of



such as Sinox and pentachlorophenol; the bipyridinium quarternary salts, such as diquat and paraquat; and the toluidines with the generalized formula of $(R_1)_3-C-$



$-N\!<\!\begin{matrix}R_2\\R_3\end{matrix}$ such as trifluralin. To this must be added those herbicides which are relatively new and different such as amitrol, endothal, pyramin, casoron, diclone, and picloram (known as Tordon or 4-amino-3,5,6-trichloropicolinic acid — potassium salt) and last but not least — the weed killing oils derived from petroleum.

[1]Extension Weed Specialist, Colorado State University, Fort Collins, Colorado.

This type of classification is meaningful to the chemist, plant physiologist and other professionally trained people, but is not very meaningful to the farmer or average layman. Therefore, a classification based on usage is probably better for us in Extension to use. This is the classification used in the *Colorado Weed Control Handbook.*

CLASSIFICATION OF HERBICIDE BY USAGE

This type of classification separates herbicides by the way they are applied, their properties, and their toxic effect on plants. However, this classification is not absolute and a herbicide may fall into several categories, depending on rate of application and other factors.

I. SELECTIVE HERBICIDES

These are chemical formulations that are more toxic to one plant than another. When such an herbicide is applied to a mixture of plants, some may be killed and some may be affected only slightly or not at all. Usually the selectivity is not absolute and may depend upon the amount of chemical applied, the way it is applied, the degree of foliage wetting, soil moisture, soil texture, temperature, humidity, plant tolerance and differences in growth habits of plant sepcies. Because selectivity can be influenced by many factors, the same chemical may be either selective or non-selective depending on the use made of it.

A. Foliage Applications

These treatments are made to leaves of growing plants, usually as sprays.

1. Translocated

Chemicals in this group move within the plant, thus they may be effective in destroying roots of perennial plants. Low volume application is often possible. Selectivity depends primarily on physiological differences among plants.

The most common herbicides in this group are the hormone weed killers including 2,4-D, 2,4-DB, 2,4,5-T, 2,4,5-TP (silvex) MCPA, Barban, Dalapon and others.

2. Contact

Chemicals in this group kill only the plants or portions of the plant actually contacted by the chemical. This means that adequate distribution of the chemical over the foilage is essential. Selectivity may depend upon differential wetting, differences in form of plant, or upon placement of the chemical. Chemicals in this group include the dinitro materials, KOCN (Potassium cyanate), selective weed oils, diquat, paraquat, and SMA (disodium methanearsonate).

B. Selective Soil Applications

Herbicides in this group are applied to the soil before emergence of the crop (preplant or preemergence) or after emergence of the crop (postemergence). The weeds may or may not have emerged, depending on the chemical and the use made of it. Surface moisture is essential for these herbicides to be effective; best results are obtained when these herbicides are carried into the soil by rainfall, sprinkler irrigation, or by mechanical soil incorporation. Selectivity depends on plant tolerance, soil texture, location of herbicide in the soil, or differences in growth habit of both crop and weed. Herbicides in this group include Amiben, Atrazine, Avadex, CDAA (Randox) CIPA, Dacthal, Diphenamid, EPTC (Ejtam), PCA (Pyral min), Tillam, Trifluralin, Zytron, and others.

II. NON-SELECTIVE HERBICIDES

These are chemicals used to remove a wide range of vegetation although different species of plants differ in their suspectibility to any specific chemical and many of the herbicides in this group are selective to certain groups of plants, but usually not to specific species.

A. Translocated foilage application

These treatments are sprayed on the leaves of growing plants. The relatively few chemicals in this group affect a wide range of plants, but as yet there is no truly non-selective, translocated herbicide.

The most common herbicide that could be classified as non-selective and translocated is ATA (Amitrol).

B. Contact foilage applications

Chemicals in this group kill the portion of plants that actually are contacted by the chemical. Success depends on thorough coverage of all vegetation. Annual weeds are usually killed by one thorough treatment, but perennial weeds are either not affected or require repeated applications for eradication.

Herbicides in this group include Acrolein, KOCN, paraquat, weed-oils and aromatic solvents.

C. Soil applications

A wide array of soil sterilants and soil fumigants fall in this group. They are used where general vegitation control is wanted or where it is desirable to kill a certain group of plant species and leave another, such as when it is desired to kill broadleaf plants and leave grasses. Some of the herbicides in this group cause essentially no soil residue toxicity, while others leave residues that persist. A temporary soil sterilant is one that causes soil to remain toxic to plants for not more than one growing season. Semi-permanent soil sterilants are chemicals that cause soil to be toxic for not more than two years and permanent soil sterilants remain in soil to affect plants for two years or longer. However, this classification is not exact because there are many factors affecting length of time a herbicide will remain in soil and affect plant growth, some of these factors include type and amount of available moisture, soil type, soil organic matter, temperature and farming practices.

1. Soil Sterilants
These chemicals are often used to kill deep-rooted perennial weeds or what it is desired to prevent all plant growth for periods varying from a few months to several years. The length of time the soil will remain sterile depends on the chemical used, the amount applied, and other factors previously mentioned. Some materials kill all vegetation while others may be particularly effective against either broadleaf or grassweeds to the extent of being partially selective and some may be partially translocated or have some contact foilage effect.

   Herbicides in this group include the borates, chlorates, chlorinated benzoic acids such as dicamba (Banvel-D) and TBA, the substituted urea compounds (Neburon, Fenuron, Diuron, Hyvar), the triazine herbicides (Simazine, Atrazine, Propazine) and picloram (Tordon).

2. Soil Fumigants and Seedbed Control Herbicides
These materials are most often used to kill plant growth before planting to more desirable species. They usually function as a vapor or gas which diffuses through the soil; they are relatively short lived in soil. The treated area often may be replanted within a few days to a month, with no toxicity remaining. Chemicals in this group include carbon disulfide, calcium cyanamide, methylbromide, DMTP (Mylone) and SMDC (Vapam).

SUMMARY

In summary, it is obvious that an adequate classification is more than an index and should divide herbicides in such a manner as to make them more understandable. The inorganic classification is probably more meaningful to the chemist or physiologist, whereas the usage classification has more meaning to the farmer and general layman. In either case the ultimate purpose of classifying herbicides is to provide more knowledge and a better basic understanding of how herbicides work.

TOXICITY OF HERBICIDES TO LIVESTOCK, FISH, HONEY BEES AND WILDLIFE

Bert L. Bohmont[1]

A brief review of the literature would indicate that relatively little information concerning the actual toxicity of herbicides to livestock, honey bee, or wildlife is available. Most of the toxicity work in these areas has been concentrated on insecticides once it appeared that most herbicides were comparatively safe to these groups. Toxicity to fish is another matter, however, and will be discussed in detail later in this paper.

In 1943 Raynor and Britton (1) of California recognized the need to pull together toxicological information concerning herbicides. Their concern was twofold:

(A) People needed to know that all herbicides were not as toxic as sodium arsenate.

(B) Little had been written concerning the newer herbicides such as ammonium sulfamate and borax.

Raynor and Britton found that ammonium sulfamate had no effect on yearling weathers at the date of one-half pound over a five-day period; that borax fed to four aged ewes at the rate of one ounce daily for fifteen days had no ill effects. They found that the lethal dose of ammonium thiocyanate for cattle was about eight ounces.

Sinox concentrate was fatal at about ten cubic centimeters (1/3 fluid ounce) when given as a drench, but greater amounts were not fatal when consumed on sprayed vegetation. The lethal dose of sodium chlorate for sheep was two to three ounces in a single dose; for cattle one ounce daily for two weeks, or two ounces daily for three days. Common salt (sodium chloride) had a lethal dose of 4.4 to 6.5 pounds for horses; 3.3 to 6.5 pounds for cattle; and 0.5 to 1.0 pounds for sheep.

These were all considered to be relatively nontoxic when compared to the highly toxic sodium arsenate which required only a few grains to cause death in livestock.

Raynor and Britton pointed out, however, that there were a number of factors that may determine the hazard of an individual herbicide to livestock. Some of these factors were: the inherent toxicity of the chemical; attractiveness or repellency; method of application; reaction of herbicide with vegetation; season of application; rate of application and size of treated area. More recently proposed factors (2) would include: improper use of the pesticide; species of animal; biological variation; age; state of the animal's body; route of entry; health of the animal; and other drugs in the animal's body. Therefore, we have many factors which could be grouped into two general categories: the manner in which the compound is handled outside the

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body, and; the manner in which the compound is handled inside the body.

In 1954, Rowe and Hymas (3) of the Dow Chemical Company summarized the toxicological information on 2,4-D and 2,4,5-T type herbicides in relation to livestock. They found that a daily dose of 30 mg/kg probably can be tolerated by cattle for prolonged periods without adverse effect. A single dose of 1000 mg/kg may or may not cause illness. Repeated doses of 1000 mg/kg would very likely cause death. They further postulated that if completely edible forage were sprayed at the rate of two quarts of Esteron Brush Killer per acre, and that if all of the spray were retained on the forage, an animal weighing 770 pounds would have to consume all of the forage on 7,440 square feet or approximately 1/6 of an acre in order to receive a lethal dose. Their conclusion was that "the hazard to livestock and wildlife associated with the use as recommended of herbicides containind 2,4-D, 2,4,5-T, MCP and silvex is negligible."

In 1958, Dr. Hymas (4) reported that when they reached 4,000 mg/kg or approximately 3.5 pounds of dalapon, they gave up trying to determine the L.D.50 of the chemical as it appeared that the cattle would need to be drowned in it to kill them.

Goldstein and Long (5) of the Ohio Department of Agriculture's Diagnostic Laboratory in the Division of Animal Industry conducted numerous experiments in 1959 and could not elicit any visible harmful effects from concentrations of 2,4-D-2,4,5-T mixtures sprayed on skins of cattle, calves, sheep and swine. They also conducted tests to determine toxicity of 2,4-D and dalapon on sprayed pasture and also to see if there was a platability preference. All results were negative.

Mr. G. E. Lynn (6) of Dow Chemical Company reported in 1965 on the toxicity of the now popular herbicide, Tordon. The 4-amino-3,5,6-trichloropicolinic acid showed no ill effects on sheep at rates up to 650 mg/kg and no ill effects on cattle at 488 mg/kg. The $L.D._{50}$ for white rats was established at 8,200 mg/kg for this material and it was determined that Tordon 22K was even less toxic. Tordon 101 mixture proved to be more toxic to sheep, causing death to 60 pound animals within three days after ingestion of 2,200 mg/kg. Calves showed less effects than sheep, but a 279 pound calf lost 29 pounds in three days after a dose of 3,163 mg/kg, but soon recovered. An L.D.50 of 3,080 mg/kg was established for white rats.

Most of the toxicity work by game and fish departments and the Fish and Wildlife Service on game animals and birds has been in relation to insecticides and it is therefore difficult to find data on toxicity of herbicides to wildlife.

Lynn (6) did report that adult Japanese Quail fed 1000 ppm Tordon in their daily ration for a period of two weeks showed no ill effects as measured by appearance, behavior, weight gains, egg production, or egg hatchability.

I would suggest that there is little danger to wildlife from toxic effects of herbicides and that probably any detrimental effects would be from the change in environment from the use of herbicides to control sagebrush, willows, etc.

Honey bees seem to be little affected by most herbicides. Johansen (7) of Washington State University reported in 1960 that "only the arsenical and dinitro weedicides have been shown to be toxic to bees." In 1964, Johansen and Eves (8) concluded that "the current aquatic weed control treatments are probably not hazardous to honey bees collecting water from irrigation canals." It would appear that most herbicides can be used around bees with a minimum of injury.

Fish are the most affected by herbicides and some of the chemicals are highly toxic to them.

The following table shows the toxicity measurements of various herbicides versus three species of fish as reported in 1962, 1963 and 1964 by Oliver B. Cope (9) of the Fish-Pesticide Research Laboratory in Denver, and by Carl E. Bond (10) et al. of the USPHS in Ohio in 1960. Bond et al. used salmon in their studies.

Table 1. Toxicity Measurements of Selected Herbicides to Fish

	Estimated $L.C._{50}$ in mg/liter at 48 hours		
Herbicide	Rainbow	Salmon	Bluegills
Acrolein	———	.08	———
Aminotriazole	———	325.0	———
Dalapon	———	340.0	115.0
Dicamba (Banvel D)	35.0	———	130.0
Casoron, WP	22.0	———	20.0
Diquat	———	28.50	———
Diuron (Karmex)	———	16.0	74.0
Endothal	———	136.0	———
Fenac sodium salt, WP	7.5	———	19.0
Hydram, tech	.29	———	.475
Hydrothal 191	1.5	———	———
IPC, tech	———	———	32.0
Monuron (CMV)	———	110.3	———
Phygon XL (Dichlone)	———	.043	———
Silvex	———	1.23	.60
Simazine	56.0	———	118.0
2,4-D	1.1	———	3.7
2,4,5-TP	1.3	———	.50
Tordon	2.4	———	13.1
Treflan	.011	———	.020

From Table I, we can see that acrolein, dichlone, technical hydram, and treflan are toxic to fish in relatively small amounts. It has been shown that aromatic solvents are also toxic to fish in concentrations used for weed control in canals.

Hydrothal, silvex, and some low volatile esters of 2,4-D and 2,4,5-T are considered as borderline on acute toxicity at concentrations necessary to kill aquatic weeds. Water areas should be carefully avoided when treating land areas with these materials.

Acid, sodium salt and amine forms of 2,4-D are much less toxic than the low volatile esters. Most of the other herbicides are generally low in toxicity, but little is known concerning the possible concentration of the chemicals in tissues.

Effects on fish other than direct toxicity are the interruption of food chains and oxygen depletion. Only a portion of a water area should be treated at a time so as not to cause oxygen depletion.

A very recent opinion by the Attorney General of California (11) concerning the code applying to fish and wildlife states that the code not only applies to stream, lake and ocean waters, but also to canals or drains of irrigation systems. However, in constructed channels where fish would not occur naturally, there would be no violation if fish have been excluded from the sections where the deleterious material or substances retain their harmful effects.

I cite this merely to show that some states are quite concerned and are taking steps to assure the safety of their fish and wildlife.

To summarize then, I would say that generally speaking, with only a few exceptions, herbicides are not to be considered toxic to livestock, honey bees, fish or wildlife. The exceptions being sodium arsenite which is highly toxic to all forms of life; the aromatic solvents and acrolein used in aquatic weed control; dichlone, technical hydram and treflan which are also toxic to fish; and the dinitro compounds which are injurious to honey bees.

Most of the deaths or injuries proven to have been cause by herbicides have been due to gross misuse of the material. Other losses have been blamed on herbicides, or alleged increase of nitrates from the application of herbicides.

It would seem to me that, until further data has been gathered on long-term effects of herbicides, or until other data has been brought to light which would change the picture, we might consider as still valid the remarks by S. N. Fertig (12) of Cornell University in 1953. Mr. Fertig stated that all alleged cases of herbicidal poisoning of livestock and wildlife that have been definitely diagnosed have been caused by one of the following: (1) lead, (2) arsenic, (3) "hardware disease," (4) poisonous plants, (5) old age, (6) parasites, (7) drowning, (8) poor marksmanship ("hot" lead), (9) contaminated food, or (10) ingestion or oral dosage of some medicine or drug. I believe that these points still apply and that the situation is much the same today.

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PROBLEMS ASSOCIATED WITH COMBINING CHEMICALS

E. Stanley Heathman[1]

The use of combinations of herbicides or combination of herbicides, insecticides, fungicides, and fertilizers are becoming widely used in agriculture. These com-

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binations can be applied in the form of tank mixtures, (formulated by the grower) as commercially prepared mixtures or applied separately, but to the same crop. Combinations of herbicides are of particular interest in this discussion but all of the combinations mentioned above are being used today. For example, insecticide and fungicide combinations have been applied for many years.

It is difficult to find a single selective herbicide that will control all weed species in a given crop. Prescription treatments using combinations of two or more herbicides for individual weed situations, offer some advantages.

Some of the advantages that can be listed for the use of herbicide combinations are:

1. A broader spectrum of weed control is often possible.
2. A lower rate of each herbicide is sometimes required. The lower application rate may influence:
   a. An improved or increased tolerance of the crop to the heribicides.
   b. A reduced amount of herbicide persisting in the soil and crop.
3. The control of a particular weed species may be improved.
4. More consistent weed control can often be achieved under varying soil and climatic conditions.
5. The total cost of the weed control program may be reduced.

