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1970

**PROCEEDINGS  
of  
THE WESTERN SOCIETY  
OF WEED SCIENCE**

**VOLUME 23**

**March 17, 18, 19, 1970**

**Sacramento, California**



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1969-1970

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# Western Society of Weed Science

Sacramento Inn, Sacramento, California

March 17, 18, 19, 1970

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## THE CHALLENGE OF THE SEVENTIES

Harold P. Alley<sup>1</sup>

It gives me great pleasure to signal the opening of the Twenty-third Meeting of the Western Society of Weed Science. It has been a wonderful and enlightening experience to be associated and work with the officers and members of this society.

The local arrangements committee, chaired by Harry Agamalian, your president elect and program chairman, Ken Dunster, along with all others having responsibility have made my job as president the easiest assignment I have ever had to date in this organization.

At no time, am I aware, has any member hesitated to accept responsibility; the cooperation has been as one would expect from a group of dedicated hard working professionals. This I feel is what has held our organization together and makes the entire society from the regional conferences through the national the organization what it is today. I am sure that with the type of cooperation and response we had this past year we are going to become a closer knit and stronger organization than ever before.

There has been much concern and discussion over the past few years as to what the Western Society of Weed Science is accomplishing and how it might be reorganized to better meet the needs of all concerned. The advent of annual meetings of the WSSA and strong state weed associations competing for the weed scientists time no doubt are the leading forces bringing about a division of time. Mr. Bill Harvey will no doubt enlighten those in attendance on this very important subject later on this morning and enlighten the group as only Bill can.

I will go on record as stating that your program chairman has been very cognizant of previous grievances and has attempted to incorporate some of your thoughts into this year's program. There are controversial topics of immediate concern which we hope will bring about active participation from the extension, research, regulatory and industry representatives that make up the membership.

Section chairmen and specifically project leaders have been asked to organize their groups so that items of immediate concern may be discussed and summarized by leaders in these specific areas. The program chairman and myself hope that we do not have just a review of the research progress reports as published. Most of us can read. The various project areas may be the heartbeat of our society. I am in hopes that the efforts put forth by the respective chairmen for this year's meetings will be an added incentive for

future chairmen to improve upon what has been attempted this year.

The preparation of the presidential address has not been an easy task. I have, however, obtained a real insight into the history of weed control, its problems and growth, the needs and future of our endeavors along with its importance to the welfare of mankind by reviewing presidential addresses of previous national and regional presidents. I find it difficult to add to what has already been said. It would be well for all of you to spend a few minutes reviewing these outstanding dissertations.

Possibly some of the younger weed scientists, attending this meeting do not realize that the Western Regional Weed Conference was organized in 1938, the first of the four regional conferences, and eighteen years before the Weed Society of America. Also seven of the first eight state weed conferences or associations were organized from the eleven states making up the Western Society of Weed Science.\* There are many other firsts which could be elaborated upon.

I am of the opinion that this society, the Western, has a heritage to live up to. Many of the original leaders in the western region were also leaders in the United States and assisted in organizing other regional conferences as well as the national. Knowing many of these fine gentlemen, as many of you in attendance here today do, I deem it a challenge to give all I can to see that their efforts do not fall by the wayside. In respect for these individuals a challenge is directed to each member of the Western Society.

It was interesting to me to review the attendance figures of the Western Society of Weed Science. The past attendance figures may tell us a story. The first meeting held in Denver, Colorado, in 1938 had 24 in attendance. The largest registration was in 1960—495 registrants, when the Western was held jointly with the Weed Society of America in Denver. However, at the joint meeting last year in Las Vegas only 145 registered, quite a reversal from the first joint meeting. The other two largest meetings were in Sacramento in 1948 and 1956. The 1956 meeting was a joint affair with the California conference, 478 registered—the second largest in the history of the Western Conference. Registration the past two years has been around 250, except the low figure at Las Vegas. The Society should be cognizant of the trend and efforts made to evaluate the situation. One might ask—is there an austerity program, too many meetings, or are we not meeting the needs of the weed scientists in our region?

The general public does not understand the importance of agriculture and especially the importance that all pesticides play in bringing to them the high quality,

<sup>1</sup>Professor Weed Control and Extension Weed Specialist, University of Wyoming, Laramie.

\*Timmons, F. L. A history of weed control in the U.S. and Canada. In Press. Weed Science.



economical products to which they are now accustomed. The importance of agriculture and the endeavors of less than 10 percent of the population of the United States can be borne out in one quotation.

"People will sell their liberty, their all for food. A starving man knows no God, no country."

Experts tell us that there are 57 million square miles of land on earth, 3.5 billion people now, 7 billion by the year 2000. Therefore, there will be 125 souls per square mile or only 5 acres per individual. In 1955 the population of the United States was 165 million, which gives 2.8 acres of arable land per person. By the year 2000 the population is expected to approach 400 million, or leave only 1.16 acres per person.

In order to have an agriculture capable of meeting the really great challenge to mankind—the race between food supply and population increase—we must have an acceptance of modern science and technology as applied to agriculture, along with the fact that herbicides are an essential and primary part of agricultural production. We are witnessing a great race between the number of people and the amount of food available and food has to win.

Despite the use of all pesticides, the destruction caused by pests is staggering. The American farmer is spending about \$2.5 billion each year to control weeds and still losing 13.5 percent of their crop production to the ever present weeds.

The average American consumer today is spending about 16.5 percent of his disposable net income at the grocery store as compared with 25 to 30 percent spent by the average wage earner in western Europe and almost 50 percent by the average Russian worker.

It bothers me as well as others in the academic world and I do not understand the lack of enthusiasm for weed science by college administrators. In a survey of the administrators, which I made for the 1967 Western meetings, a conclusion would have to be made from their remarks that there was no projection in their program for any weed science department or even contemplation of added staff members.

When we realize that there are 4 times as many professional entomologists and 3.4 times as many plant pathologists as weed scientists within the agricultural colleges, we should be very proud of our accomplishments.

President Klingman in his recent presidential address to the WSSA stated that there were 4.5 times as many students in entomology and 2.3 times as many students in plant pathology as weed science. His remarks or mine today are in no way being critical of the entomology or plant pathology programs; it is only for the purpose of pointing out the inequality that exists.

I am sure that monies available for graduate assistantships could be one of the major limiting factors in the number of graduate students in the weed science curriculum. However, from my own personal experience, I question the lack of interest by administrators and the monies available as telling the whole story. I have found the young men that are desirous of obtaining advanced degrees in weed science are of a different breed than we find in many other disciplines. We have several inquiries each year as to the possibilities of graduate assistantships. When the complete program is outlined—courses ranging from botany, ecology, through the mathematics and chemistry disciplines—plus the field work I feel essential to secure the necessary background to be called a weed scientist, their interest fades.

I am proud of every graduate student with whom I have been associated. Each one has been a very conscientious, hard working young man who has had the initiative to implement on his own. No doubt all of you in the academics have the same feelings. I would rather have one student of the calibre just discussed than have a dozen who do not know the meaning of work and responsibility. We should not be tempted to substitute quantity for quality just for the sake of having more students than some other section in our college.

Conservationists, environmental defense groups, ecologists, wildlife groups and the other "do-gooders" are screaming that the farmers are poisoning the environment. Leaders and members of these groups, who are campaigning against the use of pesticides, must be informed and reminded that the very existence of every field of endeavor beyond that of producing food is possible because there is enough food to support those additional desires.

These people must realize that the efficiency of the American farmer, his ability to double yields during the past twenty years, has made it possible to preserve millions of acres of primitive habitat, establish game refuges, recreation areas, etc. Many of these areas no doubt would and could be adapted to livestock and crop production if the efficiency of the farmer was not what it is today.

There have been tremendous strides made in the development and use of herbicides. There are few crops or situations where control measures have not been developed; however continued efforts are necessary to keep up with the ever increasing problems. I am of the opinion that our biggest problems are not the screening and development of new herbicides, biological or mechanical means of control, but to be able to use what we now have. Every state is going to have to take it upon themselves to obtain labels and use clearances for those compounds which are necessary and essential to the productive agriculture capacities of their state. This seems to be a common practice in a



few of the states. With proper organization and delegated responsibility this is an area some of us are interested in exploiting.

Adverse publicity in the last six months has caused considerable concern. The 2,4,5-T situation may have done more to hurt the name of 2,4,5-T and herbicides in general than any release to date. Since this supposedly cooperative release we have seen a rash of accusations. "Arizonans Fear Forest Spray"—"Scientists Charge Plant Killer Causes Vietnamese Birth Defects"—TV Programs Show Pulled-Tendon Ducks—Goats Suffer Malnutrition—and all blamed on an application of 2,4,5-T. Why shouldn't such publicity cause concern among the citizens?

I am sure everyone is fully aware of what has transpired since the 2,4,5-T release in early October. We all owe a pat on the back to the president of the Weed Science Society of America and the executive committee for obtaining the article "Teratogenic Evaluation of 2,4,5-T" which was proposed for publication in science, analyzing the data and informing responsible people as to its fallacy.

I would like to discuss the 2,4,5-T situation, however, as it may be repetitious to many in attendance I will forgo any discussion of the study. Those that are not aware of the reports both by the authors of the proposed article and the remarks of the president and executive committee of WSSA, you would be enlightened by obtaining copies.

The most serious problem confronting our endeavors in correcting such situations is that we never seem to reach the general public who have been subjected to the fallacies in the first place. We tell each other about our problems, and other than being published in farm magazines, and farm papers, which the general public does not read, there seems to be no way we can get back to the general public. With the mass communications media available at our disposal we must make use of them; not TV programs at 10:30 in the morning or just articles in farm journals—but prime TV time, leading newspapers, radio, etc.

The adverse publicity and false accusations bring up a need for insisting that the decisions with respect to pesticide use be made by duly constituted regulatory groups, that each study be carefully analyzed to determine if the best design or the results justify the author's conclusions. Too often the fact that the study was conducted by respected individuals or published in a scientific magazine is accepted by the public as sufficient proof of validity. If one is not well versed in a field even the best intentioned person can be in error.

The resolutions adapted by the Weed Science Society of America at the 1970 meeting well summarizes what I am trying to say.

I would like to read to you their resolution—

WHEREAS, the Weed Science Society of America represents many scientific disciplines and is interested in all aspects of weeds and their control:

and

WHEREAS, the safety of human beings, wildlife, and aquatic life, and the quality of the environment are of prime importance; therefore be it

RESOLVED that the Weed Science Society of America at its 10th meeting in Montreal, Canada, February 3-5, 1970, recommends that the secretaries of the departments of agriculture; health, education, and welfare; the interior; or the heads of any inter-departmental committee or council, obtain an evaluation of all scientific data from a broad segment of the academic and industrial community and including, where appropriate, an evaluation by a select committee of the National Academy of Science and the Weed Science Society of America before publicly announcing restrictions on uses of herbicides.

BE IT FURTHER RESOLVED that such scientific evaluation consider the benefit/risk ratio, need for, value obtained, and the adverse consequences of such restrictions as these relate to the economies of food production, the stability of American agriculture, the health of the American people, and effects on the environment.

If we would follow the lead the National Agriculture Chemicals Association is taking we can help alleviate the situation. An article appearing in the September, 1969, Farm Chemicals magazine stated, "We are not looking for a fight with our publics. Ours is an industry based on science. Science is based on reason. We tend to base our campaign on reason. But we will campaign. We have learned from the Carson experience that appeasement as a tactic can be nearly fatal."

With these few sentences, chairman of the board, Dan Keating, caught the new spirit of the National Agricultural Chemicals Association. The unwritten but guiding policy: Defend every label of every member; wage a strong fight against impending legislation; and take the offensive wherever possible.

I have been critical of the news media and the unfavorable publicity toward pesticides. Maybe these accusations are not all bad. Maybe such actions will bring forth a more closely knit organization, a group which realizes we have a tremendous task confronting us, it is going to require the help of all in our scientific discipline.

It is time to call upon the scientific community to exercise all the objectivity at its command in bringing forth the facts pertaining to the use of pesticides and their effects upon the environment. It is time to separate scientific from the political if we are genuinely interested in developing a blueprint for action that will serve the best interests of mankind and his environment.



