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Western Society of Weed Science

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AND WHERE FROM HERE

K. W. Dunster[1]

Twenty-four dedicated men met in this city in June of 1938 to establish the Western Weed Control Conference, acknowledged to be the first regional weed control organization in the United States. The objective set forth by that group reflected the need for communication and cooperation among agriculturalists and for legislative guidelines to nurture the development of an infant but much-needed scientific discipline. Mention was not made of the need to educate the non-farm public concerning the need for improved weed control methods.

Spectacular achievement has been recorded for agriculture since that meeting 33 years ago. The farmer of 1938 struggled long hours to provide for himself and perhaps 10 others in a good year. Advances in agricultural technology since that time now enable our farm worker to provide high quality food and fiber for 45 people — 39 in this country and six abroad. An increase of 418% in production efficiency provides food for the table at less than 17% of disposable income.

As our population continues to increase, the proportionate number of workers required for adequate agricultural production continues to decline. Only 1 in 20, or approximately 10.3 million of our people, currently reside on farms. Of these, only 3.5 million are actively engaged in agricultural production. The total farm labor force was 3,556,000 in February 1971. Recent computations made by Dr. Glenn Klingman (4) indicate that agricultural technology had resulted in a 29% saving in the total U.S. labor force by 1968. Nearly 23 million people had been released from food production responsibility to enter other work areas. In no other country is the agriculturalist as effective in providing so much for so many at such a reasonable cost.

It is more than coincidental that innovations in the area of pest control have paralleled the dramatic increases in food production capacity often referred to as the "agricultural miracle". Agricultural authorities have recently indicated that total agricultural output would drop by 30% without pesticides. There is no question but what the United States could survive such a drastic cut in agricultural production. We could immediately restrict foreign export, convert land currently managed for conservation purposes, and divert more grain to bread rather than beef. All of the revisions are possible but it is questionable if they would be popular.

Let us consider some of the consequences of eliminating foreign exports of agricultural products. The world granary is empty. The FAO discouragingly reports that in 1969 for the first time in 12 years the combined production of the world's farms, forests and fisheries failed to show an increase. The World Health Organization places the death rate due to malnutrition at 12,000 persons per day and rising. It has been estimated that 1.8 billion more people go to bed hungry. In addition, E. C. Stakman of FAO estimates that 60-66% of the children in underdeveloped countries suffer some degree of mental and physical damage due to malnutrition. Elimination of foreign export could only aggravate the world-wide shortage of food, and it is well known that hungry people are not happy people. Without question, we would lose the $6.6 billion income recorded for agricultural exports in 1970. In short — a political and humanitarian nightmare.

The success story of agriculture has been told many times in the past, and it must be repeated over and over because there is increasing evidence that too many people do not understand or value the vital role of agriculture. We cannot expect to have people understand the necessity for weed control programs until they fully understand the need for ever-increasing efficiency in agricultural production. People must be made to understand that milk does not come from the refrigerator or breakfast cereal from trinket manufacturers before we can anticipate wide-scale appreciation of our efforts.

The name of that weed control conference established in 1938 has changed and our membership totals 318 as we meet once again in the founding city. The goals originally set forth for this organization remain valid but their achievement is not complete. We have been most efficient in convincing agriculturalists of the economic benefits of weed control practices, assuring predictable and safe production of feed, food and fiber. The list of chemical herbicides in comerce has increased from less than 15 to more than 130 during our short history (6). The 120 million acres treated in 1965 with increasingly safe, effective and target-specific weed chemicals represent a 517% increase aver estimated 1949 use. Herbicides accounted for 57% of total pesticide sales in 1968 and it has been estimated that farmers will spend as much on herbicides as they do on fetrilizer by 1975 (4). These facts provide adequate testimony of the farmer's need and acceptance of effective weed control as a production tool. The present concern, controversy, confusion and criticism surrounding the use of herbicides provides painful evidence that we have neglected to adequately educate a very important segment of our population — the general public, that majority whose ballots could very well control our destiny. It is clear that our future efforts must include a new specialty — communicating with non-agricultural and legislative people.

Developing future new and more sophisticated herbicides will require increased expenditures of manpower and money. And develop them we must if we are going to help feed an additional 100 million people within the next 30 years. Add to this the apparent requirement for time and talent devoted to consumer education and it

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is obvious that the Weed Science community is faced with a formidable task, especially considering available resources. It is imperative that we evaluate WSWS critically in terms of current ability and future potential in providing service to fill the needs of the Western Weed Worker.

WSWS After 33 Years

The first 27 years of this organization were adequately reviewed by Dr. Jesse Hodgson (2). Our somewhat confused history is reflected by the fact that although we are 33 years old, we are meeting as a general conference group for the 24th time. After strong state weed organizations formed, in 1950 the Western Conference decided to meet biennially, with research committee meetings scheduled for the alternate years. This decision resulted in problems of program scheduling and conflicts of interest, both real and imagined. The return to annual meetings in 1967 has done much to allow more efficient and effective organization, in my opinion.

Membership

The 1964 policy of the Weed Society of America (now WSSA) initiating meetings on an annual basis caused many of our members to question whether the Western regional conference could or even should survive. A review of registration records for representative years (Table 1) indicate little, if any, effect on total attendance from the decisions of both WSWS and WSSA to meet annually. Our current membership totals 318 but meeting registration seems to have stabilized at an average attendance of 234 during the past 4 years.

Representatives from industry constitute the largest single segment of our membership. It is unfortunate that information as to category is not available to allow more logical comparison with counterparts at the state and federal level. Research personnel at the experiment station and USDA level represent the second largest group and the number participating in annual meetings has been stable in recent years. Participation by those working in extension and regulatory phases has gradually declined through the years. Attendance from outside of the Weed Science discipline has never been strong.

The personnel directory recently prepared by WSSA provides useful information on the manpower resources of the Western conference area (Table 2). In 1970 approximately 144 man years were spent on some aspect of Weed Science by 218 Federal, state and county workers in the 13 Western states. Unfortunately there is no parallel information regarding industry's involvement. Those working in research areas outnumbered extension and regulatory workers by a ratio of nearly 5 to 1. California led the way by a sizeable margin in terms of man hours expended. Hawaii and Oregon were very close for the second spot with considerable and diverse effort indicated. A comparison of WSWS attendance records and number of weed workers in the Western states indicates that we are attracting a higher percentage of available extension and regulatory workers than is the case for research.

As far as I know, WSWS has never had a membership committee or even an information or public relations committee, nor have active attempts been made to increase participation by increasing membership. I well realize that quantity is not always a good measurement of quality or accomplishment but there is much to be said for quality in quantity. It has often been speculated that we may spend too much time in meetings talking to and among ourselves. Is it possible meetings of this nature would be more justifiable if they served better as a clearing house source of information for those in more direct contact with the public — for those who will teach and implement use programs?

Program Content

We hope that the program prepared by Dr. Appleby's hard-working and conscientious committee reflects awareness of past and present concerns and needs as expressed by the memberhip. Your suggestion concerning agenda improvement collected by Mr. Jensen (3) for previous presentation to this group have been to a large extent incorporated into the program. Suggestions about possible changes in meeting sites and dates are under consideration by the Executive Committee.

The workshop approach explored and recommended by Past President Strew (5) and more recently by Bill Harvey has considerable merit. An Extension-Regulatory Workshop was initiated in 1970 and is again scheduled for this year. Enthusiasm and response to the 1970 session was less than anticipated. Perhap principles and guidelines for effective operations need to be more closely defined.

Research Sub-Committees

The Research Section meetings have and should always represent the heart-beat of this organization. In past years there has been considerable controversy in them, mostly regarding their scope rather than the question of need for an informal meeting ground to discuss needs and progress in subject-matter areas. It is becoming increasingly difficult to distinguish between the information needs of the research, extension and regulatory worker. Do we not all wear more than one hat these days?

A review by subject area of research progress reports submitted for the 1964-70 period shows continuing emphasis on chemical aspects of weed control (Table 3). About 15% of the reports in this area concerned physiological aspects, indicating good interest in determining why plants react as they do to herbicide treatment. Interest in ecological and life history studies is apparently increasing somewhat. Evidently we are becoming more aware of the need for residue studies in soil, water and wildlife. Decreasing interest is apparent in mechanical control aspects which include cropping. Little work has been reported on biological predator control. Application methods have been considered primarily in terms of biological response but information could have merit in terms of increased environmental concern relative to on-target treatment.

The distinct downward trend toward fewer reports in recent years is disturbing. A total of 130 reports were received in 1964 as compared to 73 for 1970. Increased product registration restrictions no doubt account for curtailed effort in some areas including perennial and aquatic weeds. It would seem logical to expect a proportionate increase in reports dealing with ecological considerations or perhaps in other sections. This has not occurred. I am especially concerned with the decreasing contributions offered by the chemistry and physiology sections. Surely the need continues for more basic considerations. Participation by the woody plant group has continued to decline, which is extremely unfortunate as they have been leaders in developing ecological and residue studies.

There is a distinct need for emphasis in areas of immediate concern to the public. Ecological and residue matters will become increasingly important in the registration and consumer acceptance of herbicides. We could benefit by encouraging participation of ecologists and wildlife researchers. To further minimize injury potential, still better application techniques will also be needed. Engineers from industry and the experiment stations are working on these problems. Let us utilize them more effectively in the future. The Economic Studies Committee was eliminated in 1964 because of lack of interest or effort. It seems to me that such studies are more important today than ever before if we are to convince a doubting public that weed control is necessary.

Some members want the Research Progress Report eliminated. I agree that these reports are of no value unless they are read. In preparing for this paper, I scanned and marked for future reference a wealth of information. Purchasing the Progress Report is not required of members but those who elect to not do so are overlooking a bargain.

There have been complaints that the section meetings are becoming too formal. Recent attempts at better organization were designed to stimulate, not suppress, participation and discussion. We have all attended meetings where the chairman reviewed the progress reports at the time of the session. No offense intended but we all know how to read!

WSWS In The Future

The basic question is not can or should WSWS survive in the future. It is, rather, how can WSWS operate effectively to fill the needs of Western weed control workers. Only you, as an individual, our most valuable resource, can answer this question. It is the membership which determines what an organization attempts or what it accomplishes. The key to our future success is personal involvement and responsibility. In establishing this conference, our founders were not concerned with precedent nor should we be in exploring more avenues of improvement for the Western Society of Weed Science.

1. Weed Science Society of America. 1970. Directory of personnel engaged in weed science.
2. Hodgson, J. M. 1965. A look at the Western Weed Control Conference after 27 years. Proc. WWCC 20:3-5.
3. Jensen, L. A. 1967. Presidential address. Proc. WWCC 21:1-4.
4. Klingman, G. C. 1970. Who will do the research and teaching? Weed Science 18:541-544.
5. Strew, S. W. 1968. Presidential address. Proc. WS-WS 22:1-4.
6. Timmons, F. L. 1970. A history of weed control in the United States and Canada. Weed Science 18:294-306.

Table 1. Composition of WSWS membership for certain years; number of members from different areas of interest.

Year	Extension/Regulatory		Research	Industry	Other	Total
1954	38	20 (58)	41	83	5	187
1958	68	31 (99)	64	89	30	282
1962	46	23 (69)	60	122	0	251
1965	(49)*		76	111	0	247
1967	..*		..	..	..	256
1968	..		..	..	..	238
1969	..		..	..	..	192
1970	(50)*		74	117	10	251

*Membership list did not allow accurate separation by work area

Table 2. Number of personnel engaged in weed science — thirteen Western states — 1970 (1)

State	Number of workers	Man years	Area of specialization Extension	Regulatory	Research
California	50	35.5	10	15	34
Oregon	33	22.9	4	3	26
Washington	20	13.8	5	1	19
Colorado	16	11.9	1	1	15
Arizona	10	7.1	2	0	8
Montana	10	5.5	2	1	7
Utah	10	6.5	2	0	8
New Mexico	10	5.5	4	4	6
Idaho	9	5.0	2	1	7
Nevada	7	4.1	1	1	7
Wyoming	4	3.0	2	1	3
	179	120.8	35	28	140
Hawaii	36	22.2	4	7	30
Alaska	3	0.6	..	..	3
	218	143.6	39	35	173

Table 3. Number of reports by research subject area[1]

Year	Chemical	Ecological	Mechanical	Biological	Residues	Application
1938-63[2]	686	33	52	5	*	*
1964	126 (24)[3]	12	2	0	2	1
1965	103 (19)	14	3	1	8	6
1966	(9)	9	0	1	2	0
1967	126 (18)	7	0	0	14	6
1968	94 (22)	5	3	0	12	5
1969	66 (4)	11	0	0	7	1
1970	91 (6)	8	2	0	13	0
1964-70	700 (102)	66	10	2	58[4]	19

[1]Research Progress Reports and Proceedings of WWCC and WSWS 1938-1970
[2]Hodgson, J. M. 1965. Proc. WWCC 20:3-5.
[3]Number of reports dealing with chemical/physiological aspects.
[4]Chemical residue evaluation in soil (42), water (13) and wildlife (3)
*Not considered by summarizer

RELATIONSHIP OF WSSA AND THE REGIONAL ORGANIZATIONS — ARE BOTH NEEDED?

Dayton L. Klingman[1]

I'm pleased to have this opportunity to visit with you about the subject assigned. It is a topic often raised, although perhaps not so pointedly so.

Historically, the Weed Science Society of America was fostered by the regional organizations. The Association of Regional Weed Control Conferences was organized in 1949. It was made up of two representatives from each of the regions. It initiated the first national scientific journal — WEEDS — in 1951. It sponsored the first joint meeting (national meeting) at Kansas City, Missouri, in 1953. Our present individual membership society was organized as the Weed Society of America at Fargo, North Dakota, in 1954 and held its first meeting in New York City in 1956. At first, the Weed Society of America met every 2 years.

To review the history of the regional organizations, the Canadian National Weed Committee was organized

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in 1929; the Western Weed Control Conference was organized in 1938; the North Central Weed Control Conference, in 1944; the Northeastern Weed Control Conference, and the Eastern Canadian and Western Canadian Confeernces, in 1947; and the Southern Weed Conference, in 1948 (1). These conferences are all active, and they are filling an important need in weed science today, even though the names of most have changed and the organizational structure of several has been modified to some extent.

As I see it, the needs, activities, and goals of the regional organizations and those of the Weed Science Society of America have much in common. Our organizational functions are closely inter-related. Our goals, in general, are to: (1) foster research on weeds and their control; (2) facilitate exchange of information; (3) coordinate research, extension, regulatory, and education activities; and (4) promote the discipline of weed science. I think we can generally agree that these are our common goals, even though we may differ somewhat in the details of implementation.

The regional organizations deal more effectively than the Weed Science Society of America (WSSA) with the special problems of the region. I believe the regional organizations can justifiably exchange progress information on research at an earlier stage in the research than would be possible in WSSA. Because of the more acute interest in the regional problems and more nearly local situations, such an exchange of even preliminary results at regional meetings may stimulate new approaches toward practical problems and their solution.

Of course, you recognize that no hard and fast characterization of the differences between kinds of papers, presented at regional and national meetings, can be made. Nevertheless, I think there are some generalized differences involving immediate and long-term goals.

I blieve there is a tendency for members of WSSA to submit papers for the national meeting only on research nearing completion, and which the author considers may have some general application, in principle at least, in more than one region. It is here that the national organization can serve its greatest function. It facilitates personal exchange of information and discussions among a wider range of researchers than may be available within a single region. I believe WSSA is fulfilling this role.

As I mentioned before, the regional and national organizations are closely interrelated. Our memberships overlap greatly. Although I've not surveyed this overlap, I would estimate that about 80% of the regional members are also members of the WSSA, and that almost 100% of the WSSA members are members of one or more of the regional organizations.

Each regional organization has a representative on the WSSA Executive Committee. In addition, WSSA members (including those in the Western Society of Weed Science) vote on the members-at-large for the Executive Committee. The WSSA members in the Westrn region have been active on committees and serve as officrs of WSSA. For instance, during the last year, over 30 of the members of WSSA committees were also members of the Western Society of Weed Science. Three out of the 11 past presidents of WSSA came from the West. They were: A. S. Crafts, W. R. Furtick, and B. E. Day. I could go on, but I think this is enough to indicate the active role played by your members in WSSA. I needn't mention that these same persons have had, and many still do perform, leadership roles for weed science in your region.

I believe there is an urgent need for both the regional and national associations on weed science. They should be mutually supporting — we should not waste our energies and talents competing with each other. The job to be done for weed science exceeds our combined resourcs — therefore, let us work together.

Let us work together on pertinent research that will result in improved methods of killing weeds on farms and ranches. Registrations and recommendations should be reliably based on sound research. Our research should alert us to potential problems before a control practice reaches the registration and recommendation stage. The best time to correct problems that may occur is before they occur.

Because of new concern about pesticides, our research — in addition to establishing data on effectiveness, selectivity, and efficiency — must evaluate the "fate of herbicides" — more precisely, what happens to them in the air, water, soil, and food crops? In addition, we must take a hard look at their secondary impacts on the environment and wildlife, and at their impact on esthetic values.

Perhaps most important, and most difficult for us as researchers and agricultural specialists, is the fact that we must do a better job of public relations. Let us honestly, but imaginatively, tell the public of the benefits accruing from our research. We must make opportunities to educate the columnists, and others of the news media, who "seem to be biased against" modern agricultural technology.

Let us become knowledgeable, so that we can evaluate information on the "potential hazard" of weed science technology and weigh it against benefits that accrue. We need to be able to judge what kinds of problems have valid dose-response relationships; what kinds of safety margins are involved in the exposures that result from a weed control practice as compared to toxicological feeding tests; and whether there is an accumulative response of the organism to the toxicant. We probably cannot hope to be qualified toxicologists, but we need to be able to evaluate some of the "gibberish" that is published in these days, and which alarms the public. Equally important, we need to know when we should be alarmed by toxicological findings. Only when we have developed such knowledgeable judgment can we constructively and effectively contribute to the information that should reach the public.

There are enough alarmists and doom sayers to handle the negative aspects of modern technology. We, as weed scientists, need to take a positive stance on our accomplishments. At the same time, our statements and stories should be sound and based on facts. Factual information can be made interesting to laymen. However, we will need to use some imgation in converting the facts to language and situations that laymen can understand. We tried to do some of this interpretation in a recent statement sent to the Environmental Protection Agency (EPA) on 2,4,5-T (2).

Because 2,4,5-T is sill being considered by EPA, perhaps you will be interested in some of the interpretative comparisons that we made, without my giving you the details of how we arrived at the conclusions. We started off with some general statements: "We believe the facts available to the Secretary of Agriculture on possible teratogenicity of 2,4,5-T supported his actions as 'prudent' in suspending and cancelling certain uses of 2,4,5-T." We reviewed briefly the importance of 2,4,5-T in weed and brush control. We indicated that "as currently produced, 2,4,5-T contains no more than 0.5 ppm 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD)." We reviewed characteristics of 2,4,5-T and its relatively low rate of use in the United States. We discussed drift control of 2,4,5-T and the fact that "plants are severely and visibly damaged at rates of 2,4,5-T far below levels that might be hazardous to pregnant women."

Because teratogenicity of 2,4,5-T was the crux of the matter, we quoted a letter from Dr. Leon Golberg, a much respected toxicologist. Only a brief summary of it is given here:

(1) "Summing up, therefore, my evaluation of the teratogenicity of the available data leads to the conclusion that 2,4,5-T is not a teratogen in animals, when tested under conditions of exposure which, although severe, still bear some meaningful relationship to the circumstances of human exposure of 2,4,5-T."

(2) "I now turn to the possibility of an imminent threat to human health posed by 2,4,5-T. It is my considered opinion that no such threat exists. — there is practical certainty that injury will not result from limited exposure—."

The District Court remanded 2,4,5-T for consideration by EPA, because whether the Secretary of Agriculture had considered adequately the personal exposure of pregnant women was not clear. The Court conceded that the question of exposure through food had been properly considered.

Because of the need to consider possible human exposure, particularly that of pregnant women, I did some calculations, and some of these were used in Agriculture's response to EPA.

What is the hazard from spraying drift? "Assuming a most extreme and improbable exposure of a 130-pound pregnant woman, lying naked and prone under the flight swath of an aerial application of 2 pounds per acre of 2,4,5-T, the 'oral equivalent' effective dose on her is estimated at 1/190 of that of the 'no effect level' in the teratogenic studies of 2,4,5-T on mice and rats (50 mg/kg) (3); and if she were 100 feet downwind, her exposure would be about 1/38,000 of the 'no effect level'." When we consider the most extreme exposure possible, under the recommended uses, the intake of 2,4,5-T is far below the "no effect level."

Much to do has been made of human exposure from 2,4,5-T fumes in the air. In Washington State, research did, in fact, measure 0.06 micrograms per cubic meter of phenoxy herbicides when air was sampled in the spring and early summer. This is alarming, if that is all that is considered. When translated into the amount of 2,4,5-T in the air that man can breathe, you can heave a sigh of relief. The exposure turns out to be about one two-millionth of the "no efect level."

Much has been made of the "imminent hazard" of use, by pregnant women, of 2,4,5-T around the home for control of poison ivy or for other limited uses. Packages of 2,4,5-T on "home and garden" shelves were often small (½ pint) containers that usually contained a concentration of about 1 pound 2,4,5-T per gallon. This is about 2½ times the concentration that is often used in aerial spraying. There is little possibility that any person using such a dilute herbicide in such small quantity would ever be exposed to levels approaching that of the naked woman aerially sprayed. Persons working around poison ivy are usually fully clothed. In addition, containers always carry a prominent caution statement: Keep out of reach of children. Harmful if swallowed. Avoid contact with eyes, skin, and clothing!

Suspension of the use of 2,4,5-T on ditchbanks and in aquatic sites was based on the possible hazard to those humans who might drink water contaminated by drift of the spray after used of chemicals for weed and brush control on ditchbanks or irrigation canals. Recent research indicates that this hazard is extremely small. In a study of spraying ditchbanks in irrigation canals, where the spray boom was intentially lapped 1 to 2 feet on the water's edge (4), the possible exposure of a pregnant woman, if she drank 3 liters of the water per day, would be 1/16,000 of the "no effect level." The 2,4,5-T has not been recommended for use in potable water.

Occurrences of 2,4,5-T in stream water were at concentrations of 0.01 to 0.07 ppb in 28 of 320 samples taken in 15 Western States, 1965-68 (5). These concentrations are far below biologically significant levels.

Perhaps illustrations such as these, which relate the data to meaningful comparisons showing the level of hazard of human exposure to herbicides, would calm some of the fears of those laymen who are given only information on the presence of pesticides in food, water, air, and organisms.

To get back to the subject assigned — on the relationship of WSSA and the regional organizations — we are aware that weed scientists can attend only so many meetings a year and get their work done. Meetings cost money and they take time. Both of these are usually in short supply. Therefore, it often happens that the individual needs to make a decision on such a question as, Shall I go to the WSSA meeting this year or to the Western Society of Weed Science? He probably should attend both, a good part of the time, if he is going to be an active contributor. This is a dilemma for which I have no answer.

I've been active in the Executive Committees of both a regional organization and WSSA for many years. I'm pleased to report the continuing concern and active support, evidenced one for the other, in both situations. The relative roles of two types of organizations have been repeatedly discussed in such meetings — usually without a final conclusion. Probably this has been the case because the differing roles are nebulous, somewhat overlapping, and often mutually supportong. In my opinion, a certain amount of parallel and overlapping effort is a good thing. I would become alarmed only if our organizations were moving at a tangent or at cross purposes; or if they should become overly protective of their own "spheres of influence." The worst thing that could happen to weed science would be for the various organizations to be openly competitive and jealous of the accomplishments of the other.

Therefore, I return to my earlier thesis. Let us work together. The job to be done in weed science exceeds our combined resources.

[1]Timmons, F. L. 1970. A History of Weed Control in the United States and Canada. Weed Sci. 18:294-307.

[2]U.S. Department of Agriculture. 1971. Report on Status of Knowledge Regarding 2,4,5-T. (Submitted to EPA February 5).

[3]Courtney, K. D., J. A. Moore, D. W. Gaylor, M. D. Hogen, and H. L. Falk. 1970. Summary Teratogen Study NIEHS. Hearings of the Hart Subcommittee on 2,4,5-T.

[4]Frank, P. A., R. J. Demint, and R. D. Comes. 1970. Herbicides in Irrigation Water Following Canal-Bank Treatment for Weed Control. Weed Sci. 18:687-692.

[5]Manigold, D. B. and J. A. Schulze. 1969. Pesticides in Water. Pest. Monit J. 3:124-136.

REPORT OF WEEDS TODAY MAGAZINE

James W. Koehler[1]

There have been so many changes in the status of *Weeds Today* that this report soon may be outdated. Shortly before I left Sacramento, Dr. Phil Upchurch, Past Chairman of the Popular Publication Committee, brought me up-to-date on the latest developments which we hope will soon place the publication on a sound basis.

Weeds Today was officially borne when the Executive Committee of the Weed Science Society of America at its annual meeting in Montreal, February, 1970, authorized the Popular Publications Committee to negotiate a contract with the New Science Publishing Company of Memphis, Tennessee, to publish a popular magazine on weeds and related subjects. The arrangement provided for WSSA to supply editorial copy, for the Publishers to sell advertising and to handle all layout, printing and circulation. The Publishers were to provide financial support until the venture would make a profit. A panel of 18 members selected the name *Weeds Today* (see June, 1970 issue of *Weeds Today*). Earl G. Rodgers was appointed Editor of the magazine, Richard Behrens served as Chairman of the Circulation Subcommittee and Fred Slife served as Treasurer for the venture.

In excess of 40,000 qualified names were assembled by the Circulation Subcommittee to whom distribution of *Weeds Today* was anticipated. Issues of *Weeds Today* were published for June, July, and August, 1970. The deficits on the first three issues of *Weeds Today* were approximately as estimated. However, poor business conditions reduced the capacity of the Publishers to underwrite further losses. It was necessary to cancel the issues for the last four months of 1970.