There are also some disadvantages that occur from the use of combinations of herbicides, some of those that should be considered include the following points:

1. A synergistic effect upon the weeds is hoped for, the usual result is additive.
2. Some mixtures are incompatable. Combinations of certain wettable powder and emulsifiable concentrates may result in a precipitate, making application and coverage more difficult. Also, the phytotoxicity of the herbicides may be modified.
3. If two or more materials must be measured and mixed in the spray tank, there is an increased chance that human error will result.
4. The difficulty of achieving registration for combinations of herbicides is well recognized. Some chemical companies are reluctant to become involved in the development of combinations using herbicides manufactured by some other company.
5. When mixtures are prepared at the time of application, using products of more than one manufacture, several important questions arise. Who is responsible for the proper directions for use, adequate performance and the possible side effects resulting from the application of unregistered combinations?
6. There is a lack of research information dealing with the whole concept of using combinations of pesticides. An accelerated research program in this area is urgently needed to meet the demands for further use of pesticide combinations.

A questionnaire was sent to some of the weed workers in the western United States, asking for their comments directed toward their experiences with pesticide combinations. These comments are summarized as follows:

> The day of combinations is here. Combinations are being used for weed control in sugar beets, cotton, citrus, and vineyards. The emphasis for this has resulted from the need for combinations of herbicides to control the combinations of weeds found in the field. The main problems associated with their use has been, incompatability of some of these mixtures in the spray tank, reported interaction with some insecticides (trifluralin, phorate and seedling diseases in connection with cotton seedlings), and the lack of research information dealing with the use of combinations.

HAZARDS OF DRIFT PHYTOTOXICITY AND HAZARDS TO ANIMALS

Robert E. Higgins[1]

In Washington a commercial applicator got into difficulty with the law because he was spraying when the wind was blowing over 7 miles per hour. In Arizona a cotton farmer lost a crop. In Oregon a sugar beet grower wondered what happened to his beets causing the leaves to be severly burned. In Idaho a cow died and the owner blamed the county for poisoning it with weed spray; and another rancher lost the season's crop of alfalfa hay by chemical injury. These and many more situations have occurred through the years and all of them because of real or fancied drift.

What is the problem or the hazard because of herbicide drift? Fortunately, herbicides have not been guilty of causing much of a residue problem. However, just because they haven't, doesn't mean we can be careless with them in this respect. With more critical analytical techniques detection of illegal residues is possible. Therefore, drift of an herbicide from an area of legal application to a crop where it is not registered or to areas where livestock graze can cause an illegal residue problem.

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Herbicides, because of their phytotoxic nature, have always caused damage when they drifted from the area of application to sensitive crops or other sensitive desirable vegetation. As new and better herbicides are developed this hazard increases.

Until 2,4-D came along injury from herbicide drift was a minor problem. When everyone started to use it we learned a lot about drift through experience. Not only did we get a lot of injury from droplet drift, but we also had movement of phytotoxic fumes which were more deadly to plants than the droplet drift. This kind of drift causes more widespread damage and is difficult to trace. Cotton, sugar beets, potatoes, gardens peas, alfalfa, clover, beans and other crops all have been seriously injured. Some of these injuries have resulted in lawsuits, or the crop, tree or garden has been paid for by the applicator, the county, or the neighbor. This injury occurred from across the fence to several miles from the area of application. Then, along came 2,4,5-T, Silvex, Dicamba, and Picloram. These chemicals, in turn, were capable of causing symptoms of phytotoxicity with smaller and smaller amounts and in some cases destroying a crop. Because of this extreme phytotoxicity, for example, drift of Tordon can be visually detected at least 50 times farther away than can the drift of 2,4-D. Banvel D drift from right-of-way spraying has caused severe bean damage in adjacent fields.

Contact herbicides have also caused problems, particularly when they are used as defoliants or vine killers. Diquat, Paraquat and Dinitro have drifted onto sugar beet and bean fields causing severe foliage burn. This burn may not always have resulted in serious economic loss but it has caused real concern to those whose crop was affected.

Hazard to livestock because of drift is generally at a minimum. Of greatest concern are the contact materials Diquat, Paraquat, Dinitro and Arsenicals. These are all considered to be toxic to warm blooded animals. Breathing drift of Paraquat caused an applicator to have nose bleed from which he recovered but what would be the case with livestock? Amounts resulting from drift are ordinarliy small, but even so, occasional problems with livestock occur. In Idaho last year several head of cattle were lost in an area where sodium arsenite was used as vine killer on potatoes. These losses were not proven to have resulted because of drift, but the suspicion is still there.

Drift onto feed or forage offers the most possibility for hazard. Studies have been made that show that the ensilage process decreases some herbicides residue levels. Most herbicides are relatively safe as far as being toxic to livestock is concerned, but many have the warning on the label which says not to graze or feed to livestock. For example, 2,4-D shouldn't be grazed or fed on by milk cows or animals for slaughter for at least 7 days after application. Tests by Klingman show 2,4-D residue in milk drops down to .01 ppm after 4 days when cows grazed where 2-lb. 2,4-D per acre was used. At this residual rate probably drift would be of little concern since this would be much less than 2 lb./A.

Dalapon could cause a problem if it drifted onto pastures. It will show up in the milk.

Most commonly used herbicides cause little problem because of skin or eye contact. Some, however, carry warnings against such contact. These should be watched carefully.

Amitrol is recognized as a carcenogen and as such should not be used where livestock graze. What happens from the drift of such a chemical? Washington state reports negative results on analysis for Amitrol in milk. Even so food and drug people take a dim view of such drift.

Let's consider drift of physical droplets of a spray material. The amount and distance of drift is influenced by wind velocity and air movement, height of release above ground and size of droplet which is affected by pressure, nozzle size and carrier.

The weight of material or specific gravity of the chemical being applied may be a factor in the amount of drift encountered.

The specific gravity of the spray material is determined by the material itself, the additives and the carrier. The higher the temperature the lower the specific gravity of any particular material.

Water has a specific gravity of 1.

Alcohol, 2,4-D, oil, Dinitro, and at least some additives, have a lower specific gravity than water. These materials will all have a tendency to drift to a greater extent than water. Although the differences may seem minor, tests have shown that oil sprays drift further than water sprays. When a wetting agent Triton 114 was added to a spray the drift was increased significantly.

Diquat has a specific gravity about the same as water, while sodium arsenite is heavier than water and will drift less than the other materials. I think that recognizing that there are such differences and that oil sprays and sprays with emulsifers or wetting agents will tend to drift more than those without is more important than the actual difference in specific gravity between chemicals.

Temperature and humidity influence drift. Drift is greater when the temperature is high and the air is dry. Injury resulting from drift is directly related to the inate toxicity of the chemical applied.

What factors influence volatility?

The most important are the vapor pressure of the material and the formulation used. Of all of the weed killers 2,4-D is the one which causes the greatest damage because of volatility. This is where selection of formulation is important. Ester formulations are volatile at normal temperatures. Low volatile esters are esters formulated with long carbon chain alcohols. Some of these are butoxyethanol, propylene glycol butanol, 2, ethyl hexanol, butoxy ethonol propanol, octyl, decyl, and alkyl. Low volatile or heavy esters are relatively safe to use for aerial application. They are relatively non-volatile at 70°F increase in volatility at 90°F and are highly volatile at 120°F .

High volatile or light esters are generally the culprits causing serious damage. They are formulated with short carbon chain alcohols. Butyl ester is the least volatile of these esters and iso propyl and ethyl esters the most volatile.

High volatile esters are very volatile at 70°F and almost completely volatile at 90°F. Many areas have banned the use of these esters. We have always discouraged their use but still we have them used when they should not be.

Why is volatility such a potent factor? The fumes are highly phytotoxic. They are very light and move not only in wind, but in air movement which is caused by temperature changes. 2,4-D fumes may move across a section and settle down on a crop entriely away from the point of application. It may happen several days after application.

2,4-D volatility is well shown by studies made in Washington State where air samples were analyzed for 2,4-D showing relative amounts of iso propyl, butyl, and isoctyl esters found in the air. The amounts are directly related to times of heavy application.

So, volatility is affected by the material, formulation, temperature, wind and other air movement.

To summarize, the greatest loss because of drift is directly related to the phytotoxicity of herbicides and occurs when herbicides drift onto susceptible plants.

Danger to livestock is slight.

The potential hazard and loss is high because of the possibility of illegal residues when a chemical drifts onto food crops or livestock grazing areas for which it is not registered.

Dayton Klingman in a talk on "Drift Control Additives and Their Effectiveness" at the Kansas State Ag. Chemical Workshop said, "The relative loss from spray drift in dollars might be tolerable for the country as a whole. However, to the individual cotton farmer, or to my wife, any damage is intolerable. Almost nothing generates as much "heat" as injury to an individual's property or crop caused by someone else's sprayer-operator. The damage done in public relations far exceeds the monetary damage, even though the latter may be sizeable. We must cope with the drift problem.

"Also, pesticide residues in crops outside the target area cause concern to many persons. If a herbicide that has been registered and is applied to rice, and if it should happen to drift to a field of vegetable crops, the vegetables could be seized, for illegal residues, after it has been sold."

Anborn Norris of AirChem Company, Inc., in a talk to the Washington State Weed Conference said, "I believe that without misuse, this business of drift damage would never come up, however, there are times when the misuse is due to an error in judgment and there are times when this error is made even though the decision is based on all available facts."

PROBLEMS OF SOIL CONTAMINATION, ACCUMULATION OF RESIDUES AND THE EFFECT ON SUBSEQUENT CROPPING

A. H. Lange[1]

Although an actual health hazard from herbicide residues in agricultural soils has not been demonstrated with present usage, still the legal aspects as well as the potential presence of unregistered chemicals in crops must be considered. Equally important to the producer is the potential hazard to subsequent cropping once the soil has been treated with herbicides.

Herbicides are lost from soil through leaching, volatilization, irreversible absorption, decomposition, and microbial decomposition. Although all these forces may impinge on the organic molecule in the soil, present day research findings emphasize the dominant role of soil micro-organisms in the breakdown of herbicides. Numerous species of soil micro-organisms have been isolated capable of decomposing organic compounds. Some herbicides become readily de-activated in the soil, while others persist for long periods of time. Monuron, for example, may be completely dissipated in 22 weeks in one soil, but may be present after 100 weeks in another soil. Cotton has been grown in the same soil for 10 years with repeated annual applications of monuron with no indications of a build-up and no indications of residues in the cotton seed. A rapid deactivation has been observed in the tropics with both monuron and diuron in pineapple culture with no residue in the fruit after continuous use for a number of years. The biochemical reactions known to occur in microbial decomposition of various herbicides include beta oxidation, cleavage of ether linkages, ring hydroxylation, ring cleavage, ester hydrolysis, dehalogenation and n-dealkylation. Basic work has identified some of the catalyzing enzymes.

Many ecological factors in the soil environment influence the rate of these biochemical reactions as well as the size of the specific microbial population. While the movement of herbicides can be predicted from some of the characteristics of the soil, it is much more diffi-

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cult to predict the effects of environmental variables on the ultimate disappearance of herbicides in the soil.

Ideally, if physical or chemical characteristics of the soil could be correlated with rate of loss, the agriculturist would be able to predict herbicide requirements and herbicide residue problems on the basis of these characteristics. One of the outstanding characteristics of the soil effecting many herbicides is organic matter content. Herbicides such as diuron are greatly influenced by the organic matter levels in the soil. Those soils with 4% and higher have readily deactivated diuron in a number of herbicide residue trials in California. DCPA (Dacthal) has likewise shown less activity in high organic matter soils. DCPA has been most effective as an herbicide in the desert where organic matter content is often below 1%. DCPA has consistently performed poorly in the high organic matter soils. At normal rates, it has shown a short residual in these soils. Most of the herbicides studied showed a trend toward less activity in the higher organic matter soils, however there have been notable exceptions which suggest factors other than organic matter, per se, are also important in the breakdown of DCPA. Bensulide (Prefar) showed less residual in higher organic matter soils, with the exception of the Tulelake location where other environmental factors, such as possibly cooler temperatures may have been involved in the slower rate of herbicide breakdown. Prometryne, which has consistently been more short-lived than other triazines, generally had more activity in the low organic matter soils.

The residual characteristics of herbicides at more than one location is difficult to predict with the amount of variability present, particularly for a specific location. In an extensive testing program with a specific set of crop plants in the rotation, the obvious answer to herbicide residue problems has been to include crop plants resistant to the herbicides being used. Susceptible crops must be avoided in a crop rotation including herbicides.

Long term studies in sugar cane, pineapple, citrus, and cotton with persistent-type herbicides such as monuron, diuron, and simazine have indicated no detrimental effects from repeated applications for more than 10 years in several studies. Organic herbicides would not be expected to accumulate at a rapid rate in agricultural soils under natural conditions. Most of the herbicide studies have shown that these organic molecules act as energy sources for soil micro-organisms and are therefore broken down in time to non-toxic reaction products.

In citrus and other orchard crops less herbicide is used where repeated annual applications are practiced. When the soil is left undisturbed, weed populations are reduced because of the destruction of weed seeds as they germinate. The problem of accumulation, although requiring constant *re-evluation,* has not constituted a serious problem where organic herbicides have been employed over an extended period of time.

Decontamination of herbicide residue by means of soil amendments, irrigation practice, tillage practice, cropping with resistant crops have been demonstrated experimentally. The use of activated charcoal in herbicide-treated soil has given protection to young plants. Polysulfides have been used to decontaminate simazine treated soil. Heavy irrigations have leached herbicides out of the root zone of weeds and crops. Continually moist soil has given a more rapid breakdown of some herbicides. Non-irrigated herbicide treated soils have been shown to "store" the herbicide unaltered until such time as water is applied. Crop losses have been reported as the result of herbicide application for one crop, followed by leaving the soil idle and dry because of a crop failure, and eventually replanting with a susceptible crop.

Shallow incorporation of most of our commonly used herbicides has increased the herbicidal activity as well as the residual characteristics of the herbicide. Additional tillage after cropping, where the residual herbicide is mixed into two or three times the volume originally used for incorporation, has reduced the herbicide residue in the soil proportionately.

Resistant crops such as corn, sorghum, sudangrass have reduced the residual atrazine in the soil.

A great deal of additional field work is necessary to evaluate the efficacy of decontamination techniques. Basic studies on herbicide breakdown and decontamination techniques are needed. The potential benefits from finding chemical catalysts for herbicide breakdown in soils is great. Likewise, altering the soil micro-biological environment in favor of herbicide breakdown represents another field of great practical significance needing attention.

Presently the practical answer for the farmer lies in growing resistant crops and checking them for herbicide residues.

As food prices continue to increase, so will the demand for controlled use of herbicides, particularly selective use in food production. Likewise, we must be able to control the residual characteristics of herbicides either by developing herbicides with a rapid or constant rate of breakdown under all conditions, breed crops resistant to effective herbicides, or control the breakdown of herbicides in the soil by economically feasible means.

NATURE OF SOIL ORGANIC MATTER

F. E. Broadbent[1]

Some of the principal relationships between herbicide activity and soil organic matter may be summarized as follows:

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1. Movement of herbicides in soil is restricted by organic mater.

2. Attenuation due to adsorption or other mechanisms is highly correlated with the organic matter level.

3. The general level of microbial activity and the rate of biological degradation are both associated with the organic matter level.

4. Clay content, water retention capacity and cation exchange capacity are highly correlated with the organic matter level.

5. Volatilization losses are inversely related to soil organic matter content.

6. The rate and extent of leaching of herbicides are influenced by organic matter. An understanding of the nature and properties of soil organic matter is therefore important in weed control work.

The earlier view that soil organic matter is a conglomerate mixture of breakdown products of plant, animal and microbial origin implied great variability in structure and properties of components of this mixture. This view has given way in more recent years to a realization that soil organic matter is a product in part of synthetic activities in the soil. Two important implications of this view are: (1) Properties of soil organic matter are not necessarily those of plants and microbial cells, since quite different materials may be synthesized. (2) Organic matter in a wide variety of soils may be quite similar in structure and properties. This view can be documented by consideration of the actual properties of soil organic matter.

Physical Properties

1. Bulk density and particle density. Whereas the particle density of the mineral component of soils is usually about 2.5, the value for the organic fraction is around 1.0 or slightly less. Bulk densities for mineral soils usually range from 1.0 to 1.5, compared with values for organic soils of about half this magnitude. This means that although the percentage by weight of organic matter in most western soils is less than 5, the percentage by volume is approximately twice as great.

2. Moisture retention capacity. It is not common for organic matter to absorb 300 to 800% of its weight in water, accompanied by considerable swelling. Similarly, shrinkage occurs during drying. Table 1, taken from the data of Feustel and Byers (4) illustrates the relation of organic matter to water holding properties.

Table 1. Water holding properties of clay loam and sand compared with peat. From Feustel and Byers (4).

Soil	Moisture equivalent %	Wilting point %	Available water %
Clay loam	20.2	7.1	13.1
Quartz sand	1.4	0.6	0.8
Moss peat	166	82	84
Reed peat	100	71	39

The available water is calculated from the difference between moisture content at the moisture equivalent (about 1/3 bar moisture tension) and at the wilting point (about 15 bars tension).