We need a coordinated effort by all weed scientists. This includes those engaged in research, extension, regulatory, and industry. The lines of communications must be kept open. We cannot afford a defeatist attitude. We are all dedicated to the wise use of herbicides, improvement of the environment, alleviation of hunger—our endeavors are for the benefit of all mankind.

With the black-eye we have been given, the task will not be easy or accomplished overnight. Knowing the calibre of men and potential that we have in the Western Society and in the National organization, I am positive intelligent well directed actions will be taken to educate the general public and restore confidence in our endeavors.

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**Abstract:**

**INTERNATIONAL TECHNICAL AID PROGRAM  
ON WEED CONTROL  
W. R. Furtick<sup>1</sup>....**

(Abstract) Oregon State University has sponsored a foreign aid weed control program for almost three years. This program is supported primarily by the United States State Department. Its goal is the development of modern weed control programs in underdeveloped countries, not only to increase quantity and quality of their food production, but also to help strengthen their overall economic development via more efficient farming practices.

We have a cooperative research program on new products and practices for weed control with the University of Hawaii. Hawaii provides the opportunity for year-around testing of herbicides, plus an opportunity to conduct tests under typical tropical conditions.

Weed control specialists are now located in Colombia and El Salvador. Additional placements are expected very soon in South America and Southeast Asia. These men cooperate with host country counterparts in improving research, teaching and extension programs, with the goal of developing local expertise to get the job done. Many of these countries also send capable young men to Oregon State and other Universities for advanced training.

A back-up staff is maintained at Oregon State University to handle the myriad of problems ranging from visas and passports to supply of needed chemicals and spray equipment.

We feel that good progress is being made in cooperating countries, and that there are many spin-off benefits to Oregon and the West. This program has benefited from consulting assistance by specialists from

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<sup>1</sup>International Plant Protection Center, Oregon State University.

other institutions, an example being Dr. Art Lange, and continued support of this type by others will be much appreciated.

The foreign weed control project was incorporated into a broader organization called the International Plant Protection Center at Oregon State in 1969. This Center was designed to serve as the administrative unit to provide needed coordination and back-up support for all present and projected foreign pest control programs at the University, including insect and disease control, rangeland brush control, etc.

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**2,4,5-T AND GOVERNMENT DECISIONS**

**Boysie E. Day<sup>1</sup>**

On October 29, 1969, Dr. Lee A. DuBridg, science advisor to the President, announced that the government would restrict the use of 2,4,5-T because of suspected hazards to human health. The announcement stated that the Departments of Interior and Agriculture would stop the use of 2,4,5-T in their own treatment programs in populated areas and situations where the residues could come into contact with man. It was stated that the Department of Defense would restrict its use of 2,4,5-T to sites remote from human habitation.

January 1, 1970, was announced as the deadline by which the Department of Agriculture would cancel all registrations for the use of 2,4,5-T on food crops, unless by that date the Food and Drug Administration had "found a basis for establishing a safe, legal tolerance in and on food."

The President's Office of Science and Technology later advised the Department of State to notify foreign governments of the nature of these actions and directed U.S. AID to promptly review its programs in terms of the restrictions.

The latter action made obsolete virtually all AID literature and assistance programs on pasture and range management throughout the world. For such is the importance of 2,4,5-T that any useful literature on the management of grazing land, in whatever part of the world and in whatever language, must tell how to use 2,4,5-T.

The drastic and dramatic nature of these pronouncements, the implications of general hazard to public health, and the fact that the restrictions came not from the usual regulatory agencies but from the White House would lead to the assumption that new and critical information had become available on the public-health hazard of 2,4,5-T. The DuBridg an-

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<sup>1</sup>Associate Director, California Agricultural Experiment Station, University of California, Riverside, California.



nouncement contained implications, hedged with precautionary statements, that important new research findings were available. This turned out to be an unpublished report by Bionetics Research Laboratories on studies carried out under contracts from the National Institutes of Health. This document is titled, "Teratogenic Evaluation of 2,4,5-T."

Although unpublished, this paper is now widely available through the "underground Xerox press." A part of the text of the paper is the following abstract:

"The herbicide 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) has been shown to be teratogenic and fetocidal in two strains of mice using either subcutaneous or oral routes of administration, and in one strain of rats by oral administration. Both cystic kidney and cleft palate were produced in the mice and cystic kidney was also produced in the rats. In addition, an increase in liver to body weight ration in the mouse fetus and the occurrence of hemorrhagic gastrointestinal tracts in the rat fetus suggests that this compound also has fetotoxic properties."

In my view, these findings would fully warrant the action taken by the Science Advisor to the President, provided it can be ascertained that: (1) the conclusions in the abstract are true, and (2) the dosages causing these effects are likely or even conceivably ones that might be encountered in practice. In the event either of these conditions is not met, there is no scientific basis for the action.

Having reviewed the Bionetics report and consulted with knowledgeable authorities, I conclude that Dr. DuBridge's action was unwarranted on both accounts. First, there are reasons to believe that there is not a single true statement in the abstract. Second, even if the conclusions were true, the dosages are such as to bear no significant relationship with probable or readily conceivable exposure.

The research reported by Bionetics was carried out on small populations of test animals employing a number of questionable experimental practices, the most significant of which was the use of a crude preparation of 2,4,5-T. Tests were not performed on, or compared with, purified reference samples. Further investigation of the 2,4,5-T used in the feeding studies established that it contained significant amounts of certain impurities known as dioxins. In a news release dated February 6, 1970, Ned Bayley, director of Science and Education, USDA, reported that the 2,4,5-T used by Bionetics contained 27 ppm of tetrachlorodibenzo-paradiioxin. This may be compared with only about 1 ppm of this contaminant generally present in commercial grades of 2,4,5-T. Bayley reported that new feeding trials with 2,4,5-T containing 1 ppm dioxin did not cause birth defects in test animals. A report by the National Agricultural Chemical Association dated March 4, 1970, states that preliminary re-

sults from current research by Dow Chemical Company and the National Institute of Environmental Health indicate that 2,4,5-T is not teratogenic. Thus, it seems that the Bionetics conclusions are due to one or more unfortunate errors resulting from failure of the experimenters to exercise elementary technical precautions.

Recurring to the second point, let us examine the dosage question. As reported in the Pesticides Monitoring Journal, of more than 24,000 market samples of food recently analyzed, three contained measurable quantities of 2,4,5-T. Two of the samples were milk and one was meat. Reported on a whole-milk and fresh-meat basis, the average content of 2,4,5-T in the three samples was .006 ppm. For the full 24,000 samples, the average content of 2,4,5-T amounted to  $7.5 \times 10^7$  ppm, or one milligram in 133,000 metric tons of food. The presumed maximum nonteratogenic dose of 2,4,5-T, based on the Bionetic study for a 130-pound woman, is 1.27 grams daily. At the observed level of 2,4,5-T in the nation's food supply, this person could consume 170 million tons of food daily for nine days without fear of teratogenic effects. It must surely be a comfort for pregnant mothers to know this, and it should have been equally reassuring to presidential science advisor DuBridge and his staff last October while reviewing the Bionetics report.

We cannot expect the President's Office of Science and Technology to have known last October that the Bionetics research report was erroneous, but we could expect that it should have been recognized as meaningless. The content of 2,4,5-T in food was known at the time, and the information was readily available to anyone willing to spend an afternoon in the library.

It is well recognized that there are potential errors in translating toxicity data from animals to man. Also, the monitoring of pesticide levels in food is subject to errors, and levels of use of 2,4,5-T in some areas—in Vietnam, for example—are higher than in the United States. Let us assume that 2,4,5-T is 100 times more active in man than indicated for rodents, that 100 times more 2,4,5-T is present in food supplies than analyses indicate, and that in a restricted area 100 times more 2,4,5-T is used than is normally used. Under these improbable circumstances, hazard would be multiplied a million fold. Yet, our 130 pound, pregnant woman could still safely consume 170 tons of food daily.

The point of these arguments is that danger must be assessed in terms of exposure to the hazardous agent. We need not erect barricades against dragons unless dragons exist. The infinitesimal quantities of pesticide residues we deal with are incomprehensible to the public and seemingly also to many scientists who do not regularly work with them. Let us consider



a nonchemical analogy to the restrictions placed on 2,4,5-T in the DuBridge action last October. The announcement would state that there is important new research findings that appear to indicate that when 2 million tons of steel are placed on a woman's head she is in danger of being injured. For this reason, use of steel hairpins will no longer be permitted after the first of January, unless the FDA can discover a safe, legal basis assuring that women who use hairpins will not be crushed by the weight. Federal departments are notified to restrict their use of steel in populated areas, and the Department of State is instructed to notify foreign governments of our actions. This example is quantitatively comparable to the facts available at the time restrictions were placed on the use of 2,4,5-T and the governmental action equally irrational.

It is clear that, although disguised as a scientific assessment, the decision to restrict the use of 2,4,5-T was made on some other basis than rational analysis. This has come to be recognized now, but unfortunately there are no new pronouncements from the White House to put matters straight. To the USDA and FDA, with their past history of responsible action in such affairs, comes the task of picking up the pieces. The January 1 deadline for cancellation of registration of 2,4,5-T has come and gone without action. Presidential Science Advisor DuBridge is singularly silent. The USDA and FDA issue cautiously worded statements to the effect that it was all an unfortunate mistake, but that a "great deal more research is needed."

Surely we have a right to expect better scientific decisions by our government than the present case indicates we are getting. It is said that the people get the kind of government they deserve. Ignorant and slothful people get corrupt and despotic government, while enlightened and sensitive people insist upon responsible public administration. We are a technical and scientific nation and should expect this to be reflected in sensible scientific decisions by public officials. The decision on 2,4,5-T does not meet the minimum standards necessary to operate a modern technical nation.

Dr. DuBridge has defended us from dragons that do not exist.

#### RESEARCH ON AQUATIC AND BANK WEEDS — UNIQUE CHALLENGES AND TECHNIQUES<sup>1</sup>

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Research on control of aquatic and bank weeds involves many challenging problems not encountered

<sup>1</sup>Presented at the Western Society of Weed Science, Sacramento, California, March 17-19, 1970, and published in the Proceedings.

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in research with terrestrial weeds. Equipment and techniques required are quite different, and often non-existent. Perhaps a few examples will make you terrestrial scientists and weed specialists envious of us water weed scientists because of our more challenging and pioneering adventures.

#### Bank Weeds

I shall begin with bank weeds along unlined earth irrigation canals, drainage channels, and pond and lake shorelines. The situations and techniques are much different from those in research on terrestrial weeds, but not nearly as unique as those with floating and submersed aquatic weeds which I shall discuss later.

Bank weeds range in type, from semi-aquatic species at the waterline to drought-resistant species high on the bank. Even the same species grows much more vigorously at the waterline, and it often responds differently to herbicide treatments, than it does several feet higher on the bank. The spectrum of bank weeds includes most weeds that grow on cropland and the semi-aquatic species, such as canarygrass (*Phalaris arundinacea* L.) and smartweeds (*Polygonum* spp.) in the West and paragrass (*Panicum purpurascens* Raddi), torpedograss (*Panicum repens* L.), Johnsongrass (*Sorghum halepense* (L.) Pers.), and phragmites (*Phragmites communis* Trin.) in the South. Woody plants such as saltcedar, *Tamarix pentandra* Pall., willows (*Salix* spp.), and wild rose (*Rosa* spp.) are also common bank weeds. Bank weeds grow in narrow bands along each canal bank or shoreline. The full width of canal bank must be included in each experimental plot. Canals run in all directions, so that the incidence of sunlight affects bank weed growth. The response to herbicides is different on north, south, east, and west bank slopes. These narrow bands of weeds grow immediately beside water on one side and, frequently, close to herbicide-sensitive irrigated crops on the other side. That raises the problem of herbicide residues in the water on one side, and of spray drift onto sensitive crops on the other.

Nearly all canals, drainage channels, and ponds belong to farmers or private or public agencies, and they are in continuous or frequent use for irrigating crops or draining land. Some canals furnish livestock water, and even potable water. Obtaining permission to use these canal banks for testing new herbicides requires the ultimate in diplomacy, persuasiveness, confidence, and good judgment. Once the permission for experimental use is granted, that use must be synchronized with other uses of the canal. Often several farmers along a canal must change or lose their irrigation turns during the herbicide application. If the chemically treated water cannot be used for irrigation, it must be wasted into a sump, onto wasteland, or drained into a ditch or a stream where fish toxicity must be considered.