As it became clear during January, 1971, that the New Science Publishing Company could not continue to publish *Weeds Today* the Committee explored various avenues for continuing the magazine. The best possibility developed was for WSSA to assume the role of Publisher and to secure the services of an organization to provide layout, art work, printing, and mailing services on the basis of a bimonthly publication schedule.

The January-February 1971 issue was mailed to approximately 50,000 individuals on February 26, 1971. This included the WSSA membership list so a lot of people in this audience should have their own copy of this particular issue.

The decision has been made to publish four issues in 1971. Tentatively, the mailing dates are April 25, September 25, and November 25 for the three remaining issues. Tentatively, publication will be bimonthly in 1972.

The new members of the Popular Publications Committee for 1971-72, and their assignments, are: L. L. Danielson, Chairman; John Ahrens, Circulation; G. A. Buchanan, Advertising; E. G. Rodgers, Editorial; R. P. Upchurch, Advisory; and F. W. Slife, Business Manager-Treasurer.

Weeds Today is going through some trying times, but the magazine has much to offer to the profession of Weed Science and to agriculture. Those of us who

[1]Member of 1970 WSSA Popular Publications Committee, California Department of Agriculture, Sacramento.

have been associated with its development are enthusiastic about its possibilities. I am certain that the members of the Popular Publications Committee solicit your constructive comments for the future.

TERRA SOCIETY: REASONS AND FACTS

Walter A. Houston[1]

What effect does all the controversy over pesticides have? The questions raised by the consuming public and charges by environmental groups present some real problems.

We too are still trying to find out what is causing all our problems, just why do we have so much confusion, misunderstandings, trying to determine who siad what and their justification for their analysis or their bird count or their reasons. Now it's a polarization problem which does harm the advocates.

For example, W.A.R.F. in Wisconsin has found levels of PCB's in Lake Michigan that are from three times and up greater than DDT and its metabolites.

Again, I was in Texas recently and found a great discussion going on about Brown Pelicans. According to *Bird-Lore Magazine,* the Brown Pelican count in 1918 was 5,000, then down to 900 in 1934, an 81% loss in 16 years. Yet recently a Fish and Wildlife official in Colorado claimed that 50,000 pelicans have disappeared from the Texas and Louisiana coasts since 1961. If they built up their numbers to 50,000, they did it during the years of peak DDT applications!

For example, what went wrong when the first report from the President's Science Advisor asked 2,4,5-T to be banned, and now a new report from the President's Science Advisory Committee is highly critical of the first report and concluded that no restrictions should have been placed on the use of 2,4,5-T in the first place.

A legitimate question might be, "Are the claims valid that DDT causes raptorial bird eggshell thinning." Shouldn't people get the *facts,* rather than making this claim and then later finding out that PCB's, lead, mercury or other chemicals might actually be the cause of the thin shells—or that the cause was Newcastle Disease, Calcium defiicency or hypertension.

Another example, is Lake Erie dead? According to the U.S. Department of the Interior, it's more productive of fish than it has ever been. Polluted yes, dead no! Is Lake Michigan in worsening shape, if so, someone should tell Chicago, as their City Water Department just announced that it now takes less chemicals than before to treat the water.

Last month *Science* Magazine explained that there was confusion in the analytically differentiating arsenic and phosphate. There is a wonderful new phosphate-free detergent marketed on the West coast that has just been removed from the shelves of stores because of toxicity to people. Are phosphates really that bad? Remember, we had a huge cry several years ago that forced the soap manufacturers to switch to biodegradable formulas. Did you know that DDT is biodegradable? It degrades by:

- a bateria, *Proteus vulgarus*
- insects, that's the reason for physiological resistance
- rumen, cows stomach
- ultra violet light
- alkaline materials
- high organic content in water systems
- mammals, DDT is degraded primarily to DDA (water soluble)
- birds, DDT is degraded primarily to DDE

I certainly hope that with the popular swing, or is it a push, to new compounds that we aren't continuing to jump from the ecological frying pan into the toxicological fire.

So do you see why there is a grass roots group like the Terra Society?. Isn't there a need for a middle ground in our increasingly polarized scientific, political and social systems?

Other groups, too, are actively involved in this suddenly popular field. They are gathering information, both fact and opinion, evaluation and disseminating this material. Here are a few that you might be interested to know about:

1. Scientist's Institute for Public Information (SIPI) headed by Barry Commoner as Chairman with Margaret Mead as President. This group with quite a listing of scientists on their board adopted as their official publication a magazine called *"Environment."* May I quote from their recent flyer asking me to join:

   Dear Reader: "I guess nuclear power is pretty clean. . . ."

   "I'm sure the government would let milk and meat and vegetables off the market if they were contaminated with pesticides."

   "I believe this air pollution thing is overrated—the air I breath doesn't bother me."

   Right? Wrong! You'd be the expert at every social gathering if you'd read the recent articles on these subjects in *Environment.* Written by scientists and edited by professional writers, the articles provide a factual basis for discussion

[1]Encap Products, Co., P.O. Box 278, Mt. Prospect, Illinois 60056.

with no emotional overtone. In short, they tell it like it is.

Tell it like it is? I would think we need not depend upon *Environment* alone to make everyone experts at every social gathering.

2. National Intsitute of Ecology by the Ecological Society of America. They received a rather sizable fund from the National Science Foundation through the firm, Peat, Marwick and Mitchell to initiate a study and set up an organization for them. They even planned a budget of over $1,000,000 for a data bank alone. Will this solve all our problems simply because they're well funded?
3. Public Broadcasting Environmental Center recently finished a organization study to help them prepare and disseminate environmental programs to kindergarten, grade and high schools through the member radio and TV stations of the Corporation for Public Broadcasting. Their purpose was to provide educational programs to their member stations . . . and basically it's a good idea, maybe it's needed. But don't forget it can be insidious when you wonder who writes the program, who controls it, and even as to who wrote the chapter "How Pesticides Are Ruining Our Environment."
4. Common Cause, John Gardener's new organization. As you remember, Gardener was our former secretary of H.E.W. He may have something good going here, but one wonders as to his staff and what their intentions and capabilities are.

And, of course, we have many, many other groups quite active in collecting and disseminating information, well known groups such as the National Wildlife Federation, the Audubon Society, the Sierra Club, the Friends of Earth, the Environmental Defense Fund, and the many state and local organizations. Then there are also numerous data banks such as Pestdoc, Biological Abstracts, Chemical Abstracts, Sicence Information Exchange and many others including ones at various universities.

But we may not always see comparable and effective groups from the other side of an issue providing a balanced viewpoint with room for debate. Of course, the National Agricultural Chemical Association is publishing considerable information for the public. Many of the industry people have their own programs either through their companies or through other trade organizations.

But there is no one doing what is really needed. It is quite apparent that from the vested interest of any one group, whatever side they are on, the other side won't accept the information.

Thus, I support Terra Society as one would support a library. There, I can obtain good informaiton in which to help make my decisions. And, if the librarian isn't involved in street fights or taking sides or supporting causes or issues, the conclusions should be reliable and based upon a full review of the facts not what supports political ambition, builds speaking fees or helps build a departmental budget.

The President of the National Academy of Science, Dr. Phil Handler told us that even Terra had to be "an advocate" to be effective. Yes, we agree, but only to advocate fair play, balance, reason and the attempt to get at the truth with facts.

Terra is in operation now, though short of funds. Even the source of money can make a cause suspect so we have attempted to be real careful. Terra hopes to approach everyone, every organization, every trade, every society, every profession, for financial support. At $10 to $15 each, didn't the Common Cause gather in a lot of money from over 100,000 contributors? Remember, Gardener's original appeal was please support the CAUSE. The government has money for programs like Terra, so do the large foundations . . . but they like to contribute to on-going organizations.

Terra cooperated with Purdue University to provide last December a Pesticide Symposium titled "Background for Decisions." First of its kind, highly acclaimed by ecologsts, legislators, universities and industry. Now the Lake States Governors Interdisplinary Council per their request has received a personal presentation on Terra in their continuing search for information.

Terra has not sought publiicty, it is working quietly within our purpose of preventing further polarization and in aiding authorities in making decisions. At present, we have quite a list of supporters coming from every discipline. Here's a binder listing Terra Supporters, classfied into groups:

Universities	63
County Agents	12
Publishers	17
Writers	5
Consultants	24
Government—Federal	12
Government—State	32
Government—City	4
Government—Military	2
Foreign	3
Industry—Manufacturers	52
Industry—Distributors-Dealers	18
Industry—Pest Control	19
Industry—Growers-Farmers	11
Associations	43
Individual Citizens	12
Ecology Groups	10
Teachers	1
TOTAL	340

May Terra help you? Can you help Terra? We all need to work together, we need funds, we need support, we need information and later on we need data reviewed. And, in return, if there are any questions, we'll try to answer them. If you'd like more information on some of the facts I've mentioned or background and addresses on the organization, Terra will be glad to help.

REPORT ON THE LEGISLATIVE STATUS OF HERBICIDES

James Conner[1]

Forty-eight states are in regular session in 1971 and the other two in special session. Thirty-six of these state have 136 bills pending relating to pesticides and in addition, several bills are in the National Congress though the Administration Bill (S.745 and H.R.4152) is the one which is being given the most serious consideration. Some of the features of this proposal as well as the reflected philosophy of EPA and other governmental agencies, are restricted uses of pesticide products and the categorizing of pesticides on a product by product and use by use basis. There are also provisions that would require licensing and certifying for purchase and use as well as training requirements for those who would be purchasing and applying restricted use pesticides.

The decision of the Administrator of EPA regarding the notices of intent to cancel all DDT registrations and the EPA hearings on these considerations was discussed.

[1]Director, Congressional Counsel, National Agricultural Chemical Association, Washington, D.C.

ROLE OF THE UNIVERSITY IN PROBLEM-SOLVING AGRICULLTURAL RESEARCH

A. R. Chamberlain[1]

The university as a responsible corporate citizen of society must be responsive to and a participant in problem-oriented research. To a major extent this is and has always been the case of land-grant universities in their agricultural research programs. But changes in some elements must be accepted, rather than resisted as is the case so frequently in agriculture.

Some items facing us are:

1. Accountability for accomplishment of research goals by a specified time for a specified cost will be a bigger issue (performance auditing).
2. Increasing conflict, because private enterprise is now entering the funding domain normally limited to universities, and vice versa. This problem will increase as more public research funds are labeled for solving "immediate" problems.
3. Universities will be able to get public research funds for specific commodity-oriented research only if the commodity interests provide part of the cost.
4. Role of problem-oriented research in graduate education will become an increasing source of financial policy conflict.

The most important roles of the university in problem-oriented research are:

1. The developmen and enhancement of human capital through conduct of research. The value added here will be far more enduring than the solution to a specific problem; a problem which may be history by tomorrow.
2. Development of improved delivery systems, using educational technology, to take research results and the university's special competence to the people. Part of this may be new modes of communication for Extension.
3. Encouraging the development and evaluation of new social institutions, designed to handle the new and evolving problems such as those of the environment. NOAA is an example.
4. Mobilization of talent to work on *substantial* major problems. The university should resist being drawn into small or proprietary type problems that can be better done by industry. Also, the university should not undertake very large projects; projects so large that they can't be related to graduate student needs and which can only be financed by the Federal Government.
5. The university could and should fulfill a role of "technology assessment," to assist public policy personnel in decision making regarding allocation of funds for different type of research.

[1]President, Colorado State University, Ft. Collins.

THE ROLE OF THE AGRICULTURAL EXPERIMENT STATION AND THE COOPERATIVE EXTENSION SERVICE IN PROBLEM SOLVING

D. W. Bohmont[1]

The basic federal and state laws which established the Agricultural Research and Extension functions of land-grant institutions define the role of these services to the citizens of the state and nation. In the case of the

[1]Dean of Agriculture, Director of Experiment Station, Director of Extension, University of Nevada, Reno.

Cooperative Extension program as identified by the 1914 Smith-Lever and amended acts indicates that the purpose of this group is to aid in diffusing among people of the U.S. useful and practical information on subjects relating to agriculture and home economics.

Similarly, the agriculture research arm of the land-grant institutions identiifes the experiment station in the Hatch act of 1887 for the purpose of acquiring and diffusing practical information and for scientific investigation and experimentation respecting the principles and applications of agriculture science.

During the 83 years of the experiment stations' existence, its problem solving role has been modified by the inclusion of many research efforts only indirectly related to agriculture. These project responsibilities continue to change with public demands and may be related to the dynamic growth of the research and development phase of American industry. The experiment station role is more and more identified with the search for basic facts and principles which become vital cogs in solving complex and many faceted problems.

Cooperative Extension has moved more and more with the change of social patterns and public demand toward an organization responsible for aiding all segments of rural and urban America. It is often looked upon as the conscience of the consumer whereby new innovations in the use of food and fiber are reviewed through a controlled process of comparative demonstration. Rather than considering any one patented product the demonstration programs of cooperative extension address themselves to principles of practical application of the rsearch information. It is becoming less production oriented and more people oriented in its role in society.

Because of its close association with the tax-paying public the cooperative extension service is in the unique position of being looked upon by the private and public sectors alike as being a non-biased public servant. More and more the cost of specialized demonstration programs are being paid for by the user through admissions charges and fee assessments, with the federal, state and local appropriated funds paying the basic salary costs.

The team role of the Agricultural Experiment Station and Cooperative Extenion Service is well defined and proven by years of successful experience as a key part of the land-grant university system of America. The role of conscience of the consumer and the basic source of new information on the wise management and use of the nation's human and natural resources will continue to be the appropriate function of this team.

SURFACTANTS AS THEY INFLUENCE THE MODE OF PENETRATION OF HERBICIDES

S. M. Woogerd[1]

When I was assigned a topic that called upon me to discuss "surfactants," I was disappointed in the twist of 'emantic that had me talking about surfactants and Dave Bayer talking later about "adjuvants."

"Surfactant" is a word coined by the detergent people and is a contraction of "surface active agent." It conjurs up such mental pictures as "Tide" and "Joy" being added to the spray tank—I understand that this has actually been done—once or twice.

"Adjuvant," on the other hand, is a more acceptable term—which by definition more accurately describes the funtcion of the materials we use to enhance the activity of herbicides.

So, while I am discussing "surfactants" in my introductory remarks, I will be thinking "adjuvants."

I hope that no one in the audience today will be disappointed when, at the conclusion of this session, you leave with more questions in your mind than answers. Because, if we as a group up here are successful in our presentations and subsequent discussions, that is the way it is going to be.

The use of surfactants in the enhancement of herbicidal activity is an infant science (if you care to dignify our Edisonian—or trial and error—approach to evaluating surfactants, as a science).

Most of what we are currently able to understand about the effect of surfactants on herbicide enhancement is based on the results of our emperical testing of large numbers of compounds in the greenhouse and in the field.

But we don't even yet thoroughly understand the structure of water at a solid interface, although we do have evidence that it differs from the bulk water above the interface. And water is, of course, one of major factors in the successful foliar application of herbicide sprays.

There are thousands of surfactants available for testing—equal numbers of solvents, co-solvents, and other adjuvant components. There are variations in biological and environmental conditions and a hundred or more important herbicidal materials to evaluate—and more coming every day. To obtain the optimum surfactant for every herbicide, considering these variables, is comparable to giving a million typewriters to a million monkeys with the expectation that one will eventually produce a Shakespearian classic.

This is, of course, the fallacy of placing too much dependence on the trial and error approach.

However, as our infant science begins to mature, we are learning that we can produce some pretty star-

[1]Colloidal Products Corp., Petaluma, California.

tling enchancements. Five to ten times enhancement is no longer imaginary—but these do require some specific molecular relationships between herbicide and surfactant.

We also know that surfactant concentration in the spray solution should be in the range of 0.5 to 1.5 percent for optimum enhancement, though we are not certain why—since this concentration exists for only a short moment on the plant as the spray starts to dry.

Further we know that:

Foliar penetration and herbicidal enhancement bear no direct relationship to wetting efficiency of the spray.

Surfactants can solubilize water-insoluble herbicides through micelle formation but we do not know how large a part this plays in cuticular penetration of the herbicide.

Both hydrophilic and lipophilic absorption pathways through the cuticle exist but we know very little about the role of the surfactant in their use.

Penetration of cuticle can be enhanced but we have no sound evidence that translocaiton can be enhanced by surfactants.

Based, then, on what we know and what we think we can learn, how much can we expect to enhance the activity of herbicides in the future? Five to ten times may be common in a few years. How much farther can we go? How much herbicide is really required to kill a plant? It is difficult to determine the acute oral LD_{50} of plant. Perhaps, in some cases, as little as one to five percent of what we apply would be sufficient, if we knew how to get total utilization. Wait until some instant ecologist gets ahold of that one.

The point is that with the cooperative efforts of chemists, physical chemists, botanists and plant physiologists together with a sound theoretical as well as emperical approach to the problem, we may actually be able to answer, with some degree of certainty, the questions that will be thought, if not spoken here today.

One thing *is* certain, however; that these meetings where we get together to learn from one another, are going to acclerate the process of finding these answers.

OIL ADJUVANTS AS THEY INFLUENCE MODE OF PENETRATION OF HERBICIDES

J. W. Ryder[1]

(*Abstract*) An oil adjuvant is predominantly a purified paraffinic light lube oil (98%) plus a properly matched oil soluble surfactant (2%). This type of oil adjuvant works best with herbicides that are insoluble in it and will increase the herbicide activity whether applied before, with or after the herbicide/water combination. Practically it is applied as an emulsion with the herbicide and water at a rate equal to about 10% of the total volume. The oil conditions the plant surface to allow better spreading and contact of the herbicide. Although the oil will soften the cutin layer, the mode of action is probably one of aiding (by better distribution and surface conditioning) the entry of the herbicide into the plant through living stomata or lenticils. This mechanism is suggested by the fact that the best oils are the least phytotoxic and also the ones that have the best spreading characteristics rather than the ones that are the best solvents for the cutin layer.

In work carried out at Purdue University, an entirely different approach utilizes oil soluble herbicides in an isoparaffinic oil carrier using no water at all. The isoparaffinic oil is especially selected for optimum molecular weight and is highly purified to give minimum phytotoxic effects when used in relatively high concentration (ca. 10 gal./acre). With this system the relative selectivity of the chemical herbicide is changed with the greatest increase in activity generally for grasses. The previously discussed oil adjuvant will increase activity up to two fold, but the isoparaffinic oil has been shown to increase the activity more than 16 times against several weed species. The mode of action of the isoparaffinic oil is believed to be one of carrying the herbicide in solution into the interior circulatory system of the plant.

[1]Humble Oil and Refining Co., Houston, Texas.

[1]Humbe Oil and Refining Co., Houston, Texas.

CATCLAW CONTROL IN SOUTHERN ARIZONA[1]

Howard L. Morton[2], Paul Metto[3], and Phil R. Ogden[4]

(*Abstract*) We applied 4-amino-3,5.6-trichloropicolinic acid (picloram), *m*-(3,3-dimethylureido)phenyl-*tert*-butylcarbamate (NIA 11092), 1,1-dimethyl-3-phenylurea (fenuron), 5-bromo-3-*sec*-butyl-6-methyluracil (bromacil), 3-(*p*-chlorophenyl)-1,1-dimethylurea (monuron), and a 1:1 mixture of triethylamine salts of picloram and (2,4,5-trichlorophenoxy)=acetic acid (2,4,5-T) to catclaw (*Acacia greggii* A. Gray) plants on July 30, 1969. NIA 11092, bromacil, fenuron and

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[3]Research Assistant, Department of Watershed Management, University of Arizona.

[4]Associate Professor, Department of Watershed Management, University of Arizona.

picloram were applied by hand as granular formulations and NIA 11092, bromacil, monuron, and the mixture of picloram and 2,4,5-T were applied as aqueous sprays at a volume of 10 gpa. All herbicides were applied at 1, 2, and 4 lb/A rates to plots 20 by 20 ft. Each treatment was replicated three times. In addition, sprays of 2,4,5-T; 3,6-dichloro-*o*-anisic acid (dicamba); mixtures of picloram and 2,4,5-T; dicamba and 2,4,5-T; picloram, dicamba and 2,4,5-T; and granular picloram, NIA 11092, and bromacil were applied at 1 and 2 lb/A to 1-acre plots on August 22, 1969. All plots were evaluated in November 1970 for catclaw control and injury to grasses.

Picloram was the most effective herbicide at all rates, the granular formulation killing from 70 to 96% of the catclaw plants, and the mixture of picloram and 2,4,5-T killing from 76 to 100% of the catclaw plants.

At the 4 lb/A rate wettable powder and granular formulations of NIA 11092 killed 100 and 88% of the catclaw plants, respectively, but the 1 and 2 lb/A rates of both formulations gave unacceptable control.

Bromacil wettable powder and granular formulations at 4 lb/A rate killed 74 and 75% of the catclaw plants, respectively. The lower rates of bromacil and all the fenuron and monuron treatments gave unacceptable control of catclaw.

Picloram and picloram + 2,4,5-T caused negligible injury to grasses except the 4 lb/A rate of picloram + 2,4,5-T which prevented establishment of seedlings. Both formulations of NIA 11092 and bromacil caused moderate to severe injury to grasses, with the injury increasing with rate.

We applied granular picloram at 2 lb/A at 13 dates and granular picloram and the 1:1 mixture of picloram and 2,4,5-T at 1 and 3 lb/A at 13 additoinal dates in 1969 and 1970. Only treatments applied in late July, August, and early September controlled catclaw. This is the season of summer rains in Arizona.

POPULATION DYNAMICS OF GREEN RABBITBRUSH[1]

James A. Young and Raymond A. Evans[2]

Gren rabbitbrush (*Chrysothamnus viscidiflorus* (Hook.) Nutt.) is found from North Dakota and New Mexico to the Pacific Coast of North America. In the Great Basin it is often associated with degraded big sagebrush (*Artemisia tridentata* Nutt.) communities.

A highly variable species, there are at least seven widely recognized varieties of green rabbitbrush. The variety *viscidiflorus* is associated with the granitic mountains of the western Great Basin and is the variety with which we are concerned.

Rabbitbrush is one of the first native species to invade disturbed areas in big sagebrush communities. It is one of the few native species to fill this successional role, but shares this function with a host of alien annual species.

The rapid reoccupancy of burnt big sagebrush sites by green rabbitbrush has been attributed to root sprouting. We have determined that in the western Great Basin invasion of burns is largely by seedlings with a minimal amount of root sprouting. This indicates that the green rabbitbrush seedlings, which start from extremely small achenes, can compete with the highly competitive alien annuals.

In degraded big sagebrush communities, under continued attrition by grazing, all age classes of green rabbitbrush are found in a subdominant role. In these communities the dominant big sagebrush is usually represented by a restricted group of age classes.

In portions of the range of *C. viscidiflorus* var. *viscidiflorus* it is found in complex seral communities in association with horsebrush (*Tetradymia canescens* DC.), golden currant (*Ribes aureum* Pursh.), desert peach (*Prunus andersonii* Gray), and green ephedra (*Ephedra viridis* Cov.).

[1]Contribution from the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture and the Agricultural Experiment Station, University of Nevada, Reno, Nevada.

[2]Range Scientists, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Renewable Resource Center, University of Nevada, Reno, Nevada 89502.

CONTROL OF RABBITBRUSH — A SYSTEM ANALYSIS[1]

Raymond A. Evans and James A. Young[2]

On the basis of their wide distribution, rapid invasion following disturbance and resistance to phenoxy herbicides species of rabbitbrush (*Chrysothamnus* spp.) are the most important woody range weeds in the Great Basin.

Green rabbitbrush (*Chrysothamnus viscidiflorus* (Hook.) Nutt.) communities illustrate the complexity of the decisions faced by land managers.

At the top of the successional scale we find rabbitbrush as a subordinate species in big sagebrush (*Artemisia tridentata* Nutt.) communities which contain enough remnant perennial grasses to preempt the environmental potential released by control of the shrubs. Treating this type of community with 2 to 3 lb/A of (2,4-dichlorophenoxy) acetic acid (2,4-D) has often

Contribution from the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture and the Agricultural Experiment Station, University of Nevada, Reno, Nevada.

[2]Range Scientists, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Renewable Resource Center, University of Nevada, Reno, Nevada 89502.

resulted in the removal of the big sagebrush and complete dominance of the site by the relatively resistant green rabbitbrush. The only alternatives in this situation are the use of 3,6-dichloro-o-anisic acid (dicamba), a practice which has not had sufficient testing in the Great Basin to determine its efficiency, or the proposed use of 4,amino-3,5,6-trichloropicolinic acid (picloram) which research has shown to be highly effective on green rabbitbrush. Dicamba is registered for this use on rangeland, but picloram is not registered for this use.

Lower on the successional scale are brush-dominated sites with a degraded herbaceous understory which require reseeding. On some of these sites it is necessary to suppress the resident annual population in order to establish perennial grass seedlings. Under development for this situation are combination treatments of 1 lb/A of 2 - chloro - 4 - (ethylamino) -6-(isopropylamino)-s-triazine (atrazine), applied in the fall to create a chemical fallow, followed by a spring application of 2,4-D to control the brush. This offers the possibility of a synergistic action conditioned by the conservation of environmental potential by the fallow.

The herbicide 1,1-dimethyl-3-(3-tert-butylcarbamyloxy)phenyl)urea, offers the possibility of accomplishing both the chemical fallow and the brush control in one application.