3. Surface area. Possibly the most important property of soil organic matter from the standpoint of its influence on herbicide activity is its large area of adsorption surface. Table 2, taken from the data of Jurinak and Inouye (6), emphasizes the magnitude of the surface area of organic soils as compared with mineral soils.

Table 2. Surface area of some soils as measured by glycol retention, From Jurinak and Inouye (6).

Soil	Surface area $m.^2/q.$
Hanford sandy loam	22.5
Yolo loam	82.0
Salinas clay	132
Staten peaty muck	235

Chemical properties

1. Elemental analysis. The quantities of the major elements in soil organic matter, carbon, hydrogen, oxygen, and nitrogen are remarkably uniform, as illustrated in Table 3 from Kononova (7) showing the elementary composition of humic acids from four soils of widely different origin.

Table 3. Elemental composition of humic acids from different soils. From Kononova (7).

Soil	C %	H %	O %	N %
Forest podzol	58.1	5.37	32.0	4.52
Chernozem	62.1	2.91	31.4	3.58
Chestnut soil	61.7	3.72	30.6	3.92
Sierozem	61.9	3.93	29.5	4.67

2. Solubility. Soil organic matter is relatively insoluble in both organic and inorganic solvents. It is partially dissolved by alkaline extractants such as sodium hydroxide and sodium carbonate, or by solutions having the capacity of forming complexes with metal

ions associated with organic matter, such as sodium fluoride, sodium citrate, and sodium pyrophosphate. Solubility of organic matter in water is low and for all practical purposes the organic fraction can be regarded as part of the solid phase of soils.

3. Molecular weights. Determination of molecular weights of humic acid preparations from soil organic matter by ultracentrifuge methods indicates weights in the range of 30,000 to 50,000 (5, 10, 14). Molecular weights obtained by gel flitration techniques (11) indicate that organic matter is a polydisperse polymer with molecular weights ranging from below 4,000 to greater than 200,000.

4. Functional groupings. Reactive groupings of soil organic matter include methoxyl, phenolic hydroxyl, ketonic carbonyl and carboxyl groups, some of which are quite strongly acidic with a pK range from approximately 2 to 6. As shown in Table 4, the relative quantities of functional groupings in different soils are quite similar (1).

Table 4. Chemical Properties of organic matter preparations from four soils (1).

Soil	C,%	H,%	OCH_3,%	OH,%	COOH,%
Dunkirk	53.1	6.02	2.69	4.61	6.63
Honeoye	53.4	5.70	1.96	4.08	5.55
Ontario	53.3	6.13	2.16	4.56	6.10
Yates	51.7	5.66	3.13	3.82	8.20

The presence of methoxyl groups is usually taken as an indication of lignin residues, but since methylated sugars have been identified in soil hydrolyzates the presence of methoxyl groups cannot be taken as unequivocal evidence of lignin or its decomposition products.

5. Cation retention capacity. The capacity of soil organic mater to retain cations in exchangeable form is very high relative to that of a comparable weight of clay. Table 5 shows data for several soils in which the cation retention capacity of the organic and clay fractions was determined separately (2).

Table 5. Cation exchange capacity of organic and clay fractions in four soils. (2).

Soil	A	B	C	D
% organic matter	9.75	6.57	7.34	5.70
C. E. C. of organic matter, m.e/100 g. soil	18.8	13.3	13.7	9.4
C.E.C. of clay, m.e./100 g. soil	7.4	10.9	2.7	3.4
% of total due to organic matter	72	81	83	73

Although the contribution of the organic fraction to the total cation retention capacity of mineral soils low in organic mater is unquestionably less than for the soils shown in the table, it is evident that in peats and mucks and in sandy mineral soils (3, 12) the major part of the exchange capacity lies in the organic fraction. The cation retention capacity of organic matter is influenced both by pH and by nature of the adsorbed ion. In general the capacity to retain cations increases with increasing pH and with increasing valence of the adsorbed ion. Thus, divalent ions are usually retained in greater quantity than monovalent. Furthermore, there are differences in the retention capacity among ions of equal valence. For example, copper which has a strong capacity to form complexes with organic substances, is retained in greater quantity than is calcium or magnesium. Obviously, cation retention properties of organic matter will have an important influence on the activity of cationic herbicides such as the bi-pyridillium compounds.

6. Carbohydrate fraction. Because approximately two-thirds of the dry weight of the mature plant materials from which much of soil organic matter is derived consists of carbohydrate material, much attention has been given to the carbohydrate fraction of organic matter. Analysis of soil hydrolyzates reveals the presence of a variety of sugar units in relatively small quantity. Since most carbohydrates are readily attacked by the soil microbial population, these do not accumulate to any significant extent in the soil organic fraction. Sugar units identified include pentoses, hexoses, uronic acids and hexosamines, indicating the presence of polyuronide materials, probably of microbial origin and possibly chitin of fungal or insect origin.

7. Nitrogen containing compounds. More than 50 different amino compounds have been identified in soil hydrolyzates (16). The major portion of the amino nitrogen can be accounted for in 12 to 15 amino acids and amino sugars. Some non-protein amino acids are included in the soil nitrogen fraction. It is not clear whether these amino acids are present as protein or polypeptides since tests for these compounds in unaltered soil usually prove negative. The amount of free amino acids in soils is very small.

In addition to the amino nitrogen present in soil hydrolyzates a considerable quantity of ammonia is also found. The quantity is too large to be accounted for as amides, so that some may occur in heterocyclic ring structures, serving as a bridge to link aromatic nuclei.

It is interesting to note that a substantial quantity of the total nitrogen in soils cannot be accounted for as amino nitrogen. Sawby and Ladd (15) have suggested that humic acids consists of amino acids combined with phenols or quinones to form a three dimensional copolymer. This view is in essential agreement with the ideas of Kononova and Alexandrova (8) who believe that organic residues of plant and animal origin are first decomposed to simpler compounds through the activity of microorganisms. Some of these relatively simple breakdown products are then utilized by microorganisms to synthesize specific high molecular weight humic substances. Most of the evidence suggests that condensation of aromatic compounds of the polyphenol type with nitrogenous compounds such as ammonia, amino acids, or peptones is involved, the condensation phase being assisted by enzymes of phenol-oxidase type which convert polypenols to quinones. Murphy and Moore (9) have suggested several model structures as a basis of natural humic acid, some of which are shown in figure 1.

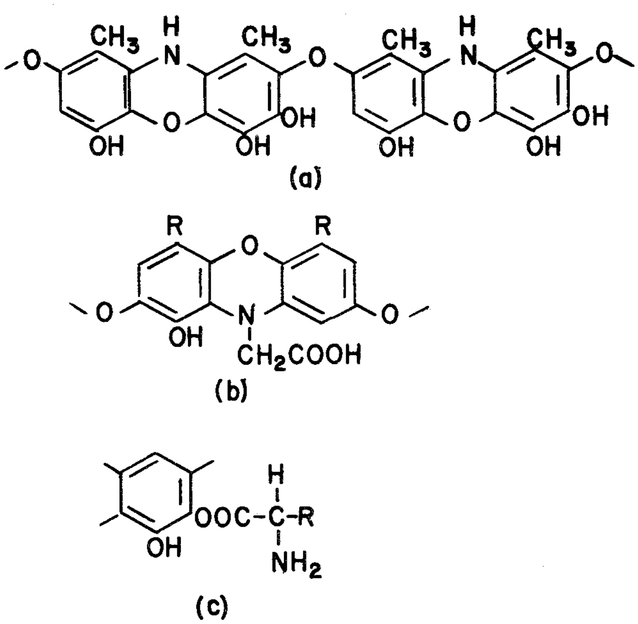

Figure 1. Some suggested model structures for humic acid (from Murphy and Moore) (9).

A number of other model structures have been proposed, for example, that of Dragunov (figure 2)

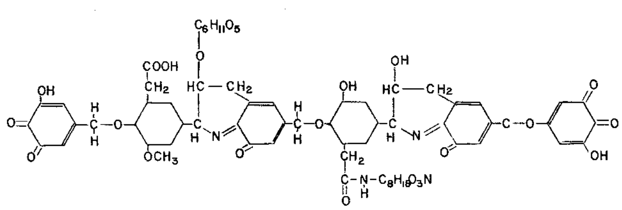

Figure 2. Structure of Humic Acid (Dragunov) (7).

(7) in which carbohydrates is regarded as an integral part of the humic acid molecule. Recently Steelink and Tollin (13) have concluded on the basis of electron paramagnetic resonance studies that soil humic acid contains stable free radicals as an integral part of its molecular structure. Their evidence is consistent with a humic acid model containing quinone, semiquinone and quinhydrone moieties.

The evidence for humus as a product formed in soil is further supported by infrared spectra, which show considerable similarity in soil organic matter fractions from a variety of sources.

8. Phosphorus and sulfur compounds. Although not major constituents of the soil organic fraction, organic forms of phosphorus and sulfur are of considerable importance in plant nutrition. Phosphorus is present in phosphate esters of inositol, in nucleic acids, and in phospholipids, although the latter two classes are present in only small amounts. Sulfur occurs principally in the sulfur-containing amino acids and as organic sulfates.

Implications for Herbicide Application

In summary, soil organic mater is an insoluble, amorphous, high molecular weight material which does not vary greatly in composition from one soil to another. It is characterized by hydroxyl, methoxyl, carboxyl and ketonic carbonyl functional groupings, and by a large adsorptive surface. These properties indicate that in most instances adsoption of herbicides is relatively non-specific, and depends more on the nature of the herbicide than on the kind of soil. In predicting herbicide-organic matter interactions the quantity of organic matter in a given soil is of great importance, but the kind is of less importance. Since water holding capacity and cation exchange capacity are highly correlated with organic mater level, the influence of these properties on herbicide adsoprtion and movement cannot be separated from that of organic matter *per se.*

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THE TECHNOLOGY OF DACAGIN

by B. A. Sprayberry and T. L. Neidlinger[1]

The introduction of DACAGIN, Diamond Alkali's new spray agent has resulted in an increasingly large display of interest from academic and industrial workers. DACAGIN is designed for the reduction of physical spray drift of pesticides applied through conventional equipment. Novel uses including increased pesticidal activity in using DACAGIN are being reported. Because of this interest we wish to discuss for you some details of this material.

DACAGIN is an effective easy-to-use polysaccharide-gum marketed in granular form. Two properties, thixotrophy and pseudoplasticity, have been associated with the product from its inception and are the primary reasons why it can be used in conventional equipment. Thixotrophy is a rather common property of non-Newtonian systems in which the viscosity of a system is dependent upon the rate of shear and also upon the length of time the shearing stress is applied. DACAGIN is thixotropic since its viscosity decreases when agitated but will increase, with time, when agitation is stopped.

A pseudoplastic system is one in which the viscosity is functionally dependent upon the rate of shear. In such liquids some sort of intermolecular structure is apparently built up under the influence of the shearing force.

DACAGIN systems are very low viscosity liquids while being agitated or pumped but have a very high viscosity after passing through a nozzle. Thus DACAGIN can easily be used in conventional equipment.

One criterion of the ability of a droplet to physically drift is its size. Naturally, smaller droplets will drift farther than larger droplets under the same conditions. However, and fortunately, no sprayable material produces droplets of uniform diameter. Rather, a range of droplet diameters is produced and this droplet size distribution may be described in the form of a curve. A plot of droplet diameters versus the culminative volume percentage of the spray constructed on a probability scale shows the mass median diameter (MMD), which is the diameter that divides the spray mass or volume in half, is 229 microns for a 5% solution of the water soluble amine salt of 2,4-D. However, the largest droplet diameter would be about 400 microns. One tenth of one percent of the spray volume had droplet diameters of 20-25 microns or less and this is the part of the spray most apt to physically drift. In contrast to this, curves were constructed from data taken under identical conditions except that DACAGIN, at the rate of 4 pounds per 100 gallons of water, was carried. The curve representing the 5% water soluble amine salt of 2,4-D had an MMD of 940 microns. Ten percent of the spray had droplet diameters greater than 1400 microns and 0.1% had droplet diameters of about 100 microns. Thus the use of DACAGIN has resulted in an approximate 5 fold diameter increase in the droplets which are most apt to drift and cause damage to susceptible crops.

Similar data was taken under conditions identical to those above with the exception that the DACAGIN rate has been increased to 5 pounds per 100 gallons of water. This resulted in an increase of the MMD to 1610 microns, a seven fold increment over the spray not containing DACAGIN. This higher rate of DACAGIN naturally resulted in larger droplets, however there was less uniformity in these large droplets.

The data for DACAMINE 4D in DACAGIN is almost identical to those for the isooctyl ester concentrates of 2,4-D in DACAGIN. The viscosity of DACAGIN gels containing DACAMINE 4D or CROP RIDER 4D is increased by the presence of small amounts of salts. Higher concentrations of salts result in generally proportional viscosity reductions. The fact that divalent cations have more effect than monovalent cations demonstrates that water hardness, as well as total salinity, is a factor in the viscosity of DACAGIN gels. However, this viscosity reduction does not become a real factor until water hardness approaches 600 ppm. Data shows that this viscosity reduction can be compensated for by increasing the rate of DACAGIN.

DACAGIN gels may be used as carriers for many crop protection chemicals of various types of formulations, including water soluble materials, emulsifiable concentrates, and wettable powders. Because of their economy and effectiveness, 2,4-D and 2,4,5-T are the most widely used herbicides. Depending upon the purpose and type of application, these two chemicals are used in sprays of various concentrations. High concentrations of herbicides in DACAGIN gels result in some viscosity reduction. DACAMINE formulations may be used at concentrations up to 10% by volume, and

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emulsifiable concentrates of esters of 2,4-D and 2,4,5-T up to 8% by volume, with no significant reduction in viscosity. The water soluble amine salts of 2,4-D and 2,4,5-T have a greater effect on viscosity at this particular rate of DACAGIN. This shows that the consumer can control the viscosity by varying the rate of DACAGIN.

The resistance to drying and the film forming characteristics of DACAGIN gel droplets have generated widespread interests in its use with insecticides, defoliants, and hebicides. Indeed, reports have been received from both academic and commercial cooperators showing greater efficiency when using these materials in a DACAGIN gel system. The rate of 4 pounds per 100 gallons of water was established by balancing ease-of-use in conventional equipment with physical spray drift reduction and economy.

Rates, however, must necessarily be adjusted to fit the particular factors involved, such as nozzle types and sizes, spray equipment used, water gallonage, herbicide rate, and so forth.

We gratefully acknowledge the cooperation of the Delavan Manufacturing Company in determining some of the data presented herein.

INCREASING THE TOLERANCE OF COTTON SEEDLINGS TO HERBICIDES BY SOIL APPLICATION OF TRIFLURALIN

H. Fred Arle[1]

Abstract. During the past 12 years diuron (3-(3, 4-dichlorophenyl)-1,1-dimethyl urea) has been used as a post-emergence treatment for the control of annual grasses and broad-leaved weeds in cotton. Incorporated-preplant applications of this herbicide have also been attempted. With the latter method, cotton seedlings are frequently injured or killed. This occurs when cotton seeds are planted in the zone of diuron-treated soil, allowing the root system to take up the herbicide which then injures or kills the seedling cotton plant.

Another herbicide, trifluralin (alpha, alpha, alpha-trifluoro-2,6-dinitro-N,N-dipropyl-P-toluidine), is also used in control weeds, primarily annual grasses, in cotton. Although this material does have a temporary adverse effect on the cotton seedling, it is used as a pre-planting, soil-incorporated treatment. Trifluralin does not appear to affect the taproot of the cotton seedling. It does, however prevent or retard the development of branch roots in the zone of soil where trifluralin is incorporated. Top growth of young cotton plants grown in trifluralin-treated soil is temporarily retarded, and this is apparently a result of the reduced branch root system.

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Studies in the greenhouse have indicated that the adverse effect of trifluralin or the branch roots of cotton seedlings may have possible advantages. When rates of diuron necessary to kill broadleaved weeds are applied in combination with trifluralin and incorporated in the surface soil the injurious effect of diuron on cotton seedlings is minimized. The absence of branch roots in the area of herbicide incorporation prevents normal uptake of diuron, and the cotton seedling is therefore not severely injured or killed.

The success of the method depends on an almost complete absence of branch roots in the zone of herbicide incorporation. This dictates the need for very uniform distribution of trifluralin. This requirement may limit use of diuron under field conditions.

EFFECT OF SD-11831 ON COTTON SEEDLINGS

W. Powell Anderson, Anna Beth Richards, and J. Wayne Whitworth

Abstract. Under greenhouse conditions, soil-incorporated 4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline (SD-11831) prevented the growth of taproots and lateral roots of cotton seedlings and induced severe stunting of the plants when the seeds were planted within seven days after incorporation. A delay of planning the cotton seeds resulted in a marked change in the effect of SD-11831 on the growth of the seedlings in that the growth of the taproots was not affected and stunting of the plants was less severe. Indications from this research are that the chemical nature of SD-11831 changes in the soil during the first two weeks, and that its adverse effect on the growth of cotton seedlings then becomes less severe and is essentially the same as that induced by a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin), a closely related herbicide.