Changes in management of a canal, because of a change in the owner's plans or unforeseen circumstances, may destroy or prevent completion of such an experiment, especially one requiring retreatments or long-term observations of results. Many experiments have been terminated by these situations, beyond control of the scientists.

In experiments to determine effectiveness of herbicides on bank weeds, the plots must be located where there are uniform stands of weeds. The plots are narrow, and usually considerably longer than wide. Replication is possible but each replicate block may extend along a considerable length of canal bank. Frequently, the distance from a plot in the first replication to one in the third or fourth replication is 1 to 2 miles. That requires mixing a herbicide solution and cleaning the sprayer for each plot in a replicate block, or driving to all replicate blocks for the application of each herbicide. To obtain reliable results, each plot must include both banks; or different replicate blocks must be located on opposite sides of the canal. That requires access to both sides of the canal, not always possible even by wading the canal, if it is deep and there is no nearby bridge or other crossing.

Because banks are usually steep, and often uneven, wheel-mounted sprayers can seldom be used. An exception is where side booms can be used on long plots along a canal served by a good road on top of the bank. Hand-spray booms and guns usually work best. A single-nozzle wand boom is ideal for following the bank contour. Sometimes a wind board must be carried by a second man, walking beside the man who carries the sprayer to prevent spray drift onto the adjacent crop, or elsewhere off the target plot.

When you are evaluating results of herbicide treatments on bank weeds, it usually is necessary to make two determinations on each plot, one at the waterline and one higher on the bank, beginning 2 or 3 feet above the waterline. Extreme care is necessary in selecting replicate blocks of plots to reduce within-block error. Variation in results from the same treatment is often considerable between blocks of plots under different conditions. Thus, many repetitions of the experiment are necessary for conclusive results, whether for average conditions or for each condition along the same type of canal.

#### Emersed Aquatic Weeds

With some exceptions, emersed aquatic weeds present research difficulties similar to those with the bank weeds. Emersed weeds such as cattail (*Typha* spp.), tules (*Scirpus* spp.), smartweeds, and watercress (*Nasturtium officinale* R. Br.) in the West, and all of these plus alligatorweed (*Alternanthera philoxeroides* (Mart.) Griseb.), waterprimrose (*Jussiaea* spp.), and others in the South, grow under less variable conditions of water supply. All are rooted in mud, usually below

the waterline. Also, they usually are not as close to desirable crops or ornamentals, even though they are in narrow bands when growing in drainage or irrigation channels or around shorelines of ponds or lakes.

Emersed weeds, like bank weeds, usually are found on private or public land, not reserved for experimental use. However, unless they are in an irrigation canal, it is not as difficult to obtain permission to conduct a control experiment. The frequent necessity for ditch cleaning at a cost of several \$100 per mile helps put irrigation district managers and farmers in a mood to permit herbicide tests in the hope of finding a less expensive method of control and management. The water in drainage channels, ponds, and lakes is much less frequently in use for a purpose with which an herbicide application or other treatment would interfere. When the water is less than 3 feet deep for a considerable distance from shore, the bands of emersed weeds around ponds or lakes are often much wider than those in canals. The broader bands permit use of wider plots and, sometimes, two or more rows of adjacent plots. When two or more rows of plots are present, herbicide applications of granules, pellets, or spray must be made from a boat or by wading in water or walking on water shoes, instead of from a sprayer or broadcaster moving on land. If the emersed weeds are tall, like cattail, this often requires underwater mowing or otherwise removing plants to provide access passageways to and between the plots. Airboats are useful and often necessary for making herbicide applications and determining results in extensive areas of emersed weeds.

Growth conditions and vigor of emersed aquatic weeds usually are uniform within experimental plots. Exceptions are in ponds or lakes with increasing depths of water from the shoreline outward, or in drain canals with silt bars and meandering channels. Herbicide, and especially mechanical, treatments are more effective with increasing depths of water. Except where water depth varies greatly, variability of results from control treatments within experiments is much less than it is with bank weeds. Results are particularly uniform from herbicide applications made on emersed or floating leaf weeds such as waterlilies (*Nymphaea* spp.), lotus (*Nelumbo lutea* (Willd.) Pers.), spatterdock (*Nuphar advena* (Ait.) Ait. f.), or watershield (*Brasenia schreberi* Gmel.), which grow in water 2 to 6 or more feet deep. Uniform applications of 2,6-dichlorobenzonitrile (dichlobenil) granules applied in early spring gave spectacularly effective, uniform, and long-lasting control of white waterlily (*N. tuberosa* Paine) in Washington and Florida. Granular applications of dichlobenil or (2,4-dichlorophenoxy)-acetic acid (2,4-D) were also effective on emersed alligatorweed in Southeastern States.

### Submersed Aquatic Weeds and Algae In Irrigation Systems

Submersed weeds and algae, which grow entirely under water except for some floating leaf species, present difficulties and require techniques in research as different from those involved with cropland or rangeland weeds as one can imagine. Because of the flowing water in irrigation and drain canals, only one treatment can be applied to the water in each canal. Canals vary widely in flow capacity, velocity of flow, water quality, temperature, and turbidity. Canals also vary in length. The size and volume of flow becomes increasingly less down an irrigation canal, but increasingly more down a drain canal. Some canals have numerous structures such as check dams, drops, siphons, and flumes, which often drastically reduce the effectiveness of volatile herbicides such as acrolein and xylene.

The difficulty in obtaining permission to use irrigation canals for experimental control treatments on submersed weeds or algae is even greater than that for experiments on control of bank weeds. The herbicide has to be applied directly in the flowing water at a concentration high enough to kill the pondweeds or algae for several miles down the canal. Before the researcher introduces the herbicide into the water, he must know whether the treated water will kill or injure fish, livestock that drink the water, or irrigated crops. Frequently, the water from a single long canal is used to irrigate 10 to 30 different crop species. If there are hazards, the irrigation company or district board and farmers along the canal must be convinced that results will justify the hazards. The expensive, unsatisfactory, outmoded practices of chaining to remove submersed weeds from canals, the difficulties and high costs of removing dislodged weeds from the canal by hand or with a dragline, and the subsequent clogging of sprinkler irrigation systems by weed fragments have aided greatly in obtaining cooperation in conducting experiments with herbicides.

In order for a researcher to know that much about a herbicide before it is field tested in a commercial canal or drain, the herbicide must successfully pass a series of increasingly rigorous tests in greenhouse or growth room aquaria, outdoor bins or pools, and small closed system flowing "mini-canals." In addition, the effects that the herbicide in the water may have on irrigated crops must be ascertained.

Equipment for all, or several, of these preliminary tests are in use at our research stations at Davis, California; Denver, Colorado; Prosser, Washington; and Fort Lauderdale, Florida. These include glass aquaria for submersed weeds at Fort Lauderdale and Denver, plastic aquaria for floating weeds at Fort Lauderdale, 4x4 plastic pools for submersed weeds, fish, and Asiatic clams at Davis, outdoor plastic pools at Fort Lauderdale

and Davis, and the experimental plots at Prosser for research on crop tolerance to herbicides in irrigation water and on herbicide residues in crops.

Herbicides that are soluble or emulsifiable in water are applied under water in a canal at one location or at a series of locations several miles apart. Application equipment depends upon the size of the canal and type and amount of herbicides to be applied. For xylene, they range from small one- or two-nozzle sprayers, usually located above a weir drop, to large many-nozzle booms, spray guns, or open hoses with high pressure for larger canals.

Concentrations of only 0.1 to 0.6 ppmv of acrolein over long exposure periods of 8 to 48 hours will control most submersed weeds. Because acrolein creates an explosive mixture with air in a tank and polymerizes at small jet openings into air, the herbicide must be stored in pressure-resistant cylinders and delivered beneath the water surface under nitrogen gas pressure. Small plastic tubes with a screw clamp or regulator valve will deliver enough acrolein from a nitrogen gas pressurized cylinder to treat canals carrying from 200 to 2,000 cfs. The small tank holds 50 gallons of acrolein. Large tanks hold 250 gallons each. A small plastic tube delivers 0.1 ppm into a canal carrying 2000 cfs of water. The acrolein applied from one bank dispersed entirely across that large canal within about 200 ft. The treatment gave complete control of submersed weeds from there down the canal 20 miles and gave adequate control for 50 miles.

Evaluating the results of herbicide treatments is simple in small canals with clear water. The degree of collapsing of weeds, of increased water flow at several day intervals after treatment, and, finally, sloughing of the leaves and stems are good criteria. Later, at intervals of 1 to several weeks, the degree of sloughing of weed leaves and stems, and, finally, the beginning and rapidity of regrowth, are observed and recorded. In large deeper canals or in small canals with turbid water, surface observations are not reliable. Dragging a long handle rake through small canals or many pronged gadgets on the end of a long nylon rope through large canals were techniques used for several years.

We are now much more sophisticated and use scuba diving in large canals and in lakes to evaluate results of herbicide treatments and make weed surveys and ecological studies of submerged weeds. Scuba diving equipment and techniques are efficient and essential for weed studies in deep water. All safety rules of scuba diving must be scrupulously followed without exception, just as safety belts must always be fastened in moving cars and trucks to greatly reduce the chances of serious or fatal injury.

Only one treatment can be made in each canal at one time. It is difficult to get permission to use several similar canals for identical treatments on the same day



or during a span of several days. Therefore, it is almost impossible to replicate treatments that are applied in flowing water. For that reason, and because of the variability, repetitions of the treatment must be made in as many existing canals as possible at each of our field stations each year. Usually, these applications must be repeated at all stations for several years before conclusive results are obtained.

Fortunately, it is still possible to obtain permission to use existing canals and ponds or lakes for testing promising new herbicides in Washington, Montana, Wyoming, Colorado, and even in Florida. In highly urbanized California, it is much more difficult, and almost impossible. Because of that situation, and the urgent need for information on control of the critical submersed weed and algae problems in California, four Federal and State agencies have constructed, on the Experiment Station campus at Davis, an aquatic weed research center at a total cost of nearly \$250,000. The cooperating agencies are the Bureau of Reclamation, the California Department of Water Resources, the Agricultural Research Service, and the California Agricultural Experiment Station. The center consists of four 15x30x3-ft ponds for biological control studies, four concrete-lined canals 150x15x3 ft with an enclosed flowing water system, a well drained concrete platform with space for ten 10-ft-diameter plastic bins and eighty 4-ft-square plastic bins, a 30x40-ft greenhouse, a 28x70-ft headhouse-shop complex, and two lined 3/4-acre holding and evaporation ponds which receive all herbicide-treated water and prevent it from getting into the underground water table.

The Bureau of Reclamation has a single outdoor concrete-lined canal system below Carter Lake in Colorado which makes possible many kinds of control tests with herbicides on submersed weeds and algae in flowing water.

#### **Submersed Weeds in Lakes and Ponds**

Field research on control of submersed weed problems in lakes and ponds is conducted by two main techniques: (1) metal or plastic enclosures 5 to 12 ft square, which separate the water and weeds within each enclosure from the remainder of the lake during the desired period of treatment exposure; and (2) large open-water plots 50 to 100 ft square with untreated borders of about equal widths between plots. The former technique is used for preliminary tests of promising herbicides and mixtures. The large open-water plots are used for final replicated plot tests before the herbicide is used for total or partial area lake or pond treatments. In "Winderful" Wyoming, or anywhere the wind blows, it is very difficult to stake out open water plots from a boat. It's much more accurate and easier to cut holes in the ice in winter and insert a concrete block weighed plastic bottle float with a black metal shield for each plot corner marker.

Metal enclosures, 12 ft square, have been used for preliminary lake treatments in Wyoming. Each enclosure can be lifted by inflating the rubber tube that is attached near the bottom, the enclosure moved to a new location, and settled into place by deflating the rubber tube. The enclosure can be quickly dismantled into four metal sheets 4x12 ft for hauling long distances.

Smaller 6x6-ft metal enclosures have been used in Wyoming lakes and also in irrigation canals in Wyoming and Montana for testing the amounts of water (simulated precipitation) required to leach soil-applied herbicides to effective depths in the canal bottom soil to give complete control of pondweed tubers.