HERBICIDES FOR CONTROL OF BRACKEN AND THEIR EFFECTS ON FORAGE PRODUCTION[1]

W. C. Robocker[2]

(*Abstract*) Nineteen herbicides in various formulations were tested pre- and postemergence over a 10-year period for control of western bracken (*Pteridium aquilinum* (L.) Khun, var. *pubescens* Underw.). A maximum of approximately 50% suppression was obtained in the season of application with 2-(2,4-dichlorophenoxy)propionic acid (dichlorprop) at 9 lb/A, 4-chlorophenoxy-acetic acid (4-CPA) at 8 lb/A, and 2,3,6-trichlorobenzoic acid (2,3,6-TBA) at 6 lb/A, applied postemergence. Suppression a year later was minor.

Excellent control for 1 year was obtained with October application of granular formulations of 2,6-dichlorobenzonitrile (dichlobenil) at 6 to 9 lb/A; 4-amino-3,5,6-trichloropicolinic acid (picloram) at 2 lb/A; and 3,6-dichloro-*o*-anisic acid (dicamba) at 4 to 8 lb/A. Forage species were killed by dichlobenil, and bracken recovered rapidly after 1 year of suppression. No visual injury to grasses was apparent from picloram. Dicamba caused some injury to orchardgrass (*Dactylis glomerata* L.). Kentucky bluegrass (*Poa pratensis* L.) was more tolerant to dicamba and tended to replace orchardgrass.

Bracken recovered considerably from herbicides the second season after application of picloram or dicamba.

[1]Cooperative investigations of the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the Washington Agricultural Experiment Station, Pullman, Washington.

[2]Research Agronomist, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Washington State University, Pullman, Washington.

DODDER CONTROL WITH CHLORPROPHAM IMPROVED BY p-CHLOROPHENYL N-METHYLCARBAMATE

J. H. Dawson[1]

Isopropyl *m*-chlorocarbanilate (chlorpropham) is widely used to control dodder (*Cuscuta* spp.) in alfalfa (*Medicago sativa* L.). Chlorpropham at 6 lb/A controls dodder for about 4 weeks after application. A longer period of control is needed.

The non-phytotoxic compound, *p*-chlorophenyl *N*-methylcarbamate (hereinafter called PCMC), protects chlorpropham from microbial decomposition in soil. PCMC was applied with chlorpropham to the soil for dodder control in greenhouse and field experiments.

In the greenhouse, chlorpropham alone at 6 lb/A controlled dodder for 4 or 5 weeks, as expected, whereas the same rate plus PCMC at 1½ lb/A controlled dodder for 8 or 9 weeks.

In the field, chlorpropham at 6 lb/A was applied on March 15 and April 15, 1969 and 1970 with and without PCMC. All applications were made on the soil surface as well as incorporated one inch deep. Soil moisture was regulated with sprinkler irrigation so dodder would emerge in two separate and distinct flushes. One flush emerged in early May and the other in early June. Control of each flush of dodder was measured separately. Control was considered satisfactory when attachment to host plants was reduced 95 to 100%.

All four applications of chlorpropham alone on April 15 controlled the first flush of dodder satisfactorily. Only two out of four similar applications on March 15 (one surface and one incorporated) controlled the first flush effectively. Chlorpropham alone never controlled the second flush of dodder satisfactorily, whether applied April 15 or March 15.

In contrast, all applications of chlorpropham plus PCMC controlled the first flush of dodder satisfactorily, and seven of eight applications effectively controlled the

[1]Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the Washington Agricultural Experiment Station, Irrigated Agriculture Research and Extension Center, Prosser, Washington.

second flush. The one exception was an application on soil surface on April 15, 1969, which controlled 92 percent of the second flush.

THE USE OF INFRARED COLOR PHOTOGRAPHY IN THE DETECTION OF PLANT STRESS

Jess L. Fults and Bert L. Bohmont[1]

Infrared color photography has been used for several years for detection of camouflage, vegetation mapping and land use surveys. Its use by plant pathologists to detect the specific locations of plants under the stress of disease has been well established. Its use for the evaluation of the herbicidal control of range weeds (rabbit brush-*Chrysothamnus viscidiflorus* and medusa head (*Taentatherim asperum*) has been pioneered by Young, Evans and Tüeller working in Nevada. Since infrared color photography has been applied to the detection of specific clinical diseases of animals that could not be detected by other forms of photography, this suggested that certain kinds of stress in plants might be more specifically detected by infrared color photography than by ordinary color photography. The objective of the investgations reported here have explored this question. The kinds of stress explored include that produced by insect injury, moisture stress and herbicide damage. The color film used was 35 mm Kodachrome II; the infrared color film used was Kodak Ektachrome Infrared Aero film 8443. The camera used was a Canon equipped with a macro-lens FL 50 mm, 1:35. A No. 12 K light yellow filter was used with the infrared film-development was by Eastman Kodak Process E-3. Plants used for comparisons "in the field" included corn, sugar beets, barley, potatoes, beans and several kinds of turf grasses-particularly Kentucky bluegrass, bentgrass, perennial ryegrass and mixed bluegrass-buffalo grass.

Results of aerial photography comparisons — scale 1:2880 to 1:5000. Each crop could be identified by their specific color in the infrared films — the color differences were somewhat more specific than with ordinary color (Kodachrome II). Stress produced by different herbicides was not *distinguished* by either infrared or color film. Different kinds of turf grasses produced characteristic colors with both infrared and color film; the size of the differences between kinds was perhaps a little greater in the case of the infrared film.

When the amount of injury produced by certain herbicides on bluegrass turf was compared in infrared vs Kodachrome II, it was found that the differences were about equal. Evaluation of the several plots using either type of film showed specific differences between the stress produced by different herbicides. The information was well correlated with ground based photography and vegetation evaluation.

Results of greenhouse and laboratory comparisons. Stress symptoms produced in cultures of bluegrass turf produced by drought, insects and growth inhibition by a growth regulating chemical were somewhat more apparent with infrared photography than with color photography. Drought stress produced on infrared color images were distinctly different than those produced by insect attack or growth regulating chemical.

Varigated leaves (those lacking chlorophyll in certain areas) produced distinctly greater color differences with infrared film than color film but basically did not add much specifically to biological interpretation.

Leaves of bean plants grown under phytoxic levels of herbicides produced specific images on both infrared and color film. However the differences between control and herbicide treatments seemed definitely better with simple color film compared to the infrared.

[1]Weed Research Laboratory, Colorado Agri. Exp. Stat. and Colorado Cooper. Extension Serv., Colorado State University, Fort Collins, Colorado.

A-820 SELECTIVITY AND BIOLOGICAL PERFORMANCE ON AGRONOMIC AND HORTICULTURAL CROPS

S. R. McLane, R. A. Fosse, and L. L. Whitendale[1]

Introduction

A-820 is the Amchem Products, Inc. designation for a new herbicide of the dinitro aniline class. Specifically it is N-sec-butyl-4-tert-butyl-2, 6-dinitro aniline. The material is stable, has a melting point of 59-60°C and is orange. It has a solubility of 188 ppm in water and is readily soluble in many organic solvents. A-820 is essentially non-volatile at 50°C (122°F). Laboratory volatility studies measured loss from the technical chemical on a dry surface. When water was added to the test dishes in the laboratory, there were significant losses as A-820 co-distilled with the water. Under field conditions apparently volatility is determined by soil mixture and moist soil would require soil incorporation.

A-820 has been formulated as a liquid and as a granule. The liquid formulation (Amchem 70-25) is a 4 lb/gal emulsifiable concentrate. The formula was not broken by temperatures below 32°F but storage below 25°F should be avoided. Various granular formulations have been prepared on different type matrices. Four and 10% materials have been prepared on attaclay and 2.3 and 4% on vermiculite.

[1]Assistant Director Biological Research; Manager, Western Area Research and Development; Farm Manager, Visalia, California, Amchem Products, Inc., Ambler, Pennsylvania 19002.

Various application methods were studied. Preplant power incorporation 2 to 3 inches deep gave best weed control. However, under very dry soil conditions in irrigated areas, preemergence and preplant incorporation trial activity were similar.

Weed control may be reduced by low temperature, as observed in trials conducted in Oregon on peas and lentils. Weed control was poorer when A-820 was applied early in the growing season than when applied later when temperatures were higher.

Toxicity

A-820 has very low mammalian toxicity, but ordinary precautionary measures for handling any pesticide are advised. The toxicity of A-820 unformulated and as Amchem 70-25, the principal formulation tested in 1970, appears below.

Unformulated N-sec-butyl-4-tert-butyl-2, 6-dinitro aniline has the following mammalian toxicities:

Acute oral, young albino rats	LD_{50} = 12,600 mg/kg
Acute dermal, albino rabbits	LD_{50} = 10,200 mg/kg
Eye irritation, albino rabbits	10.0/110 (mild irritant)

Toxicity studies of A-820 formulated as emulsifiable Amchem 70-25 show:

Acute oral, albino rats	LD_{50} = 2,500 mg/kg
Acute dermal, albino rabbits	LD_{50} = 4,600 mg/kg
Acute aerosol inhalation, albino rats	LD_{50} = 50 mg/L air (four hour exposure)
Eye irritation, albino rabbits	64.0/110 (extreme irritant)

Fish: bluegills, TL_{50} = 4.2 ppm; trout, TL_{50} = 3.4 ppm

Materials and Methods

The horticultural crops tested at Amchem Research Farm in Ambler, Pa. were Black Valentine snapbeans, Fordhook 242 lima beans, red kidney beans, Campbell 29 tomatoes, Yolo Wonder peppers, Waltham 29 broccoli, Marian Market cabbage, Early Fortune cucumbers, Hales Best Jumbo cantaloupes and New Hampshire Midget watermelons.

Weed species evaluated included redroot pigweed (*Amaranthus retroflexus*), common ragweed (*Ambrosia artemisiifolia*), velvetleaf (*Abutilon theophrasti*), wild mustard (*Brassica kaber* var. *pinnatafida*), common lambsquarters (*Chenopodium album*), tall morningglory (*Ipomoea purpurea*), Pennsylvania smartweed (*Polygonum pensylvanicum*), common purslane (*Portulaca oleracea*), and giant foxtail (*Setaria faberii*).

A-820 was applied at rates of 1.5, 2.5 and 3.5 pounds active ingredient per acre with a bicycle sprayer in a volume of 40 gallons water per acre. All plots were rotovated 2 to 3 inches deep within 30 minutes after application. Plot sizes were 8 by 10 feet and 8 by 20 feet, two rows per crop and 3 to 4 replications. Planting and evaluation dates are shown in Table 1.

The vegetable crops under test at the Amchem Research Farm in Greenville, Mississippi were Burpee Long Green cucumbers, Hale's Best cantaloupes, Dixie Queen watermelons, Pinto beans, Henderson's lima beans, Early Ramshorn southern peas, kidney beans, mung beans, Pink Ponderosa tomatoes and California Wonder peppers.

Weed species evaluated included redroot pigweed, common lambsquarters, morningglory (*Ipomoea* sp), barnyardgrass (*Echinochloa crusgalli*), johnsongrass (*Sorghum halepense*), crabgrass (*Digitaria sanguinalis*), broadleaf signalgrass (*Brachiaria platyphylla*), teaweed (*Sida sp*), and coffeeweed (*Sesbania exaltata*).

A-820 was applied at various rates with a tractor sprayer in a volume of 16 gallons of water per acre. All plots were rotovated 2 inches deep.

In cotton tests at the Amchem Research Farm in Mississippi, A-820 formulated as Amchem 70-25 was evaluated on the following weeds and grasses in field-size plots containing 14 rows 96 feet long: pigweed, morningglory, barnyardgrass, johnsongrass seedlings, crabgrass, broadleaf signalgrass, teaweed, coffeeweed and purslane. Fall and spring applications were tested on Sharkey clay, a medium clay loam and a light sandy loam soil. The rates of A-820 used in the fall application were 4 and 2 lb/A for the heavy and medium soils and 2 lb/A for the medium and light sandy loam soils. The spring application rates were 4, 3 and 1½ lb/A of A-820 respectively on the heavy clay, medium soil and sandy loam solis. The sprays were applied in 17 gallons of carrier per acre. Areas for both the spring and fall applications were double disced and hipped up. After the spring treatment, the beds were knocked down and the cotton planted. The area treated in the fall was bedded in fall and the beds knocked down and planted in the spring.

Rates, also, were studied at the Mississippi Amchem Farm. A-820 was applied at 0.5, 0.75, 1, 1.5, 2, 4 and 6 lb/A. The plots contained two 70-foot rows. A-820 was applied by a tractor sprayer at 17 gallons volume per acre and incorporated by a power driven tilrovator set 3 inches deep. The test was replicated four times on a light sandy loam soil. Seedling johnsongrass, crabgrass and broadleaf signalgrass were present. There was nutsedge (*Cyperus rotundus*) in most plots.

A-820 was evaluated under furrow and sprinkler irrigation on the Amchem Research Farm in Visalia, California. In a series of trials A-820 was applied at 1, 2, 4 and 6 lb/A. The chemical was immediately incorporated with a disc in some trials and a power incorporator in other trials. Crops and weeds were planted into the areas immediately, 2, 4, 8, 16 and 24 weeks later. Areas awaiting planting were kept moist by sprinkler or furrow irrigation. Observations were made on pigweed, barnyardgrass, foxtail (*Setaria* sp), ryegrass (*Lolium* sp) and sugarbeet (*Beta vulgaris*) as representative of weed species.

Results and Discussion

Table 1 is a summary of annual broadleaf weed and annual grass control and crop injury ratings at the Amchem Research Farm, Ambler, Pa. The rating system is 0 to 100; 0 repreesnts no control or no crop injury and 100 represents complete kill of weeds or crop.

In eight tests, annual broadleaved weed and annual grass control averaged 75 and 95 percent respectively at 1.5 pounds active ingredient per acre. Watermelons and cucumbers were slightly stunted. Later observations indicated vigorous growth and normal fruit production.

In seven tests at 2.5 pounds active ingredient per acre, broadleaved weed and grass control were 82 and 98 percent respectively with slight stunting of cucumbers and moderate stunting of watermelons. Later observations indicated that cucumbers had completely recovered. Watermelons continued to show growth inhibition.

In four tests at 3.5 pounds per acre, broadleaved weed and grass control were 83 and 98 percent respectively. Transplanted tomatoes were slightly stunted but there was no detrimental effect on yield. Lower rates had no effect on vegetative growth.

Table 1. Annual weed control and crop selectivity with preplant incorporated treatments of A-820, Amchem Research Farm, Ambler, Pa. 1970.

Crop	Date planted	Date rated	Rate lb/A	Percent weed control Broadleaves	Grasses	Injury*
Direct-seeded						
snapbeans	5-4	6-18	1.5	86	90	0
			2.5	85	95	0
			3.5	90	98	0
lima beans	5-12	6-19	1.5	82	95	0
			2.5	83	97	0
			3.5	85	100	0
red kidney beans	5-15	6-22	1.5	58	100	0
cucumber	6-17	7-17	1.5	70	90	5
			2.5	80	100	5
cantaloupe	6-25	7-24	1.5	86	97	0
			2.5	90	98	0
watermelon	6-25	7-24	1.5	86	98	10
			2.5	91	98	30
Transplanted						
tomatoes	5-21	6-21	1.5	67	98	0
			2.5	71	100	0
			3.5	75	100	8
peppers	5-21	6-21	1.5	67	98	0
			2.5	71	100	0
			3.5	75	100	8
broccoli and cabbage	5-28	6-25	1.5	67	90	0
			2.5	77	100	0
			3.5	83	100	0
Averages						
8 tests			1.5	75	95	
7 tests			2.5	82	98	
4 tests			3.5	83	99	

*Rating system: 0 - 100: 0 = no control or crop injury.
100 = complete kill of weeds or crop.

Table 2 shows the average weed control by species in the nine separate tests at the Amchem Research Farm, Ambler, Pa. The numbers in parentheses represent the number of tests in which the species was abundant enough to rate.

At 1.5 pounds per acre there was excellent control of redroot pigweed, lambsquarters, Pennsylvania smartweed, purslane and giant foxtail. Control of velvetleaf, wild mustard and tall morningglory was not commercially acceptable. Ragweed was not controlled.

At 2.5 pounds per acre, there was excellent control of tall morningglory in adition to the excellently controlled species mentioned above. Wild mustard control was commercially acceptable and velvetleaf marginally acceptable. Ragweed was not controlled.

At 3.5 pounds per acre there was excellent control of all species listed in Table 2 except wild mustard, which showed very good control, and ragweed, which was tolerant.

Although barnyardgrass population was spotty, control appeared to be excellent in all the tests.

Table 2. Weed control evaluations of preplant incorporated treatments with A-820. Amchem Research Farm, Ambler, Pa. 1970

Species	lb A-820 ai per acre 1.5		2.5		3.5	
Redroot pigweed	96%	(8)*	96%	(7)*	98%	(5)*
Common ragweed	0	(9)	0	(8)	0	(6)
Velvetleaf	63	(3)	77	(3)	92	(1)
Wild mustard	61	(5)	85	(4)	88	(4)
Common lambsquarters	99	(8)	99	(7)	99	(8)
Tall morningglory	79	(6)	92	(5)	96	(3)
Pennsylvania smartweed	93	(6)	98	(5)	98	(6)
Common purslane	90	(1)	....	....	100	(1)
Giant foxtail	93	(9)	98	(9)	99	(9)

*Number of tests in which species was rated.

Table 3 is a partial summary of 1969 and 1970 trials at the Amchem Research Farm in Greenville, Mississippi. Southern peas and various type beans all showed good tolerance of A-820. Increasing the rate from 2 to 3 lb/A increased crop phytotoxicity only slightly. In one trial at 6 lb/A the injury to lima, pinto and mung beans was rated 0, 15 and 0% respectively. Under the warm growing conditions of the south 1 lb/A controlled weeds adequately.

Table 3. Summary of crop injury and weed control in A-820 screening trials. Amchem Research Farm, Greenville, Mississippi. 1969 and 1970.

Crop or weed	% Injury or control Rate (lb ai per acre) 0.5	1	1.5	2	3
Southern peas	0	0	..*	15	20
Lima beans	0	0	0	15	0
Snapbeans	0	0	..	10	25
Pinto beans	..	0	0	15	25
Sunflower	..	0	0	0	0
Kidney beans	..	0	0	0	0
Mung beans	..	0	0	0	15
Peppers**	..	0	0	0	0
Tomatoes**	..	0	0	0	0
Okra	0	0	0	..	..
Crabgrass	70	100	98	100	99
Seedling johnsongrass	70	100	98	100	99
Signalgrass	75	100	98	100	95
Pigweed	..	95	95	95	100

*Rate not used in any of the trials.
**Transplants.

Cucurbit tolerance was determined in replicated trials (Table 4). The southern data is somewhat different from the data produced in the Northeast. Watermelons showed complete tolerance. Cucumbers were injured slightly more than the cantaloupe. The observations in Table 4 were made 33 days after planting. At rates up to 2 lb/A cantaloupe and cucumber stunting was temporary. Growth was very good and a heavy crop was produced but yields were not taken. No selectivity among annual grasses was noted in these trials; thus signalgrass, johnsongrass, crabgrass and barnyardgrass are grouped a "grass".

Table 4. The effect of 0.75 to 4 lb/A of A-820 on the growth of cucurbits and weeds. Amchem Research Farm, Greenville, Mississippi. 1970.

Rate of A-820 lb ai per acre	% Crop injury			% Control	
	Watermelon	Cantaloupe	Cucumber	Pigweed	Grass**
0.75	7	0	3	91	92
1.0	0	7	25	92	97
1.5	0	30	58	100	97
2.0	0	92	80	100	99
4.0	0	93	93	100	100
0.0*	10	57	13	55	40

*Tractor cultivated check.
**Signalgrass, johnsongrass, crabgrass, barnyardgrass.

Table 5 ummarizes the cotton trial results, broadleaf weed and grass control as well as average yields from both spring and fall applications of A-820 on all three soil types. The 4 lb rate applied to Sharkey clay more than 5 months prior to planting produced excellent weed control. Cotton stands were not good in the checks or the treated plots. Cotton growth was not affected by 4 lb/A of A-820. As can be seen from the cotton yield figures as well as the weed and grass control ratings, 2 lb/A of A-820 applied to a medium clay loam soil in the fall is not a satisfactory treatment. Residual weed control was good at time of planting, but "broke" between planting and date of evaluation. These results suggest that a 3 lb/A rate would be required for sufficient persistence on medium clay soil to produce good weed control from fall applications. The cultivated check yields are very low, reflecting a high weed and grass infestation. There was no hoed check in this test. The 2 lb/ rate on sandy loam has produced excellent results. Weeds were controlled and the cotton yield was over 2000 pounds per acre.

Table 5. Results of fall and spring preplant incorporation study with A-820 on cotton[1]

A-820 lb/A	Soil type	Cotton	Pigweed	Seedling johnsongrass	Crab-grass	Brachiaria	Coffee-weed	Barnyard-grass	Tea-weed	Cotton lb/A
				Fall						
4	Sharky clay	0	98	99	99	95	80	95	85	1,853
2	Medium clay	0	75	70	70	65	65	65	40	872
Check	Medium clay	0	0	0	0	0	0	0	0	29
2	Sandy loam	0	100	100	99	95	95	95	80	2,228
Check	Sandy loam	0	0	0	0	0	0	0	0	173
				Spring						
4	Sharky clay	0	100	100	100	....	65	100	80	983
Check	Sharky clay	0	0	0	0	0	0	0	0	216
3	Medium clay	0	99	99	100	100	60	95	60	1,350
1-½	Sandy loam	0	100	95	100	100	....	93	55	569
Check	Sandy loam	0	0	0	0	0	0	0	0	22

[1]Treated and planted May 12, 1970; evaluated June 19, 1970; variety Stoneville 213. Weed and crop rating scale: 0 = no injury, 100 = complete kill.

Table 6 shows the average grass control ratings and cotton yields from 4 replications. This test was on a light sandy loam soil. There was no injury to the cotton at the highest rate of A-820 applied. Grass control was satisfactory in this type soil at 0.75 lb/A of A-820. The 1.5 lb/A rate produced excellent weed control and excellent yields. Rates of 1.5 lb/A and above maintained weed control throughout the growing season.

A number of other trials were run in Mississippi, Arkansas, Louisiana and Tennessee. These were not replicated tests. Results in them were very encouraging. Weed control was equal or superior to the standard pre-emergence or preplant incorporated chemical used by the cooperator. The cotton was carried to maturity and harvested. The quality appeared to be unaffected by the A-820 treatment. In one test site, teaweed was a severe problem. A-820 was superior to the standard preplant incorporated treatment plus a post-emergence chemical treatment, especially for teaweed control.

In the California trials furrow and sprinkler irriga-

Table 6. **Annual weed control and cotton selectivity with ppi treatments of A-820. Amchem Research Farm, Wayside, Mississippi.**

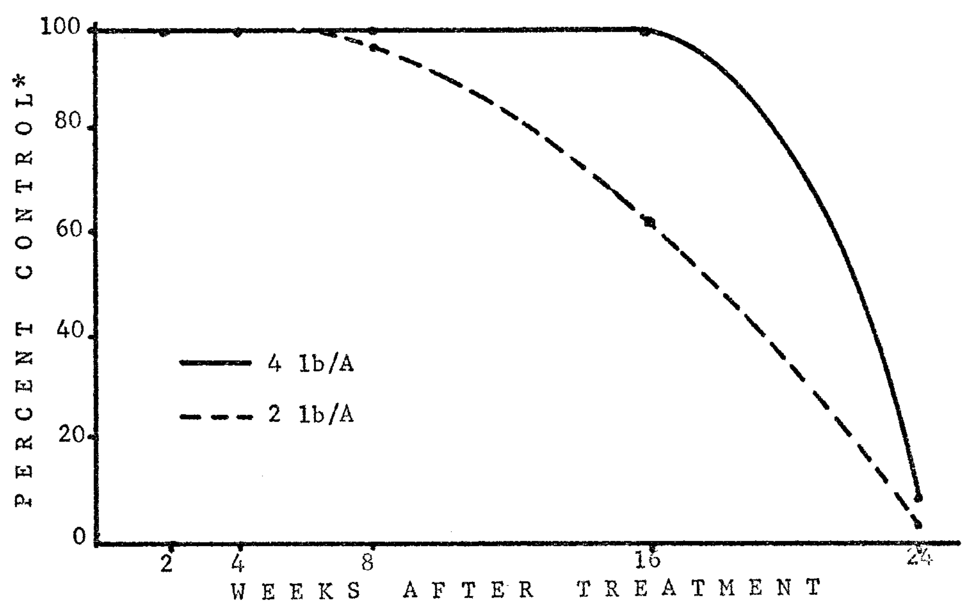
A-820 lb/A	Seedling johnsongrass	Crabgrass	Brachiaria	Cotton lb/A
0.5	65	84	84	1,179
0.75	88	94	89	2,014
1	78	94	85	2,579
1.5	94	99	95	3,415
2.0	97	99	95	3,906
4.0	97	99	98	3,267
6.0	95	100	98	3,562
Weedy ck	0	0	0	516
Clean ck	99	99	99	2,579
				Average of 4 replications

Planted and treated May 13, 1970; evaluated June 15, 1970; variety: Stoneville 213
Weed and crop rating scale, 0 = no injury; 100 = complete kill

tion produced almost identical results on crops and weeds in plots treated with 1 to 6 lb/A of A-820. Figure 1 summarizes the results obtained in a considerable number of experiments. A number of factors showed little or no difference and could be pooled to plot the activity and disappearance of A-820 from the moist soil. Thorough disc incorporation gave weed control equal to that obtained in the power incorporation trials. With the 2 and 4 lb/A rates of A-820 application there were no differences from the sequential plantings of 0, 2 and 4 weeks; weed control was 100%. At 8 weeks the 2 lb rate began to break and at 16 weeks average weed control was reduced to about 60%. In 24 weeks the 2 lb/A of the A-820 appeared to have been inactivated. The 4 lb rate of A-820 maintained 100% weed control for 16 weeks and then effectiveness decreased very rapidly, with an average of only 8% weed control for the 24 week planting.