Unless otherwise stated, the results reported below were obtained when the interval of time between soil-incorporation of SD-11831 and planting of the cotton seeds was less than one day.

Applied at dosages of 0.13, 0.25, 0.50, 0.75, and 1.0 lb/A and soil-incorporated to depths of 1 inch and 4 inches, SD-11831 induced stunting of seedling height ranging from about 13% at the lowest dosage to about 70% at the highest dosage. Soil-incorporated 1 inch deep, above the seed, there was no adverse effect on root growth at any of these dosages; incorporated 4 inches deep, 2.5 inches below the seed, elongation of the taproot was prevented by 0.75 and 1.0 lb/A but not at lower dosages, and lateral root growth was prevented at all dosages in the region of treated soil.

When SD-11831 was soil-incorporated at 1.0 lb/A in a 1-inch or 2-inch band of soil located at various depths in the soil, prevention of root growth occurred only when it was located below the seed; stunting of seedling height occurred when SD-11831 was located in the soil above the seed or where the seed was immediately above it, 0.25-inch of untreated soil separating the seed from the treated soil. Indications from this are that SD-11831 is translocated upward in the cotton seedling in amounts sufficient to induce an apparent response but not downward in similar amounts.

Indications are the SD-11831 predisposes the cotton seedling to disease at low temperatures (40-45°F), that this effect becomes apparent at 0.5 lb/A, is evident by the death of the seedlings, and is most severe following shallow incorporation (1 inch), and less severe with deeper incorporation (4 inches.)

SD-11831, with a water solubility of 0.6 ppm, was readily leached in a clay loam soil having a pH of 7.8 and an organic matter content of 1.0%. Eight inches of water leached a sufficient amount of this chemical from the upper 0.25-inch layer of soil, containing 1.0 lb/A of SD-11831, deep enough to adversely affect the growth of roots of cotton seedlings from seeds planted 1.5 inches deep.

When SD-11831 was soil-incorporated at 1 lb/A to a depth of 4 inches and cotton seeds planted 1.5 inches deep immediately after incorporation and at weekly intervals for six weeks, there was a distinct difference in response of the plants from the first two plantings as compared with subsequent plantings. From plantings made immediately after incorporation and seven days later, the growth of the taproots was prevented, the base of the hypocotyl tended to rot away, adventitious roots grew from the hypocotyl just below the soil surface, and the plants were stunted about 50% as compared to untreated controls. From plantings made 14 days or more after incorporation, the growth of the taproots was not effected, the growth of lateral roots was prevented along that portion of taproot located in treated soil but not along portions in untreated soil, and the plants were stunted about 25% as compared to untreated controls.

The effect of SD-11831 on the growth of cotton seedlings was compared with that of trifluralin. Each herbicide was applied at 1 lb/A, soil-incorporated 4 inches, and cotton seeded immediately thereafter and at six weekly intervals. From the first two plantings, SD-11831 affected the growth of the seedlings more adversely than did trifluralin. The severity of stunting was greater and more persistent and the growth of the taproot was prevented. From the third and later plantings, the effect on growth from SD-11831 was less severe than from the earlier plantings and was essentially the same as that induced by trifluralin; the growth of the taproot was not affected, lateral root growth was prevented in the region of treated soil but was normal below the treated soil, and plant stunting occurred but was much less severe than from the two earlier plantings. (Agricultural Experiment Station, New Mexico State University, University Park, New Mexico)

WEED CONTROL IN SUGAR BEETS — PREPLANTING VERSUS PREPLANTING PLUS LAYBY HERBICIDE APPLICATIONS

E. E. Schweizer, and D. M. Weatherspoon

Abstract. In 1966, we conducted a field experiment to compare a preplanting herbicide mixture, applied singly and in combination with two layby herbicide treatments, for their effectiveness to control weeds for the entire growing season. The preplanting mixture consisted of 3.75 lb/A of pyrazon plus 2.5 lb/A of N,N-dimethyltridecylamine salt of endothal (TD283). The layby treatments were: (a) a mixture of 3 lb/A of pyrazon and 2.5 lb/A of dalapon and (b) 2 lb/A of EPTC. On March 24, we applied the preplanting mixture to a 7-inch band, at a volume equivalent to 60 gpa broadcast, on 8-row plots. On June 6, the layby treatments were applied at a volume of 60 gpa to sugar beets in the 6 to 8 leaf stage. The mixture of pyrazon and dalapon was applied as a directed spray to an 11-inch band and the EPTC was injected into the soil with two knife-type applicators. The applicators were 6 inches apart, centered over the row of sugar beets, and were set to inject EPTC about 1 1/2 inches deep.

Weed control on June 8 from the preplanting mixture of pyrazon plus TD283 was as follows: 89% for foxtail (*Setaria italica* L. Beau.), 96% for wild buckwheat (*Polygonum convolvulus* L.), 71% for kochia (*Kochia scoparia* L. Roth), 98% for lambsquarter (*Chenopodium album* L.), and 99% for redroot pigweed (*Amaranthus retroflexus* L.). All weeds taller than 1 inch were removed before the layby treatments were applied.

The principal weed infestation in October was foxtail. The percentage control of foxtail on October 26 was 80% in plots treated only with the preplanting mixture; 91% in plots treated with the preplanting mixture plus the layby mixture of pyrazon and dalapon; and 89% in plots treated with the preplanting mixture plus the layby treatment of EPTC.

The herbicide-treated plots had a significantly higher yield of sugar beet roots than the untreated plots. Gross sugar, percentage sucrose, and number of roots, did not differ significantly between the treated and untreated plots. (USDA in cooperation with Colorado Agri. Expt. Sta., Colorado State University, Fort Collins. This is a report on the current status of research on weed control practices. It does not contain weed control recommendations, nor does it imply that the herbicide uses discussed have been registered. All uses of pesticides must be registered by appropriate State and Federal agencies before their recommendation and use.)

POWER INCORPORATION VERSUS KNIFE INJECTION OF THREE THIOLCARBAMATE HERDICIDES FOR PREPLANTING WEED CONTROL IN SUGAR BEETS[1]

E. E. Schweizer, and D. M. Weatherspoon

Abstract. In 1966, we conducted a field experiment to evaluate two methods of applying preplanting herbicides in soil to control weeds in sugar beets. Main plots were 4 rows wide and subplots were 2 rows wide. On April 2, we applied herbicides to a 7-inch band by incorporating them on 2 rows and injecting them in the other 2 rows of each main plot. The herbicides were incorporated or injected into the soil to a depth of about 1 1/2 inches. Four knife-type applicators were used per row for the injection method. Two knife-type applicators were spaced 1 1/4 and 3 1/4 inches from the center (each side) of the sugar beet row. The herbicides were applied at a volume equivalent to 60 gpa. Herbicides and rates are listed in the accompanying table.

The herbicidal activity of EPTC was not affected by the method of application, but herbicidal activity pebulate and *S*-ethyl ethylcyclohexyl-thiocarbamate (R2063) was decreased considerably when injected. For example, EPTC at 4 lb/A reduced the stand of pigweed (*Amaranthus retroflexus* L.), foxtail (*Setaria italica* L. Beau.) and wild oats (*Avena fatua* L.) by 96% when injected and 95% when incorporated as compared to 71 and 88%, respectively, with 4 lb/A of pebulate and 57 and 95%, respectively, with 4 lb/A of R2063, Furthermore, the herbicidal activity of the mixture of 2 lb/A each of EPTC plus pebulate was not affected by either method of application; whereas, the herbicidal activity of the mixture of EPTC plus R2063 and R2063 plus pebulate was decreased when these mixtures were injected.

The stand of sugar beets was reduced less when the herbicides were incorporated into the soil than when they were injected. EPTC caused the most reduction in stand of sugar beets and R2063 the least. (USDA in cooperation with Colorado Agri. Expt. Sta., Colorado State University, Fort Collins. This is a report on the current status of research on weed control practices. It does not contain weed control recommendations, nor does it imply that the herbicide uses discussed have been registered. All uses of pesticides must be registered by appropriate State and Federal agencies before their recommendation and use.)

A comparison between power incorporation and knife injection of three thiolcarbamates for weed control in sugar beets.

	Rate	Sugar beet[2] stand reduction		Weeds evaluated[2]							
				Pigweed		Foxtail		Wild oats		Average	
Herbicides[1]	lb/A	Knife	Power	Knife	Power	Knife	Power	Knife	Power	Knife	Power
EPTC	2	22	10	75	90	91	89	89	79	85	86
EPTC	4	64	51	94	96	98	95	97	93	96	95
EPTC	6	76	46	99	95	99	96	99	95	99	95
pebulate	2	0	0	54	93	41	58	53	74	49	75
pebulate	4	1	2	67	97	56	72	89	95	71	88
pebulate	6	23	0	95	98	66	79	93	94	85	90
R2063	2	0	0	0	51	54	91	67	81	40	74
R2063	4	4	2	45	92	64	96	61	97	57	95
R2063	6	7	0	72	95	85	99	75	97	77	97
EPTC + pebulate	2 + 2	44	20	88	94	94	82	97	90	93	89
EPTC + R2063	2 + 2	35	18	41	87	96	99	94	99	77	95
R2063 + pebulate	2 + 2	12	0	66	95	65	93	69	93	67	94

[1]On April 2 the preplanting herbicides were applied and the beets planted. Evaluation data taken on June 24 (avg of 3 replications).

[2]Values are a percentage of untreated sugar beet or weed stand where O = no stand reduction and 100 = complete reduction.

CONTROL OF BROADLEAF WEEDS IN POTATOES

Don Smith

Abstract. Field experiments were conducted in the San Luis Valley in southern Colorado (elev. 7,400 ft.) to determine effect of preplanting, preemergence, and layby applications of herbicides and normal cultivation on weed population and on yield and quality of potatoes. Plots were 4 rows (34 in. apart) wide, and 50 feet long, and treatments were replicated 6 times. All plots were furrow irrigated. We harvested tubers from 40 feet of each of the middle 2 rows. Diphenamid (6 lb/A), EPTC (3 lb/A), EPTC + 2,4-D (2 + 1 lb/A), and DCPA (10 lb/A) were sprayed on the surface and disked in before planting. Linuron (1½ lb/A), DNBP (3 lb/A), and trifluralin (1 lb/A) were applied in a volume of 18 gpa. before emergence but after hilling; these plots were not cultivated after the herbicides were incorporated into the soil with a rotary hoe. NPA (4 lb/A), 2,4-DEP (4 lb/A), and EPTC (3 lb/A) were applied after a layby cultivation. EPTC and 2,4-DEP were applied broadcast in a volume of 30 gpa. EPTC was incorporated immediately with a hand rake. We spread the PNA granules by hand and tried to avoid getting granules on the potato plant.

All four preplant treatments controlled weeds better than the cultivated check plots. In the preemergence experiment, weed control was excellent in the plots treated with linuron, and potato quality and total yield were significantly increased when compared to the uncultivated check. Weed control, yield, and quality of potatoes from plots treated with DNBP and trifluralin did not differ from the uncultivated check. EPTC, 2,4-DEP, and layby cultivation greatly reduced weed populations, but did not differ from one another in potato yield or quality. NPA caused a marked reductoin in growth of tops, and significantly reduced yield. (Colorado Agricultural Experiment Station, Colorado State University, Fort Collins.)

LOGARITHMIC DETERMINATIONS AND RESPONSE FROM YIELD EVALUATIONS OF PRE-EMERGENCE AND PRE-PLANTING SOIL-INCORPORATED APPLICATIONS OF HERBICIDES IN FURROW-IRRIGATED LIMA BEANS

Alvin R. Hamson[1]

Evaluations of herbicides on lima beans initiated at the Farmington Field Station in Utah in 1961 indicated considerably greater sensitivity and a lower margin of safety of lima beans to herbicides than for snap beans. The evaluations from 1961 to 1963 were essentially negative except for DNBP which did not give adequate weed control. In 1964 and 1965 logarithmic trials were conducted including 71 herbicides in 1964 with and without incorporation in the top 3″ with a hooded rotovator with 'L' shaped teeth, and 28 herbicides in 1965 with incorporation. The more promising herbicides and their performance in the logarithmic trial of 1964 with pre-emergence application of herbicides without incorporation are indicated in Table 1. Weed control was generally superior with incorporation as indicated for the more promising herbicides in the 1964 logarithmic evaluation in Table 2. The 1965 logarithmic evaluations included only the herbicides which showed a measure of selectivity on lima beans and had sufficient herbicidal activity in previous evaluations for acceptable weed control. Combinations of herbicides were included to broaden the spectrum of weed control.

The best herbicides from the logarithmic evaluations were applied to a yield trial of 4 replications in 1966 with incorporation 2 inches deep by a hooded field rotovator with 'L' shaped teeth. A similar replicated evaluation was also made with herbicides applied directly after planting and activated by 1 inch of overhead irrigation. The ratings of weed control, visible injury or lack of injury to the lima beans and yield data are indicated in Table 4 for incorporated herbicides and Table 5 for preemergence herbicides.

[1]Department of Plant Science, Utah State University, Logan, Utah.

Table 1. 1964 Logarithmic Weed Control Experiment on Lima Beans with Preemergent Application without Incorporation.

Chemical Company	Herbicides	Lbs/A of Log Concentrate (1)	Tolerance to Herbicides by Lima Beans		Weed Control	
			Rate Tolerated (2)	Rate to Normal (3)	Grass (4)	Broadleaved (5)
Stauffer (R1607)	Vernam	20 lbs	20 lbs	20 lbs	10.8 lbs	8.2 lbs
Stauffer (R4461)	Prefar	20 lbs	20 lbs	20 lbs	9.2 lbs	20 lbs
Dow	DNBP	20 lbs	20 lbs	20 lbs	13.2 lbs	12 lbs
Pennsalt	TD283	20 lbs	20 lbs	20 lbs	1.8 lbs	12 lbs
Shell	SD7585	5 lbs	5 lbs	5 lbs	0.5 lbs	2.2 lbs
Naugatuck	B528-44E	10 lbs	10 lbs	10 lbs	8.1 lbs	7.2 lbs
Amchem	Amiben	10 lbs	10 lbs	5 lbs	9.5 lbs	9.5 lbs
Amchem	Dinoben	10 lbs	10 lbs	10 lbs	10 lbs	10 lbs
Lilly	Trifluralin	20 lbs	20 lbs	20 lbs	1.3 lbs	1.1 lbs
	Trefmid	20 lbs	20 lbs	20 lbs	0.6 lbs	2.4 lbs

1. Herbicides applied by logarithmic sprayer at 100 gal/A with dilution to 1/2 concentration of herbicide every 12.5 feet.
2. Concentration of herbicides at which plants will grow, though they may be severely damaged. Evaluation made Sept. 10.
3. Concentration of herbicides at which plants appear to grow normally.
4. Minimum rate of herbicides to control annual grass.
5. Minimum rate of herbicides to control annual broadleaved weeds.

Table 2. 1964 Logarithmic Weed Control Experiment on Lima Beans with Incorporation (2).

Chemical Company	Herbicides	Lbs/A of Log Concentrate (1)	Tolerance to Herbicides by Lima Beans		Weed Control	
			Rate Tolerated (3)	Rate to Normal (4)	Grass (5)	Broadleaved (6)
Stauffer (R1607)	(Vernam)	20 lbs	5.5 lbs	1.8 lbs	0.3 lbs	0.6 lbs
Stauffer (R4461)	(Prefar)	20 lbs	20 lbs	20 lbs	0.6 lbs	16.5 lbs
Monsanto	Vegadex	20 lbs	20 lbs	5 lbs	0.2 lbs	0.6 lbs
Dow	DNBP	20 lbs	20 lbs	20 lbs	0.1 lbs	5.2 lbs
Pennsalt	TD62	20 lbs	20 lbs	20 lbs	12.0 lbs	10.8 lbs
Shell	SD9515	5 lbs	5 lbs	5 lbs	0.8 lbs	4.3 lbs
Chipman	Butoxone Ester (Butyric acid)	5 lbs	5 lbs	5 lbs	2.6 lbs	3.7 lbs
Naugatuck	Falodin	10 lbs	10 lbs	10 lbs	3.0 lbs	2.7 lbs
Amchem	Amiben	10 lbs	10 lbs	2.2 lbs	6.0 lbs	4.1 lbs
Amchem	Butyrac 118	10 lbs	10 lbs	1.9 lbs	2.8 lbs	2.8 lbs
Amchem	Dinoben	10 lbs	10 lbs	0.2 lbs	5.4 lbs	10.0 lbs
Lilly	Trifluralin	20 lbs	2.3 lbs	1.2 lbs	0.1 lbs	0.5 lbs
Lilly	Trefmid	20 lbs	20 lbs	4.1 lbs	1.3 lbs	1.3 lbs

1. Herbicides applied by logarithmic sprayer at 100 gal/A with dilution to 1/2 concentration of herbicide every 12.5 feet.
2. Herbicides were incorporated within minutes with a hooded, field, rotary tiller with L-shaped teeth set for 3" depth.
3. Concentration of herbicides at which plants will grow, though they may be severely damaged. Evaluations made Sept. 10.
4. Concentration of herbicides at which plants appear to grow normally.
5. Minimum rate of herbicides to control annual grasses.
6. Minimum rate to control annual broadleaved weeds.