Inexpensive, and quickly set up or dismantled plastic enclosures were developed by John Gallagher of Amchem Products, Inc., for preliminary tests of herbicides on submersed weeds in lakes and marshes. These plastic enclosures are being extensively used by our Agricultural Research Service team at Fort Lauderdale. They are being used in several other eastern states by other investigators.

Time does not permit my discussing in detail the unique difficulties and research techniques involved in working with floating weeds like waterhyacinth (*Eichhornia crassipes* (Mart.) Solms), waterlettuce (*Pistia stratiotes* L.), and alligatorweed. The most difficult problem is holding the treated plots in place long enough after treatment to determine results of the treatment. This has been successfully accomplished in some situations by inserting bamboo or other poles 2 to 4 ft apart around each plot, a tedious and time-consuming, but necessary, procedure.

#### **Determining Herbicide Residues in Water**

In recent years, the need for information on concentrations of herbicides in water and the rate of dissipation from water after treatments for control of aquatic or bank weeds has necessitated the development of reliable sampling techniques and effective methods of preserving the water samples against deteriorations prior to chemical analysis. The sampling technique finally established for both aquatic and bank weed treatments in or along canals is to begin by marking the beginning and end of the treatment with a slug of dye in the flowing water. Water samples are taken at pre-selected locations down the canal below the lower end of the bank treatment, or beginning 1/2 mile below the point of introducing the aquatic weed treatment. Sampling is begun at each downstream location as soon as the first dye-marked water reaches that location, and is continued at frequent intervals until the upstream dye-marked water reaches the location. This sampling procedure permits determining the herbicide concentration curve in the treated zone of water as it moves downstream and usually enough of the dissipation rate of pattern to predict, with considerable accuracy, the

distance downstream at which the herbicide residue could no longer be detected.

The residue levels of 2,2-dichloropropionic acid (dalapon), trichloroacetic acid (TCA), and 2,4-D were only about 5 to 23 ppb in water following a ditchbank treatment in Washington (Table 1). The concentrations varied from sample to sample within narrow limits during the 5.5 hours the water along the treated bank was passing the sampling station at the downstream end of the treated bank. The concentrations then dropped rapidly to zero as the last dye-marked water flowed past. When a volatile herbicide such as acrolein or emulsified xylene is introduced into a canal at one location, there is a rapid loss of herbicide during the first several miles downstream, followed by a more gradual decrease.

Determinations of herbicide residues and rates of dissipation in water and hydrosol are also necessary following applications for control of aquatic weeds in ponds. Studies were initiated several years ago in ponds and small reservoirs in Colorado and California following total area application. Sampling of water or hydrosol following total area treatments is not complicated, but care must be used to obtain a sufficient number of samples on each sampling date to accurately represent the water and hydrosol throughout the treated area. In bodies of water 6 ft or more deep, water samples should be taken near the surface and near the bottom to determine whether a thermocline exists and is affecting the concentration of herbicide at different depths. Samplings of water and hydrosol are continued for a sufficient period after treatment to measure the trends of dissipation and, when possible, until residues are no longer found.

Six, 7-dihydrodipyrid [1,2-*a*:2',1'-*c*] pyrazinedium ion (diquat) disappeared from the water within 10 days but was quickly absorbed by the hydrosol to a maximum of 40 ppm and remained at a high concentration during 160 days without any herbicide getting back into the water. 2,4-D remained in both the water and hydrosol nearly 40 days. After 40 days, the concentration of dichlobenil decreased more rapidly in hydrosol than in the water until 120 days after treatment, showing a definite feedback into the water. (Two-3, 6-trichlorophenyl) acetic acid (fenac) showed a similar trend but with a slower feedback into the water.

Studies are now underway in Washington and Florida to determine herbicide residues and rates of dissipation following isolated plot treatments with a granular formulation of dichlobenil. In these situations, samples are taken periodically in the treated area and also at various distances from the treated area in at least two directions to measure lateral dispersion of the herbicide in the water, and subsequent absorption by the hydrosol.

This paper has not described all of the challenges

and thrills which researchers in aquatic and bank weed control experience. However, I hope the examples were sufficient to entice several promising young scientists to begin sharing those challenges and thrills with us.

Table 1. — Residue levels of dalapon, TCA, and 2,4-D in Lateral No. 4

Sampling intervals	PPB residues		
	Dalapon	TCA	2,4-D
0	20.5	8.4	5.2
20 min	16.6	7.1	3.6
40 min	13.4	4.9	4.0
60 min	17.0	6.9	3.6
80 min	16.2	5.2	3.1
220 min	11.3	4.1	2.4
240 min	12.8	4.7	2.7
260 min	14.0	6.8	3.6
280 min	18.8	9.5	5.0
5 hr	23.4	11.6	4.2
5.5 hr	6.5	2.3	1.6
6 hr	0.7	0.0	0.1
8 hr	0.3	0.0	0.0
10 hr	0.3	0.0	0.0

#### 2,4-D CONTAMINATION AND PERSISTENCE IN IRRIGATION WATER<sup>1</sup>

T. R. Bartley and A. R. Hatrup<sup>2</sup>

##### Introduction

In early 1969, the Bureau of Reclamation and the Federal Water Pollution Control Administration (FWPCA) reached an agreement whereby the FWPCA would support the Bureau in performing work on herbicide residues in irrigation water. The amount of 2,4-D getting into irrigation water and the rate of herbicide dissipation as the water moved downstream as a result of ditchbank spraying were emphasized during the 1969 irrigation season. The field phase of the program was carried out on the three irrigation districts of the Columbia Basin Project in Washington, and the laboratory work and analysis were performed in the Bureau of Reclamation laboratories, Denver, Colorado.

The Columbia Basin Project in Washington was selected for the field phase of the herbicide monitoring program because of the great variation in the number,

<sup>1</sup>Investigations of the Research Division and Columbia Basin Project, Bureau of Reclamation, U.S. Department of the Interior, Denver, Colorado, and Ephrata, Washington, in cooperation with the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Denver, Colorado, and the Federal Water Pollution Control Administration, U.S. Department of the Interior.

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size, length, and capacity of its delivery and drainage channels. The field work was carried out in cooperation with the Quincy, East, and South Columbia Basin Irrigation Districts which operate the Columbia Basin Project.

The canals on the Columbia Basin Project vary in length to 87 miles (139.98 km) and in capacity to 5,100 cfs (144.43 m<sup>3</sup>/sec). This great variation provides combinations of physical characteristics desirable in achieving a good cross sectional representation in residue work. In addition, well-trained herbicide applicators and modern application equipment are available.

#### Methods and Materials

Specially designed boom sprayers were used for the application of 2,4-D to canal bank weeds. These sprayers are equipped with low-pressure, 10-psi (0.7-kg/cm<sup>2</sup>) whirlchamber nozzles mounted on 20-inch (40.8-cm) centers. A three-section, 24-foot (7.322m) contourmatic boom is mounted on each side of the spray rig along with an 8-foot (2.44-m) boom across the rear of the sprayer, resulting in a total boom length of 56 feet (17.07 m).

The herbicide application rate ranged from 1.4 to 2.5 pounds of the active ingredient of 2,4-D per acre (1.57 to 2.8 kg/ha). This quantity of herbicide was applied in about 50 gallons (189.25 l) of water. Diesel oil was added to the solution at the rate of about 1 gallon (3.785 l) per acre (0.405 ha) to increase the wetting of the plants. The dimethylamine salt formulation of 2,4-D was used in all canal bank treatment sampled for residues.

The field portion of the monitoring program begins with the selection of the channel to be sampled, taking into consideration such physical characteristics as size, length, slope, and structures. Arrangements are then made with the irrigation district for the application of the herbicide to the selected canal bank.

Prior to the application of the herbicide, a 5-gallon (18.93-l) plastic drum is filled with irrigation water for later use as pretreat samples and for making up standard samples. A solution of fluorescent dye is placed in the channel immediately prior to the herbicide application and again at the end of the application. These dye markers are very effective in determining the location of the treated water, visually during the day and with an ultra-violet light at night. Environmental factors such as air and water temperature, wind and weather conditions, and degree of water clarity and other factors that have an influence upon the herbicide application are recorded at the site of the field activity.

The length of canal bank treated with herbicide varied from 0.5 to 5.1 miles (0.8 to 8.2 km), and the spray overlap of water surface varied from 0 to about 2 feet (0.0 to 0.6 m) and in a few instances up to 4

feet (1.22 m). Following the herbicide application, sampling stations were established at points about ¼, 1¼, 2½, 5, 7½, and 10 miles (0.24, 2.01, 4.02, 8.04, 12.07, and 16.09 km) below the treated area depending on the length of the canal being sampled. Sampling began as the leading edge of the first dye marker reached the sampling station and continued until the trailing edge of the rear marker had passed the station. Samples were taken as 0, 10, 25, 50, 75, 90, and 100 percent of the treated water passed the station. Samples were taken from the center of the channel where possible; if not, they were collected from the main flow of water along one of the banks. Three 1-quart (0.946-l) bottles were filled simultaneously, resulting in triplicate samples collected at all sampling intervals and stations.

The samples were acidified immediately after they were taken by the addition of 10 ml of hydrochloric acid to each sample bottle, and this was followed by the addition of 25 ml of chloroform. The samples were then placed in boxes until they could be removed to the project laboratory for extraction. All samples were stored under refrigeration in the laboratory until the extraction procedures were initiated. The 25 ml of chloroform added in the field were drawn from the bottom of the sample bottle with a pipet and transferred to a 4-ounce (118.3-ml) bottle. Following the first extraction, a second 25-ml portion of chloroform was added to each sample bottle, and the bottle was shaken for 1 minute. This second portion of chloroform was then drawn from the sample bottle in the same manner as the first and added to the 4-ounce (118.3-ml) bottle containing the first extraction. These 4-ounce (118.3-ml) bottles were then stored under refrigeration until shipment by air freight to the Denver laboratory for analysis.

Standards were prepared in the Project laboratory by the addition of the aqueous solution of 2,4-D to the untreated irrigation water taken before the spraying operation began. Standards of 2,4-D were prepared in the following concentrations: 0.01, 0.05, and 0.1 ppm. The standard and check samples were extracted in the same manner as the field samples and shipped to Denver for use in the analytical procedures.

The method used for the extraction and analysis of the dimethylamine salt of 2,4-D is the one described by Dr. P. A. Frank of the Agricultural Research Service, Denver, Colorado, and it is included as Exhibit A under the title "Extraction of 2,4-D Acid, Amines and Mineral Salts from Water and Analysis by Gas Chromatography."