In the trials where the soil was treated with A-820 and then kept dry without irrigation, A-820 showed no loss during the 24-week period. This result was true for surface applied or incorporated A-820. Under these conditions there was no indication of volatility, photodecomposition or microbial breakdown of A-820.

Figure 1. Rate of A-820 disappearance from moist soil. Weed control level averaged from disc and power incorporation trials.



*Average of pigweed, barnyardgrass, ryegrass, foxtail, volunteer sugarbeet.

Summary

Cotton has shown excellent tolerance of A-820 even at rates up to 6 lb/A. The rate required to control weeds can be doubled and sometimes tripled without affecting cotton yields or quality. In Mississippi and other southern states, California, and Arizona, 1 to 3 lb/A (depending on soil type) controlled crabgrass, barnyardgrass, seedling johnsongrass, foxtail, signalgrass, fall panic grass (*Panicum dichotomiflorum*), pigweed, purslane, lambsquarters, and prickly sida (*Sida spinosa*).

Results have been good with A-820 applied in the fall as a preplant incorporated weed control treatment for spring-planted cotton. For full growing season control of annual grasses and broadleaf weeds the following year, the normal spring application rate should be increased by one-quarter or one-half. This treatment has repressed growth of established johnsongrass.

The general margin of safety between weed control and general vegetable crop injury appears to be very good to excellent. The rate advisable for most vegetable crops is about 1.5 to 2.0 lb/A.

The following vegetable crops tolerated at least 1.5 lb/A of A-820; direct-seeded tomatoes; snap, lima, red kidney, and mung beans; cantaloupes and watermelons; okra; spinach; squash; transplanted tomatoes, peppers, sweet and white potatoes, broccoli and cabbage. In general, watermelons and cantaloupes have been more tolerant than cucumbers, but the reverse was true under cool Pennsylvania conditions.

Direct-seeded tomatoes and peppers seem to be slightly more sensitive than transplants, which showed little or no effect at rates up to 6 lb/A. Direct-seeded tomatoes tolerated 3 lb/A.

EVALUATION OF THE RELATIVE PHYTOTOXICITY OF HERBICIDES TO COTTON AND NUTSEDGE[1]

P. E. Keeley, C. H. Carter, and J. H. Miller[2]

(*Abstract*) We evaluated the following herbicides for relative phytotoxicity to cotton (*Gossypium hirsutum* L., var. Acala SJ-1), purple nutsedge (*Cyperus rotundus* L.), and yellow nutsedge (*Cyperus esculentus* L.) under greenhouse conditions: 2-chloro-2', 6'-diethyl-*N*-(methoxymethyl)acetanilide (alachlor); 2-chloro-2', 6'-diethyl-*N*-(butoxymethyl)acetanilide (CP-53619); 2-(3, 4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,-5-dione (VCS-438); 4-chloro-5-(dimethylamino)-2-*a,a,a*-trifluoro-*m*-tolyl)-3 (2*H*)-pyridazinone (San-6706); 2-(napthoxy)-*N, N*-diethylpropionamide (R-7465); *S* - isopropyl 5-ethyl-2-methyl-piperidine-1-carbothioate (R-12001).

Herbicides were applied at rates of 1, 2, and 4 lb/A and incorporated 2.5 inches deep into a fine sandy loam prior to planting. Duration of experiments ranged from 4 to 8 weeks.

Three herbicides (R-7465, VCS-438, and CP-53-619) controlled yellow nutsedge, and one herbicide (R-7465) controlled purple nutsedge for 8 weeks at rates tolerated by cotton. CP-53619 controlled purple nutsedge for 4 weeks without injury to cotton. R-12001 and San-6706 at 1 lb/A controlled purple and yellow nutsedge for 8 weeks with moderate injury to cotton.

Alachlor injured cotton at all rates, but at 1 lb/A controlled purple nutsedge for 4 weeks and yellow nutsedge for 8 weeks. VCS-438 controlled yellow nutsedge at 2 lb/A, failed to control purple nutsedge at all rates, and injured cotton at 4 lb/A. An application of 1 lb/A of R-7465 controlled purple and yellow nutsedge, whereas 2 lb/A injured cotton. CP-53619 controlled both purple and yellow nutsedge at 1 lb/A and moderately injured cotton at 4 lb/A.

[1]Cooperative investigations of the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the California Agricultural Experiment Station.

[2]Plant Physiologist, Research Assistant, and Agronomist, respectively, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Shafter, California.

BROMOXYNIL COMBINATIONS WITH DIURON AND LINURON FOR BROAD SPECTRUM WEED CONTROL IN WINTER WHEAT AND BARLEY

J. R. McKinley and S. R. McLane[1]

Experiments were conducted in the Pacific Northwest in 1970 to evaluate combinations of bromoxynil and diuron or linuron for annual weed control in winter wheat and barley. In replicated field trials at four locations bromoxynil rates of 0.125, 0.25 and 0.5 lb/A were combined with diuron at 0.3, 0.4, 0.6 and 1.2 lb/A and with linuron at 0.25 and 0.5 lb/A. All chemicals in the combinations were also applied separately.

The treatments were applied postemergence when annual broadleaf weeds had from 2 to 20 leaves and were 4 to 5 inches tall. Nine weed species were evaluated.

Weed control with combinations of 0.25 lb/A bromoxynil and 0.3 to 0.6 lb/A diuron and bromoxynil plus linuron at 0.25 plus 0.25 lb/A was superior to that with bromoxynil, diuron or linuron applied separately at these rates or at the higher commercial ones.

The contact activity of bromoxynil coupled with soil activity and some contact activity from linuron and diuron broadens the spectrum of weeds controlled, and kill of much larger weeds was better than with the com-

[1]Amchem Products, Inc., Ambler, Pa.

ponents applied separately at higher rates. The combination also acted considerably faster than did the components applied separately. In these combinations bromoxynil apparently increased the foliar activity of diuron and linuron.

High rates of these combinations, particularly when applied to foliage that was wet for several hours, caused some chlorosis in cereals, but they outgrew the yellowing and it was not noticeable a few weeks after treatment. Both winter wheat and barley appeared to tolerate the combinations well at rates needed for good weed control.

SOYBEAN AND COTTON ROOT-GROWTH INHIBITION WITH AN-56477

W. P. Anderson[1]

The objective of this research was to determine the effect of a substituted dinitro aniline herbicide, AN-56477 (trade mark "Torpedo"), soil incorporated, on the root-growth of soybean and cotton seedlings.

The following information is based on the results of greenhouse experiments using a clay loam soil in 4.5 by 8 inch containers water by subirrigation. Seeds of soybean or cotton were planted (4 to a container) 1.5 inches deep. The herbicide was applied at dosages of 0, 0.25, 0.5, 0.75, 1.0, 1.5, 2.0, 3.0, and 4.0 lb/A and incorporated into the soil to a depth of 4 inches. Treatments were replicated four times and experiments twice. In general, the experiments extended over a 3-week growing period during May and June.

The development of taproots of soybean and cotton seedlings was prevented by concentrations of AN-56477 in soil at 1 ppmw and 2 ppmw, respectively (1 ppmw is equivalent to 1 lb/A incorporated 4 inches deep). At concentrations lower than this, growth of the taproots appeared normal.

The growth of lateral roots of soybean and cotton seedlings was prevented by AN-56477 at concentrations as low as 0.2 ppmw (the lowest tested).

In general, seedling height showed litle or no stunting at dosages below 2 lb/A during the first 3 weeks of growth, in spite of the adverse effects on root growth. In the field, this lack of apparent stunting could be misleading when evaluating herbicide injury if the plants are not dug and the roots inspected.

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RESULTS OF FIELD TESTS WITH OUTFOX[1] ON CORN

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"Outfox" (2-chloro-4-cyclopropylamino-6-isipropylamino-1,3,5-triazine), formerly S-6115, is a new herbicide discovered and developed by Gulf Research and Development Company for post-emergence weed control in corn. The compound has a proposed common name of "cyprazine" and has been tested under the code numbers S-6115 and S-9115.

Most broadleaf and grassy weeds common to corn fields are susceptible to "Outfox" with the exception of perennial species which usually are not killed but are stunted.

Replicated small plot field tests were conducted in 10 midwestern states in 1968. Excellent control of most problem species was obtained. The following year tests ranging in size from 1 to 12 acres were expanded to the 14 states in which over one million acres of corn were grown. Weed control and yield data collected from both farmer-applied and Gulf Research-applied tests showed satisfactory results in almost all instances.

Evaluation began in 1968 of the persistence of "Outfox" in soil. Samples were taken periodically during the growing year and again the following spring. Both chemical and bioasay determinations were made and with both methods "Outfox" was found to decline rapidly.

Experiments were continued in 1969 in 14 states representing 27 soil types in which pre- and post-emergent applications were made. Soybeans, oats and turnips were seeded at application time and at intervals of approximately 30, 60 and 90 days. Pooled results showed that oats and soybeans seeded 60 days after treatment and turnips seeded 90 days after treatment grew normally.

These results were reinforced by observing over 100 fields during the spring and summer of 1970 on which "Outfox" had been applied in May or June of 1969. On 5 of these fields there was an indication of carry-over and in these cases it was due to an application of higher rates than recommended.

"Outfox" has also shown promise as a pre-emergent material applied alone and in combination with other pre-emergent herbicides for corn. Preliminary data from "Outfox" applications to sorghum and sugar cane have also appeared promising.

[1]Trademark of Gulf Oil Corporation.

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HERBICIDE TOLERANCE OF IRRIGATED PASTURE LEGUMES

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Tolerance of three irrigated pasture legumes to phenoxy herbicides and paraquat was measured in glasshouse and field experiments. Salina strawberry clover (*Trifolium fragiferum* L.) has recently been planted

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in a significant proportion of Pacific coast irrigated pastures and a measure of its tolerance to common herbicides is frequently requested by growers. Since a considerable knowledge of the use of herbicides on Ladino clover (*Trifolium repens* L.) has accumulated over the years the response of Salina strawberry clover was measured relative to Ladino clover. Birdsfoot trefoil (*Lotus corniculatus* L.) was also in all experiments. In glasshouse experiments herbicide damage to legumes was increased with the addition of a surfactant. These experiments also guided the selection of rates to be used in the field. In the field, logarithmic dilutions of commercial formulations of 2,4-D, 2,4-DB and MCPA herbicides begining at 4 kg/ha were applied to monospecific swards 2, 6, and 18 months of age. Two-month-old plants were severely damaged by all materials except 2,4-DB. Six-month- and eighteen-monthold plants were not all killed by the highest rate of any material. Damage from application of 2 kg/ha usually was slight and recovery was rapid. Salina strawberry clover was at least as tolerant of all materials as was Ladino clover. Trefoil was much more sensitive. Accessory treatments and measurements in commercial fields showed substantially the same effects. A large proportion of the owners and operators of the million acres of irrigated pasture and meadow in California are ill-equipped to perform the crop rotation and land grading necessary to maintain top production. However, herbicide application, especially by custom operators, is well within their reach. A high level legume tolerance to cheap and usable herbicides suggest this is a likely avenue for improved management.

THE STATUS OF 2,4-D, 2,4,5-T, SILVEX AND MCPA HERBICIDES[1]

C. S. Williams[2]

Background

The herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) was developed in the mid-forties and was the foreruner of a group of phenoxy herbicides that have been instrumental in the control of broadleved weeds in food crops and undesireable brush species on industrial rights-of-way. In addition these products have contributed immeasurably to beef production by controlling weed and/or brush on pasture and rangeland, resulting in increased grass production and corresponding increase in carrying capacity for livestock.

Besides 2,4-D, 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 2-(2,4,5-trichlorophenoxy) propionic acid (silvex or 2,4,5-TP), and 2-methyl-4-chlorophenoxy acetic (MCPA) are major phenoxy products of similar chemical structure, as shown below, but with unique characteristics of their own with respects to species controlled and crop selectivity.

Chronology Of Events

Over the years there has been considerable improvement in phenoxy herbicides and their use. Development of new formulations, performance information, crop safety, timing of application, spray equipment, toxicology, use hazards, and environmental implications have contributed to both better product and specific directions for use.

These herbicides are not protected by patents, so seven commercial companies were manufacturing one or more of the four phenoxies (2, 4-D, 2, 4, 5-T, silvex, MCPA) at the time when the USDDA announcement to abolish the no residue status was issued on April 13, 1966. Basic manufacturers included: Diamond, Dow, Hercules, Monsanto, Rhodia (then Chipman), Thompson, and Thompson-Hayward. These companies joined to form the Industry Task Force on Phenoxy Herbicide Tolerances (ITFPHT). The chronology of major events associated with this has been as follows:

April 13, 1966

USDA announcement to abolish no residue status-industry must comply by obtaining tolerances for residues in all treated food and feed products and byproducts by December 31, 1970.

August 23, 1966

Industry Task Force on Phenoxy Herbicide Tolerance was formed to handle 2,4-D, 2,4,5-T, MCPA and silvex.

December, 1967

Submitted petitions to FDA for tolerances of 2, 4-D, 2, 4, 5-T, silvex and MCPA covering all food crop uses listed at that time in the USA Summary of Registered Agricultural Chemical Uses. Extension of registration was requested for uses of these herbicides in pasture and rangeland.

April, 1968

Industry Task Force advised of inadequacies, in the petitions plus requirement for information on all metabolites of the herbicides that might occur as residues in foods.

September, 1968

Review of literature on metabolism submitted to resolve metabolite question.

During 1968 programs were established to determine on which crops additional work would be undertaken and what specific projects would be done by each company in the Task Force.

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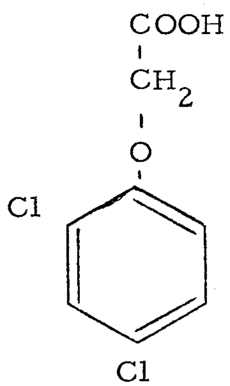
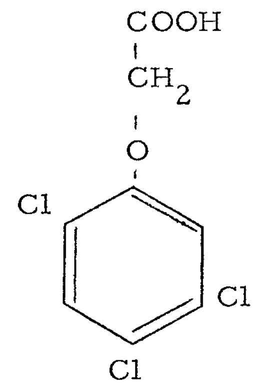
[1]Presented at the North Central Weed Control Conference, Lexington, Kentucky, December 8, 1970, and the Illinois Custom Sprayer School, Urbana, Illinois, January 27, 1971.

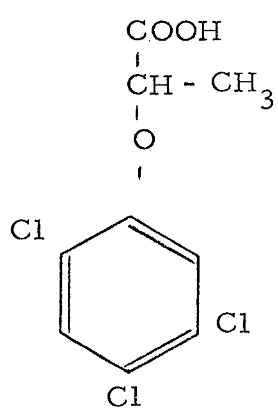
[2]Agricultural Department, The Dow Chemical Company, Midland, Michigan.



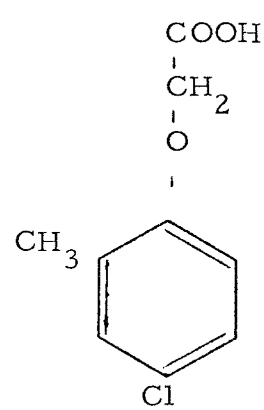
2, 4-dichlorophenoxyacetic acid



2, 4, 5-trichlorophenoxyacetic acid



2-(2, 4, 5-trichlorophenoxy)-propionic acid



2-methyl-4-chlorophenoxyacetic acid

October 29, 1968

Industry Task Force requested extension for continued use of 2, 4-D, 2, 4, 5-T, silvex, and MCPA on pastures and rangeland. Extension was granted until January 1, 1970.

January 31, 1969

Use of 2,4-D, 2, 4, 5-T and silvex on aquatic sites extended to January 1, 1970.

Crop samples for residue analyses were collected during summer and fall of 1969.

Protocols for milk and meat studies were established during 1969. It was decided that analyses of animal tissues would include the phenol corresponding to each phenoxy compound. Dow handled dairy cattle feeding and milk analysis for all four phenoxies and began feeding February, 1970.

USDA was scheduled to handle feeding of phenoxies to beef cattle and sheep during winter, 1969-1970.

October 29, 1969

The Office of Science and Technology issued statement on teratogenic hazard of 2,4,5-T bosed on work by Bionetics Research Laboratory.

December 22, 1969

Phenoxy registration for rangeland use extended until January 1, 1971, except for 2,4,5-T. Dow undertook feeding of 2,4,5-T to beef animals.

December 31, 1969

Petition for tolerances of 2,4,5-T in food crops was withdrawn by Industry Task Force since tolerances could not be established by January 1, 1970, the deadline set by the Office of Science and Technology.

January 19, 1970

Registration of 2,4-D, silvex and MCPA extended by USDA for use on food crops until January 1, 1971.

March 4, 1970

Registration of 2,4,5-T was also extended until January 1, 1971 for use on apples, blueberries, grains, pastures, rangeland, rice and sugarcane.

April 15, 1970

Results of additional work on teratogenic properties of 2,4,5-T prompted suspension by USDA of 2,4,5-T for aquatic and home uses.

May 1, 1970

Cancellation by USDA of 2,4,5-T for use on food crops. Uses on pasture, forests and industrial areas not affected.

May 28, 1970

Dow appealed the cancellation of 2,4,5-T for use on rice. Hercules and Amchem also appealed cancellation for rice usage. Each company could appeal only crops listed on their labels for 2,4,5-T products. The appeal is to be reviewed by an Advisory Committee appointed by the National Academy of Sciences.

June 16, 1970

USDA began the beef feeding studies scheduled to have been done the previous winter.

November 24, 1970

Crop residue work completed. Milk analysis completed. Meat analyses underway. Completed data will be submitted as amendment to petitions prior to December 31, 1970.

To date, no official notice has been received concerning appointment of National Academy of Science Advisory Committee to review the appeal on the cancellation of rice.

Registration Status

Tolerances have been established for 2,4-D in apples, barley, grapefruit, lemons, oats, oranges, pears, rye and wheat. There is also a tolerance for the sodium salt of 2,4-D in asparagus.

Data originally submitted with petitions in December, 1967 is expected to be sufficient for 2,4-D in blueberries, cranberries, grapes and raspberries; for silvex in apples, pears and prunes; and for MCPA in peas. Data on residues in grass includes that from previous work and from 1970 residue samples additionally analysed by Dow for support with respect to pasture and rangeland usage.

The Industry Task Force supported the following work for determining residues:

	2,4-D	2,4,5-T	Silvex	MCPA
Corn	+	+	----	----
Rice	+	+	+	+
Flax	----	----	----	+
Small Grains (Barley, Oats, Rye, Wheat)	Tolerances Granted	----	----	+
Sorghum	+	----	----	----
Sugarcane	+	+	+	----
Milk	+	+	+	+
Meat	+	+	+	+

For virtually all of this work, new analytical methods had to be developed that would permit analyses down to 0.1 ppm phenoxy acid in crops and to 0.05 ppm acid or corresponding phenol in the animal tissues and milk.

For present registered uses residue analyses indicate 0.2 ppm for all phenoxy acids in all crops at time of harvest.

The Phenoxies were fed at levels of 30, 100 and 300 ppm for two weeks and 1000 ppm for three weeks in the total diet of dairy cows. Milk was collected and analysed for residues. Grazing restrictions compatible with levels of phenoxies in milk as related to levels in forage remain to be determined. There was no evidence of accumulation of phenoxies in the cream.

At time of this writing, December 1, 1970, analyses are being run on samples of muscle, kidney, liver and fat of beef animals. Data are expected to be available prior to December 31, 1970.

Amendments to the petitions for tolerances for 2,4-D silvex and MCPA will be submitted to the appropriate agency in charge, including uses in pasture and rangeland. The 2,4,5-T petition will be reactivated—deadline for this compliance will be accomplished prior to December 31, 1970.

Toxicology

Negligible residue tolerances can be obtained based on information from 90 day toxicology studies in two species of mammals. However, tolerances at higher (permissible) residue levels require two year feeding studies on rats and dogs, plus fertility and reproduction studies on rats. At the time the phenoxy herbicides were developed these long term feeding studies were not necessary, since these compounds were registered on a "no residue" basis.

FDA has conducted two year feeding studies on 2, 4-D including reproduction and fertility. Dow has conducted two year feeding studies on silvex but not reproduction or fertility studies.

Ninety day feeding studies have been run on rats and dogs for 2,4-D, 2,4,5-T, silvex and MCPA. The no-ill effect levels are shown in the following table:

Approximate No-Ill Effect Levels (Mg/Kg/Day)

	2,4-D	2,4,5-T	Silvex	MCPA
Rats	30	30	5-10	16
Dogs	10	5	7	8-10

Based on single oral doses in rats, 2,4-D, 2,4,5-T, silvex and MCPA are classed as "slightly toxic" with LD_{50} values ranging from three hundred to seven hundred mg/kg body weight.

2, 3, 7, 8-Tetrachlorodibenzo-p-Dioxin

The word teratology has reecntly become much more familiar. It was tied to 2,4,5-T when studies by Bionetics Research LaLboratory implied that 2,4,5-T was teratogenic (producing malformed fetuses) in mice and rats. Subsequent studies have shown that a potential toxic contaminant, 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin, is responsible for the findings attributed to 2, 4,5-T. The sample of 2,4,5-T employed in the Bionetics study contained 27 ppm, 2,3,7,8-tetrachlorodibenzo-p-dioxin.

Additional studies have shown that oral administration of 2,4,5-T containing 1 ppm 2,3,7,8-tetrachlorodibenzo-p-dioxin produced no teratogenic effects on rats, rabbits or mice. The obvious concern is to produce 2,4,5-T without the contaminant.

The 2,3,7,8-tetrachlorodibenzo-p-dioxin can be formed in the manufacture of the precursor 2,4,5-trichlorophenol. The conditions required for its formation are high temperatures and basic conditions. This can occur in the alkaline hydrolysis of 1,2,4,5-tetrachlorobenzene to the trichlorophenol.

No detectable dioxins have been observed in 2,4-D. This is due to the fact that the precursor 2,4-dichlorophenol is made by direct chlorination of the phenol and not by alkaline hydrolysis of 1, 2, 4-trichlorobenzene.

To date analytical methods have been developed and validated for a method sensitivity of 0.5 ppm for 2,3,7,8-tetrachlorodibenzo-p-dioxin in 2,4,5-T acid. With proper manufacturing controls there is no problem in producing 2,4,5-T with no 2,3,7,8-tetrachloro-p-dioxin as indicated by these analytical methods.

The Future

By December 31, 1970 the Industry Task Force on Phenoxy Herbicide Tolerances will have furnished to FDA the supplemental residue data necessary for the continued evaluation of the petitions to establish negligible residue tolerances for 2,4-D, 2,4,5-T, silvex and MCPA on the appropriate food crops and meat and milk tissues. Registrations (USDA) are expected to remain in force.

Data provided to date indicate no hazard and no significant residues in food crops. Toxicology data support the use claims. The proper manufacturing of 2,4,5-T should aleviate the problems associated with 2,3,7,8-tetrachlorodibenzo-p-dioxin.

The USDA has recently stated that prohibiting the use of phenoxy herbicides "would cost the U.S. farmers an additional $290 million to maintain current agricultural production. In addition, farmers and their families would have to work 20 million more hours to control the weeds without these herbicides. For this extra labor, the farmers would obtain no additional income."

Several hundred thousands of dollars have been expended over the past several years to prove the safety of phenoxy herbicides to man and his environment. From a scientific base the phenoxy herbicides can contribute economically, efficiently, and safely in the future for the control of broadleaved weeds and brush on food crops, pasture, rangeland and non-cropland areas as they have for over 20 years.

ALFALFA SEED BIOASSAY FOR AQUEOUS SOLUTIONS OF ORANGE

R. W. Gesink,[1] J. W. Akerman,[1] and W. Hurtt[2]

An alfalfa (*Medicago sativa* L.) seed bioassay was developed to detect contamination of water by low concentrations of the herbicide ORANGE (50:50 mixture of the n-butyl esters of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid). The bioassay was accomplished by germinating alfalfa seed on filter paper in petri plates and moistened with 2.5 ml of known solutions of herbicide. Fifteen seeds were germinated in each plate and six replicate groups of seed were employed for each of seven different concentrations of ORANGE which ranged from 0.02-0.6 ppm. Untreated controls were germinated in plates containing only distilled water.

Measurements were taken of the combined lengths of root and shoot 72 hours after germination. The mean length for each treatment, expressed as percent of control, was plotted against concentration to obtain a typical bioassay standard curve which proved to be sensitive from 0.02-0.40 ppm. A regression line relating the degree of inhibition of root plus shoot growth to concentration of ORANGE was estimated and found to be significant at the 0.01 level. Additionally, 0.95 prediction limits were computed for the degree of inhibition for a given concentration of the herbicide.

This bioassay offers the advantage of being both simple and rapid. It can be performed with a minimum of equipment, and can be readily duplicated by other workers.

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[2]Plant Physiologist, Plant Sciences Laboratories, USA Biological Defense Research Center, Fort Detrick, Frederick, Maryland.

EFFECT OF CONTAINER COMPOSITION ON HERBICIDE RESIDUES IN WATER[1]

Robert J. Demint and Peter A. Frank[2]

Herbicides are known to undergo chemical and biological degradation under field conditions and under certain storage conditions. Residue studies present an additional problem involving sorptive losses on container walls during handling and storage. Sorption is a function of the type and concentration of herbicide and characteristics of the container surface area. Many of these properties can effect the validity of herbicide residue analysis of water. From a practical standpoint, we have undertaken to determine the most desirable container, appropriate storage conditions, and the length of time it is feasible to store a particular herbicide without excessive loss. Herbicides included in this study were 3-amino-*s*-triazole (amitrole), 2,2-dichloropropionic acid (dalapon), 2,6-dichlorobenzonitrile (dichlobenil), 6,7-dihydrodipyrido [1,2-*a*:2',1'-*c*]pyrazinediium ion (diquat), trichloroacetic acid (TCA), the dimethylamine salt of (2,4-dichlorophenoxy) acetic acid (2,4-D), and the butoxyethanol and isooctyl esters of 2,4-D.