Table 3. 1965 Logarithmic Weed Control Experiment on Lima Beans with Incorporation (2)

Chemical Company	Herbicides	Lbs/A of Log Concen-trate (1)	Tolerance to Herbicides by Lima Beans: Rate Tol-erated (3)	Tolerance to Herbicides by Lima Beans: Rate to Normal (4)	Weed Control: Grass (5)	Weed Control: Broad-leaved (6)	Weed Control range (7)
Amchem	Amiben	10 lbs	10 lbs	2.0 lbs	2.4 lbs	7.6 lbs	0.4-2.0 lbs
Amchem	Amiben (methylester)	10 lbs	10 lbs	2.3 lbs	0.55 lbs	1.5 lbs	0.25-2.3 lbs
Amchem	Dinoben	10 lbs	10 lbs	1.3 lbs	0.9 lbs	2.0 lbs	1.1-4.3 lbs
Amchem	D-263 Sindone	10 lbs	10 lbs	1.9 lbs	0.01 lbs	2.8 lbs	0.2-1.9 lbs
Amchem	ACP Butyrac 118	10 lbs	5.7 lbs	0.05 lbs	0.13 lbs	0.8 lbs	0.01-0.06 lbs
Amchem	Butoxone ester (Butyric acid)	10 lbs	8.6 lbs	0.25 lbs	0.01 lbs	0.01 lbs	0.01-0.25 lbs
CIBA	Cotoran	10 lbs	1.6 lbs	0.10 lbs	0.01 lbs	0.01 lbs	Too toxic
CIBA	Patoran	10 lbs	10 lbs	1.4 lbs	0.45 lbs	0.01 lbs	0.35-3.3 lbs
CIBA	Tenoran	10 lbs	10 lbs	2.0 lbs	1.3 lbs	3.9 lbs	3.3-5.7 lbs
Dow	DNBP	20 lbs	20 lbs	7.8 lbs	0.10 lbs	20 lbs	lacks weed control
Lilly	Diphenamid	10 lbs	10 lbs	2.8 lbs	0.8 lbs	2.8 lbs	0.5-3.3 lbs
Lilly	Trifluralin	5 lbs	5 lbs	1.5 lbs	0.01 lbs	0.01 lbs	0.1-2.2 lbs Exc.
Lilly	Trefmid	10 lbs	10 lbs	4.8 lbs	0.01 lbs	0.08 lbs	0.1-6.4 lbs
Monsanto	Vegadex	20 lbs	20 lbs	1.1 lbs	0.01 lbs	0.3 lbs	0.15-4.5 lbs
Pennsalt	TD62	20 lbs	20 lbs	20 lbs	4.3 lbs	20 lbs	lacks weed control
Pennsalt	TD283	20 lbs	20 lbs	4.5 lbs	0.26lbs	1.1 lbs	1.4-5.2 lbs
Shell	SD9515	10 lbs	10 lbs	4.1 lbs	0.5 lbs	6.0 lbs	0.65-5.7 lbs
Stauffer	R1607 Vernam	10 lbs	1.3 lbs	0.18 lbs	0.01 lbs	0.5 lbs	Too toxic
Stauffer	R4461 Prefar	20 lbs	20 lbs	2.4 lbs	0.2 lbs	1.0 lbs	1.7-9.7 lbs
Naugatuck	B528-44E	10 lbs	7.6 lbs	0.1 lbs	0.01 lbs	0.18 lbs	0.10- .35 lbs
Naugatuck	Falodin	20 lbs	20 lbs	13.2 lbs	4.1 lbs	9.2 lbs	lacks weed control
Velsicol	OCS-21693	10 lbs	10 lbs	10 lbs	0.6 lbs	4.6 lbs	.65-7.2 lbs
Velsicol	Glenbar	10 lbs	10 lbs	6 lbs	1.5 lbs	7.5 lbs	lacks weed control
Amchem	Amiben + Sindone	10 + 10	10 lbs	7.2 lbs	0.2 lbs	2.7 lbs	.65-7.6 Exc.
Amchem	Amiben (m.e. + Sindone	10 + 10	10 lbs	7.2 lbs	0.1 lbs	1.3 lbs	.65-10 Exc.
Amchem	Dinoben + Sindone	10 + 10	10 lbs	2.1 lbs	0.1 lbs	0.95 lbs	0.3-5.7 lbs
Amchem + Dow	DNBP + Sindone	20 + 20	20 lbs	3.1 lbs	0.1 lbs	0.70 lbs	1.5-20 lbs

1. Herbicides applied by logarithmic sprayer at 100 gal/A with dilution to 1/2 concentration of herbicide every 12.5 feet.
2. Herbicides were incorporated within minutes with a hooded, field, rotary tiller with L-shaped teeth set for 3″ depth.
3. Concentration of herbicides at which plants will grow, though they may be severely damaged.
4. Concentration of herbicides at which plants appear to grow normally.
5. Minimum rate of herbicides to control annual grass.
6. Minimum rate to control annual broadleaved weeds.
7. Range of acceptable weed control without obvious crop damage.

Table 4. Lima Bean Weed Control Yield Trial with Incorporation.

Chemical Company	Herbicide	Rate/A	Weed Control Rating (1) Broad-leaved	Weed Control Rating (1) Grass	Crop Response Plant Rating (2)	Crop Response Yield T/A Shelled Beans (3)
Velsicol	OCS21693	2 lbs	7.8	8.8	8.8	4.41 a
Velsicol	OCS21693	4 lbs	9.2	10	7.5	4.94 a
Velsicol	OCS21799	2 lbs	10	10	3.5	3.52 b
Velsicol	OCS21799	4 lbs	10	10	2.8	1.69 c
CIBA	Tenoran	4 lbs	10	10	6	3.35 b
CIBA	Patoran	3 lbs	9.8	10	3.5	2.79 c
CIBA + Amchem	Patoran + Sindone	3 + 2 lbs	10	10	4.8	3.75 b
Amchem	Amiben	2 lbs	10	10	7.8	4.76 a
Amchem	Amiben + Sindone	2 + 1 lbs	10	10	8.5	5.26 a
Amchem	Amiben ester	2 lbs	9.8	10	9	4.53 a
Amchem	Amiben ester + Sindone	2 + 1 lbs	10	10	8.5	4.58 a
Amchem	Amiben ester + Sindone	2 + 2 lbs	9.8	10	8.8	4.36 a
Amchem	Amiben ester + Sindone	4 + 2 lbs	10	10	7.2	4.13 b
Shell	SD11831 (Planavin)	.75 lbs	9.5	10	8.8	4.99 a
Shell	SD11831 (Planavin)	1.50 lbs	10	10	8.2	5.13 a
Lilly	Diphenamid	6 lbs	10	10	7.8	4.59 a
Lilly	Trifluralin	.5 lbs	9.5	10	8.2	4.53 a
Lilly	Trifluralin	.75 lbs	10	10	8.2	4.78 a
Stauffer	Prefar	5 lbs	8.5	9.5	8.5	4.38 a
Check			6.5	7	7.8	4.80 a

1. 1 = poor weed control, 10 = excellent weed control
2. 1 = poor lima bean growth, 10 = excellent growth of lima beans
3. Yields with a common letter not significantly different at odds of 19 to 1 by Duncans Multiple Range.

Table 5. 1966 Lima Bean Weed Control Yield Trial with Preemergence Application of Herbicides Activated by 1 inch of Overhead Irrigation.

			Weed Control Rating (1)		Crop Response	
Chemical Company	Herbicide	Rate/A	Broad-leaved	Grass	Plant Rating (2)	Yield T/A Shelled Beans (3)
Velsicol	OCS21693	2 lbs	9	9.5	7.8	4.29 a
Velsicol	OCS21693	4 lbs	8.2	9.8	7	3.86 a
Velsicol	OCS21799	2 lbs	10	10	5.8	4.23 a
Velsicol	OCS21799	4 lbs	10	10	6	4.01 a
CIBA	Tenoran	4 lbs	8.5	9.5	7.2	3.43 b
CIBA	Patoran	3 lbs	9.8	9.5	7.5	4.60 a
CIBA	Patoran + Sindone	3 + 2 lbs	10	10	6.5	3.87 a
Amchem	Amiben	2 lbs	9.2	10	7.8	3.76 a
Amchem	Amiben + Sindone	2 + 1 lbs	9.5	10	8.2	3.86 a
Amchem	Amiben ester	2 lbs	9.5	10	8.2	4.30 a
Amchem	Amiben ester + Sindone	2 + 1 lbs	10	10	8.2	3.70 a
Amchem	Amiben ester + Sindone	2 + 2 lbs	10	10	8	4.53 a
Amchem	Amiben ester + Sindone	4 + 2 lbs	9.8	10	8.8	3.93 a
Shell	SD11831 (Planavin)	.75 lbs	8.5	10	8.2	3.64 a
Shell	SD11831 (Planavin)	1.5 lbs	8.8	9.5	9	3.57 a
Lilly	Diphenamid	6 lbs	9.8	10	9	4.26 a
Lilly	Trifluralin	.5 lbs	8.5	9.5	8.2	4.11 a
Lilly	Trifluralin	.75 lbs	9	10	8.2	4.15 a
Check			7	7	8	4.41 a

1. 1 = poor weed control, 10 = excellent weed control

2. 1 = poor lima bean growth 10 = excellent growth of lima beans

3. Yields with a common letter not significantly different at odds of 1 9to 1 by Duncan's Multiple Range.

FACTORS AFFECTING THE USE OF BROMOXYNIL IN ONIONS

R. A. Fosse and C. B. Mitchell

ABSTRACT:

Early information from field tests using Bromoxynil for weed control in onions indicate selectivity can be obtained.

The purpose of these experiments was to study the effect of rate of Bromoxynil, volume of carrier, stage of onion growth and repeated applications on onion selectivity and weed control.

Duplicate experiments were conducted at Brownsville, Texas and Visalia, California.

Rates studied were 0, 2, 4, 6 and 12 ounces active Bromoxynil per acre.

Volumes of carrier studied were 10, 20, 40 and 80 gallons per acre.

Stages of growth studied were (1) crook to early flag (2) late flag to early 2 leaf (3) late 2 leaf and early 3 leaf (4) 3 to 4 leaf.

Results of early stage treatments show onion injury varying from 17% at the 2 ounce rate to 92% at the 12 ounce rate. Weed control at this stage was 100% at all rates of application.

Stage of growth studies indicate an increased tolerance of the onions at the later growth stages.

Repeated applications did not increase onion injury.

Volume of carrier studies showed slightly increased activity at the higher volumes.

(Amchem Products, Inc., Fremont, California)

FIELD STUDIES OF THE CONTROL OF AQUATIC WEEDS AND DISSIPATION OF ENDOTHALL FROM RESERVOIRS

R. R. Yeo

ABSTRACT:

Endothall is a chemical that is used for controlling submersed aquatic weeds in reservoirs, lakes, and ponds. These waters are usually used for irrigation, watering livestock, fishing, and swimming. It is desirable to know the amounts of endothall remaining in the water after a reasonable period of time. A study to determine the kinds of aquatic weeds controlled and the rate of dissipation of several concentrations of endothall from treated reservoirs over a 12-day period was made at Davis, California during 1964-1966.

Twenty-three reservoirs were treated with the sodium or potassium salts of endothall with concentrations varying from 125 to 3000 ppbw. The kinds of aquatic weeds that were controlled by the different concentrations were recorded. The dissipation of endothall was investigated in 14 reservoirs at concentrations ranging from 250 to 3000 ppbw. Water samples containing the residues were collected ½ hour, 4, 8, and 12 days after application. A flax seed bioassay method of analysis was used to determine the concentrations of endothall in the samples. Small amounts were obtained by concentrating the endothall in the samples using a rotary evaporator. Several of the environmental factors were recorded for each reservoir.

The following aquatic weeds were controlled: sago pondweed (*Potamogeton pectinatus L.*) 350 to 3000 ppbw, American pondweed (*P. nodosus* Poir.) 350 to 3000 ppbw, small pondweed (*P. pusillus* L.) 570 to 2000 ppbw, curlyleaf pondweed (*P. crispus* L.) 250 to 1000 ppbw, waterthread pondweed (*P. diversifolius* Raf.) 900 ppbw, horned pondweed (*Zannichellia palustris* L.) 700 to 1400 ppbw, southern naiad (*Najas guadalupensis* (Spreng.) Magnus) 250 to 2000 ppbw, and coontail (*Ceratophyllum demersum* L.) 350 to 1900 ppbw. Aquatic plants not controlled were American elodea (*Elodea canadensis* Michx.) 500 to 1400 ppbw, nitella (*Nitella clavata* Kutzing) 900 ppbw, and California waterprimrose (*Jussieae californica* (Wats.) Jepson) 500 to 1400 ppbw.

The rates of dissipation were inconsistent over the 12-day sampling period. Residues decreased very little from the fourth to twelfth day in eight of the studies. In four of the studies where the dissipation decreased to 180 ppbw and less, the water temperature throughout the reservoir was greater than 70° F. Calcium and total hardness, pH, and total alkalinity did not appear to be related to the rate of dissipation. In one reservoir a thermocline was evident. Concentrations of endothall in the residues taken from the epilimnion were found to be greater than in the hypolimnion. (Cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, the California Agricultural Experiment Station, Davis, the Bureau of Reclamation, Region 2, Sacramento; and the California Department of Water Resources.)

EFFECTS OF SIMAZINE UPON PIGMENTS, SOLUBLE SOLIDS, AND SOME OXIDATIVE ENZYMES OF APPLE AND CHERRY

Jawad T. Agha and J. LaMar Anderson

ABSTRACT:

Studies of metabolic effects of differential simazine treatments to apple and cherry trees over a 3-year period have shown changes in chlorophyll and anthocyanin pigments. Chlorophyll pigments in both sour cherry and apple leaves increased at the four-pound level of simazine. In the field, the chlorophyll content

of sour cherry leaves which received the four-pound-per-acre treatment for three years showed an increase of 28 per cent chlorophyll as compared with the untreated control. At the highest level, simazine caused a definite decrease of chlorophyll content. Both sweet cherry and *Prunus mahaleb* showed a decrease in chlorophyll at all levels of simazine. This indicates that simazine is toxic to both sweet cherry and *P. mahaleb*.

The analysis of sour cherry fruit indicates increase in both percentage of soluble solids and anthocyanin pigments at the four-pound rate, while a decrease in anthocyanin and a continued increase in per cent of soluble solids occurred at the 12-pound level of simazine

Enzyme analyses indicate an increase of both peroxidase and polyphenol oxidase in all plant species used at all levels of simazine as compared with the control. These results are in agreement with the results of other workers who found that atrazine, the related compound to simazine, caused increase in the peroxidase activity of citrus leaves. The catalase activity and cytochrome oxidase activity decreased in both sweet cherry and *P. mahaleb* leaves at all levels of simazine; while in apple and sour cherry, these enzymes tend to increase or do not change significantly.

Our studies have shown by both visual and chemical determinations that apple and sour cherry trees are fairly tolerant to simazine at the recommended dosages (4 pounds of active ingredient per acre), while sweet cherry, and to a greater extent, *P. mahaleb,* are sensitive to simazine. At the four-pound level, simazine causes an increase in chlorophyll content of leaves and anthocyanin pigments; while of the higher concentrations, a decrease in these pigments has been shown. In general, simazine causes an increase in both peroxidase and polyphenol oxidase activity in all species studied. Sweet cherry and *P. mahaleb* show a decrease in catalase and cytochrome oxidase activity at all simazine concentrations. The study on sour cherry trees indicates an increase in catalase activity at low dosage, while a decrease was found at the high dosage. The activity of cytochrome oxidase in sour cherry tends to decrease following treatment at all levels. Simazine, in general, caused an increase of catalase and cytochrome oxidase activity in apples. (Plant Science Department, Utah State University, Logan, Utah)

INFLUENCE OF SIMAZINE ON NITROGEN FRACTIONS OF APPLE SEEDLINGS GROWN AT DIFFERENT NITROGEN LEVELS

Ming-te Lin and J. LaMar Anderson

ABSTRACT:

Apple seedlings were grown in a normal Hoagland solution and in a minus nitrogen solution in sand culture. Sixty days later they were treated with simazine (2-chloro-4,6-bis (ethylamino)-s-triazine) at rates of 0.5, 1.0 and 2.0 lb/A. Three weeks after treatment, seedlings were harvested and separated into root, stem and leaf portions. Total nitrogen, protein nitrogen, total soluble nitrogen, fractions of soluble nitrogen (amide, amino, nitrate, and amonia), and dry weight of samples were determined. Dry weights of all simazine treated samples were less than the untreated seedlings. Nitrogen fractions increased as a result of simazine treatment, regardless of the nitrogen level at which they were grown. Results indicate that the percentage nitrogen content increase of the treated plants is not due to increased nitrogen absorption from the nutrient solution but to a decrease in other constituents.