Acid-washed glass bottles and teflon-lined caps were used in the collecting, processing, and shipping of all samples. Following receipt of the chloroform extracts of water samples in Denver from the Columbia Basin Project, they were stored under refrigeration for



Canal No.	Sample No.	2,4-D concentration — PPB — Average of three reps							
		A	B	C	D	E	F	G	H
III	1	....	1.0	T ....	1.0	T			
	2	....	3.0	T	2.0	2.7			
	3	....	5.0	T	6.0	5.0			
	4	....	4.0	1.0	6.3	6.0			
	5	....	3.3	2.7	4.7	4.3			
	6	....	1.7	4.0	2.7	0.7			
	7	....	1.0	5.0	1.0	0.7			
	8					T			
	9					T			
	10					T			
	Average	....	2.7	3.2	3.4	3.2			
IV	1	T	T	T	T				
	2	27.7	4.7	2.3	1.7				
	3	15.3	10.3	14.0	3.7				
	4	18.7	9.3	13.0	12.7				
	5	15.3	8.3	13.3	5.0				
	6	8.0	8.3	T	3.0				
	7	2.7	3.0	T	2.0				
	8		0.7		2.0				
	9				1.0				
	10				T				
	Average	17.0	7.3	10.7	4.7				
V	1	1.0	T	2.3	T	1.3	1.3		
	2	23.0	9.0	23.7	4.3	4.7	4.0		
	3	34.0	43.3	42.3	14.0	18.3	24.0		
	4	32.0	48.3	40.0	22.0	33.7	33.0		
	5	14.7	40.7	3.7	9.7	7.7	8.0		
	6	3.0	24.7	1.0	3.0	2.7	3.3		
	7	2.3	13.0	0.7	1.0	0.7	2.0		
	8		5.3				1.5		
	9						1.0		
	10						1.3		
	Average	21.3	26.3	22.4	10.6	13.4	12.4		
VI	1	6.7	17.7	60.7	77.0				
	2	187.7	211.7	171.3	79.3				
	3	150.3	213.7	133.0	54.3				
	4	105.3	54.3	45.7	26.3				
	5	37.7	13.0	6.3	14.3				
	6	38.7	6.7	2.0	6.3				
	7	28.7	2.7	2.5	4.7				
	8	8.7			4.0				
	9				0.7				
	10				....				
	11				T				
	Average	70.5	86.2	83.4	42.9				
VII	1	0.0	0.0	0.0	0.0	0.0	1.0		
	2	1.7	1.3	T	0.0	0.7	1.3		
	3	6.3	5.0	2.0	1.7	3.7	3.7		
	4	5.3	7.0	3.7	13.0	10.7	10.7		
	5	9.0	7.0	6.0	6.0	5.0	2.0		
	6	2.3	1.7	5.0	1.3	1.3	T		
	7	0.0	0.0	0.0	0.0	1.0	T		
	8			0.0			0.0		
	9						0.0		
	Average	4.9	4.4	4.2	5.5	4.3	3.7		



Canal No.	Sample No.	2,4-D concentration - PPB - Average of three reps							
		A	B	C	D	E	F	G	H
VIII	1	0.0	0.0	0.0	3.3	T			
	2	19.0	1.7	2.7	0.0	T			
	3	9.0	10.0	11.7	1.0	3.0			
	4	16.0	12.7	15.0	9.0	4.0			
	5	T	5.7	10.3	3.3	T			
	6	0.0	T	3.7	T	T			
	7	0.0	0.7	1.7	T	T			
	8					T			
	9					T			
	10					T			
	Average	14.7	9.5	8.7	4.2	3.5			
IX	1	0.9	....						
	2	12.5	4.5						
	3	10.8	10.1						
	4	7.2	10.3						
	5	7.9	12.5						
	6	8.9	9.8						
	7	8.4	9.2						
	8	10.8	9.7						
	9	12.1	8.4						
	10	17.5	7.4						
	11	9.4	7.2						
	12	15.1	6.5						
	13	17.6	5.7						
	14	18.3	4.7						
	15	8.5	4.0						
	16	13.5	4.2						
	17	9.6	4.8						
	18	11.8	3.6						
	19	6.7	4.2						
	20	....	1.9						
	21	1.7	1.0						
	Average	11.5	7.0						
X	1	....	0.6	0.9	0.1	T	T	1.4	2.1
	2	....	1.0	0.7	0.2	1.1	T	0.8	1.4
	3	1.1	2.1	1.6	1.0	2.0	0.8	2.3	1.0
	4	0.9	2.0	1.3	2.4	2.0	4.2	2.4	0.2
	5	2.6	2.2	1.1	2.3	2.4	4.6	2.0	1.9
	6	1.8	2.9	2.1	5.9	2.1	5.3	1.5	0.4
	7	1.5	2.9	1.0	3.8	1.7	4.8	2.5	0.8
	8								0.6
	9								0.4
	Average	1.6	2.2	1.2	3.1	1.9	4.7	1.8	1.0
XI	1	5.5	53.5	55.6	82.0				
	2	63.2	59.8	54.5	84.8				
	3	71.1	42.2	69.0	82.1				
	4	24.3	50.2	63.0	54.8				
	5	94.4	44.3	25.8	63.5				
	6	81.6	15.8	2.5	76.7				
	7	63.7	2.5	2.0	24.8				
	8	3.2			3.9				
	9				1.9				
	10				1.0				
	Average	66.4	44.6	53.6	67.0				

Canal No.	Sample No.	2,4-D concentration - PPB - Average of three reps							
		A	B	C	D	E	F	G	H
XII	1	2.9	....	5.5	2.4				
	2	52.5	....	68.9	26.3				
	3	40.0	....	49.1	77.8				
	4	....	34.7	19.4	20.6				
	5	....	31.2	43.8	16.0				
	6	....	6.5	2.4	2.4				
	7	....	2.0	1.8	1.6				
	8				1.6				
	9				1.1				
	Average	46.3	33.0	45.3	35.2				
XIII	1	0.7	T	0.8	0.8	0.2			
	2	5.0	4.3	3.3	1.7	0.3			
	3	7.4	7.9	7.3	3.2	1.5			
	4	12.7	6.7	6.0	5.3	3.3			
	5	7.1	4.5	6.0	2.0	2.6			
	6	3.5	2.5	3.9	1.1	1.0			
	7	0.6	1.5	1.4	0.8	1.1			
	8					0.5			
	9					0.2			
	10					0.2			
	Average	7.1	5.9	5.3	2.7	1.9			
XIV	1	0.5	0.4	0.6	0.9				
	2	19.2	7.7	2.5	1.1				
	3	4.9	11.8	8.7	5.5				
	4	28.8	37.5	24.4	15.6				
	5	23.0	25.7	16.5	37.7				
	6	1.9	3.4	7.4	23.5				
	7	0.7	0.8	3.5	9.9				
	8				4.7				
	9				0.7				
	10				0.0				
	Average	19.0	20.7	14.3	16.2				
XV	1	85.9							
	2	96.6							
	3	93.2							
	4	100.0							
	5	84.0							
	6	79.1							
	7	84.2							
	8	90.7							
	9	30.6							
	10	49.9							
	11	90.6							
	12	75.7							
	13	53.8							
	14	40.1							
	15	59.3							
	16	45.6							
	17	31.7							
	18	66.9							
	19	60.3							
	20	63.9							
	21	62.1							
	22	83.0							
	23	60.9							
	24	16.8							
	25	5.0							
	Average	64.4							

Canal No.	Sample No.	2,4-D concentration — PPB — Average of three reps							
		A	B	C	D	E	F	G	H
XVI	1	2.1	0.0						
	2	1.5	0.0						
	3	2.1	0.3						
	4	7.5	2.5						
	5	9.9	4.4						
	6	11.0	5.1						
	7	7.0	4.6						
	8	3.1	12.0						
	9	6.5	7.7						
	10	5.6	7.3						
	11	1.9	4.3						
	12	1.6	5.7						
	13	1.4	4.2						
	14	1.2	2.4						
	15	1.6	1.6						
	16	0.3	3.1						
	17	3.7	1.0						
	18	2.3	1.1						
	19	1.1	2.0						
	20	0.0	2.0						
	21	0.0	0.5						
	22		1.0						
	Average	3.8	3.2						
XVII	1	95.3	87.2	54.2					
	2	118.4	82.3	55.0					
	3	113.2	78.1	47.9					
	4	138.5	87.5	67.8					
	5	124.2	92.1	54.8					
	6	76.1	98.7	45.4					
	7	86.2	75.8	72.6					
	8		94.8	69.9					
	9		90.6	48.5					
	10		72.0	51.8					
	11		69.1	67.8					
	12			66.6					
	Average	107.4	84.4	58.5					
XVIII	1	51.9	3.5						
	2	77.1	25.2						
	3	45.8	34.9						
	4	35.5	58.5						
	5	17.9	47.8						
	6	36.7	33.6						
	7	13.5	28.5						
	8	4.3	30.0						
	9	4.2	14.2						
	10		4.0						
	11		1.5						
	12		0.6						
	13		0.5						
	Average	39.8	28.0						

\*The T stands for a trace.  
 \*\*A dash (—) indicates that a determination was not made due to procedural errors, breakage of sample containers, etc.

Rather than attempting to discuss the details of 2, 4-D concentrations found in all 18 canals, the levels found in 5 canals have been selected to illustrate various conditions. Two figures are used to show graphic information on 2,4-D levels found in each of the canals. In one figure the peak and average 2,4-D concentration for each station is plotted against distance downstream from the treated area. The other figure is a bar graph showing the level of 2,4-D for each sampling interval at each station with respect to time.

Figures 1 and 2 show the data found on the PE 14.7 lateral where the highest levels of 2,4-D occurred. In Figure 1 the peak concentration curve shows an elevation of 213 ppb followed by a rather rapid dissipation until the concentration falls below 100 ppb 5 miles (8.05 km) downstream. The average concentration for each station ranged from 42.9 to 86.2 ppb indicating that the higher levels occurred during only two or three of the sampling intervals used at each station. This is apparent in Figure 2 where the 2,4-D content for many of the sampling intervals fell below 50 ppb. The much higher concentration of 2,4-D found in this canal compared to the others is believed to be due to an excessive overlap of the spray solution into the water surface for a short distance and an error made in the spraying of a 3-lb/acre (3.37-kg/ha) rate rather than the intended 2-lb/acre (2.24-kg/ha) rate.

Figures 3 and 4 present data on the EL 29 lateral where very low levels of 2,4-D were found. The peak and average 2,4-D concentration curves in Figure 3 are very flat and the 2,4-D levels ranged from 5 to 6 ppb and 2.7 to 3.4 ppb, respectively. The curves show the lack of 2,4-D dissipation with distance from the treated area. The rather gradual rise and decline in 2,4-D concentration as the treated water passed the sampling stations are shown in Figure 4. These data indicate that the peak values occurred for a relatively short time period.

Figures 5 and 6 show the levels of 2,4-D found at eight sampling stations spaced over a 19.2-mile (30.89-km) distance below the treated reach. This is the greatest number of sampling stations and distance covered in the 18-canal study. The concentration of 2,4-D was very low in this irrigation canal. The concentration showed rises and declines in 2,4-D content as the water moved from station to station. A definite dissipation in 2,4-D is noted toward the lower sampling stations. By projecting the average concentration curve to a zero point, the distance required to accomplish near complete dissipation would be about 24 miles below the treated area. The bar graphs in Figure 6 show considerable variation in 2,4-D concentrations at these low levels.

On the W-20 lateral a great number of samples were collected at 1 and 7 miles (1.6 and 11.26 km) distance below a 5-mile (8.05-km) treated reach of

canal bank. A rather low level of 2,4-D was found in this irrigation water. Both the peak and average concentrations show a decline in 2,4-D level as the water moved from the 1-mile (1.6-km) to the 7-mile (11.26-km) station, Figure 7. Figure 8 illustrates the irregularities in the amount of 2,4-D input into the irrigation water that occurred in samples taken at 20-minute intervals during the passing of treated water by the two stations. In comparing 2,4-D concentrations at Station B with those of Station A, it is noted that the overall 2,4-D level has decreased and the variation in 2,4-D content for the sampling intervals has decreased.

The pattern of herbicide concentration decline as the water moved downstream in the RB-5 lateral is typical of what may be expected from the water soluble 2,4-D formulation where the dissipation rate is dependent primarily upon dilution as caused by the hydraulic characteristics of the channel, Figures 9 and 10. The waterflow pattern would vary from channel to channel, and this factor is believed to be an important contribution to the variations in herbicide concentrations found in each canal in this study.

In most of the canals, the 2,4-D concentration showed a decline as the water moved downstream. The decline was primarily due to dilution caused by mixing in to untreated water on both ends of the treated segment. Although the concentration declined by this process, the overall quantity of herbicide probably remained about constant since the 2,4-D formulation would not be expected to degrade to any extent in this short period of time or significant quantities be lost by sorption or other avenues.

In considering factors important to the amount of herbicide found in irrigation water as a result of ditch-bank spraying with water in the canal, three significant ones are: (1) rate of herbicide application, (2) amount of overlap of herbicide spray onto the water surface, and (3) the volume of waterflow in the channel expressed as cubic feet per second (cfs). The amount of herbicide spray overlap on the water surface is affected by a number of factors such as back and forth movement of spray boom from the waterline due to ground surface irregularities, irregularities in shoreline, variation in height of vegetation at waterline, and wind velocity and direction of movement. These factors directly affect the herbicide input into the irrigation water and could cause wide variations in herbicide concentration in the water over short periods of time. The variable herbicide input is well illustrated in Figure 8.

Much information was collected on herbicide treatment, canal parameters, sampling routine, and other field features for each of the canals treated and sampled. This was done to aid in interpreting the results of the study and to use for predicting levels of herbicides that

The rate of 2,4-D application varied from 1.4 to may occur in irrigation water under certain conditions.