Materials and Methods

Amitrole solutions were prepared in tap water in large glass containers at concentrations of 29 and 200 ppb. Portions of 500 ml each were transferred to quart-sized glass and low density polyethylene (LDP) containers. Dalapon solutions in glass, high density polyethylene (HDP), and polyvinyl chloride (PVC) pint containers were prepared by the addition of 450 ml of tap water and then spiking with the sodium salt of dalapon to provide a concentration of 25 ppb. Solutions of the acid, ester, and the dimethylamine salt of 2,4-D were prepared by the addition of 40 ug of the acid equivalent of the respective 2,4-D derivative to 400 ml of tap or distilled water in each of several types of pint containers. Dichlobenil, diquat, and TCA solutions in tap water at a concentration of 100 ppb were prepared as described for 2,4-D. Since TCA is very hygroscopic, reagent grade TCA was heated in an oven at 125 to 130 C for approximately an hour, to remove the water prior to weighing the chemical for preparation of solutions.

Half of the containers of each herbicide solution were frozen at -10 C and the other half were stored at room temperature (21 to 25 C). All of the herbicides were protected from light with the exception of amitrole and dalapon. Samples were taken from storage for analyses at various intervals from 1 up to 91 days for amitrole and up to 28 days for each of the other seven herbicides. Analyses were conducted by procedures specifically adapted to water by our Denver laboratory (1, 2, 3, 4). Analyses on all control samples were commenced within 2 hours of preparation of solutions. Since analyses of preparations of some of the herbicides in various containers were performed at different times, different controls were employed. These were referenced to the 0-day control in glass.

Results and Discussion

Prior to initiating this study, we observed that a standard solution of amitrole in glass was stable up to

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[1]Investigations of the Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the Division of General Research, Bureau of Reclamation, Denver, Colorado.

[2]Research Chemist and Plant Physiologist, Crops Research Division, Agricultural Research Service, U.S. Deparment of Agriculture, Denver, Colorado.

5 months. However, the concentration was much higher than residue levels ordinarily found in irrigation water. Since sorption was likely to be more important at the low concentration found in irrigation water, two concentrations were selected to show the effect of concentration on sorption. Table 1 illustrates the effect of container composition, storage conditions and concentration on the percent recovery of amitrole from water. Losses of amitrole at the 200 ppb level were minimal, usually not exceeding 10%. The losses of amitrole at the 29 ppb level stored in both glass and LDP containers were greater. Adsorption appeared to be a factor of greater importance at the lower concentration. Some of the loss occurred on the first day indicating a partial saturation of the surface area. This suggests that some loss might be avoided by a procedure in which a bottle is filled, then emptied and refilled. The greater losses from frozen containers suggest storing at as low a temperature as possible without actual freezing. Since microbiological degradation may occur in canal-water samples, depending on microorganisms present, no assumption should be made that amitrole would not decompose in fieldwater samples when stored at room temperature.

The effects of container composition and storage conditions on percent recovery of dalapon from water containing 25 ppb of dalapon are shown in Table 2. Samples stored at room temperature in both glass and PVC deteriorated rapidly after days, whereas the samples stored in HDP at room temperature seemed stable. Since the PVC and glass containers were clear, whereas HDP containers were nearly opaque, it is probable that light instability caused this deterioration. Dalapon is known to hydrolyze to pyruvic acid at elevated temperatures, and photolysis conceivably could initiate this same hydrolysis. Frozen samples stored in both HDP and PVC containers were stable up to 28 days.

The effects of container composition and storage conditions on the percent recovery of 2,4-D from water containing 100 ppb of acid equivalent of the dimethylamine salt of 2,4-D are shown in Table 3. Recoveries are somewhat variable between sampling days as well as between different containers. However, no trends were evident that would have indicated any appreciable losses of the dimethylamine salt of 2,4-D from any type of container. Nor did it appear that there was any advantage in freezing over storage at room temperature. Since the samples were prepared with distilled water, microbial activity was pobably not involved. Room temperature storage of field samples might result in herbicide losses due to the presence of microorganisms.

Recoveries of the isooctyl ester of 2,4-D are shown in Table 4. Again, no losses were evident in glass bottles kept at room temperature. However, initial losses from HDP and LDP at room temperature were significant. In the period up to 4 days, losses of 90% from HDP bottles were noted. No further loss occurred between 4 and 11 days. Freezing reduced the rate of loss as well as the total 2,4-D lost up to 11 days. However, the extent of the loss was such that freezing water samples containing isooctyl ester of 2,4-D in HDP bottles is not feasible. Loss of isooctyl ester of 2,4-D from water stored in LDP botles followed much the same pattern as was observed for the HDP.

PVC as a container material is satisfactory for collecting and storing samples containing the isooctyl ester of 2,4-D. PVC bottles are less durable than polyethylene and some breakage occurs on freezing. This problem is minimized by filling to 90% of capacity or by adding the equivalent of 75 g of reagent grade NaCl per liter of water before freezing. The NaCl does not interfere with extraction or analysis of 2,4-D. It does have a slight buffering effect which necessitates the use of more acid when adjusting the pH of the water sample.

Butoxyethanol ester of 2,4-D. Recoveries for this ester of 2,4-D which was more stable than the isooctyl ester of 2,4-D are shown in Table 5. Samples in glass, PVC, and HDP showed only slight losses of 2,4-D after room temperature or frozen storage for periods up to 28 days. LDP did not perform well as a sample container. Not only was an immediate loss shown, but losses of 30% or higher occurred between 1 to 28 days of storage.

Dichlobenil. The recoveries of dichlobenil from various containers are presented in Table 6. Recoveries of dichlobenil from glass and PVC containers were good up to 28 days. Poor recovery of dichlobenil was obtained from HDP containers stored 7 to 28 days at room temperature, however good recovery was noted for the frozen containers. Rapid loss of dichlobenil occurred in LDP containers. Recovery was better when the containers were frozen, but was not as good as the other types of containers.

Diquat. The recovery of diquat is shown in Table 7. Recovery of diquat from all containers was in the range of 10 to 25% lower than that of the control or 0-day samples. Time did not seem to increase the losses. Either of the plastics, as well as glass, could be employed for storage. The plastic containers are superior to glass for freezer storage which is desirable for inhibition of microbiological degradation.

TCA. While some variation is shown in the data of Table 8, essentially no additional loss of TCA is shown by an increase in storage time up to 28 days. Recovery of TCA from containers seemed to be independent of temperature and container composition among the types studied.

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Table 1. Effect of container composition, storage conditions, and concentration on percent recovery of amitrole from water.

Time days	LDP[1] RT[2] 200 ppb	Glass RT 29 ppb	LDP RT 29 ppb	LDP Fzn[3] 29 ppb
0	100[4]	100[4]	....	....
1	91	....	92	90
3	93	....	87	93
7	95	84	84	79
14	93	86	91	74
21	89	....	85	78
28	93	88	84	78
63	91	82	79	71
91	93	....	....	....

[1]Low density polyethylene.
[2]Room temperature.
[3]Frozen.
[4]All recoveries relative to 0-day control in glass.

Table 2. Effect of container composition and storage conditions on percent recovery of dalapon from water containing 255 ppb of dalapon.

Time days	Glass RT	HDP[1] RT	HDP Fzn	PVC[2] RT	PVC Fzn
0	100[3]	....	....	....	....
1	....	99	99	....	....
3	....	99	103	....	....
7	95	97	101	95	99
14	64	88	96	15	99
21	....	104	108	....	....
28	1	89	103	1	106

[1]High density polyethylene.
[2]Polyvinyl chloride.
[3]All recoveries relative to 0-day control in glass.

Table 3. Effect of container composition and storage conditions on the percent recovery of 2,4-D from water containing 100 ppb of acid equivalent of the dimethylamine salt of 2,4-D.

Time days	Glass RT	PVC RT	PVC Fzn	HDP RT	HDP Fzn
0	90	91	....	88	....
1	84	92	85	87	92
3	84	87	100	92	103
7	87	79	90	76	89
14	83	91	92	96	98
21	85	89	91	89	92
28	86	86	90	92	92

Table 4. Effect of container composition and storage conditions on the percent recovery of 2,4-D from water containing 100 ppb of acid equivalent of the isooctyl ester of 2,4-D.

Time days	Glass RT	HDP RT	HDP Fzn	LDP RT	LDP Fzn	PVC RT	PVC Fzn
0	100[1]	71	....	66	....	....	....
1	100	32	42	39	53	102	102
3	85	....	....	22	41	98	96
4	100	10	32	....	....	....	....
7	76	....	....	8	22	95	96
8	91	9	28	....	....	....	....
11	104	12	39	....	....	....	....
14	77	....	....	7	23	100	91
21	91	....	....	9	30	96	94
28	90	....	....	9	30	93	97

[1]All recoveries relative to 0-day control in glass.

Table 5. Effect of container composition and storage conditions on the percent recovery of 2,4-D from water containing 100 ppb of acid equivalent of the butoxyethanol ester of 2,4-D.

Time days	Glass RT	PVC RT	PVC Fzn	HDP RT	HDP Fzn	LDP RT	LDP Fzn
0	100	97	....	93	....	86	....
1	96	98	100	83	85	68	70
3	94	91	97	94	93	68	75
7	100	98	99	90	91	63	63
14	88	89	93	96	97	74	61
21	90	91	88	92	79	75	64
28	95	93	95	96	89	73	67

Table 6. **Effect of container composition and storage conditions on the percent recovery of dichlobenil from water containing 100 ppb of dichlobenil.**

Time days	Glass RT	PVC RT	PVC Fzn	HDP RT	HDP Fzn	LDP RT	LDP Fzn
0	101	97	....	93	....	92	....
1	98	98	94	92	98	79	88
3	101	95	88	93	95	71	95
7	100	87	87	83	93	61	90
14	94	91	93	77	92	45	79
21	89	80	97	69	86	40	75
28	103	96	100	75	98	38	80

Table 7. **Effect of container composition and storage conditions on the percent recovery of diquat from water containing 100 ppb of diquat.**

Time days	Glass RT	PVC RT	PVC Fzn	HDP RT	HDP Fzn
0	100[1]	....	....	....	....
1	77	79	85	89	86
3	74	74	77	77	89
7	89	90	87	86	78
14	72	85	74	82	77
21	82	87	74	85	88
28	88	86	78	86	86

[1]All recoveries relative to 0-day control in glass.

Table 8. **Effect of container composition and storage conditions on the percent recovery of TCA from water containing 100 ppb of TCA.**

Time days	Glass RT	PVC RT	PVC Fzn	HDP RT	HDP Fzn	LDP RT	LDP Fzn
0	87	87	....	....	....	....	....
1	81	79	78	79	79	68	67
3	79	76	72	82	75	80	69
7	83	79	75	78	76	83	74
14	84	85	89	78	82	78	79
21	75	81	79	72	72	75	79
28	76	80	77	76	80	77	77

POTENTIAL USES OF HERBICIDE COMBINATIONS FOR PERENNIAL WEED CONTROL

Eugene Heikes[1]

During a recent meeting with farmers, a statement was made that we are worse off now for having effective methods for control of perennial weeds than we were twenty years ago. This may be true if we think only in terms of chemical control; in the 1950's and early 60's there were several soil sterilant type herbicides that could be used to eradicate small areas of perennial weeds. However, we seem to have forgotten that some of the most effective and economical control methods combine improved cropping practices with the use of herbicides. We probably have looked too much to herbicides alone and have forgotten some of the effective cultural controls.

Because of restricted uses of herbicides, we may have to change some of our thinking about perennial weeds; we may need to think more in terms of preventing further spread and stopping seed production and less about eradication. It is realized that this is not a popular philosophy, but with the herbicides now registered for cropland use, we cannot think in terms of eradicating large areas of some weeds with herbicides alone. Some perennial weeds can be eradicated with *repeated* applications of 2,4-D, provided applications are repeated often enough for a long enough period.

[1]Extension Professor, Colorado State University, Fort Collins, Colorado.

This is true for Canada thistle and whitetop, but research has shown that some perennial weed species are not likely to be eradicated with 2,4-D, even after several years of repeated applications. Amitrol which is registered for limited cropland use has effectively controlled whitetop and quackgrass.

Perhaps we are all partly to blame for the shift in emphasis to herbicides for perennial weed control and away from cultural controls, or a combination of cultural controls and herbicides. Farmers and ranchers would like to have an herbicide or a combination of herbicides that could be applied once and that would consistently eradicate weeds, but even the best herbicides have not proven to be that effective. Many of the plots we established in the early 1960's were in waste areas; there was a thin stand of grass in some areas, other areas no grass, but in many cases the grass was either eliminated or thinned out. Complete control was reported with many of these for the first two or three years after the application—100% eradication, but now five to ten years later, most weeds have reestablished and the weed populations are not much different than they were in the beginning. The reestablishment has been partly from seedlings but there are also many old plants that were not completely killed. We have also noticed that following the use of a soil sterilant, where the soil is made completely bare for several years, usually the first plant to revegetate the area is the original weed. The weed will usually reestablish before grass or before a crop can be established. So based on more than 25 years of experience with perennial weeds, chemical control alone is seriously questioned.

Sometime ago while speaking to a group, I was asked why we have the perennial weed situation that we do; the person that asked the question was insinuating that it was because of lack of concern by landowners—a complacency attitude. Although this is undoubtedly true in some cases, I do not think it is true in most cases. I think most landowners are weed conscious and realize the seriousness of weeds, but the spread of perennial weeds has come about largely because we have not had effective, economical perennial weed control herbicides to use in waste areas and on low valued lands. If we had more economical, consistently effective herbicides for use in these areas, we would not have the serious perennial weed problem that we do today. Many farmers and ranchers have tried herbicides and have spent considerable money with very little or no success. They are not willing to do the same thing again unless they are reasonably sure of more positive results.

There are probably very few weed problems that cannot be corrected by proven, present weed control methods, providing one makes enough effort. The question is usually a matter of economics and whether the land is really worth the expense and effort. There are many weed infestations that will probably not be controlled soon because the control methods we have now are not sufficiently economical. This seems to be particularly true for certain perennial weeds on range lands.

WEED CONTROL METHODS ON CULTIVATED LANDS VARY WITH AREA: There is no one method of controlling perennial weeds on cultivated lands that is good in all areas; each situation is different. The wise farmer or rancher will select the combination of control methods that best fits his cropping program, his farming practices and his pocketbook.

Some very fine perennial weed research has been done in past years but much of the results of these studies has been overlooked recently. This has probably come about because of too great an emphasis on herbicides, rather than on the use of *both* improved farming practices and herbicides. When one reviews the literature, one cannot help but wonder why we still have the vast acres of perennial weeds. Let us briefly review some of the earlier reports and then reevaluate our present position.

CANADA THISTLE: In 1934, Tingey, working in Utah, and in 1952, Seely in Idaho reported complete control of Canada thistle in one season by shallow cultivation. However, this was not new since Cox (USDA) in 1913 described a cultivation method whereby Canada thistle was eliminated from cropland. Another report made in 1923 showed that mowing pastures for two years under some conditions, would practically eradicate thistles. The value of competitive crops such as alfalfa have been reported to be effective. Results from the use of soil sterilants, repeated applications of 2,4-D, benzoic acids and picloram, have all been described and publicized for the control of Canada thistle. Similar work has been done with field bindweed, Russian knapweed, whitetop, and others. However, the most highly effective control on cropland has been accomplished by combined tillage, cropping practices *and* herbicides. There are not many reports of eradicating perennial weeds in waste areas with herbicides used alone.

Some of the most extensive work on Canada thistle using crop competition and other cultural practices in combination with herbicides, was reported by Hodgson in 1958. Sixteen combination treatments and a number of single treatments were evaluated over a four-year period—1953 to 1956, at Bozeman, Montana. The results were a classic example of the advantages of combining cropping, cultivation and chemicals. The stand of Canada thistle was reduced by all cultural treatments which involved 2,4-D spraying. Complete eradication was accomplished by only two treatments during the four years of the experiment. These were as follows:

1. a. Cultivation with duckfoot sweeps, 3 to 4 inches deep every 21 days for one season.

b. Spring wheat seeded second season.
c. 2,4-D applied at ¾ lb/A at early bud stage of Canada thistle.
d. Plowed immediately after harvest.
e. Step (a) repeated in 3rd season and steps (b and c) in the 4th season.

2. Row cropping, inter-row cultivation and 2,4-D.
a. 1st year: Potatoes planted, cultivated twice between rows, 2,4-D applied at 1 lb/A, 2 weeks before harvest.
b. 2nd, 3rd and 4th years: Silage corn planted after one cultivation in the spring; 2,4-D applied at 1 lb/A when corn was 8 to 12 inches tall; corn harvested as silage and the soil fall plowed.

The results of other experiments with combinations of cropping, fertilizer and 2,4-D treatments for the control of Canada thistle in spring wheat at Bozeman, Montana, are shown in Table 1.

Table 1. Effect of spring wheat, nitrogen fertilizer and 2,4-D spray on the control of Canada thistle, Bozeman, Monana.

Crop, and/or Chemical Treatment	1953	1954	1955	1956	1953	1954	1955	1956	Net increase above treatment D in 4 years Bu/A[a]
A. Spring wheat, N Fertilizer & 2, 4-D Spray	100	0	3	1	55	59	51	68	69
B. Spring wheat, N Fertilizer	100	56	310	312	62	48	29	30	10
C. Spring wheat, 2,4-D	100	14	3	1	54	65	48	44	63
D. Spring wheat, check	100	110	147	157	49	47	28	20	0
E. Sprayed with 2,4-D only each year	100	29	49	39	....	....	....	....	....

[a]The number bushels of wheat equivalent to cost of extra treatments with 2,4-D and for nitrogen were deducted. Price of wheat assumed $2.00/bu.

2,4-D at 3/4 lb/A was used for both fertilizer and unfertilized treatments, 2 lbs/A was used where there was no crop — treatment E.

Dicamba (Banvel) has been evaluated for control of several perennial weeds. It is generally not as effective as picloram (Tordon) but when combined with tillage and other farming practices, dicamba has controlled field bindweed, Russian knapweed and some rangeweeds. Its short soil persistence has made it possible to grow a corn or sorghum crop in treated areas the spring following a fall application. These crops will usually tolerate 2 lbs per/A applied the fall previous. Four and 6 lbs/A has caused crop reduction.

Dicamba has not been highly effective in waste areas without crop competition or tillage to assist. In non-cropped areas, dicamba looks good for one or two seasons but without the help of cultivation, the weeds usually come back. Non-cropland areas should be resprayed with dicamba or 2,4-D to prevent the weed from reinvading.

FIELD BINDWEED: Herbicides have been evaluated at several locations in Colorado for control of field bindweed. Several compounds have shown promise initially but without follow-up by cropping or 2,4-D, the area usually becomes reinfested after several years. The plants that reinvade are not all seedlings; many are from old established root systems. Herbicide combinations using picloram plus 2,4-D or picloram plus 2,4-D plus dicamba, have not been significantly better than the same herbicides alone when used at the same rate of total active ingredient.

A dense stand of field bindweed was treated with picloram and picloram/2,4-D combinations at two locations in July 1966. Four years of data are shown in Table 2. At the Prowers County site, eradication was reported for two years but there has been considerable reinvasion during the last two years. This is characteristic of most situations where only chemical control is used. Neither of these sites were cultivated or cropped during the four years. There was very little grass competition at either site before or after the herbicides were applied.

Table 2. Field Bindweed (Convolvulus arvensis) control with picloram and picloram/2,4-D combinations — Applied July 1966.

Herbicide	Rate per Acre	Percent Kill: Baca County 7/67	7/68	7/69	7/70	Prowers County 7/67	7/68	7/69	7/70
Picloram[1]	1/4 lb	20	0	0	0				
Picloram	1/2 lb	60	20	0	0	100	70	50	20
Picloram	1 lb	85	50	25	0	100	100	75	55
Picloram	1½ lb	95	75	65	45	100	100	75	60
Picloram	2 lb	99	95	90	60	100	100	90	60
Picloram[2] 2,4-D	1/4 + 1/2 lb	40	20	0	0	90	50	20	0
Picloram/ 2,4-D	1/2 + 1 lb	70	20	0	0	100	50	20	0
Picloram/ 2,4-D	1 + 2 lbs	70	50	25	0	99	95	50	0
Picloram/ 2,4-D	1½ + 3 lbs	80	60	50	20	100	100	75	55
Picloram/ 2,4-D	2 + 4 lbs	90	70	70	40	100	90	50	25
Picloram[3] granules	1 lb								
Picloram Tordon granules	2 lbs					100	100	95	75

[1]Tordon 22K
[2]Tordon 212
[3]Tordon Be[a]ds

RUSSIAN KNAPWEED (*Centaurea repens*): Picloram, picloram/2,4-D picloram/2,4,5-T and dicamba was applied to a dense stand of Russian knapweed in May 1967. The treated area was not disturbed or farmed after the herbicides were applied. Russian knapweed did not reinvade most plots as much as field bindweed did following similar herbicide treatments. If this area had been tilled and handled like normal farmland, there would probably have been less reinvasion than the data shows. Picloram and the combinations have been more effective on knapweed than on some of the other noxious perennial weeds. Four years of data is shown in Table 3.

SUMMARY: We may need to think more in terms of weed control and preventing further spread of perennial weeds and less about eradication. In recent years, emphasis has been on chemical control of perennial weeds; we have forgotten some of the effective and economical control methods which combined cropping practices with herbicides. There are many weed infestations in waste areas and on low valued lands that will probably not be controlled soon because present chemical control methods are not sufficiently economical or effective. Several herbicides show promise initially after application for control of perennial weeds, but without folliow-up by cropping or 2,4-D, the area becomes reinfested after several years. Herbicide combinations have not been significantly better than the same herbicides alone when used at the same rate of active ingredient.

Table 3. Russian Knapweed (Centaurea repens) control with picloram, dicamba and combinations — Applied May 1967.

	Herbicide	Rate per Acre	Percent Kill 9/67	8/68	9/69	7/70
1.	Picloram/ 2,4-D[1]	1/2 + 1 lb	60	85	65	40
2.	Picloram/ 2,4-D	1 + 2 lbs	75	99	95	65
3.	Picloram/ 2,4-D	1½ + 3 lbs	85	100	99	75
4.	Picloram/ 2,4-D	2 + 4 lbs	99	100	99	85
5.	Picloram[2]	½ lb	95	99	99	50
6.	Picloram	1 lb	90	100	100	90
7.	Picloram	1½ lbs	98	100	100	95
8.	Picloram	2 lbs	99	100	100	95
9.	Dicamba	5 lbs	75	25	0	0
10.	Dicamba	10 lbs	99	60	0	0
11.	Picloram/[3] 2,4,5-T	½ + ½ lb	75	95	75	50
12.	Picloram/ 2,4,5-T	1 + 1 lb	90	100	100	97
13.	Picloram/ 2,4,5-T	1½ + 1½ lb	100	100	100	99
14.	Picloram/ 2,4,5-T	2 + 2 lbs	99	100	100	99
15.	Picloram granules[4]	1 lb	50	100	100	99
16.	Picloram granules	2 lbs	95	100	100	99

7/70 Knapweed seedlings were growing in all plots
[1]Tordon 212
[2]Tordon 22K
[3]Tordon 225
[4]Tordon Beads

FACTORS INVOLVED IN STATE REGISTRATION
The Case For State Registration

Harold P. Alley[1]

I am sure there are mixed emotions, misunderstandings, a feeling of insecurity along with a deep desire among many research, extension and regulatory people concerning state registration of herbicides.

In building a case for state registration I would hesitate to conclude that any two states would have similar problems or a need for the same herbicides to alleviate their problem.

It has always been my contention that when herbicides are available that are outstanding for specific weed problems we should be able to utilize these compounds. I am in no way contending that any herbicide be registered for use in any state without the research first being conducted and a knowledge of the limitations and potentials fully understood.

[1]Professor and Extension Weed Specialist, University of Wyoming, Laramie.

There is also a necessity for close cooperation between the University, State Department of Agriculture and the chemical company involved. The applicator, farmer or rancher and distributor must be cognizant of the fact that certain restrictions for the use of state labeled compounds are necessary and must be abided by. We do not want to lose an important tool through mis-use.

Wyoming is in the process of finalizing a state label for the use of Tordon-22K (picolinic acid) for control of specific rangeland weed species.

Fifteen years of research for the control of Geyer larkspur (Delphinium geyeri) has shown that there is not a predictable chemical control method other than picolinic acid.

Animal losses from poisonous plants are difficult to determine with any degree of accuracy. Estimates indicate between 2% and 15% cattle losses occur each year from poisonous plants. An example of the economic importance of one poisonous plant species to the cattle industry of Wyoming can be borne out in the following deductions. Wyoming has around 1.3 million head of cattle. A 5% loss means a $13 million dollar loss for Wyoming's limited number of ranchers to absorb.

If we have means to help alleviate this great economic loss of our own cattlemen I think we should do everything possible to obtain state registration of the compound or compounds that we know will effectively do the job.

State labels should be developed for specific uses, applicators licensed and monitored. Labels should be developed before wider use is made where there is no clearance over the application. It would be much wiser to close the barn door before the horse escapes, than after.

DATA REQUIRED AND MECHANICS OF STATE REGISTRATION

Robert Sullivan[1]

Judging from the response of the ten states that replied to our inquiry regarding data and mechanics of state registration, I believe that the registration requirements are generally quite uniform.

The prime prerequisite for state registration is that the product have Federal approval and registration.

The registration procedures for new registration do vary only to a limited degree from state to state, except at least in one case where state registration may be obtaind by submitting only a letter indicating the name of the product and the Federal registration number.