(Department of Plant Science, Utah State University, Logan, Utah)

MORPHOLOGICAL AND ANATOMICAL EFFECTS OF PYRAZON UPON PHASEOLUS VULGARIS

James E. Rodebush and J. LaMar Anderson

ABSTRACT:

Pyrazon induces a marginal chlorosis of unifoliate leaves when applied to germinating seeds. The chlorosis is progressive toward the inner leaf areas, with the intervenal areas being more susceptible to chlorosis than the veins. The extent and severity of chlorosis is dependent upon rate and duration of treatment and upon the age of the unifoliate leaves.

Studies of chlorotic tissue with the light microscope revealed progressive changes in chloroplast preceding destruction. These changes involved a change in shape from discoid to spherical with an increase in density to light, a clumping of chloroplasts within the cell, followed by eventual breakdown of chloroplasts. These changes occurred prior to a disorganization and collapse of the effected cells.

Nodulation on seedlings developed from seeds exposed to pyrazon during germination was inversely proportional to the rate of treatment. This does not appear to be an antagonistic effect due to pyrazon but rather a plant bacterial interaction.

(Plant Science Department, Utah State University, Logan,Utah)

CHEMICAL THINNING — BETTER FORESTRY AT LOWER COST

by Michael Newton

ABSTRACT:

Maximum forest value growth is attained only if all trees are salable and if trees are grown to salable spec-

ifications in a minimum number of years. Control of tree spacing, and selection of desirable trees in the first 10-30 years in the life of a forest will expedite development of salable trees by five to 30 years. Unit value of forest products may be increased if only selected trees are grown. Maximum benefits are accrued when stand regulation is applied at an early age.

Chemicals have been developed and tested as a means of replacing the power saw as the principal means of tree spacing. Injection systems have been used to increase the number of trees treated for a given labor investment, and to reduce the need for transporting large amounts of inactive herbicide carrier materials. Chemical thinning in ponderosa pine forests should be possible at lower cost than power saw thinning when less than 2,000 to 5,000 trees per acre are to be treated, depending on accessibility and stand characteristics. In other forest types, injection may be more economical at almost any density. The magnitude of the problem of forest composition and density is so great that several million acres could be treated annually on a near-indefinite basis, selecting only sites on which investment in such treatment would produce return comparable to good investment alternatives. Existing herbicides are adaptable to the host of species combinations needing treatment.

Chemical thinning has the added advantage over conventional means that herbicides are available that kill trees, repelling or killing insects through habitat modification or specific toxicity. Moreover, killing trees without felling is less unsightly than massive slash accumulations, and prevents the heavy accumulation of fuel.

(School of Forestry, Oregon State University, Corvalis, Oregon)

THE DIFFERENTIAL RESPONSE OF GREEN ASH, SWEET GUM, AND SILVER MAPLE TO PICLORAM

Warren L. Webb

ABSTRACT:

Picloram (4-amino, 3,5,6-trichloropicolinic acid) was tested on one and two-year-old seedlings of three woody species exhibiting field tolerances to picloram varying from resistant to susceptible. Green ash, *Fraxinus pennsylvanica* Marsh, (resistant), sweet gum, *Liquidombar styraciflua* L. (intermediate) and silver maple,*Acer saccharinum* L. (susceptible) were grown in nutrient solutions in a controlled environment room. Picloram (concentrations of 0.03, 0.06, 0.1, 0.3, 1.0 ppm) was introduced through the roots via the nutrient solution to establish relative biochemical tolerances. Response was measured in terms of percent change in CO_2 absorption or evolution to establish comparable response concentration curves among species.

The time-dependent change in CO_2 absorption and evolution for all three species in 0.1 ppm picloram over 24-28 days was determined and the picloram absorption per plant was estimated by periodically sampling the nutrient solution for the unabsorped chemical. (Chemical analysis with GLC).

CO_2 absorption of silver maple declined steadily to 25 percent of original value while apparent photosynthesis of green ash and sweet gum recovered following an initial depression to 50 percent. This is indicative of a shift in a biochemical pathway or a possible enzyme adaption—a feature not found in the susceptible silver maple. The comparative change of CO_2 absorption as a function of picloram concentration showed silver maple to be slightly less tolerant but the exposure time (ten days) was too short for "steady state" conditions to exist between chemical and plant.

Initial root absorption of picloram by silver maple was followed by an egress back to the nutrient solution. Severe wilting and twisting of aerial plant parts suggest that this chemical flow is the result of loss of membrane integrity. A similar uptake and egress pattern occurred in sweet gum but slightly increased respiration and minor morphological damage suggest active exudation as a possible resistence mechanism. Green ash accumulated picloram slowly and no chemical flow back to the nutrient solution was observed.

(USDA, Pacific Southwest Forest and Range Experiment Station, Berkeley, California)

THE ROLE OF LIGHT, CONCENTRATION, AND SPECIES IN FOLIAR UPTAKE OF HERBICIDES IN WOODY PLANTS

F. S. Davis, R. W. Bovey and M. G. Merkle

ABSTRACT:

Uptake of 2 herbicides into leaves of 10 species of woody plants was studied using a gas chromatographic assay. In most species, picloram entered faster and to a higher final concentration than 2,4,5-T. Leaves of these species absorbed 2,4,5-T in amounts relative to their susceptibility to 2,4,5-T. A circle of tissue cut from a leaf absorbed more than an entire leaf. In the range 0.004 to 0.5M, sodium acetate had little effect on uptake of either herbicide. The abaxial surface of the leaf usually absorbed more than the adaxial surface. Herbicides entered the leaf in amounts approximately proportional to the log of the concentration of the herbicide outside of the leaf. Light intensity was inversely related to uptake and light quality had no significant effect.

(Agricultural Research Service, U.S. Department of Agriculture and Dept. of Soil and Crop Science, Texas A&M University, College Station, Texas.)

AERIAL AND GROUND APPLICATION OF HERBICIDES FOR CONTROL OF RUNNING LIVE OAK

R. W. Bovey and S. K. Lehman

ABSTRACT:

Running live oak (*Quercus virginiana* Mill) is an evergreen woody plant rapidly encroaching on pasture and rangelands on the Gulf Coast Prairie in Texas. Heavy infestations cause low forage production and attempts to control the species by burning, mowing or 2,4,5-T have not been very successful. Bromacil at 5 and 10 lb/A, paraquat plus bromacil at 4 plus 4 lb/A and picloram at 4 and 8 lb/A applied with ground equipment have given excellent control of running live oak. Aerial application of picloram at 1, 2, and 4 lb/A is showing promise from both fall and spring treatments. Picloram and bromacil granular formulations applied to the soil are also effective in controlling live oak.

(Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, and Department of Range Sicence, Texas A&M University, College Station, Texas.)

SAGEBRUCH CONTROL AND USE OF INVERT EMULSION IN WYOMING

Claire E. Letson[1]

The control of sagebrush has been practiced by land managers for many years. Yet, it is generally believed that the 96½ million acres of sagebrush covered land in the West today exceeds that existing prior to the settlement of the West and the resulting influence of the white man.

With different goals in mind, various means of control have been tried. These include burning, plowing, disking, seeding, blading, use of anchor chains, brush combs and beaters, and, since about 1950, spraying with chemicals.

The earliest chemical control project of record on Bureau of Land Management lands in Wyoming took place in 1952. This project was small and the program remained so for several years. A recent check of project records revealed 51,000 acres of successful brush control work completed through 1963. The total acreage treated by the close of the 1966 season is nearly three times that figure (144,638 acres).

During the period of time since chemical control became popular, many improvements and advancements in application have been made. Initial efforts were made with "ground rigs." Control of spray pattern was precise, but equipment use, labor requirements, and total cost per acre were high. Because the time period during which successful spraying could be done was restricted to about eight weeks in the spring of the year, the amount of brush controlled in a given year was quite limited.

Fixed wing aircraft replaced ground equipment and opened the door to control of large acreages within the short interval of time when vegetative and soil moisture conditions were optimum. At the same time, control cost per acre was reduced to a point considered economically feasible in terms of anticipated benefits.

With the advent of aerial spraying came the problems of spray drift and accelerated rate of evaporation. These problems were lessened by the use of diesel oil as a carrier instead of water. Greater control was achieved under certain location conditions with the use of helicopters. The ability of "choppers" to hover and fly at low speeds provided another means of precise spray pattern control in areas of irregular boundaries, adverse terrain, and where deletions were required to peserve desirable cover and forage patches for wildlife. Helicopters offered a cost advantage in many areas where the nearest adequate landing strip involved a long ferry distance for fixed wing aircraft.

Fixed wing aircraft were soon designed primarily for spraying operations instead of converting other type aircraft for this use. With a properly designed fixed wing aircraft, more precise control of spray patterns was achieved over converted aircraft.

With the advanced techniques in equipment design and contract supervision, many problems of an administrative, mechanical, or technical nature were resolved to a point of seeming practicality. However, one problem related to application has remained. Wind has indirectly been a cause for concern for two reasons. First, despite the advanced techniques employed, the degree of spray pattern control desired is not always achieved. Second, because of excessive wind velocities, the time and attendant contract supervision cost has been high, and at times prohibitive.

In an effort to correct the problems associated with wind, the use of invert emulsions was initiated in sagebrush control contracts in Wyoming in the spring of 1966. Three separate contracts were awarded. One contract involved the use of helicopters and provided for spraying with conventional formulations and inverts on contiguous tracts of lands simultaneously. The other two contracts were executed with fixed wing aircraft and only invert emulsions were used.

A total of 24,854 acres was sprayed with invert emulsions. Sixteen different site locations provided an opportunity to observe the new method of application under a variety of climatic and terrain conditions with respect to elevation (6,500-8,500 ft.), wind velocities, topography, and the like.

The average contract cost was $2.90 per acre. As a means of comparison, 26,700 acres were sprayed by conventional methods, using both helicopters and

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fixed wing aircraft. The average contract cost for this work was $3.21 per acre.

On the basis of observations to date the degree of success, or percent of sagebrush kill, is comparable whether using the conventional or the bifluid method of application. In the one contract where conventional spraying and application of inverts were carried out side by side, there was no perceptible difference in degree of sagebrush kill six months after treatment.

The invert emulsion method of application, together with the specialized equipment needed, is probably best identified as a bifluid application system. This system is basically a process for the simultaneous proportioning, mixing, and spraying of an oil base pesticide chemical formulation and water. These components, when metered into a mixing chamber at a predetermined ratio of oil to water, form an emulsion of *water-in-oil,* commonly referred to as an invert emulsion. This contrasts to the conventional *oil-in-water* emulsion normally used. With an invert emulsion, each droplet of water is encased by a film of oil.

Water-in-oil emulsions characteristically have a thick mayonnaise-like consistency and appearance. This consistency, in part, accounts for the resistance to wind drift. In addition, the water part of the droplet is surrounded by a film of oil which greatly reduces the evaporation rate of the droplet as it moves through the air and as it is being absorbed into the leaf. The resistance to evaporation by the invert droplet accounts for part of the drift resistance and for the uniformity of spray pattern, since the droplets tend to retain their size from point of discharge to the intended target. Conventional oil-in-water droplets reduce in size rapidly as the outer film of water evaporates. Thus, they are more susceptible to drift.

Contracts for application of invert emulsions were worded to specifically permit the use of the Stull Bifluid System with Instimul and the Hercules Rhap-Trol System with Visko-Rhap, or other comparable systems and formulations. In each of the three contracts, the contractor chose to use the products of Stull Chemical Company. It should be noted, however, that aside from some basic equipment parts, the contractors were prone to build their own bifluid applicator system, thus reducing the cost of tooling up for the invert operation. Bifluid equipment costs (about $400) and installation did not appear to be a major factor in the bid cost per acre, or receive more attention in bidding than did the contractor's own inexperience in cost estimating with invert emulsions.

Execution of the contract in field operations was carried out in much the same manner as with conventional spraying. The differences encountered stemmed from an unfamiliarity with the equipment and application method on the part of both the contractor and the project supervisor.

In each case, a representative from Stull Chemical Company spent some time with the applicator assisting in the installation of equipment on the plane and making preliminary tests of equipment operation and calibration for the contract involved. The company representative was usually on hand to advise and assist in further calibration refinement as contract field operations commenced. Because of some equipment malfunction and new equipment adjustments necessary, precise time requirements for equipment calibrations on two of the contracts could not be accurately determined. On the third contract, however, no problems were encountered with equipment operation. Nozzle orifices of the right size had been installed to give adequate droplet size during initial equipment operation. Approximately one hour was required to calibrate this plane for proper ratio mix of oil phase to water phase, swath width, and volume per acre. The plane was recalibrated on two other occasions during the course of this contract when minor malfunctions occurred and were corrected. In neither case did it require more than one hour to recalibrate the plane. Adjustments were made between loads. This plane was flying three loads per hour, and capable of carrying 300 gallons per load.

Excessive "down" time could be attributed to two major causes. Unfamiliarity with new equipment by all personnel present required more time than would normally be expected in locating and correcting the cause of any malfunction. Of equal or greater concern, and a potential problem on future contracts, was the problem of ground support and material supply. Considerable flying time was lost because of insufficient manpower and/or equipment to keep a supply of oil and water phase mixture available for the plane during days when wind velocities permitted continuous flying operations for several hours. Shutdowns for mixing operations normally lasted about two hours.

Minimum ground equipment should consist of two storage tanks, two sets of suction and discharge lines, and two pumping units with metering devices at the loading zone. In addition, two supply tankers should be available for preparation and delivery of the oil and water phase mixtures to the storage tanks. The tank trucks should have access to suction and discharge lines and a pumping unit with metering device independent of the units supplied for the storage tanks. The number of additional supply tankers and pumping unit assemblies needed will vary with the distance supplies must be transported and the rate at which the contractor can move the formulation from the storage tanks. An individual should man the loading zone at all times during flight operations to facilitate loading and mixing operations, and to assist with equipment inspection or minor adjustments needed between flights. Additional manpower should be available to operate supply tankers.

Water quality was not a problem in obtaining an invert mixture with the products used. Water must be free of sediments, however, if clogged nozzles are to be avoided. When awarding a contract for use of invert emulsions, the land manager should ascertain as early as possible, the invert product to be used. This is necessary as certain invert additives will operate effectively only within a narrow pH range while others have a wide latitude of pH tolerance. Some invert additives markedly increase the acidity of the water used to a point that it is extremely dangerous for handlers and highly corrosive to equipment. The contractor should be advised of the water quality factors which may cause problems. Attempts to correct this situation after a Notice to Proceed has been issued could prove very time consuming and costly to both contractor and the Government.

It is generally recognized that maximum absorption of the spray materials by the leaf surface, the most uniform spray pattern, and, therefore, optimum beneficial results in plant control, are obtained when spray droplet size is held to a minimum. When using convenient spray formulations, as large a proportion of droplets as possible should be in the size range of 200-800 microns in diameter, recognizing that to keep drift to a minimum and still obtain good coverage the droplet size must be within these limits. As a gauge to droplet size, the period at the end of this sentence is about 1000 microns in diameter. The following table shows for a given droplet diameter, the number of droplets to be expected per square inch of surface when (1) applied at one gallon of solution per acre, and (2) when applied at the normal application rate of four gallons per acre.

Droplet Diameter in Microns	Type of Droplet	No. Droplets per sq. Inch from 1 gal. Solution per Acre	No. Droplets per sq. Inch from 4 gal. Solution per Acre
5	Fog	9,000,000	
100	Mist	1,164	4,656
200		144	576
300		43	172
400		18	72
500(1/50″)	Light Rain	9.2	36.8
600		5.3	21.2
700		3.3	13.2
800		2.3	9.2
900		1.6	5.4
1000	Moderate Rain	1.2	4.8

Spray pattern, density, and drift were checked with the use of oil sensitive cards and with bond paper. Because of the difficulty in measuring droplets of such small size, reliance was placed on the number of droplets per square inch received in a uniform swath width spray pattern to indicate droplet size. Drift and total deposit was judged by placing one set of cards to obtain initial spray deposits and then placing additional cards in the same swath to record drift accumulation from subsequent passes. Several sample counts were made from the test cards. A count of 200 to 300 droplets per square inch was not uncommon, indicating, with reference to the above table, that the major portion of the droplets were within the 200-400 micron diameter size range.