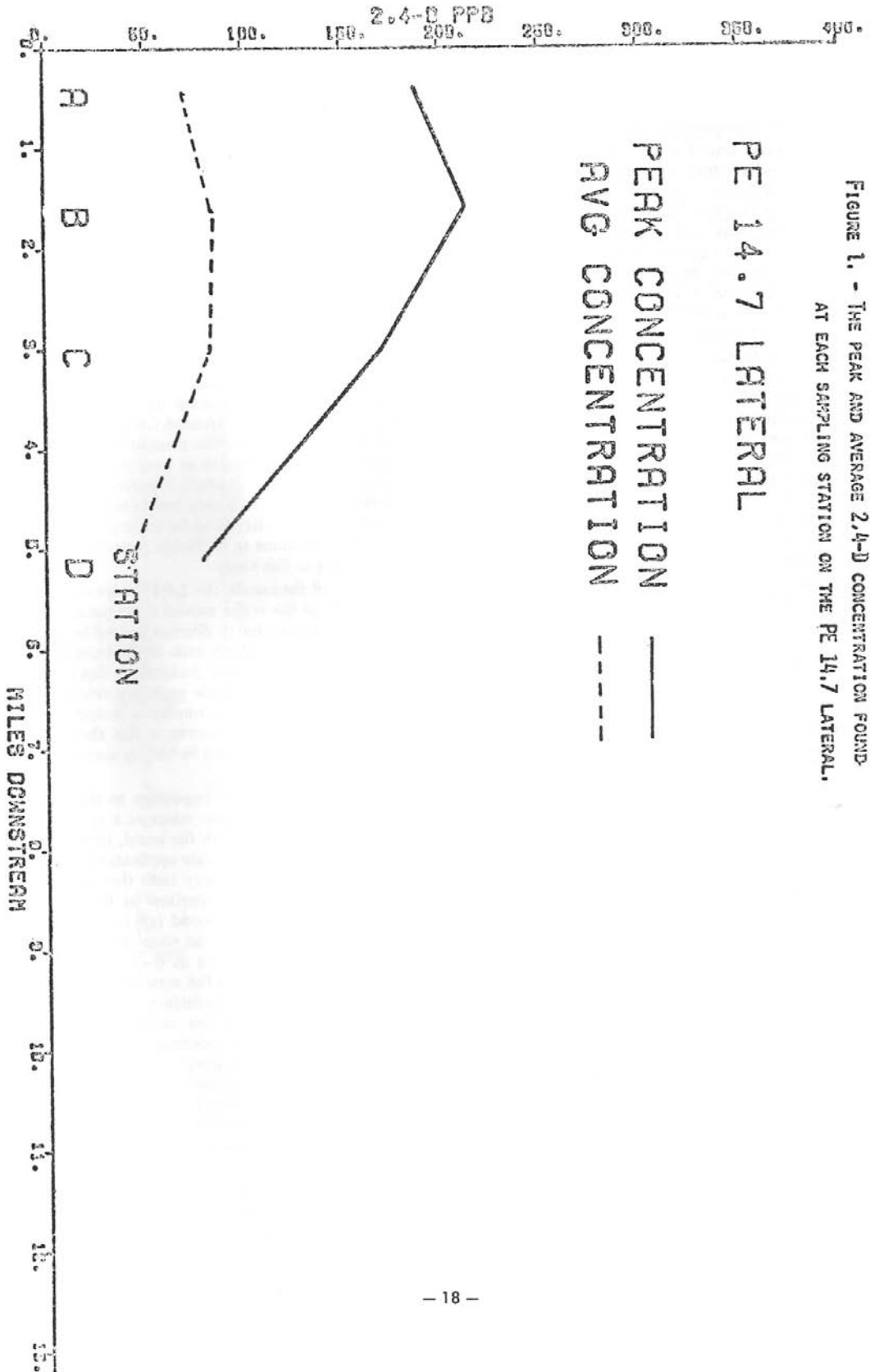


FIGURE 1. - THE PEAK AND AVERAGE 2,4-D CONCENTRATION FOUND AT EACH SAMPLING STATION ON THE PE 14.7 LATERAL.

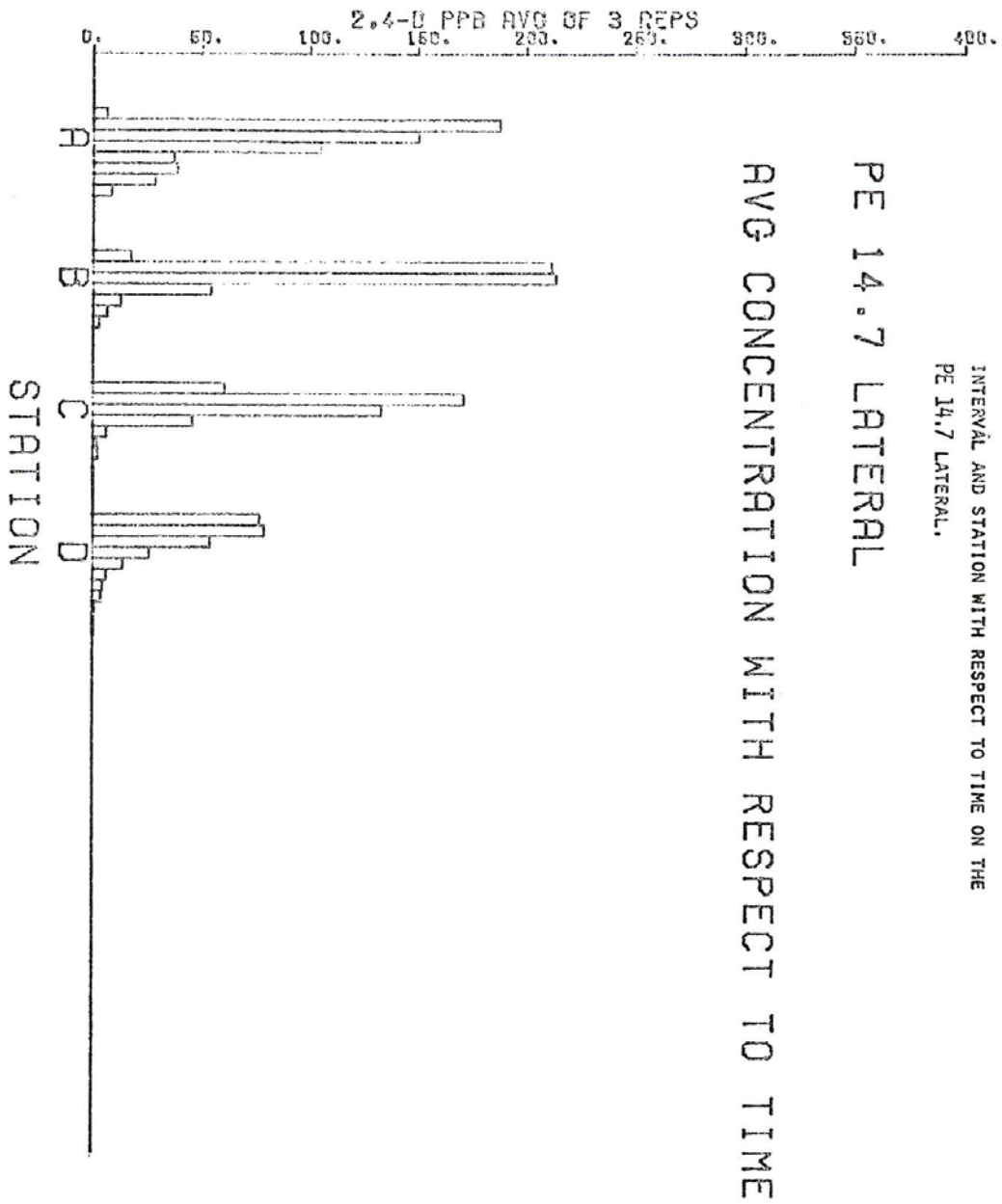
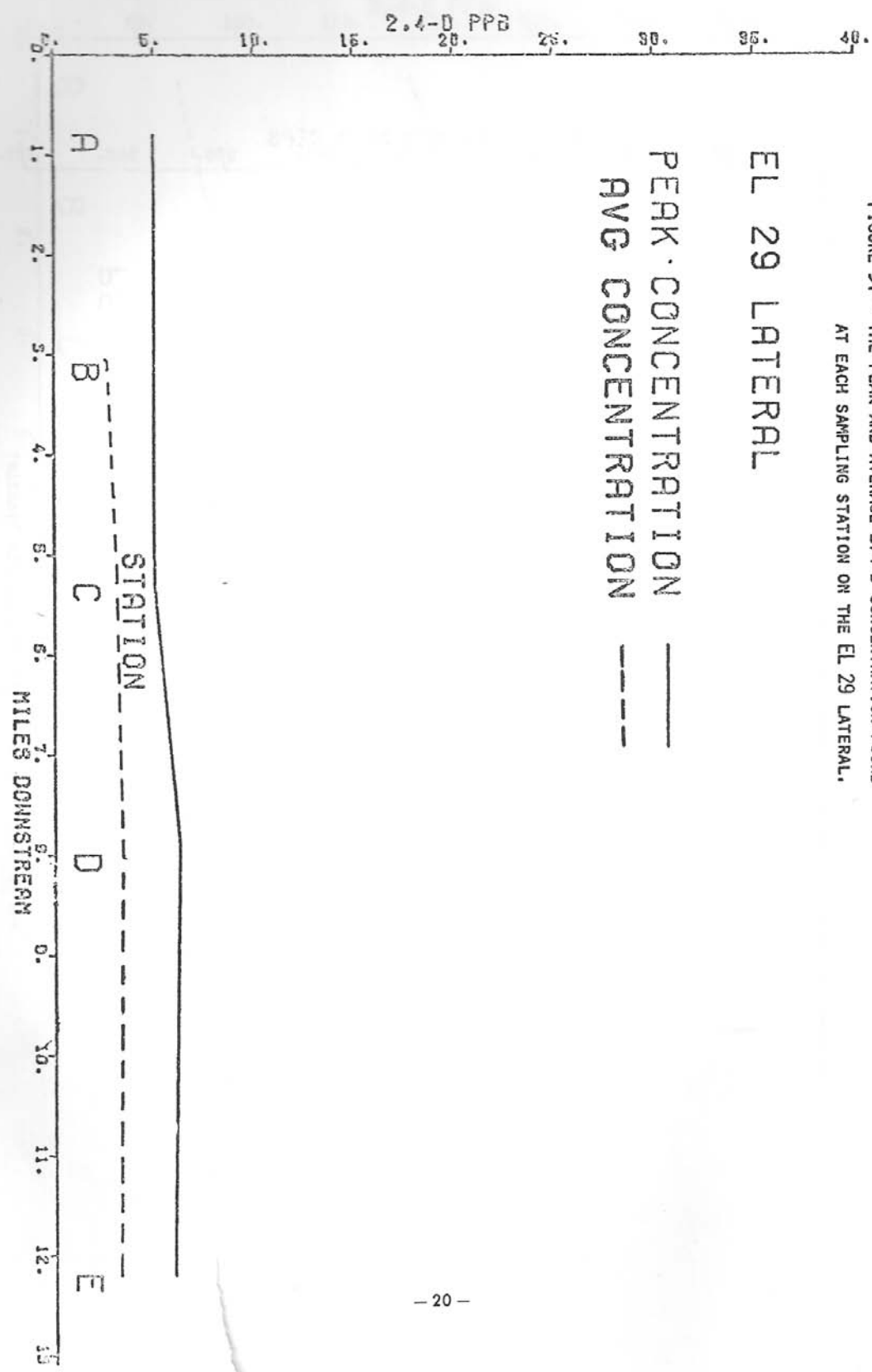
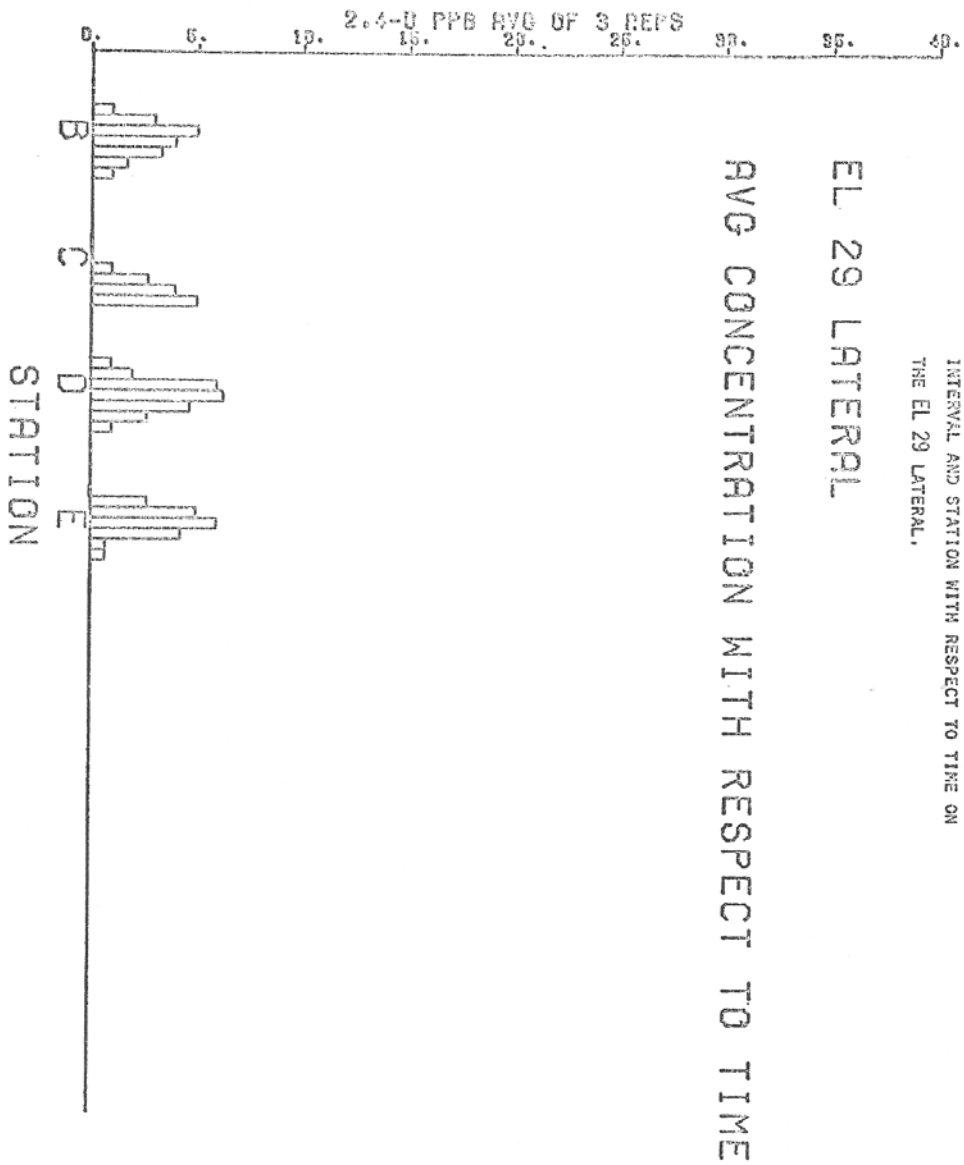