In most instancs, applicants are required to complete and submit a standard application form furnished by the state, completing information relating to—

1—Federal registration number.

2—The name and address of the registrant and the name and address of the person whose name will appear on the label if other than the registrant.

3—The brand name of the pesticide.

4—The complete statement of each active ingredient and its percentage—and a complete statement of each inert ingredient and its percentage. To my knowledge, all information relating to the inert ingredient provided in the application is held in strict confidence.

In those states where the registrant chooses to list only the name and total percentage of the active ingredients, the percentage of each active as required on the application is also considered a part of the confidential information, and in Colorado, our pesticide law does not provide an alternate choice of ingredient statements. Label ingreident statements are required to carry the percentage as well as the name of each active ingredient; and

5—Any other pertinent information.

Applicants are required to submit with the application, a copy of the labeling which must carry—

The name of the product.

Name and address of the manufacturer or person for whom manufactured.

Directions for use.

Statement of net content, and

Warning or caution statement.

Also, in that all advertising is considered part of the labeling, all pamphlets, brochures or other material accompanying the product is required to be submitted with the labeling, for review.

It is intended that the labeling directions and caution statements shall be adequate to prevent injury to man, animals, and useful vegetation, and to prevent possible illegal residue.

At the time of application, a product registration may be limited in distribution or use, or if it does not appear to meet the standards of the Act, registration may be denied.

If it appears that the composition of the pesticide is such as to warrant the claims for it, and if the pesticide and its labeling meet all the other requirements, the regsitration is issued.

Most states also require the registrant to submit the fee with the application—Colorado procedure, in order to comply with the accounting and auditing programs, provides that the application be submitted and approved, and the applicant then notified of the fee due when the labeling has been approved for registration.

If there is a question as to the efficacy, safety, or other, the applicant may be requested to submit additional information. Such may include request for performance data, residue, phytotoxicity or safety. The type or types of test data is governed by the type of product in question.

An applicant who is denied registration, or whose registration has been limited, may request a hearing, and in the event that the matter cannot be resolved by hearing, there is, of course, the avenue of judicial review.

At any time that a registered product under customary conditions of use appears to be creating serious problems, the registration may be revoked.

State registration is for one year, and re-registration is required annually. The re-registration procedures, however, are not as involved as the initial registration. Registrants are mailed a list of their registered products and asked to sign the statement requesting re-registration, and verifying that there has been no change in the labeling from the previous year. Signing the application for re-registration actually constitutes a certification that there have been no revisions. In the event of a

[1]Colorado State Dept. of Agriculture, Denver, Colorado.

change in name, composition or labeling, the applicant is required to execute the same procedure as is required for an original registration.

It is generally provided that identical products may be registered under a single fee, but some states require the registration of each brand name, whether the additional brand names are the result of packaging under private labels or from name change by the manufacturer.

PROBLEMS CONCERNED WITH REGISTERED HERBICIDES

E. A. Walker[1]

The Environmental Protection Agency came into being on December 2, 1970, and has taken over the responsibility for enforcing the Federal Insecticide, Fungicide, and Rodenticide Act of 1947, which was previously administered by the U.S. Department of Agriculture. This Act regulates the marketing of pesticide chemicals and requires that these products be registered with the EPA prior to shipment in interstate commerce. The Acting Commissioner of Pesticides has delegated the Pesticides Regulation Division to continue the registration of pesticides and the enforcement activities embodied in the Act.

There has been considerable public discussion and investigation about the dangers from use and misuse of pesticides. You are acquainted with the Globe, Arizona, Tonto National Forest case that received national prominence in 1969. The area was sprayed with 2,4-D and 2,4,5-T in 1965 and 1966 and silvex in 1969. Federal investigation revealed no apparent injury to animals in the area.

There was the case of mercury poisoning in New Mexico where pigs were fed screenings from treated grain, and the sick pigs were consumed by the family.

Many reports have come in about poisoning of livestock that grazed on areas treated with sodium arsenite or drank from ponds that were treated to control aquatic weeds.

There has been much action at the federal level to reduce the use of herbicides during the past year. Sodium arsenite use around the home was curtailed. Labeling for products containing more than 2% sodium arsenate or more than 1.5% arsenic trioxide for use around the home was not accetpable and all sodium arsenite product labels would carry the warning "Do not use or store in or around the home or allow domestic animals to graze treated areas." Cancellation is being issued for all uses of sodium arsenite to control aquatic weeds.

The Agency is concerned with environmental contamination by pesticides containing mercury. The registrations of some mercury products for certain uses have already been cancelled or suspended. All seed treatment uses of alkyl mercury compounds have been suspended. This means that these compounds can no longer be legally shipped in interstate commerce for the purpose of treating seeds. Cancellation of registration of all mercury containing pesticides used as algaecides, slimicides, and in laundries were recently cancelled. This will help reduce the direct contamination of our waters with mercury. Mercury used in ship bottom paints are not being cancelled; however, these products are being phased out by paint companies on their own accord. Phenyl mercury acetate is still on the market for control of crabgrass and certain turf fungi in lawns and golf courses. However, this Agency is making a thorough review of all the remaining uses for mercury preparation used as pesticides. Further cancellations will be made if the study shows that other uses of mercury are hazardous to humans or the environment.

Registrations of certain 2,4,5-T liquid herbicides used around the home and on lakes, ponds, and ditch banks have been suspended. Registration of nonliquid formulations of 2,4,5-T used around the home and on all food crops intended for human consumption, including apples, blueberries, cereal grains, rice, and sugarcane were cancelled. These actions did not affect the use of 2,4,5-T on ranges, pastures, forests, rights-of-way, or on other nonagrictultural lands, providing cautions were exercised not to use these products near homes or recreational areas.

Instructions of the U.S. Court of Appeals issued as a result of the case of *Environmental Defense Fund, et al., v. William D. Ruckelshaus, Administrator of the Environmental Protection Agency, et al.,* are being followed. This Agency published a notice in the Federal Register on January 20 requesting written comments on the question of whether DDT or 2,4,5-T products constitute an imminent hazard to the public. A review of the comments received along with other pertinent informaiton will be made to determine if registrations for products containing those chemicals should be suspended immediately. The report is due on March 18, 1971.

In the face of court actions, cancellation and suspension of registrations of products containing 2,4,5-T, there is an advisory committee appointed by the National Research Council that is reviewing the uses of 2,4,5-T to determine if the suspensions and cancellations are to be upheld. They held their final meeting on Monday and Tuesday, March 8 and 9. Their report with recommendations will be issued in about thirty days.

The use of amitrole is being reviewed by an advisory

[1]Chief Staff Officer, Herbicides and Plant Growth Regulators Staff, Environmental Protection Agency, Washington, D.C.

committee and their report is due soon. The registered use of amitrole on cranberries had already been cancelled. The fate of this chemical now hangs in the balance. Chlordane for crabgrass control is rapidly being phased out by the registrant. The rate of 60 pounds actual chemical per acre product resulted in an extremely large amount of persistent herbicide in the soil which was not good.

Picloram, an excellent chemical for killing weeds, has not been registered for use on any crop. There is hope that it may find use in isolated range country for controlling brush and hard-to-kill weeds. This chemical is extremely phytotoxic and is mobile; i.e., readily soluble in water and transported with water movement to cropland areas where it should not be.

Dicamba, a good herbicide for use in controlling lawn weeds, like sheepsorrel, knotweed, and clover, causes considerable injury to hedge, shrubs, and trees with roots extending into the grass area that has been treated. Many companies are discontinuing the use of dicamba as a mixture with other herbicides and fertilizers for use on home lawns.

We, in the Environmental Protection Agency, are aware of the problems faced by farmers, ranchers, and foresters in maintaining economic production in view of the possible restrictions on certain pesticides. We will make every effort to develop policies which will continue to provide for effective pest control while protecting the environment from further contamination.

THE RESPONSE OF CANADA THISTLE TO SOIL-INJECTED HERBICIDES

D. E. Baldridge[1]

Canada thistle (*Cirsium arvense* (L.) Scop.) was exposed to soil injected treatments of three chemicals at Huntley, Montana, in 1970. Dichloropropene (Telone) was applied at 30, 45 and 60 gallons material per acre with dicamba and fenac at 3 and 6-4½ and 6 lbs. per acre respectively. The dicamba and fenac were applied with water at the rate of 30 gallons per acre.

The herbicide treatments were applied on November 6, 1969, in a Pryor clay soil containing 25 percent moisture at 53° F. The herbicide solutions were injected into the soil to a depth of 10 inches with a 12-foot liquid fertilizer injector having shanks on 12-inch centers. The area was rolled immedaitely following injection with flexible roller.

[1]Montana State University Agricultural Experiment Station, Huntley, Montana.

Treatment		% Control
dichloropropene	30 gal.	80
dichloropropene	45 gal.	100
dichloropropene	60 gal.	100
dicamba	3 lbs.	95
dicamba	6 lbs.	100
fenac	4½ lbs.	30
fenac	6 lbs.	50

Sugar beets, corn, barley and pinto beans were planted in the dichloropropene plots on June 1, 1970, and normal growth was achieved.

PRODUCTION OF SUGARBEETS WITHOUT HAND WEEDING

E. E. Schweizer[1]

(*Abstract*) A crop of sugarbeets (*Beta vulgaris* L.) was produced by controlling annual weeds between the rows with cultivation and within the rows with herbicides. The competition of foxtail millet (*Setaria italica* (L.) Beauv.), kochia (*Kochia scoparia* (L.) Schrad.), and pigweed (*Amaranthus* spp.) was nearly eliminated throughout the growing season by a combination of 3 lb/A of cycloate plus 1 lb/A of 3′-(*N*-isopropylcarbamoyloxy)propionanilide (R 11913) applied preplanting and 1.5 or 2 lb/A of phenmedipham applied postemergence. This combination of treatments had reduced the average stand of the three weed species by 98% in 1969 and 90% in 1970 when weed control was assessed in June. In October, weed control was estimated to be 95% in 1969 and 85% in 1970 where the combination of treatments had been used. Since competition from weeds was minimized all season, the yield of roots was only 0.7 tons per acre less in 1969 and 1.1 tons per acre less in 1970 than the untreated, hand-weeded check. Yield of sucrose per acre in the treated plots was reduced less than 500 pounds per acre. These differences were not significant at the 5% level of probability.

[1]Plant Physiologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture, in cooperation with the Colorado Agricultural Experiment Station, Fort Collins, Colorado.

PREPLANT INCORPORATED AND POST-EMERGENCE HERBICIDE COMBINATIONS FOR WEED CONTROL IN SUGAR BEETS

Robert F. Norris[1] **and Jack P. Orr**[2]

During the last few years there have been several reports that complementary treatments of a post-emer-

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gence herbicide over a previous preplant incorporated treatment were superior to either type of treatment applied alone. Several trials have been establishd to study such combinations for use in California grown sugar beets. This report discusses three such trials conducted during 1970 in the Sacramento Valley.

The methods used were similar for all trials. All were on furrow irrigated sugar beets grown on single row beds, spaced 30″ on center. Cycloate was incorporated 3-4″ deep; 2-chloro-N-(isobutoxymethyl)-2′,6′-acetoxylidide (CP-52223) and pyrazon were incorporated approximately 1½″ deep, all using a power driven rotary tiller prior to planting. Post-emergence treatments were applied with a CO_2 backpack sprayer delivering 30-35 gal/A, at the 2 true-leaf growth stage of the sugar beets in the untreated plots. All fields were thinned and cultivated following normal field practice. The soil types at the three sites, with soil analyses from two, are shown below:

Location.	EC	% OM	% Clay	% Silt	% Sand	Description
Sacramento-Elk Grove	1.11	0.75	18.5	28.5	53.0	Sandy loam
Sacramento-Courtland	2.30	4.10	42.5	24.5	33.0	Clay loam
Colusa		No data available				Clay

Split plot analyses of variance have been performed where appropriate.

Results and discussion

At Elk Grove (Table 1), in the sandy loam soil CP-52223 alone at 0.75 lbs/A provided good weed control coupled with excellent crop safety, being considerably superior to the commercially applied cycloate in both respects. Almost complete weed control was provided by 1.5 lbs/A but was more injurious to the sugar beets at early stages, although this was not reflected in beet number or tonnage at harvest. In fact, at harvest, both 0.75 and 1.5 lbs/A of CP-52223 treatments had significantly higher numbers of sugar beets than the untreated check. 3.0 lbs/A of CP-52223 reduced the stand and severely stunted the beets; weed control was essentially complete. The fact that beet stand and tonnage for the 3.0 lbs/A treatment of CP-52223 was not reduced at harvest was somewhat suprising in light of the severe early injury; it emphasizes very clearly the ability of the beet plant to recover from an early setback. Commercially applied cycloate at 4.5 lb/A was not equal to CP-52223 at 0.75 lbs/A although the number of beets harvested and the tons/A were not significantly different from the untreated control. Pyrazon alone did not provide satisfactory weed control. Phenmedipham or Pyramin-plus post-emergence treatments did not give adequate weed control. Phenmedipham was, however, considerably superior to Pyramin-plus although it did injure the sugar beets to a somewhat greater degree. Overall, both post-emergence treatments resulted in significantly reduced beet number at harvest, although tonnage was not affected. Combinations of preplant and post-emergence treatments did not provide useful benefit in this trial, as marginal increases in weed control were offset by considerably increased beet injury. Data obtained at harvest time showed a significant interaction between preplant and post-emergence treatments for numbers of sugar beets per plot; the combinations with CP-52223 or pyrazn reduced the number of beets harvested. Tons/A, percent sucrose, and lbs/A of sucrose did not show such an interaction, and no treatment showed a statistically significant (at 5% level) difference from the check, although some herbicide treatments were significantly better than others; for example cycloate followed by phenmedipham or Pyramin-plus, or 0.75 lb/A CP-52223 followed by phenmedipham were superior to 1.5 or 3.0 lbs/A of CP-52223 followed by phenmedipham.

At the Courtland trial CP-52223 again provided very good weed control coupled with good sugar beet safety (Table 2). In this heavier soil 1.5 lbs/A was required to achieve adequate weed control; also, in this soil 3.0 lbs/A produced only slight sugar beet injury. All treatments of CP-52223 significantly reduced the stand in the 5/28/70 count, but no differences in stand were recorded at harvest. This was attributed to thinning negating this early effect. Cycloate or pyrazon alone did not provide commercially acceptable weed control, primarily because of lack of effect on the heavy stand of knotweed (*Polygonum aviculare* L.). Phenmedipham alone post-emergence also provided acceptable weed control and crop safety, without any reduction of sugar beet stand. Pyramin-plus alone did not provide adequate weed control, and even in combination with preplant herbicides it was considerably less effective than phenmedipham. Preplant combinations with phenmedipham did provide increases in the weed control attained, but this was again offset by increased sugar beet injury. Overall, no treatment produced significant effects at harvest either in number of beets per plot, tons/A, percent sucrose or lbs/A of sucrose.

No yield data are available for the Colusa trial as the sugar beets will not be harvested until spring 1971.

Table 1. Effect of preplant incorporated and post-emergence herbicides for sugar beet weed control at Elk Grove, Sacramento County.

Applied 3/27/70 Pre-plant Incorporated	Lbs/A	4/22/70 Sugar Beet Vigor	4/22/70 Grass Control	4/22/70 Broad Leaf Control	Applied 4/22/70 Post-Emergence	5/5/70 Sugar Beet Estimated Stand	5/5/70 Sugar Beet Estimated Vigor	5/5/70 Barnyard Grass Control	5/5/70 Broad Leaf Control	No. of Beets/60'	Tons/A	% Sucrose	Lbs/A Sucrose
CP-52223	0.75				Pyramin plus[1]	9.3	6.5	9.6	10.0	86.0	30.8	12.8	7906
					Phenmedipham[2]	8.0	5.8	9.8	9.8	66.5	33.7	13.3	8984
		6.6	8.9	9.0	Untreated	9.8	9.4	8.6	8.5	99.5	34.3	11.9	8116
CP-52223	1.5				Pyramin-plus	7.2	6.0	10.0	10.0	61.5	25.3	12.6	6579
					Phenmedipham	6.0	4.2	10.0	9.9	66.0	26.3	12.7	6726
		4.5	10.0	10.0	Untreated	8.9	7.8	9.9	9.5	100.8	34.6	12.4	8554
CP-52223	3.0				Pyramin-plus	3.5	3.0	10.0	10.0	56.2	28.6	13.8	7994
					Phenmedipham	3.2	2.5	10.0	10.0	62.8	26.5	13.1	7114
		2.2	10.0	9.9	Untreated	4.8	4.8	10.0	9.5	77.0	32.4	13.0	8470
Pyrazon	4.0				Pyramin-plus	10.0	7.9	4.0	6.9	81.0	32.4	13.6	8781
					Phenmedipham	9.8	6.6	7.2	8.9	81.0	29.7	14.1	8380
		8.2	2.5	7.2	Untreated	9.8	10.0	1.2	5.0	91.5	31.6	14.0	8880
Untreated Check					Pyramin-plus	9.8	8.0	2.0	4.5	86.0	32.0	12.6	8086
					Phenmedipham	9.0	6.2	5.8	6.2	83.0	29.3	13.3	7833
		8.9	0.0	0.0	Untreated	10.0	10.0	0.0	10.0	63.2	28.9	12.7	7331
Cycloate (commercial)	4.5				Pyramin-plus	9.0	5.2	9.1	9.8	76.8	35.6	13.0	9225
					Phenmedipham	8.8	4.5	9.7	9.9	94.8	35.6	12.9	9157
		7.0	9.2	9.3	Untreated	9.5	8.2	7.6	8.5	81.0	34.0	12.0	8245

All data are mean of 4 replications.
[1]Pyramin-plus used at 12.0 lbs/A of product.
[2]Phenmedipham used at 1.5 lbs/A.
Crop stand or vigor: 0 = none or dead, 10 = no effect or full vigor.
Weed Control: 0 = none, 10 = complete.

Table 2. Effect of preplant incorporated and post-emergence herbicides for weed control in sugar beets near Courtland, Sacramento County.

Applied 4/10/70 Preplant Incorporated	Lbs/A	5/20/70 Sugar Beets Stand	5/20/70 Sugar Beets Vigor	Applied 5/20/70 Post Emergence	5/28/70 Sugar Beets Stand[1] Count	5/28/70 Sugar Beets Vigor	5/28/70 Overall[2] Weed Control	Harvest 9/27/70 Tons/A	Harvest 9/27/70 Stand[1] Count	Harvest 9/27/70 % Sucrose	Harvest 9/27/70 Lbs/A Sucrose
CP-52223	0.75			Phenmedipham[3]	52	5.9	9.3	32.5	27.1	15.4	8,332
				Pyramin-plus[4]	56	8.5	8.5	33.8	30.9	16.3	10,154
		9.4	8.4	Untreated	59ab	9.6	6.4	36.0	27.4	16.0	8,770
CP-52223	1.5			Phenmedipham	59	6.9	9.4	34.2	27.3	15.4	8,475
				Pyramin-plus	48	8.1	8.9	29.2	26.5	15.9	8,473
		8.9	8.4	Untreated	58ab	8.7	8.5	39.2	29.2	15.4	9,023
CP-52223	3.0			Phenmedipham	54	5.5	9.9	37.7	29.6	15.1	8,935
				Pyramin-plus	55	7.2	8.9	35.0	30.2	15.2	9,397
		7.9	7.2	Untreated	48a	8.2	9.1	33.0	29.9	15.8	9,482
Pyrazon	4.0			Phenmedipham	70	7.2	8.9	40.8	27.7	15.8	8,806
				Pyramin-plus	75	8.9	4.9	38.5	29.3	15.7	9,246
		9.9	9.9	Untreated	74c	10.0	3.2	39.2	27.6	16.4	9,044
Cycloate	4.0	10.0	9.5	Phenmedipham	65	7.4	8.8	38.2	26.8	16.9	9,075
				Pyramin-plus	70	9.0	1.1	35.2	28.1	16.6	9,395
				Untreated	73bc	10.0	1.8	37.0	29.1	16.4	9,424
Untreated Check		9.2	9.6	Phenmedipham	78	7.1	8.4	38.5	27.2	16.2	8,764
				Pyramin-plus	76	7.9	4.0	37.5	28.3	16.0	9,004
				Untreated	74c	9.5	1.8	34.8	28.0	15.8	8,820

All data mean of 4 replications. Means followed by different letters significantly different at P=0.05 level.
[1]Sugar beets/30′ row
[2]Weed species included **Polygonum aviculare, Atriplex patula** and **Brassica arvensis.**
[3]Phenmedipham used at 1.5 lbs/A.
[4]Pyramin-plus used at 12.0 lbs/A of product.

No chemical caused a statistically significant effect on sugar beet stand (Table 3). Vigor reductions noted on 7/6/1970, although moderate to severe, had all been outgrown by 8/20/70. CP-52223 required 3.0 lbs/A for good weed control. Cycloate plus EPTC also gave good weed control, but was one of the more injurious treatments. Cycloate or pyrazon alone provided moderate to good weed control. Pyramin-plus post-emergence, although it performed better than at Elk Grove or Courtland, provided only moderate weed control.

Phenmedipham alone at 1.5 lb/A was the best single herbicide in this trial, and early beet injury was rapidly outgrown. The preplant treatment of 2.0 lbs/A of cycloate followed by 0.75 lbs/A of phenmedipham post-emergence was marginally the best overall treatment. This marginal increase in weed control would probably not justify making two herbicide applications versus one post-emergence treatment of 1.5 lbs/A of phenmedipham.

Table 3. Effect of preplant incorporated and post-emergence herbicides for sugar beet weed control in Colusa County, California.

				7/6/1970			8/20/70
				Sugar Beets			
Applied 5/29/70 Preplant Incorporated		Applied 6/26/70 Post-Emergence		Stand Count 20′ Row	Vigor Estimate	Overall Weed Control	Vigor Estimate
Cycloate	2.0	Phenmedipham	0.75	52.0	6.0	9.6	9.8
		Phenmedipham	1.50	42.5	4.8	9.6	9.4
		Pyramin-plus	12.00	5.0	6.1	8.6	9.6
		Untreated Check		48.8	8.6	6.0	10.0
Cycloate	4.0	Phenmedipham	0.75	49.0	6.6	9.3	9.6
		Phenmedipham	1.50	43.5	5.5	9.8	9.3
		Pyramin-plus	12.00	31.2	5.0	9.3	9.2
		Untreated Check		44.8	7.9	8.3	9.7
Cycloate +	2.0+	Phenmedipham	0.75	38.8	5.5	9.8	9.7
EPTC	1.0	Phenmedipham	1.50	35.0	6.1	9.6	9.5
		Pyramin-plus	12.00	39.8	5.8	9.5	9.8
		Untreated Check		43.5	6.8	9.0	9.9
Pyrazon	4.0	Phenmedipham	0.75	40.8	6.1	9.2	9.4
		Phenmedipham	1.50	42.0	5.9	9.1	9.8
		Pyramin-plus	12.00	44.5	6.0	9.1	9.6
		Untreated Check		59.8	7.8	7.1	9.9
CP-52223	0.75	Phenmedipham	0.75	53.2	6.5	9.4	9.9
		Phenmedipham	1.50	39.0	4.2	9.6	9.2
		Pyramin-plus	12.00	49.5	6.6	8.5	9.8
		Untreated Check		47.2	7.5	7.5	9.8
CP-52223	1.5	Phenmedipham	0.75	38.2	5.1	9.4	9.4
		Phenmedipham	1.50	44.5	4.8	9.8	9.7
		Pyramin-plus	12.00	45.8	6.2	8.8	9.7
		Untreated Check		49.2	8.0	7.1	10.0
CP-52223	3.0	Phenmedipham	0.75	33.5	7.0	9.5	9.8
		Phenmedipham	1.50	44.0	5.0	9.9	9.4
		Pyramin-plus	12.00	49.8	7.0	9.8	9.8
		Untreated Check		51.5	8.1	9.4	9.8
Untreated Check		Phenmedipham	0.75	41.5	6.4	8.2	9.4
		Phenmedipham	1.50	41.0	6.1	9.2	9.6
		Pyramin-plus	12.00	52.5	7.1	6.2	10.0
		Untreated Check		48.5	8.8	1.8	9.8

All data are mean of 4 replications.

Summary

CP-52223 used alone preplant incorporated 1½" deep, at a rate appropriate to soil type proved superior in weed control and not significantly more injurious to sugar beets than cycloate or pyrazon preplant incorporated. Pyramin-plus performed poorly in all tests, and phenmedipham varied from excellent to poor. No evidence was obtained that would warrant advocating preplant incorporated and post-emergence herbicide combinations, unless cycloate or pyrazon had been used with poor resutls, when a phenmediphan treatment could be used to obtain better weed control, depending on the weed spectrum present. Throughout these trials it was obvious that moderate early injury, and even 20 percent stand reduction, to the sugar beets was of no significance at harvest. These fields were not planted to a stand, and it is possible that the injury seen in some instances could not have been tolerated in a field planted to final stand.

The assistance of Mr. Renzo Lardelli, laboratory technician; Mr. Robert Mullen, farm advisor in Contra Costa County; and Mr. Robert T. Peterson, farm advisor in Colusa County, is gratefully acknowledged.

A TWO-YEAR COMPARATIVE STUDY OF PYRAZON AND BAS 3501(2)-H-(DIMETHYLHYDROXYETHYLAMMONIUM-N-[2-PHENYL-4-BROMO-3-PYRIDAZON-5-YL] OXAMATE)

A. L Rivers[1]

Pyrazon (5-amino-4-chloro-2-phenyl-3(2H)-pyridazinone) as a preemergence herbicide and pyrazon combined with dalapon (2,2-dichloro-propionic acid, sodium salt) as a postemergence herbicide have been useful as sugar beet plant protectants for a number of years.