Invert emulsions have a high surface tension which is a requirement of larger droplet size. This surface tension tends to counteract forces of evaporation and permits the droplet to reach the ground at practically the same size as when it left the spray nozzle. Accordingly, the tendency to drift is reduced and uniformity of spray pattern can be expected to improve. Because of the high surface tension of the invert emulsion, some larger than desirable droplets may be observed, even though spray pattern and particle size in general are satisfactory. This will be most noticeable whenever pump pressure or wind pressure across the nozzle is low.

Spray pattern and droplet size was adjusted in the field by inserting various size orifices in the nozzles, by positioning the nozzles at varied verticle and horizontal angles on the spray boom, and by adjusting the spacing of nozzles on the boom.

While a droplet of invert emulsion is more resistant to drift than a conventional droplet of the same size, both are subject to movement because of surface winds. Where a five-mile wind velocity appears to be the maximum under which satisfactory spraying can be obtained with the conventional droplet, a wind velocity of 15 mph appears to be the maximum allowable for use of invert emulsions.

Heavy bond paper was used briefly as a substitute and alternative to oil sensitive cards for checking spray pattern. The spray deposit is obtained in the same manner as it is on oil sensitive cards. After the spray is deposited, the sheets are emersed in a dye solution, rinsed in clear water and dried.

The dye solution is prepared by dissolving Nigrosine 128B concentrated crystals or Nigrosine 140 crystals in water until a deep color is obtained. About one-half teaspoon of crystals per gallon of water is sufficient.

This method of testing for spray pattern has some distinct advantages. It is cheaper than oil sensitive cards. Except for the dye, which may be purchased in most drug stores, the materials are readily available. The large sheets of paper are easier to file, seem to show more precise droplet size, and are easier to write on for identification. This method also has some disadvantages. A dye solution must be mixed and the paper has to be dried, although one can see the spray pattern very distinctly when wet, and quite well immediately after the spray has been deposited. If sheets are to be identified for future reference prior to emersion in the dye solution, a waterproof marker must be used.

The land manager might also investigate the use of Minnesota Mining and Manufacturing Company's Type

607 photocopy paper as an alternative to oil sensitive cards. Droplets do not spread beyond impact size. As the paper is light sensitive, the spray pattern will develop as brown spots after being exposed to sunlight for a period of about five minutes. This photocopy paper has one disadvantage, as it must be retrieved shortly after the spray pattern is deposited since extended exposure would change the color of the entire sheet of paper.

A review of flight logs and daily project data sheets indicated a distinct savings in contract supervision costs. On those days when wind velocities would ground conventional spray planes during a large portion of the day, bifluid spray planes could continue to operate. Approximately 50 percent more flying time was obtained with the bifluid system plane as compared to the conventional plane.

Because of the additional flying time possible with the bifluid system, the land manager should be prepared to authorize compensatory time or overtime, or provide relief crews for project supervision. Depending to some extent on the size of ground support crew furnished by the contractor, some project supervision may be required continuously from 4:00 a.m. to 10:00 p.m. on days of good flying weather. Although flying operations must cease with darkness, mixing operations will continue until the storage tanks are filled and ready for the next day's operations.

Project supervision personnel may at times see an "oil mist" when looking into the flight pattern and against the sun. Standing under the flight pattern or behind the flight line with back to the sun, this apparent "heavy drift" of emulsion will not be seen. The "oil mist" will often appear to hang in the air for some time (10-15 seconds) and move downwind. However, inspection on the ground will verify that the emulsion is coming down within the flight swath pattern.

The favorable characteristics of invert emulsions may provide new opportunities for its application and use. In sagebrush control there is a constant safety hazard involved with pilots flying 10-20 feet above the ground at high speeds over rough terrain. With the use of invert emulsions, it may be possible to increase the droplet size and the amount of acid equivalent per acre, while saving the additional cost by using larger planes flying higher above the ground. Small fixed wing planes and helicopters may still be used for spraying borders. Even with no cost advantage, the increased safety factor obtained would justify the operation when using a low toxicity material such as 2,4-D.

Another possible use for invert emulsions of 2,4-D, a growth stimulant, is in the field of wildlife habitat devlopment. The degree of control possible with inverts indicates that it may be utilized on irregular patches of desirable browse. By applying the chemical at a lower dosage rate, it may be possible to stimulate stem and leaf growth to provide additional forage on heavily used wildlife ranges.

In fire suppression activities, the practice of bombing with fire retardant slurries has become quite common. Depending on the effective tenure required, one of three basic slurries is selected. The cost of the slurry ranges from fifteen to forty-two cents per gallon. Once the slurry has been mixed and loaded in the plane, it must be dropped even though conditions on the fire line may have changed. The mixed slurry cannot be returned to the loading dock, even though no longer needed on the fire. By using the invert emulsion bifluid principle, the mixing operation could take place on the plane as the slurry is being dropped. If not needed, the components would be returned to their respective storage tanks for later use. In the event sufficient quantities could not be pumped through the booms, mixing can be conduced prior to loading. The premixed slurry could possibly be returned to a suitable storage tank since most invert emulsions will hold their consistency for an extended length of time.

SCOTCH THISTLE AND ITS CONTROL

James A. Young and Raymond A. Evans

ABSTRACT:

Scotch thistle, *Onopordum acanthium* L., is a serious range and pasture weed problem in California, Oregon, Idaho, and Nevada. It closely resembles the thistles of the genus *Cirsium.* A useful identifying characteristic for Scotch thistle is the deeply pitted or honeycombed receptacles without the hairs found on the flat receptacles in *Cirsium.*

Scotch thistle, generally regarded as biennial, produces in its 1st year a stemless rosette and in the 2nd, a flowering stalk. However, Scotch thistle selections found in northern California and Nevada are capable of summer annual, winter annual or biennial life cycle. Apparently the species has lost either its cold requirement, daylength requirement, or both. Its rosettes grow to form a coarse, repeatedly branched plant up to 8 or 9 ft. tall and 5 or 6 ft. across. Under poor growing conditions, Scotch thistle will flower as a small depauperate plant scarcely 6 inches tall.

Scotch thistle probably originated in Central Asia. It occurs throughout Europe south of the Scandinavian countries and was supposedly introduced during the development of early agriculture. In eastern European grasslands, it is an important weedy species in areas dominated by *Agropyron cristatum* (L.) Gaertn. It forms successional communities with such weedy plants as: *Bromus tectorum* L., *Lepidium perfoliatum* L. and *Centaurea cyanus* L.

Scotch thistle was recorded in the northeastern United States in the late 19th century. Plants were

collected at Brigham, Utah, in 1910. Since 1942, it has been rapidly spreading in northeastern California. In Idaho and Nevada, it is a roadside weed in areas having 8 to 12 inches of annual precipitation, and it has invaded crested wheatgrass seedings, cereal grain fields, and native meadows.

A single Scotch thistle plant can produce 250,000 achenes which can remain viable in the soil for years. The prolific seed production and long seed viability makes control difficult. Even when existing plants are killed, control is effective only after the supply of achenes in the soil is exhausted.

In two years of herbicide trials, phenoxy compounds have not killed Scotch thistle. The rosettes are more susceptible in early spring, but application of 4 lb/A of a low volatile ester of 2,4-D consistently has had little effect on the species.

Amitrole applied in the fall at 4 lb/A controlled Scotch thistle rosettes, but the plots were restocked with germinating seedlings by the following summer.

Dicamba, applied at 4 lb/A in June, controlled Scotch thistle rosettes only until September rains initiated further germination.

The rosettes are very susceptible to low rates of picloram. Rates of ⅛ to ¼ lb/A of picloram controlled dense stands of rosettes and killed subsequent germinating seedlings for 18 months after treatment. The same rates of picloram were effective when applied before seedlings emerged.

Picloram at ½ to ¾ lb/A, and amitrole at 6 lb/A have given satisfactory control of flowering Scotch thistle. In all cases it requires less herbicide to control rosettes than flowering Scotch thistle plants. Picloram and amitrole are not registered for use on rangelands.

(Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, University of Nevada, Reno, Nevada)

A SUMMARY OF RESEARCH ON MEDUSAHEAD ELYMUS CAPUT — MEDUSAE L.

Lambert C. Erickson

ABSTRACT:

Medusahead is a harsh textured weedy winter annual grass that dominates many dryland ranges extending from California to Montana. This weed has been under investigation almost continuously for the past 14 years. Phases studied include: edaphic and climatic adaptation, germination and vernalization requirements, seed and plant morphology, modes of seedling emergence, factors altering palatability, plant cyclic growth rate, chemical composition and cyclic silica absorption, and control by grazing, cultivation, chemicals and fire.

(Idaho Agricultural Experiment Station, University of Idaho, Moscow)

MINUTES OF THE BUSINESS MEETING OF THE WESTERN WEED CONTROL CONFERENCE HELD AT THE WESTWARD HO HOTEL, PHOENIX, ARIZONA, MARCH 17, 1967

President L. Jensen called for the Secretary to read the minutes of the Albuquerque Business Meeting of March 19, 1965. The minutes were approved as read.

Treasurer's Report by J. L. Anderson indicated the conference was solvent and its financial position was improving. The Auditing Committee Report by K. Dunster confirmed the Treasurer's report. The Auditing Committee (K. Dunster, D. Ragsdale, C. Williams) recommended (1) cancelling accounts receivable prior to 1962, (2) maintaining a list of bad debts, and (3) accepting the Treasurer's Report. R. Schieferstein moved to accept Treasurer's Report. Seconded by R. Higgins. Passed unanimously.

Research Commitee Report—R. Schieferstein, Chairman. H. Alley was commended for the excellent preparation of the past two Research Project Reports. Seven project meetings were held at Phoenix.

Project 1. *Perennial Herbaceous Weeds.* The meeting was conducted by Oliver Leonard since Dave Bayer and Al Fechtig could not attend. Al Fechtig is the next chairman.

Project 2. *Herbaceous Range Weeds.* Chairman Coburn Williams reported J. A. Young will be the next chairman.

Project 3. *Undesirable Woody Plants.* Chairman Mike Newton reported Herb Hull is the new chairman.

Project 4. *Weeds in Horticultural Crops.* Since Roman Romanowski could not attend, the meeting was conducted by the new chairman, Harry Agamalian.

Project 5. *Weeds in Agronomic Crops.* Chairman Ed Albeke announced Dwight Peabody is the next chairman.

Project 6. *Aquatic and Ditchbank Weeds.* Don Seaman could not attend so the meeting was conducted by the new chairman, E. J. Bowles.

Project 7. *Chemical and Physiological Studies.* Chairman Reed Gray reported Wayne Whitworth is the new chairman.

Unless changed by the proposed constitution the new project chairmen will serve two years. The new chairman of the Research Committee is Harold Alley. Motion by F. L. Timmons to accept the report. Seconded from the floor. Passed unanimously.

Education Committee Report—Robert E. Higgins, Chairman, Art Lange, Dean Swan. The Education Committee met and discussed ideas to strengthen or support the educational value of the Western Weed

Control Conference and the service performed by this conference.

The committee felt that making a long list of propositions or projects would not be of great value to the conference and instead selected a single project to which all can contribute.

However, the conference and members are reminded of the following:

1. We should re-emphasize the value of continued good communication between states, research, industry, extension, resident teaching and regulatory. Each member and segment has responsibility.
2. We should continue to make available the opportunity to exchange publications, ideas, and information. Every member is doing educational work to some degree.
3. People in educational positions such as, resident, teaching, extension and others should take a more active part in the operation of the conference and in the program.
4. Every participant should continue to prepare and use visual materials that are understandable, easily seen and read. The large screen and good projectionist helped a great deal at this meeting.

For a specific project this committee suggests that the Western Weed Control Conference sponsor the preparation and publication of a manual on the "Recognition of the Seedlings of Common Weeds." This manual will meet a real need by all and everyone can contribute. Art Lange, Dean Swan, Clarence Seely and others already have started accumulating colored slides of seedlings. Such a publication will be illustrated in color. The photographs will be supplemented by line drawings.

Regulatory Committee Report—James Koehler, Chairman. The new chairman is Bert Bohmont.

Resolutions Committee Report—T. L. Timmons, Chairman, Dean Boyle, Rex Warren. The Committee has carefully reviewed all resolutions received from members and Committees of the Conference and offers the following resolutions for consideration and possible adoption by the Conference:

RESOLUTION NO. 1

Whereas, our Conference officers during the past two years, President L. A. Jensen; Vice-President and Program Chairman S. W. Strew; Secretary K. C. Hamilton; Business Manager-Treasurer J. LaMar Anderson; WSA Representative and Constitution Revision Committee Chairman J. M. Hodgson; Director at Large A. P. Appleby and R. H. Schieferstein, Chairman and H. P. Alley Vice-Chairman of the Research Committee, have spent much time and effort in connection with the Conference.

Now, therefore, be it resolved that we express to them our appreciation and thanks for their services.

RESOLUTION NO. 2

Whereas, the Western Weed Control Conference assembled in Phoenix, Arizona on March 17, 1967, appreciates the opportunity to meet in Phoenix and,

Whereas, the Local Arrangements Committee, H. Fred Arle, Chairman, and R. A. Fisher have done an outstanding job.

Now, therefore, be it resolved that we express to them our appreciation and thanks for their service.

RESOLUTION NO. 3

Whereas, 2,4-D has been extensively used on aquatic and bank weeds along irrigation canals and streams, on ponds and lakes in many states since 1947, and

Whereas, 2,4-D at recommended treatment rates has not caused damage to fish, wildlife, humans, and warm-blooded animals during this period, and

Whereas, many restrictions have now been placed on the use of 2,4-D in or along aquatic sites, and

Whereas, 2,4-D provides the most effective and economical control of many species of aquatic and bank weeds.

Now, therefore, be it resolved that the Western Weed Control Conference urgently request that reasonable tolerances be established on 2,4-D for use in aquatic sites and any other necessary actions be taken to permit safe and effective use of 2,4-D for control of aquatic and bank weeds,

Be it further resolved, that the Conference Secretary send copies of this resolution to the United States Secretaries of Agriculture; Health, Education, and Welfare; and Interior; to the Federal Committee on Pest Control; and to comparable state agencies in each of the thirteen Western States.

RESOLUTION NO. 4

Whereas, alligatorweed, Austrian fieldcress, Canada thistle, Eurasian watermilfoil, field bindweed, halogeton, hoary cress, Johnsongrass, leafy surge, quackgrass, Russian knapweed, Russian thistle, St. Johnswort, waterhyacinth, and many other undesirable plants have been introduced into the United States from other coutries and have caused extensive losses to agriculture, health, navigation, recreation, and other National industries and resources, and

Whereas, noxious weeds such as field bindweed, Canada thistle, musk thistle, and witchweed exist in many states and these weeds to invade other states from adjoining areas, and

Whereas, the U.S. Department of Agriculture does not now have legislative authority or contingency funds for regulating the importations of weeds and weed propagules from foreign countries, or their transportation across state lines in the United States, and

Whereas, the need for such authority and funds for regulating the movement of noxious weeds into the United States is as great as that for the authority and funds the U.S. Department of Agriculture now has to regulate the importation and movement of insects, nematodes, and plant and animal diseases into the United States and between states.

Whereas, the National Association of State Departments of Agriculture at Honolulu, Hawaii, November, 1966, adopted a resolution urging legislation to give the Secretary of Agriculture such authority regarding noxious weeds and the necessary contingency funds.

Whereas, Senate Bill S. 580 recently introduced into the United States is a good beginning toward meeting this critical need.

Now, therefore, be it resolved, that the Western Weed Control Conference in convention assembled at Phoenix, Arizona, March 15-17, 1967, urges all Congressman and Senators of the thirteen Western States to take necessary measures to provide the U.S. Department of Agriculture with the additional authority and funds necessary to prevent importation of noxious aquatic, also terrestial weeds, seeds, and other propagating parts into the United States; to quarantine infestations within the United States, and to control such noxious weeds similar to the authority the Department now has for regulating the movement of and controlling insects, nematodes, and plant and animal diseases.

Be it further resolved, that the Conference Secretary send a copy of this resolution to each United States Congressman and Senator from the thirteen Western States, and to the Secretary of the U.S. Department of Agriculture.

Moved by F. L. Timmons to adopt Resolutions 1 and 2. Seconded by R. Fosse. Passed unanimously.

Implications of Resolution 3 were discussed. Motion by F. L. Timmons to adopt Resolution 3. Seconded by Dean Swan and passed unanimously.

Resolution 4 was amended to read thirteen western states. Motion by F. L. Timmons to adopt Resolution 4. Seconded by R. Higgins. Passed unanimously.

The dates and sites of future meetings were discussed by L. Jensen. The membership voting by mail favored Phoenix, Arizona. The next meeting will be March 19, 20, 21, 1968 at the Owyhee Hotel in Boise, Idaho. In 1969 the WWCC will have a ½-day session before the meeting of WSA at Las Vegas, Nevada.