FIGURE 2. - THE 2,4-D CONCENTRATION SHOWN FOR EACH SAMPLING INTERVAL AND STATION WITH RESPECT TO TIME ON THE PE 14.7 LATERAL.

FIGURE 3. - THE PEAK AND AVERAGE 2,4-D CONCENTRATION FOUND AT EACH SAMPLING STATION ON THE EL 29 LATERAL.









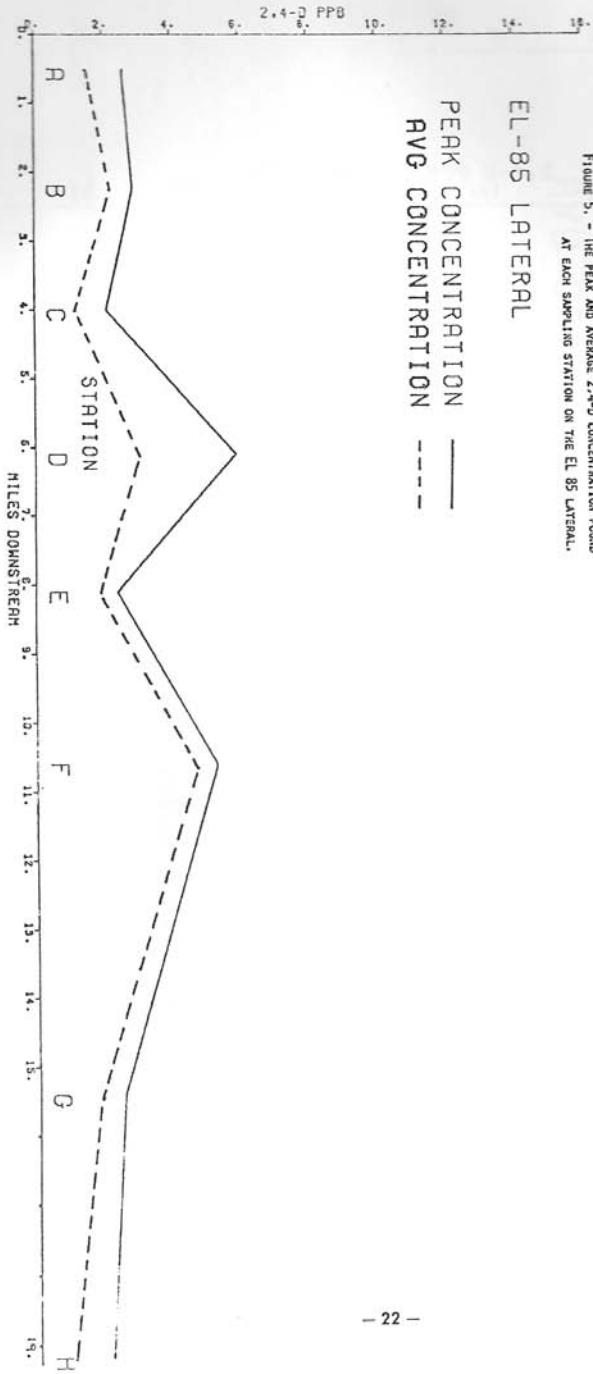
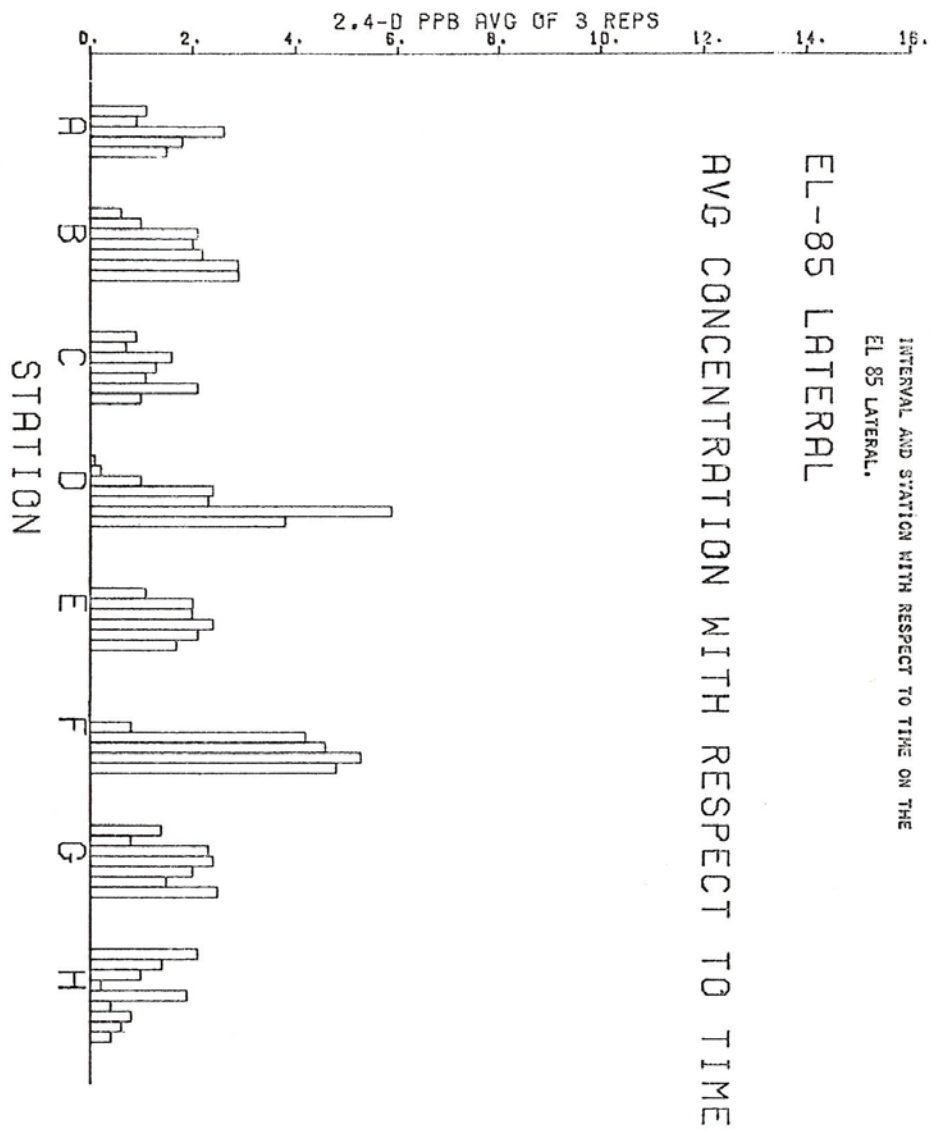


FIGURE 5. - THE PEAK AND AVERAGE 2,4-D CONCENTRATION FOUND AT EACH SAMPLING STATION ON THE EL 85 LATERAL.



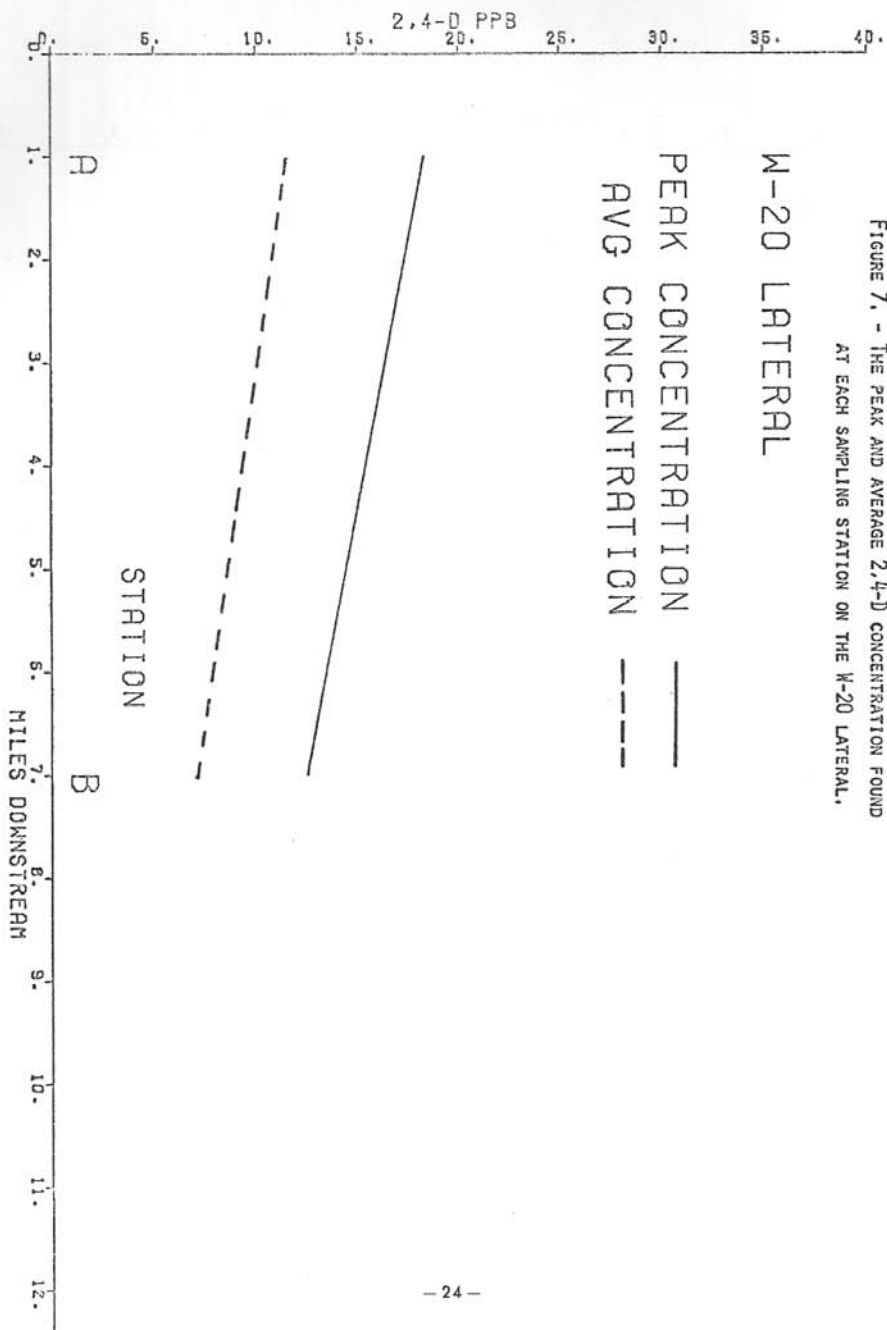


FIGURE 7. - THE PEAK AND AVERAGE 2,4-D CONCENTRATION FOUND AT EACH SAMPLING STATION ON THE M-20 LATERAL.