A promising pyridazinone numbered BAS 3501(2)-H (Dimethylhydroxyethylammonium-N-[2 phenyl-4-bromo-3-pyridazon-5-yl] oxamate) was tested in 1968. This herbicide can be formulated as an emulsifiable concentrate and has been tested in 1969-70 under the code numbers of BAS 3501-H and BAS 3502-H, primarily as a 2.5 lbs/gallon E.C.

During the 1969 and 1970 crop season this herbicide was directly compared to pyrazon and the pyrazon-dalapon herbicide combination. BAS 3501(2)-H and pyrazon were applied at the 4 lbs/A rate, preemergence. As a post-emergence application, BAS 3501(2)-H was again applied at 4 lbs/A rate and the pyrazon-dalapon combination was applied as Pyramin Plus @ 12 lbs product/A. The major weed species for all locations were *Amaranthus retroflexus* L., *Chenopodium album* L., *Echinochloa crusgalli* (L)., Beuav., and *Setaria viridis* (L)., Beuav.

Crop tolerance was good for both preemergence herbicides. Broadleaf weed control was not dramatically improved with applications of BAS 3501(2)-H. However, BAS 3501(2)-H proved to be a more consistent herbicide in controlling broadleaf weeds. Such consistency was less apparent for grass species. However, overall control of the grass species was improved with application of BAS 3501(2)-H. This consistency and/or increased herbicidal activity may be due to the increased solubility of the emulsifiable concentrate or due to the brominated moleculeof BAS 3501(2)-H as opposed to the chlorinated molecule of pyrazon.

Both Pyramin Plus and BAS 3501(2)-H showed similar (87% to 93%) control characteristics of the annual broadleaf weed species. A definite advantage was shown for Pyramin Plus over BAS 3501(2)-H in the control of the grass species present in the trials. For the two-year period, grass species control with Pyramin Plus was 84% to 95% compared to 66% to 78% for BAS 3501(2)-H.

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SEQUENCE APPLICATIONS OF HERBICIDES ON SUGAR BEETS, 1968-70

E. F. Sullivan and L. T. Fagala[1]

Studies have been conducted each year since 1965 to discover effective systems for chemical weeding in sugar bets. Results during 1965-67 revealed that post-emergence herbicides had increased effectiveness when placed timely after a preplanting herbicide. Reliable preplanting-postplanting sequences were formulated from these early results. These new systems employing labeled herbicides have performed exceptionally well, averaging between 90-100 percentage points weed control during 1968-70. Average root yields remained unaffected or were increased when compared to results obtained from the standard hand weeded and thinned plots. In addition, crop quality remained unaffected by chemical treatment. It is expected that application of herbicides in sequence will substantially reduce hand labor for the production of sugar beets in early decade 1970.

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FULL-SEASON WEED CONTROL IN SUGARBEETS IN THE 1970's

J. H. Dawson[1]

Production of sugarbeets (*Beta vulgaris* L.) traditionally has required a high input of hand labor. Although harvest has been fully mechanized for 20 years, weed control and thinning has required 2 to 4 hand operations per year.

In recent years, improvements in chemical and mechanical weed control and mechanical thinning have reduced the amount of hand labor needed to produce sugarbeets. Selective thinners have been developed that sense the sugarbeet plants and remove only the plants not needed for the final stand. Such machines cannot differentiate between seedlings of weeds and sugarbeets. Consequently, their benefit to sugarbeet production cannot be realized without excellent weed control before thinning.

The trend in the 70's will probably be towards analysis of total weed problems in sugarbeets. Components thereof will be identified, based on periods of the growing season, weed species involved, cultural practices, and environmental conditions. Control measures will be developed for each component. These will be synthesized into programs of full-season control that can bring the crop to harvest free of weeds.

Hand labor probably will not be eliminated as a method for weed control in sugarbeets, but its part of the total input for full-season control will be greatly reduced. The traditional use of labor for weed control at thinning time should be eliminated. Whether the crop is thinned by labor or by mechanical methods, the job will be done without consideration of weeds. The input of labor should become limited to one rapid operation late in the season when the few weeds that survived earlier control methods are removed.

Further improvements in machinery for mechanical weed control and for herbicide application can be expected.

As measures are developed and applied for the control of major weed species, other species of minor importance could increase and become of major importance if they happen to be tolerant of the treatments. Constant vigilance will be required to foresee potential new problems and forestall them.

Our work in Washington provides an example of analysis of full-season weed control in sugarbeets and synthesis of control components into a full-season control program.

We recognize three separate periods of the growing season, each of which has a distinct weed problem that is independent of the problems in the other periods. The periods, with approximate dates for Washington, are as follows: Period I is from planting to thinning (March 15 to May 5); Period II is from thinning until lay-by (May 5 to July 1); Period III is from lay-by until the weed end-point (July 1 to August 1).

Major annual weeds in Washington can be controlled in Period I with *S*-ethyl *N*-ethylthiocyclohexanecarbamate (cycloate) at 3 lb/A, introduced into the soil at or before planting, followed by a post-emergence application of methyl *m*-hydroxycarbanilate *m*-methylcarbanilate (phenmedipham) at 1 lb/A.

Weeds of Period II can be controlled by *a* ,*a* ,*a*,-trifluoro-2,6-dinitro-*N* ,*N*-dipropyl-*p*-toluidine (trifluralin) at ½ lb/A incorporated with a flex-tine harrow, follow by additional flextine harrowing over a 4-week period. Labor (usually not exceeding 5 hr/A) near the end of Period II removes the scattered weeds that may have escaped control measures for Periods I and II.

Weeds that emerge during Period III are troublesome only if the stand of sugarbeets is incomplete or non-thrifty. Vigorous sugarbeets in a full stand suppress weeds that emerge during Period III by shading them. Where the stand of sugarbeets is not complete, the residual activity of trifluralin, applied for weed control in Period II, controls weeds within the rows. Weeds may be troublesome between the rows in Period III because the area is not cultivated after normal lay-by, and cultivating, hilling, and ditching at lay-by expose untreated soil. Tillage between the rows at the end of July with tools mounted on a tractor with narrow wheels (10 inches wide) has controlled such weeds without seriously damaging the sugarbeets.

When control measures for all periods have been synthesized into programs for full-season weed control, total labor required for complete control has been reduced by 95%.

[1]Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the Washington Agricultural Experiment Station, Irrigated Agriculture Research and Extension Center, Prosser, Washington.

ECONOMIC POTENTIAL OF WEED CONTROL PROGRAMS IN THE 1970's

George Lapaseotes[1]

We have heard a lot of discussion today and in the past about the merits of chemicals and their application. There are a few people who feel, from using chemicals, that we are reducing tonnage and experiencing too much or too little control. Our experience in the past, from numerous studies conducted throughout the industry, tells us that there definitely is not a decrease in sugarbeet tonnage from the proper use of herbicides. In fact, we feel that the proper use of chemicals will increase labor performance, yield, acres, and sugar in the bag. This

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is our goal. It is true that today we can't say to a beet grower that we have a prescription to cure all his ailments and give him 100% weed control under all conditions, but we can honestly say, after all our mistakes, trials and successes, that we can give him the type of weed control he will be satisfied with and get a maximum acreage planted, worked, and harvested with what labor is on the market and with the criterion that our growers must contend with in using these people.

However, whatever our successes have been in the past, herbicides should be used as another tool in the production of sugarbeets. We are gratified to know that we have many good herbicides which have helped keep many of our growers from dropping out of the beet business. We feel that chemicals and their usage will continue to play a big part in the sugarbeet industry. In the G. W. Fact. Dists. last year, herbicide sales amounted to $282,326 for the beet crop alone. Farmers feel that, even though we can't completely eliminate labor with our present herbicides, it is still a large step in the right direction knowing that someday shortly the answer will come along. In Nebraska this year, we expect to see pre-emergence herbicides on 80% of our beet acreage, 10% treated with post-emergence, and 6% treated lay-by. Pre-emergence usage of herbicides has been widely accepted among the growers of the Great Western Sugar Company. Present-day post-emergence chemicals are generally quite specific as to control of weed species. In order to get the most from post-emergence herbicides, growers must know which herbicides control which weeds, and when to apply these chemicals. We have learned that lay-by herbicides effectively control late-emerging weeds. Increased cost of labor is having the effect of causing growers to search for other means of weeding and thinning sugarbeets. We know that variables exist which cause failures in the chemical and mechanical systems, and we feel that it is wise at this point to continue supplying labor to a beet grower at a rate agreeable to him. Growers are willing to put up with reasonable levels of frustration, but they are hesitant to take any financial loss resulting from faulty application of herbicides. Growers know from past experience that failures will be their loss and we still have some growers who want to sit back and wait to see the proof. A few have tried to eliminate labor entirely, and they usually get by the thinning operation, but end up requiring a weeding prior to harvest. Widespread use of selective herbicides, monogerm seed, and electronic thinners now provide a better opportunity for growers to grow beets without hand labor. Growers want to eliminate the dependence upon labor and they are making the extra effort needed to accomplish this, but the system is not yet dependable enough to work every year under the varying climatic conditions that are encountered. Complete independence from hand work, therefore has not been realized, and we can't say we've produced many acres of "labor-free beets." Quite candidly, our growers will continue to grow beets as long as they can profitably, and with a system they like. I believe that the production of beets without large numbers of migrants and increased usage of herbicides is possible and very close, but "no-labor beets" will not become a reality for some time to come.

There have been more strides and advancement made over the last 10-year period in the raising of the sugarbeet crop than in the 50-year period previous to this time. We will see this trend continue at a more accelerated pace during the 1970s. We predict that by 1973, labor performance, as a result of herbicide usage, will be twice what it was in 1968. We predict that the sugarbeet crop will, for the most part, be completely mechanized before we enter the next 10-year period of the '80s. Electronic thinning, in combination with herbicide usage, will become a way of life during our present 10-year period, and most of the hand thinning will diminish. There is no question that labor costs will be replaced with the cost of chemicals. As an example, if we apply a medium rate (3 lbs.) in a 7-inch band of Roneet pre-emergence costing $5 per acre for material, Pyramin-Plus Post-Emergence costing $7.72, and Eptam as a lay-by, costing $2.178 per acre, we come up with a total material cost of $14.90 per acre. Custom selectronic thinning costs $14.50 per acre. Combine these two costs, and you come up with $29.40 per acre, or a comparable cost of which our average grower today puts out for hand labor. From the economic aspect, herbicide and machine costs must be comparable to hand labor costs. I believe hand labor will price themselves out of the picture. Over-capitalization will remain a problem, but growers have a source of skills and equipment for critical operations, providing the rates are reasonable. In order to keep a beet grower in business, we need to keep the economic picture in balance.

There will be no new labor houses built in the very immediate future because of the capital expenditure involved and because we feel that our beet growers realize that the manpower needed to raise an acre of sugarbeets will be reduced substantially before we enter the priod of the '80s. Much energy is being exerted toward mchanizing the crop. Sooner or later, we will be forced to mechanization. Growers will make this transition faster when they are in the right frame of mind, and as labor costs continue to rise. This transition is rapidly picking up tempo.

It is gratifying to know that we have so many ways to eliminate weeds with the chemicals on hand. It presently appears that we have a three-barrel shotgun to get the job done, and we have enough ammunition for all three barrels in the form of pre-, post-, and lay-by herbicides. Our best chemical prescription that we have on the shelf today is called "good farming practices." By using this medicine, we can incorporate all of our techniques and knowledge and eliminate our No. 1 problem, weeds, which in turn, will eliminate labor; and I feel that we, as processors and producers will be able to produce a maximum tonnage crop at a fair return to all.

USE OF DYE AS A MODEL OF HERBICIDE DISSIPATION IN IRRIGATION WATER[1]

Robert J. Demint

(*Abstract*) Three continuous applications of rhodamine-B dye of 15, 30, and 56 minutes duration were made at a single site, to Boulder Feeder Canal, to provide the equivalent of 2,500, 4,400, and 6,600-ft. of surface treatment. Families of curves are presented for each application, based on dye concentration and time for passage of the dye at sampling stations, 0.25 to 9 miles downstream from the application site. The curves were asymmetrical; leading edges were shorter than tailing edges and the ratio of tailing edge to leading edge increased with downstream flow. Reductions in maximum concentration with downstream flow were 74, 47, and 32% for the 2,500, 4,400, and 6,600-ft. applications, respetcively. Elongations of the dye clouds with downstream flow were linear. Rates of elongation were 12, 18, and 18 minutes/mile of flow for the 2,500, 4,400, and 6,600-ft. applications, respectively.

Introduction

One of the problems encountered in herbicidal dissipation rate studies on irrigation canals is the rate of elongation of the herbicidal cloud as it moves downstream. This information is required to properly plan sampling schedules so as to obtain representative residue samples. Another area of concern is the influence of the length of a ditchbank treatment alongside an irrigation canal on the rate of dissipation of residues in irrigation water. Previous monitoring of herbicidal residues in irrigation water, following ditchbank treatments of one-half to one mile in length alongside irrigation canals (1), has demonstrated the futility of predicting dissipation rates with any degree of reliability becaus of variable input factors. The continuous injection of material at a uniform rate into a canal was shown to provide conditions for obtaining data sufficiently reliable to enable calculation of dissipation rates and prediction of downstream distances at which residues would be reduced to a negligible level. The rapidity, accuracy, and high precision of fluorescent-dye analysis in water at low ppb concentration suggested the use of dye as a model of behavior of water-soluble herbicides in irrigation water.

Field Methods

The Boulder Feeder Canal near Lyons, Colorado, was selected to conduct this study. At the time of treatments, the water was clear and free of suspended sediments. The canal bottom and slopes were covered with numerous small stones; submersed weeds were absent and very few bank weeds were present. Continuous applications of rhodamine-B dye solutions were made at a uniform rate on three different days and were calculated to provide approximately 300 ppb in the canal water at the injection site. The dye was injected from a 3-nozzle boom held a few inches under the water surface. Table 1 shows the flow characteristics of the Boulder Feeder Canal and lists some of the dye treatment data for the three applications. All three treatments were made from the same injetcion site. The volumes of water flow at the time of treatment were 153, 97, and 58 cfs and provided flow rates of 2.8, 2.5, and 2 ft./sec., respectively. Treatment time of 15, 30, and 56 minute duration were equivalent to treatment lengths of 2,500, 4,400, and 6,600-ft., respectively.

Eight sample stations were selected for the shortest treatment of 2,500 ft. These stations were located 0.25 miles below the dye injection and each 1.25 mile thereafter up to 9 miles. Data analysis immediately following the 2,500-ft. treatment allowed reduction in the number of sample stations to 7 and 5 for the 4,400 and 6,600-ft. treatments, respectively. Water samples were caught at each station shortly before arrival of the dye and at equally spaced time intervals throughout passage of the dye cloud. Sampling intervals were 2 minutes apart at the first station following the 2,500-ft. treatment and gradually were increased at each succeeding station up to 9 minutes at the last station to compensate for dye cloud elongation. The same type of sampling was conducted for the two longer dye applications, except for an increase in spacing of sample intervals to provide for the longer dye clouds. This sampling schedule provided for a minimum of 9 and up to a maximum of 20 sample intervals at each station. All samples were collected in duplicate in polyethylene bottles and protected from light.

Analysis

Dye concentrations in the canal water samples were determined by fluorometric analysis on a Turner Model No. 111 Fluorometer. The instrument was equipped with primary filters No. 110-814 and 110-822, and with secondary filter No. 110-824. Dye concentration was obtained by direct comparison against appropriate

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[1]Cooperative investigations of the Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture and the Division of General Research, Bureau of Reclamation, Denver Federal Center, Denver, Colorado, 80225. Paper presented at the 1970 meeting of WSWS, Sacramento, Calif.

dye standards, and by using canal water for both dilution and reference calibration. Dial reading was a linear response at concentrations below 300 ppb, and this direct comparison eliminated the necessity of separate recovery determiations. The minimum detectable quantity of dye in clear water is considerably below 1 ppb (2).

Results and Discussion

The influence of treatment length on dye distribution in an irrigation canal, as a function of downstream movement, is shown in a series of three figures. For the family of curves (Figure 1) representing the 2,500-ft. application, short plateaus of maximum concentration occurred on curves o fthe 0.25 and 1.5-mile stations. These plateaus gave way to a pronounced peak at the 2.75 mile station, and gradually changed to a broadened peak at succeeding downstream stations. Between the first and last station a 74% reduction in peak concentration occurred. A skewing of the curves with downstream flow also was noted. For the 4,400-ft. application (Figure 2), the same general trend occurred. Two exceptions were noted. There was an increase in plateau length attribuable to increased treatment time. Reduction in peak concentration between the first and last station was 47%, which was considerably less than the 74% reduction noted for the shorter treatment. For the 6,600-ft. application (Figure 3), a further increase in initial plateau lengths was observed along with a 32% reduction in peak concentration between the first and last station. This reduction was considerably lower than values observed for the shorter treatments.

Since rhodamine-B is known to adsorb onto suspended particles (2), depending upon their nature, the determination of a mass dye balance was considered a prerequisite to interpretation of data obtained by the dye model. The amount of dye lost in transit was approximated by comparing the areas under the dye concentration curves for the first and the 7.85-mile station for all three dye applications. Calculated recoveries of dye at the last station ranged between 81 and 94%. Areas under the curves of each treatment obtained by planimeter or computation were in good agreement. The average losses of dye for all three treatments were 13 to 14%, with reductions in flow volume of approximately 5% between the first and last stations, accounting for a portion of this loss. The net reduction of 8 to 9% was considered minor for the time and travel distance involved, particularly when compared to the effects of dilution. In any event the loss by sorption was approximately equal for all three treatments.

It was noted earlier that all three families of curves (Figures 1, 2, 3) were asymmetrical. The time required for the dye concentration to reach a maximum (leading edge) was of shorter duration than the time required for the maximum amount of dye to dissipate (tailing edge). Table 2 compares the time of passage of leading and tailing edges and their ratios. At the first sample station the tailing edge time was 15 to 20% greater than the leading edge time. This disparity rapidly increased with downstream flow. After 8 miles of flow, the tailing edge was up to twice as long as the leading edge. Two factors contributed to this disparity. An 8 to 9% flow rate differential between leading edge and mean flow rates resulted in progressively earlier arrival of a low concnrtation of dye ahead of the main dye body, at each downstream station. This same differential flow was probably responsible for an equivalent amount of retardation throughout the tailing edge. Also of importance was the roughness factor, which exerted an additional retardation effect on flow along the canal margins. This was observed during the last stage of the tailing edge movement and was noted by clear water in the center of the canal followed by a slower dissipation of dye along the canal banks.

The progressive elongation of the dye cloud with downstream flow is shown in Figure 4. Dye cloud elongation was obtained by measuring the length of time in minutes for the dye to pass each station. Since ability to visually detect threshold dye concentrations of a few ppb was difficult, elongation times were arbitrarily calculated on time required for passage of 98% of the maximum dye concentration at each station. This required extrapolation for some stations, but did serve to provide a uniform basis of comparison. The elongations for the three applications were linear with downstream flow. Elongation rates derived from the slopes of these three lines were 12, 18, and 18 minutes/mile of flow for the 2,500, 4,400, and 6,600-ft. treatments, respectively.

These rates may be useful as an approximation for predicting passage time of herbicide clouds at various downstream locations, following ditchbank treatments alongside irrigation canals. Prediction of these passage times should facilitate monitoring studies and make possible more reliable scheduling of sampling frequency. Elongation rates could also be useful in determining time required for shutting gates on individual irrigation systems, to meet crop protection requirements of sensitive crops. It should be noted that these elongation rates were dependent upon the roughness factor. The roughness factor would vary on other irrigation systems with the number of drop structures and the amount of weed growth.

Figure 5 shows the influence of treatment length on both maximum and mean dye concentrations as a function of downstream flow. Some striking differences are immediately apparent. Within the family of curves for maximum dye concentrations the shortest treatment is curved and the two longer treatments are linear, while the family of curves for mean dye concentrations exhibits a degree of curvature inversely proportional to

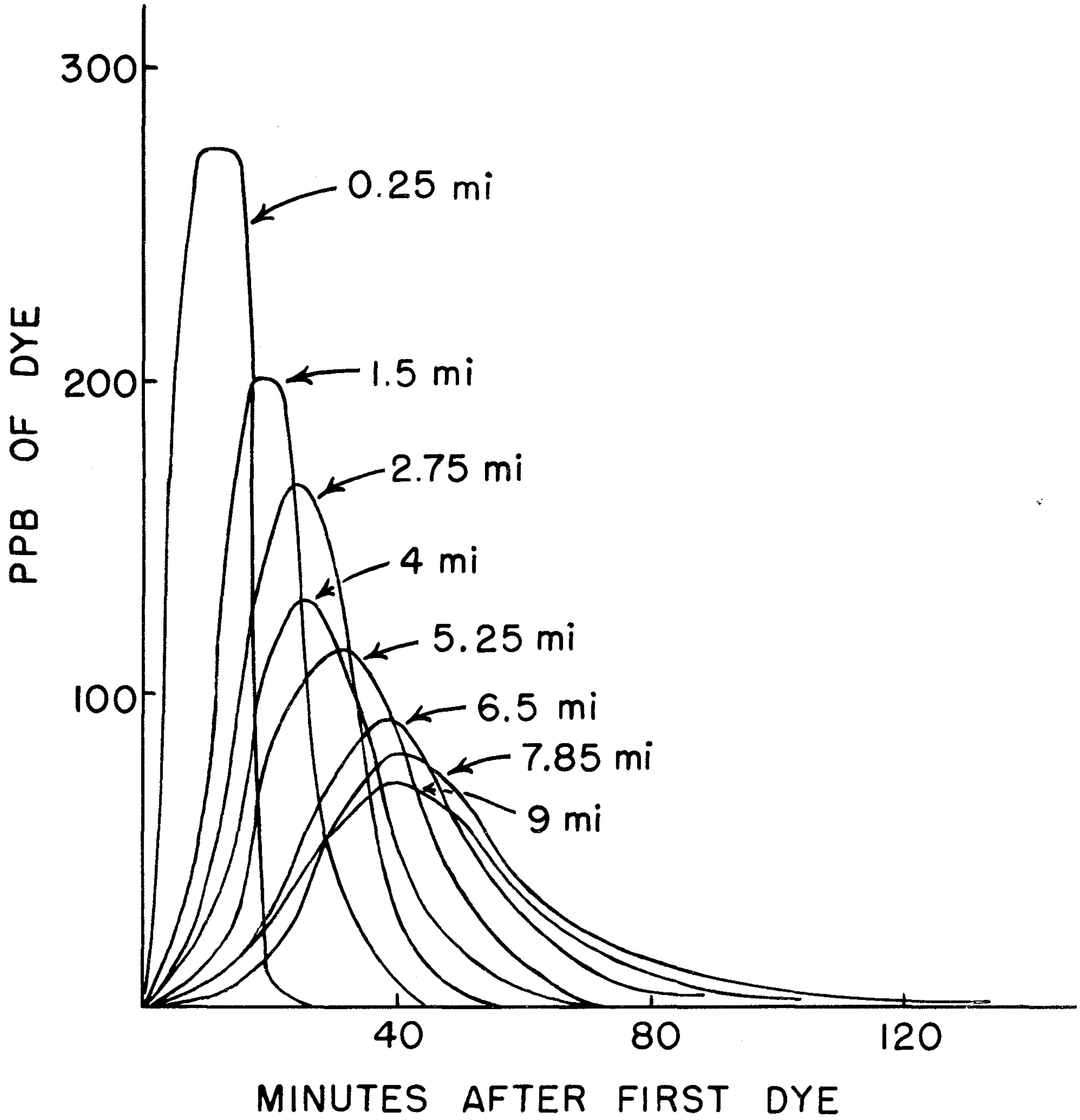

Figure 1. Dye movement in Boulder Feeder Canal following continuous injection of dye for 15 minutes to provide the equivalent of a 2,500-ft. application.

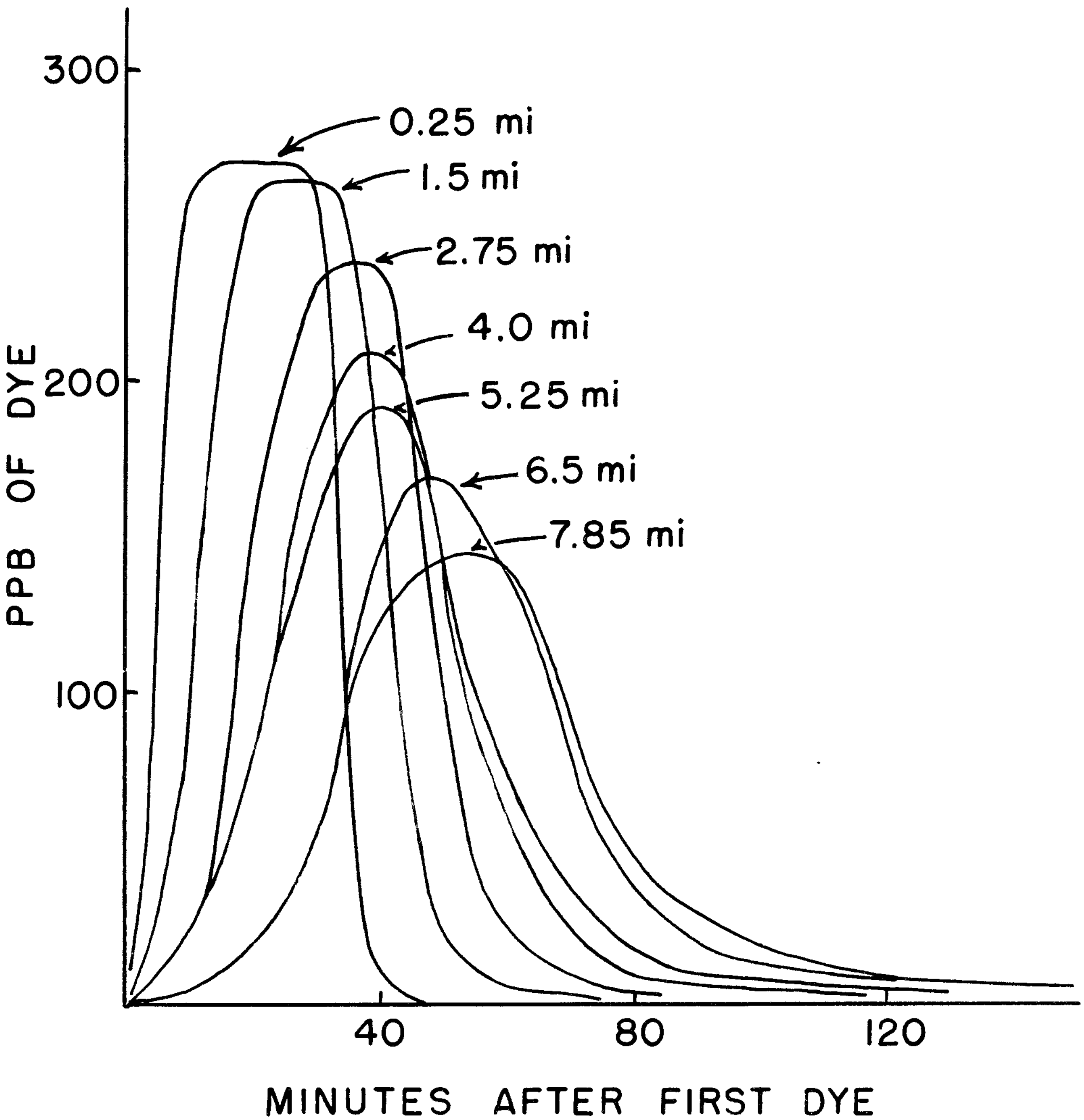

Figure 2. Dye movement in Boulder Feeder Canal following continuous injection of dye for 30 minutes to provide the equivalent of a 4400-ft. application.