The members at the Phoenix meeting were able to express their views on future meeting dates and sites. Seventy-five percent wanted to continue with the same dates. Seventy-five percent favored rotation of meeting sites and 22 percent favored meetings at key cities. The majority wished to meet in California. Las Vegas, Portland, Denver, Salt Lake City, Phoenix, Boise, and Seattle received many votes.

The 1970 meeting will be at a California city to be determined by the local arrangement committee.

Moved by Oliver Leonard to accept the 1968, 1969, and 1970 meeting sites and dates. J. Miller pointed out action was not needed.

Nomination Committee Report — A. Appleby, Chairman, Ron Collins, Bill Harvey. The officers elected for the next year are:

President—S. W. Strew, Colloidal Products Corporation
Vice-President—K. C. Hamilton, University of Arizona
Secretary—H. Alley, University of Wyoming

WSA Report—Jesse Hodgson. Changes in the name of Weed Society of America and future meetings and officers of WSA were discussed.

Constitution Revision Committee Report—J. Hodgson, Chairman. The first line of the proposed Constitution changing the name of the Western Weed Control Conference was mentioned and a long, intense discussion followed.

Powell Anderson moved to change the name to "Western Conference of Weed Science." Seconded by Rex Warren. A heated discussion followed. John Miller moved to table the motion. Passed 60 to 1.

F. L. Timmons moved to allow the membership to vote by mail on four possible names for the conference.

1. Western Society of Weed Science.
2. Western Weed Science Conference.
3. Western Conference of Weed Science.
4. Western Weed Control Conference.

Seconded from floor and passed unanimously.

The further of publications, dues, and research project meetings under the proposed Constitution were discussed.

R. Fosse moved to have Constitution and By-Laws state "that Research Progress Report be available at the meeting." Seconded by Lambert Erickson. Passed unanimously.

Lambert Erickson moved that the statement be placed in the Research Progress Report, "Research Progress Reports are not considered prior publication." Seconded by John Miller. Passed unanimously.

Lambert Erickson moved to accept the Constitution and By-laws as amended. Seconded by R. Fosse. Passed unanimously.

Program Committee Report—This report was not read at the Business Meeting but was acted upon in Executive Committee session and is being included here as a matter of record.

The policy of this Conference regarding prior publication will follow that adopted by WSA, quoted as follows:

"When all or the major part of the contents of a manuscript submitted to WEEDS has been published anywhere in any form other than an abstract, such manuscript is considered to have had prior publication and will not be accepted for publication in WEEDS. However, verbal presentation of data as a paper at a regional weed conference or elsewhere does not constitute prior publication; subsequent publication of the information as an abstract in the proceedings or elsewhere likewise does not constitute prior publication."

Registration for the Phoenix meeting was 255. All members were urged to work for increased membership.

Adjourned 12:30 p.m.

K. C. Hamilton, Secretary

FINANCIAL STATEMENT OF WESTERN WEED CONTROL CONFERENCE 15 MARCH 1966 — 10 MARCH 1967

INCOME		
On hand, 15 March 1966	$615.12	
Registration Research Committee meeting, Reno	182.00	
Sale of 1966 Research Progress Report	733.99	
Sale of old publications	400.00	
Payment of outstanding accounts	286.24	
Sale of filing cabinet	61.88	
Sale of one 1964 Research Progress Report photocopy	24.00	
Total		$2,303.23
EXPENSES		
Postage	$194.81	
1966 Research Progress Report printing costs	463.68	
Office equipment	83.15	
Secretarial help	24.35	
Office supplies and printing of notices, stationary	228.75	
Refunds	59.00	
Total		$1,053.74
Cash on hand, 10 March 1967		$1,249.49
Accounts receivable		74.50
Value of publications on hand		1,128.00
Potential net worth		$2,451.99

J. LaMar Anderson
Business Manager-Treasurer

AUDIT OF THE FINANCIAL STATUS OF THE WESTERN WEED CONTROL CONFERENCE

The financial records of the WWCC for the period March 15, 1966 to March 10, 1967 were reviewed by the Auditing Committee on March 14, 1967. The financial statement as prepared and submitted by LaMar Anderson, Conference Business Manager was found to be well documented with proper receipts and records.

INCOME:

There was evidence that the Business Manager had made every effort to sell back issues of Conference publications and collect accounts receivable.

EXPENSES:

Unusual expenditures were not encountered in conducting this audit. A minor error was discovered in the itemized listing which did not alter the total sum of expenditures.

It was suggested that a more detailed, itemized record of expenses by subject matter would prove useful in conducting future audits. The suggestion was well taken and Dr. Anderson plans to amend the original statement to correct the minor error.

NET WORTH:

ACCOUNTS RECEIVABLE—

It is the opinion of the committee that every reasonable effort has been made to collect the following past due accounts for conference publications.

S0-97	Vermin & Noxious Weeds District Board, East Melbourne, Australia	$ 3.00
S0-80	Librarian, Department of Agriculture, Victoria, Australia	3.00
S0-76	E. Robert, Paris, France	3.00
S0-72	Dr. K. L. Roos, Consultant, Basle, Switzerland	8.50
S0-57	Goode, Durand & Meury, Inc., New York 36, N.Y.	3.00
S0-20	Agricultural Service & Supply, Tel Aviv, Israel	3.00
62-257	T. E. Wilde—Reichhold Chemical Co., San Francisco, California	3.00
63-82	Central Magazine Company, Inc., Riverside, California	2.50
63-70, 63-67	Turner Subscription Agency, New York, N.Y.	7.00
		$36.00

It is recommended that the above accounts be charged off as accounts not receivable and the sum of $36.00 be deducted from net worth.

It is further recommended that a permanent list of cancelled accounts resulting from unpaid debts is maintained by the Business Manager. It is suggested that two contacts in addition to the original billing be made prior to cancellation of the account in future collection processes. The attachment of Conference addressed envelopes to billing statements may facilitate payment.

VALUE OF PUBLICATIONS ON HAND

The Executive Committee has instructed the Business Manager to dispose of 125 1960 Research Progress Reports and 10 copies of the 1949 Conference Proceedings. At an assumed value of $3.00 per copy, the sum of $405.00 should be deducted from the net worth as reported in the financial statement reviewed. The amended statement should read as follows:

Assets		
Balance on hand March 15, 1966	$ 615.12	
Income March 15, 1966-March 10, 1967	1,688.11	
Value of publications	723.00	
Value of publications on hand		$3,100.73
Expenses		1,053.74
Net Worth		$2,046.99

The committee recommends that the financial report submitted by the Business Manager and as amended in this report be accepted by the Western Weed Control Conference.

Respectfully submitted,
Ken W. Dunster, Chairman
Dan Ragsdale

THE WESTERN SOCIETY OF WEED SCIENCE CONSTITUTION AND BY-LAWS AS REVISED AND APPROVED BY THE SOCIETY AT PHOENIX, ARIZ., MARCH 17, 1967

ARTICLE I—*Name*

Section 1. The name of this organization shall be the "Western Society of Weed Science" hereinafter called the "Society." It shall include the states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, and persons of the western provinces of Canada and of other states and nations as may wish to become members.

ARTICLE II—*Objectives*

The objectives of the Society shall be:

Section 1. To foster cooperation among state, federal, and private agencies in matters of weed science in the Society area.

Section 2. To support the Weed Science Society of America and foster state and regional organizations of persons and agencies interested in weed control.

Section 3. To aid and support commercial, private and public agencies in the solution of weed problems.

Section 4. To foster and encourage education and research in Weed Science.

Section 5. To support legislation governing weed control programs and weed research and education programs.

Section 6. To assist in the development of uniform weed control and eradication legislation and weed seed quarantine legislation and regulations.

ARTICLE III—*Membership*

Section 1. Membership shall be open to anyone interested in the objectives of the Society. Two types of membership are provided (1) active and (2) honorary.

Section 2. Active members are individuals who are interested in weeds or their control and who have paid their annual dues to the treasurer. Active members may attend all Society meetings, vote on Society matters, hold office and receive official notices of all meetings.

Section 3. Honorary members are members who have given meritorious service in research, education or regulatory phases of Weed Science, and who are elected by 2/3 majority of the Executive Committee of the Society. Honorary members shall have all the privileges of active members and shall receive the publications of the Society. Not more than two honorary members shall be elected each year, except that five honorary members may be elected the first year of this constitution.

ARTICLE IV—*Officers and Executive Committee*

Section 1. The officers of the Society shall be:

(1) President
(2) President-elect who serves as Program chairman.
(3) Secretary

Section 2. The Executive Committee shall be composed of:

The President
President-elect
Secretary
Immediate Past-President
The Representative to WSSA
Chairman of the Research Section
Chairman of the Education and Regulatory Section
One member chosen at large by the President with the consent of other members of the Executive Committee.

Section 3. The President. President-elect, and Secretary shall begin their duties at the close of the regular business meeting at which they are installed and shall remain in office until the close of the next regular Society business meeting. Other members of the Executive Committee shall begin their terms at the close of the meeting at which they are installed.

Section 4. The Chairman of the Research Section and the Chairman of the Education and Regulatory Section shall serve a one year term beginning at the close of the business meeting at which they become chairmen.

Section 5. The Society Representative to the Weed Science Society of America shall serve 4 years beginning at the close of the meeting at which he is elected.

Section 6. The Executive Committee may elect a Treasurer-Business Manager to serve as they may direct.

ARTICLE V - Society Sections

Section 1. In promoting a full exchange of ideas and information on Weed Science and to facilitate programming of meetings there shall be two general sections as follows:

(1) The Research Section and

(2) The Education and Regulatory Section

Section 2. These two Sections may have sectional programs, project meetings, and informal discussions of research reports and other pertinent information. Such meetings shall be at the regular meeting at a time designated by the Program Committee.

Section 3. The chairman of each of these Sections shall be a member of the Society Executive Committee and shall be elected as stated in Article VI, Section 3.

ARTICLE VI - Election of Officers

Section 1. The Nominating Committee shall be appointed by the President, with the advice and consent of the Executive Committee. They shall present their nominations for each office to be filled at the annual meeting. No members name shall be placed in nomination by the Nominating Committee without his prior consent. All candidates for office shall be selected from the Society membership and shall be elected by the majority of the members voting.

Section 2. The terms of office shall be as follows: The officer moving through the office of president-elect, president, and past president shall be a member of the Executive Committee for a 3-year term, the secretary shall serve a one-year term but shall be eligible for renomination as secretary or as any other officer.

Section 3. The Chairman-elect of each of the two Sections shall be elected by the Society and serve a one-year term. Following this he shall succeed as chairman of the Section for an additional one-year term. The Chairman-elect shall serve as Chairman if the Chairman is unable to serve his term.

Section 4. If any elected officer cannot serve the full term, the vacancy shall be filled for the interim by appointment by the President with the advice and consent of the Executive Committee, unless otherwise provided for in this constitution. The President-elect shall serve as President if the President becomes unable to serve. This service shall not constitute his term as President.

ARTICLE VII - Standing Committees

Section 1. There shall be five standing committees: Program, Finance, Resolutions, Local Arrangements, and Nominations, appointed by the President with the advice and consent of the Executive Committee.

Section 2. The Program Committee shall consist of the President-elect as chairman, the two Section chairmen and such other members appointed by the Program Committee Chairman as required to give all phases of Weed Science adequate representation.

Section 3. The Finance Committee shall consist of a chairman and two members. Terms of these committee members shall be established to expire alternately so that at least 2 members continue over each year.

Section 4. The Resolutions Committee shall consist of a chairman and 2 additional members. Terms of office of this committee shall be as in Section 3 above.

Section 5. The Local Arrangements Committee shall consist of a chairman and others as needed. They shall be appointed from coming meeting site area.

Section 6. The Nominating Committee shall consist of a chairman and two members. Terms of this committee shall be as in Section 3 above.

ARTICLE VIII - Dues

Section 1. The amount of dues and the method of collecting such dues shall be determined by the Executive Committee.

ARTICLE IX - Meetings

Section 1. Meetings shall be held at such times and places as may be determined by the President in consultation with the Executive Committee.

ARTICLE X - By-Laws

Section 1. The Conference may adopt By-Laws.

ARTICLE XI - Amendments

Section 1. The Constitution and By-Laws may be amended by majority vote of the members present at any regular meeting.

BY - LAWS

ARTICLE I. Duties of Officers

Section 1. The President shall be the executive officer of the Society. He shall act as chairman of the Executive Committee, carry out the spirit of the constitution and the decisions of the Executive Committee, prepare agenda and preside at all meetings of the Society and Executive Committee, appoint designated officers and committees and perform other usual duties of that office.

Section 2. The President-elect shall perform the duties of President if he cannot serve, serve as chairman of Program Committee, develop program outlines of the Society meetings, assign responsibilities to Program Committee to prepare the programs, issue calls for papers and advise Executive Committee of program status 1 month before the meeting date, and present a copy of the program to the Business Manager for publication.

Section 3. The Secretary shall prepare minutes of Society and Executive Committee meetings, prepare and maintain an up-to-date list of officers including Executive Committee, all standing committees and special committees, perform other duties when designated by the President.

Section 4. The Treasurer-business manager will receive and disperse monies of the Society in accordance with prescribed policies, maintain financial records and records of property, prepare records for annual audit and meet with designated auditors, maintains supplies of Proceedings and Research Progress Reports, receive and fill orders for above publications and collect payments for same, maintain standing orders and mailing lists for distribution of publications, arrange for and consumate publications of the Society.

ARTICLE II. Duties of Standing Committees

Section 1. The Program Committee shall develop the program for the meetings of the Society. The president-elect who is chairman shall delegate duties to members as he deems advisable. (see duties of President-elect).

Section 2. The Finance Committee shall analyze the financial condition of the Society and recommend if needed immediate and long-range plans for sound growth of the Society, recommend budget policies, recommend policies regarding registration fees and prices of publications, audit the financial account at least annually and make a report to the Society.

Section 3. The Resolutions Committee shall develop resolutions and recommendations regarding the general field of weed science within the Society area and put into writing important recommendations that the Society should promote and encourage; they shall report to the annual meeting.

Section 4. The Local Arrangements Committee shall make all arrangements in all matters pertaining to the meeting place. They shall contact Chambers of Commerce or Convention Boards of the city chosen for the conference, choose an adequate hotel, make recommendations to Executive Committee, get agreement of hotel to sponsor no other conventions or competing activities during meetings, reserve meeting rooms, estimate costs, arrange for registration at meetings, name tags, typewriters, receipts, cash box, etc.

Section 5. The Nominations Committee shall nominate at the annual meeting candidates for the offices of President-elect, Secretary, Chairman-elect of the Research Section, Chairman-elect of the Education and Regulatory Section, and WSSA Representative when necessary. Such candidates shall be contacted and cleared as set forth in Article VI of the Constitution.

ARTICLE III. Duties of the Section Chairman

Section 1. The chairman of the Research Section shall organize sectional and project meetings of those engaged in Research in the Society to exchange information and ideas and for improvement of research in Weed Science. He shall solicit and assemble abstracts of Research Progress Reports from research workers for publication by the Society each year. The Chairman may delegate to the Chairman-elect part of his duties as may be wise.

Section 2. The Chairman of the Education and Regulatory Section shall organize sectional meetings of those engaged in this phase of Weed Science in the Society for exchange of information and improvement of the work. He shall solicit program reports of education and regulatory work in Weed Science for publication in the Society Proceedings. The Chairman may delegate part of these duties to the Chairman-elect.

Section 3. The Chairman-elect of each of these Sections may attend Executive Committee meetings but can not vote.

ARTICLE IV. Publications

Section 1. Proceedings and Progress Reports will be published for each annual meeting. Publications will consist of reports and papers to be given at the meetings, reports of the Standing Committees and special committees, minutes of the business meeting, and Progress Reports from the two Sections. Research Progress Reports shall be available at the annual meeting. Other publications may be authorized from time to time by the Executive Committee.

ARTICLE V. Rules of Order

Section 1. Business at all regular meetings of the Society shall be conducted according to Robert's Rules of Order.

ARTICLE VI Quorum

Section 1. All members of the Society in good standing who are present at any regular meeting shall constitute a quorum.

ARTICLE VII. Authorization

Section 1. The adoption of this Constitution and By-Laws shall render null and void all previous rules and regulations of this Society.

RESULTS OF THE NAME CHANGE BALLOT

Members of the Conference were polled to determine their wishes regarding a possible name change. A total of 484 ballots were mailed out; 195 were returned. The voting went as follows:

The Western Society of Weed Science	90
The Western Weed Science Conference	61
The Western Weed Control Conference	23
The Western Conference of Weed Science	21
	195

As a result of the voting the new name, The Western Society of Weed Science, appears in the constitution and by-laws and becomes effective the date of this printing.

CONFERENCE REGISTRATION LIST, PHOENIX, ARIZONA, MARCH 15-17, 1967

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