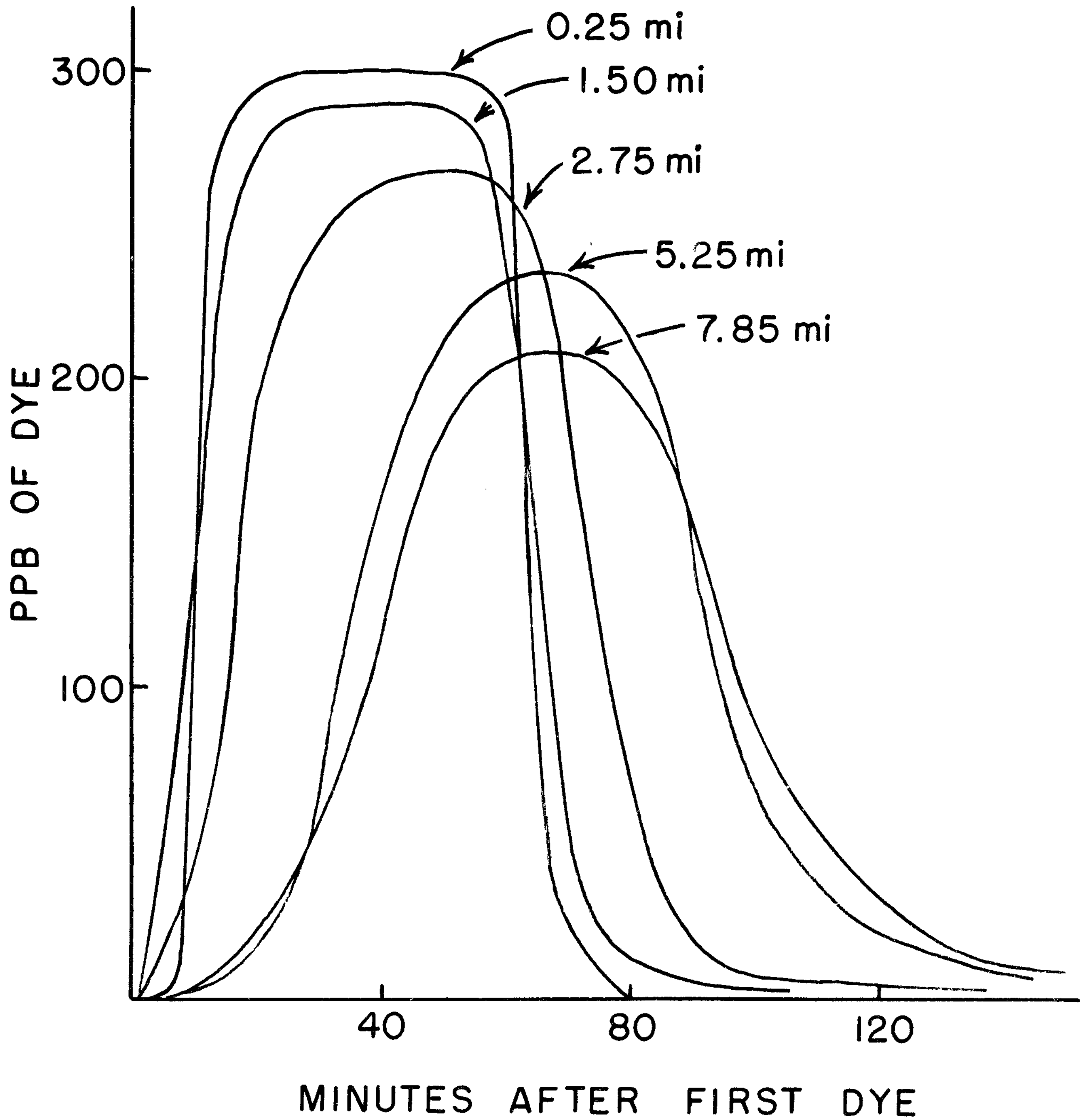

Figure 3. Dye movement in Boulder Feeder Canal following continuous injection of dye for 56 minutes to provide the equivalent of a 6600-ft. application.

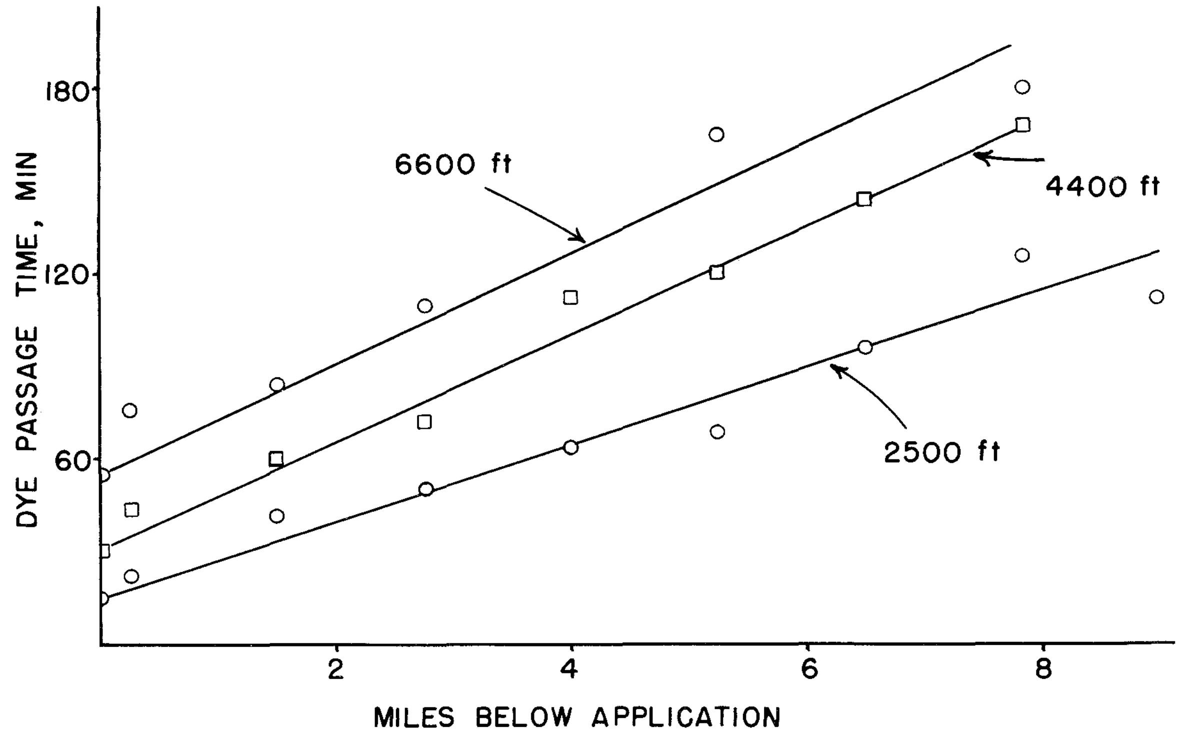

Figure 4. Elongation rates of dye clouds following three continuous dye applications to Boulder Feeder Canal.

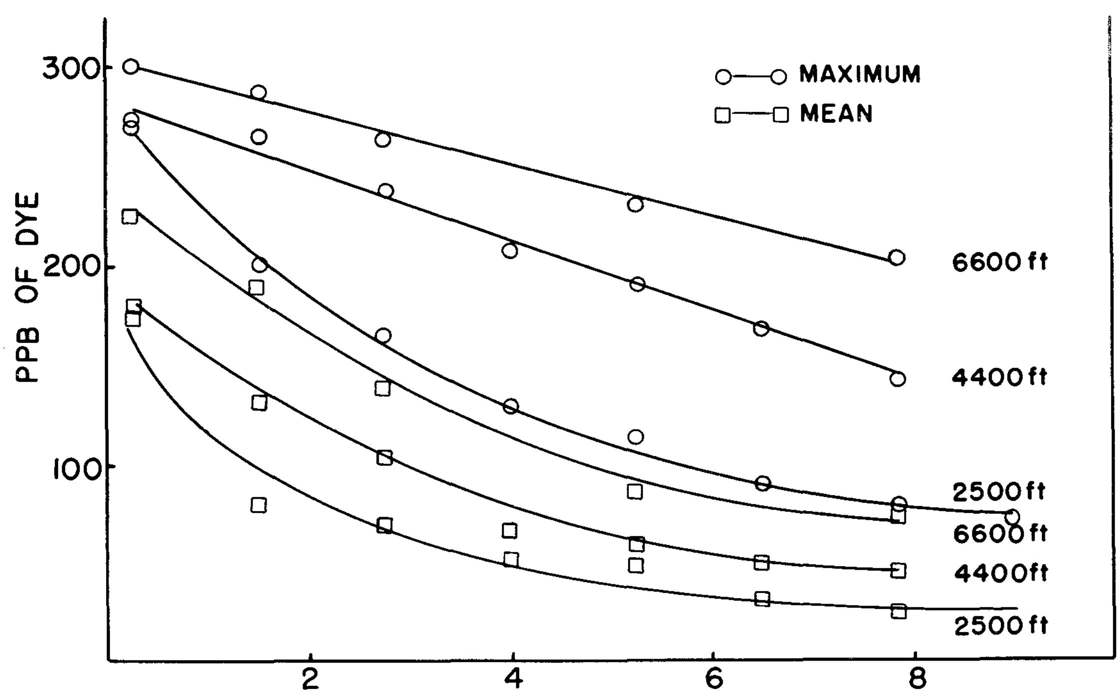

Figure 5. Influence of treatment length on dissipation of dye in Boulder Feeder Canal.

treatment length. Constant elongation of the dye cloud was noted previously. This constant elongation is typical of dilution action within the herbicide cloud. Maximum or peak dye concentrations are diluted by mixing with slightly lower adjacent dye concentrations. However, mean dye concentrations are a function not only of slow dilution within the peak area, but are also influenced by a more rapid dilution with water of zero dye concentration at both extremities of the dye cloud. Consequently, mean dye concentrations for the first several miles of downstream flow will dissipate at a more rapid rate than maximum concentration. However, as the dye cloud continues to move downstream, dilution exerts a progressively smaller effect on concentration. This is best demonstrated by the curve of maximum values for the 2,500-ft. treatment. Curvature is noted for the first 3 or 4 miles of flow, but as the dye cloud lengthens, dilution effects becoem less pronounced and the curve approaches linearity. Obviously, treatments of equal or shorter duration than the elongation rate would result in very rapid initial dissipation moderating with downstream flow.

Literature Cited

(1) Demint, R. J., P. A. Frank, and R. D. Comes. 1970. Amitrole residues and rate of dissipation in irrigation water. Weed Sci. 18:439-442.

(2) Feuerstein, D. L. and R. E. Selleck. 1963. Fluorescent tracers for dispersion measurements. J. San. Eng. Div., ASCE. 89:1-21.

Table 1. Boulder Feeder Canal characteristics and dye treatment data.

CHARACTERISTIC AND UNIT	TREATMENT		
Flow volume, cfs			
Application site	153	97	58
Last station	148	92	54
Treatment time, minutes	15.25	29.87	55.5
Length of treatment, ft	2500	4400	6600
Amount of dye, ml	2810	3480	3870
Volume of dye solution, gal.	15.25	30	54.5
Water temperature, C	8	8	8
Upstream canal width, ft	17	14	13
Upstream canal depth, in	56	42	32
Canal width at last station, ft	....	....	16
Application site flow rate, ft/sec	2.75	2.45	1.99
Leading edge flow rate, application site to last station, ft/sec	1.93	1.83	1.66
Mean flow rate, application to last station, ft/sec	1.79	1.67	1.53
Ratio of leading edge/mean flow rates	1.079	1.096	1.085

Table 2. Comparison of time of passage of leading and tailing edge of dye cloud with downstream flow.

Distance Downstream Miles	Leading Edge Minutes	Tailing Edge Minutes	Tailing/Leading Edge Ratio
	2500 foot application		
0.25	10	12	1.20
1.5	18	24	1.33
2.75	23	28	1.22
4.0	25	39	1.56
5.25	30	39	1.30
6.5	37	59	1.59
7.85	40	86	2.15
9.0	38	74	1.95
	4400 foot application		
0.25	20	23	1.15
1.5	25	35	1.40
2.75	35	37	1.06
4.0	38	74	1.95
5.25	39	81	2.08
6.5	48	96	2.00
7.85	53	115	2.17
	6600 foot application		
0.25	35	41	1.17
1.5	35	49	1.40
2.75	45	65	1.45
5.25	65	100	1.54
7.85	65	115	1.77

MINUTES OF THE BUSINESS MEETING MARCH 18, 1971

The meeting was called to order at 10:26 a.m. by President Dunster. It was moved and seconded that the reading of the Business Meeting Minutes from March 19, 1970, be dispensed with and approved as printed in the Proceedings. Passed unanimously.

Nomination Committee Report — S. Strew, Chairman, P. Heikes, J. Hodgson

J. Hodgson in the absence of Chairman Strew reported the results of the balloting, Officers elected by the Society are:

President-Elect ....D. E. Bayer
Secretary ....C. H. Slater
Chairman-Elect, Research Section....J. O. Evans
Chairman-Elect, Extension and
Regulatory Section ....E. S. Heathman

A motion to accept the nomination report was seconded and carried.

Treasurer-Business Manager Report — J. L. Anderson

Treasurer-Business Manager Anderson reported that the Society had $3,765.17 on hand and the potential Net worth was $3,819.17. He reported the Society had received 100% response to $20.00 contribution requests from industry to help defray coffeee break expenses. Increasing costs associated with the Society's meeting and publications has required an increase of $1.00 each for Registration, Proceedings, and Research Progress Report.

Finance Committee Report — J. McKinley, Chairman, J. Whitworth, J. Dawson

Chairman McKinley reported the Society's books kept by Treasurer-Business Manager Anderson were in good shape. Recommendations of the Finance Committee were:

1. Honorarium of $250.00 be given to Treasurer-Business Manager Anderson in appreciation of his efforts in behalf of the Society.
2. that the fees for registration, proceedings, and research progress report be combined. Following a discussion a motion was made that fees remain separated as is present practice. Seconded and carried.
3. that the society should maintain in reserve assets sufficient to provide for one year's operation.

Local Arrangeemnts 1971 Report — R. Zimdahl, Chairman, P. Heikes, G. Kennedy, E. Nelson, A. Gale

Chairman Zimdahl praised his committee for their hard work on the 1971 meeting but indicated he was unhappy with the service provided by the Hotel.

1972 Meeting—The 1972 WSWS meeting will be held at the Hotel Utah, Salt Lake City, Utah, on March 14-16, 1972.

1973 Meeting—The 1973 WSWS meeting will be held at the Hotel Ridgepath, Spokane, Washington.

Resolution Committee — W. Harvey, Chairman, L. Warren, A. Gale

The following resolutions were submitted to the Society for consideration:

Resolution No. 1

WHEREAS, federal registration of new herbicides or new uses is excessively time consuming and expensive and lacks well-defined protocol and guidelines for registrants to follow, and

WHEREAS, this extreme cost in money and manpower discourages the development of new chemical tools for agriculture and vegetation management, and

WHEREAS, such guidelines are needed to enable development of adequate research programs by Federal, State, grower and industry organizations to satisfy requirements for registrations, and

WHEREAS, limited funds by all agencies involved in research and development of new herbicides or new uses requires maximum return in these programs.

BE IT RESOLVED that EPA, in co-operation with Federal, State and industry scientists, be asked to formulate specific guidelines and requirements for registration of herbicides, including kind and amount of various types of data on performance, residues and safety studies, and that EPA streamline these procedures to reduce the time required for processing such petitions.

(Copies to be sent to Senators and Representatives representing this Region, chairman of National Advisory Committees, Agricultural, Pres. Science Advisory Committee and such other committees deemed influential in this area.)

Resolution No. 2

WHEREAS, the adverse effects of weeds on crop production, the health of man, and vegetation management on rights-of-way, highways and other noncrop areas are costly to our society and the total environment, Be it resolved that USDA be urged to devote a yearbook to the Impact and Costs of Weeds similar to the yearbooks devoted to Insects and Plant Diseases.

(Send to USDA and Chairman of Agricultural Committee.)

Resolution No. 3

WHEREAS, it is desirable to stimulate interest in weed science by college students and

Contents of courses and teaching methods in various aspects of weed science have not been emphasized in the clearing house functions of WSWS and this will contribute to the developmentof better Weed Science curricula at the various Universities.

Be it Resolved that WSWS program committee consider a section devoted to the exchange of ideas, techniques and information relating to weed science courses or curricula.

The Committee suggested that printing of appreciation resolutions should be discontinued. A motion to accept this resolution was seconded and carried.

Research Committee Report — G. Lee, Chairman

Chairman Lee reported the Research Progress Report totaled 177 pages with 83 authors participating. He indicated more care should be used in preparing reports.

A brief report was presented by each project chairman.

Project 1—Perennial Herbaceous Weeds. Report was presented for L. Sonders by R. Collins. The new chairman is R. Collins and the chairman-elect is D. Baldridge.

An excellent session with ample discussion followed brief topic presentations. There were 65 people in attendance.

Project 2—Herbaceous Range Weeds. Report was presented for R. Martin by W. Currier. The new chairman is W. Currier and the chairman-elect is J. Warren.

Discussion centered around four major topics these included a summary of range weed problems in Idaho; the Halogeton poisoning incident in Southern Idaho; insect control of range weeds; and research underway at the Rocky Mountain Forest and Range Experiment Station. There were approximately 30 in attendance.

Project 3—Undesirable Woody Plants. Report was presented by H. Morton. The new chairman is W. Gould and the chairman-elect is R. Martin.

Major topics discussed were need for determining the carrier and volume of carrier needed for optimum control, research to minimize drift and to obtain maximum deposition on target species, and need for continued manipulation of vegetation on public lands for implementation of the multiple-use concept.

Project 4—Weeds in Horticultural Crops. Report was presented for A. Lange by H. Agamalian. The new chairman is G. Massey and the chairman-elect is A. Ogg.

An attempt was made to develop a list of resistant and susceptible weed species to many of the herbicides common to horticultural crops. Other topics discussed were activity of herbicides in soil and the factors affecting their movement, incorporation of herbicides including the use of the spray blade, and application of herbicides in irrigation water.

Project 5—Weeds in Agronomic Crops. Report was presented by C. Slater. The new chairman is J. Evans and the chairman-elect is L. Warner.

There were 73 people in attendance. A symposium format was followed giving emphasis to weed control problems in small grains, corn, beans, and cotton. Following the summaries excellent discussions were held.

Project 6—Aquatic and Ditchbank Weeds. Report was presented by R. Comes. The new chairman is W. McHenry and the chairman-elect is D. Schachterle.

There were 54 people in attendance. The registration status of aquatic hrbicides, the need for a protocol to follow in the registration of aquatic herbicides, and comparison of chemical and mechanical control of aquatic and ditchbank weeds were discussed.

Project 7—Chemical and Physiological Studies. Report was presented by E. Schweizer. The new chairman is J. Corkins and the chairman-elect is R. Norris.

There were 100 people registered for this session. An informal symposium on foliar penetration and translocation of herbicides was successful.

Extension and Regulatory Section — Report presented by D. Swan.

An active discussion was held using a panel format. Regulatory input was represented by representatives from 9 states. Some lack of agreement on terminology was evident.

Education Committee on Weed dentification — Report presented by P. Heikes.

Committee has been inactive for the most part. It was suggested maybe committee should re-orient and prepare a list of literature that is available. This literature would include books, slide sets, etc.

WSSA Representative — Report was presented by K. C. Hamilton.

Representative Hamilton reported on WSSA business conducted at the Dallas, Texas, meeting in February 1971. A copy of his report is included in the Proceeding.

President Dunster reported he had appointed a Publications Committee to assist the Society with its publications. He then thanked those responsible for making the 1971 meeting a success. The Presidency was transferred to incoming President Arnold Appleby who adjourned the meeting at 11:47 a.m.

Respectfully submitted,
David E. Bayer,
Secretary

HONORARY MEMBERS

In recognition for their work in weed science and their years of service to the Western Society of Weed Science VIRGIL H. FREED, Department of Agricultural Chemistry, Oregon State University, and WILLIAM A. HARVEY, Botany Department, University of California, Davis, were cited and selected as honorary members of the Western Society of Weed Science.

FINANCIAL STATEMENT OF WESTERN SOCIETY OF WEED SCIENCE MARCH 10, 1970 — MARCH 10, 1971

Income

In hand, March 10, 1970	$3,146.37
Registration, Sacramento Meeting	496.00
Dues, persons not attending meetings	70.00
Sacramento luncheon tickets	553.00
1970 Research Progress Reports	892.40
1970 Proceedings	928.70
Sale of old publications	61.00
Payment of outstanding accounts	29.20
Interest on savings	93.75
Advance payments	5.00
Chemical Company Contributions	380.00
	$6,655.42

Expenditures

Annual Meeting incidental expenses	244.43
Sacramento Luncheon	552.78
1970 Research Progress Report	628.94
1970 Proceedings	1,095.00
Office Supplies	95.50
Secretarial Help	36.00
Postage	197.00
Plaques for honorary members	40.60
Gratis publications (28)	
	$2,890.25

Liquid Assets		$3,765.17
Savings	(2,400.00)	
Checking	(1,265.17)	
Cash on hand	(100.00)	
Accounts Receivable		54.00
Potential Net Worth		$3,819.17
Old Publications on hand (555)		

CHAIRMAN AND CHAIRMAN-ELECT PROJECTS 1 THROUGH 7

Project 1 — Perennial Herbaceous Weeds

Chairman R. Collins, 229 N.E. 17th Street, Hillsboro, Oregon 97123

Chairman-Elect D. Baldridge, Montana State University, Huntley Branch Experiment Station, Huntley, Montana 59037.

Project 2 — Herbaceous Range Weeds

Chairman W. Currier, U.S. Forest Service, 517 Gold S.W., Albuquerque, New Mexico

Chairman-Elect J. Warren, P.O. Box 390, Davis, California 95616

Project 3 — Undesirable Woody Plants

Chairman W. Gould, Department of Agronomy, New Mexico State University, Las Cruces, New Mexico 88001

Chairman-Elect R. Martin, Bureau of Land Management, Portland Service Center, P.O. Box 3861, Portland, Oregon 97208

Project 4 — Weeds in Horticutural Crops

Chairman G. Massey, 7521 W. California Avenue, Fresno, California 93706

Chairman-Elect A. Ogg, Irrigated Agricultural Research and Extension Center, Prosser, Washington 99350

Project 5 — Weeds in Agronomic Crops

Chairman J. Evans, Plant Science Department, University of Utah, Logan, Utah 84321

Chairman-Elect L. Warner, 240 E. Braemere Road, Boise, Idaho 83702

Project 6 — Aquatic and Ditchbank Weeds

Chairman W. McHenry, Department of Botany, University of California, Davis, California 95616

Chairman-Elect D. Schachterle, U.S.B.R. Bldg. 20, Denver Federal Center, Denver, Colorado 80225

Project 7 — Chemical and Physiological Studies

Chairman J. Corkins, 1696 S. Leggett Street, Porterville, California 93257

Chairman-Elect R. Norris, Department of Botany, University of California, Davis, California 95616

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Secretary: C. H. Slater, 12821-25th Avenue, Spokane, Washington 99216

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Charman-Elect Research Section: J. O. Evans, Plant Science Department, University of Utah, Logan, Utah 84321

Chairman Extension and Regulatory Section: D. W. Swan, 173 Johnson Hall, Washington State University, Pullman, Washington 99163

Chairman-Elect Extension and Regulatory Section: E. S. Heathman, Agricultural Extension Service, University of Arizona, Tucson, Arizona 85721

Immediate Past President: K. W. Dunster, 221 Sierra Vista Drive, Loveland, Colorado 80537

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Treasurer-Business Manager: J. L. Anderson, Plant Science Department, Utah State University, Logan, Utah 84321

Member at Large: R. Zimdahl, Weed Research Laboratory, Colorado State University, Ft. Collins, Colorado 80521

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