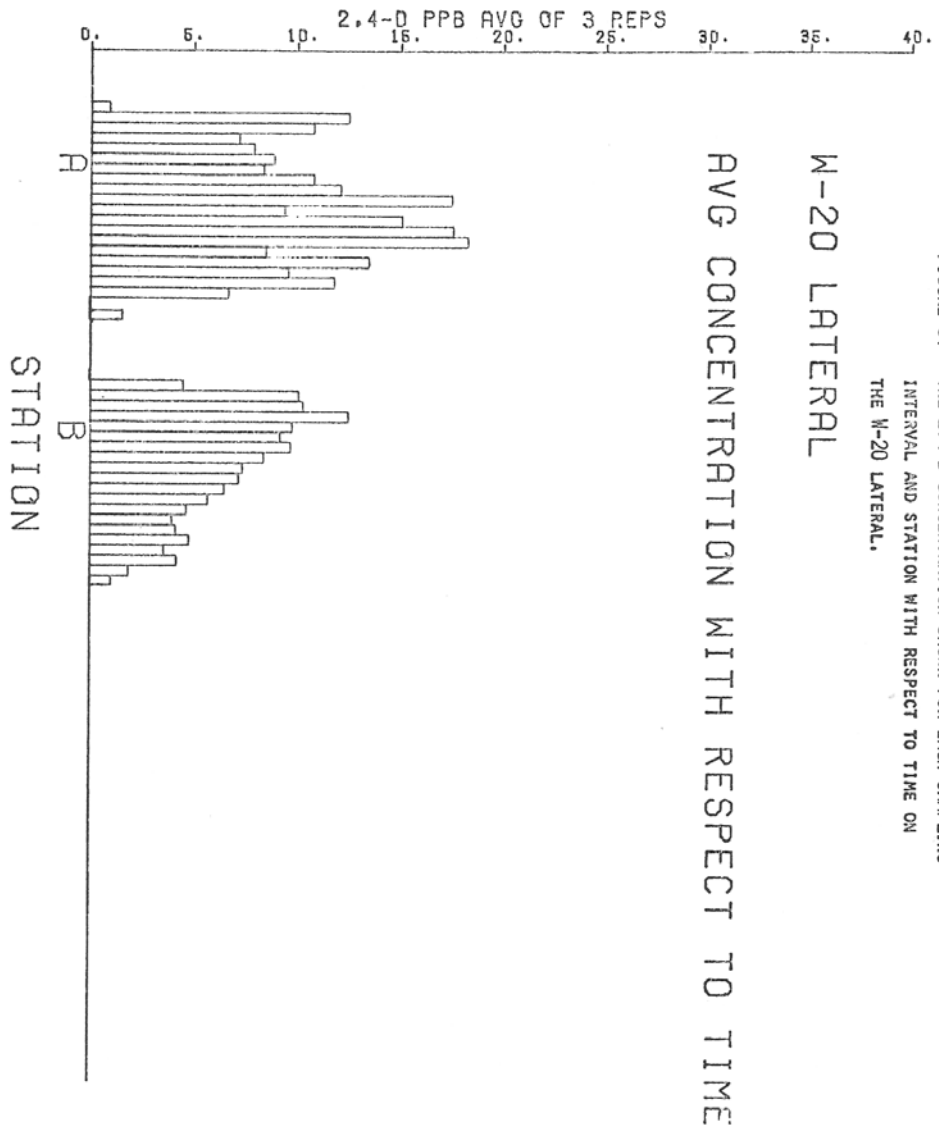


FIGURE 8. - THE 2,4-D CONCENTRATION SHOWN FOR EACH SAMPLING INTERVAL AND STATION WITH RESPECT TO TIME ON THE W-20 LATERAL.

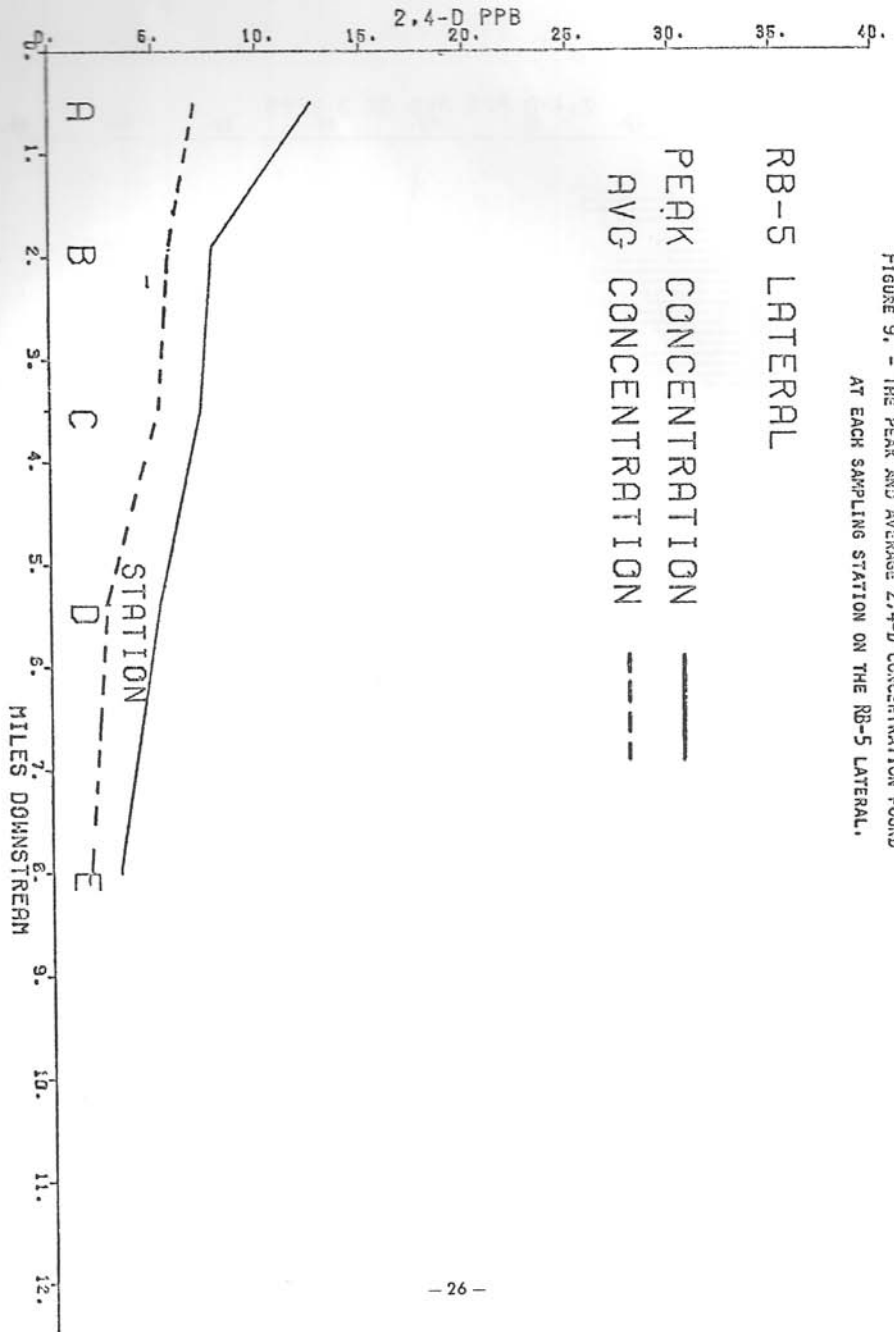
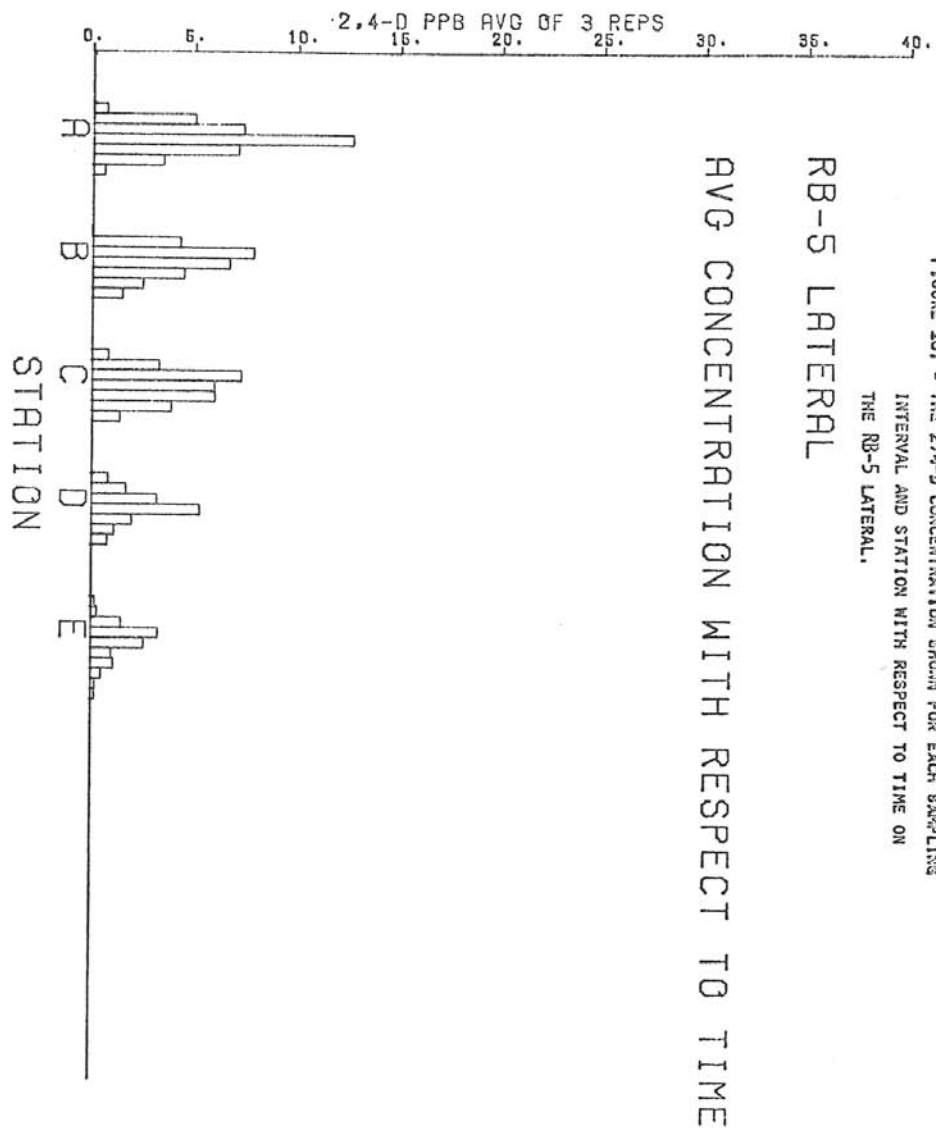


FIGURE 9. - THE PEAK AND AVERAGE 2,4-D CONCENTRATION FOUND AT EACH SAMPLING STATION ON THE RB-5 LATERAL.



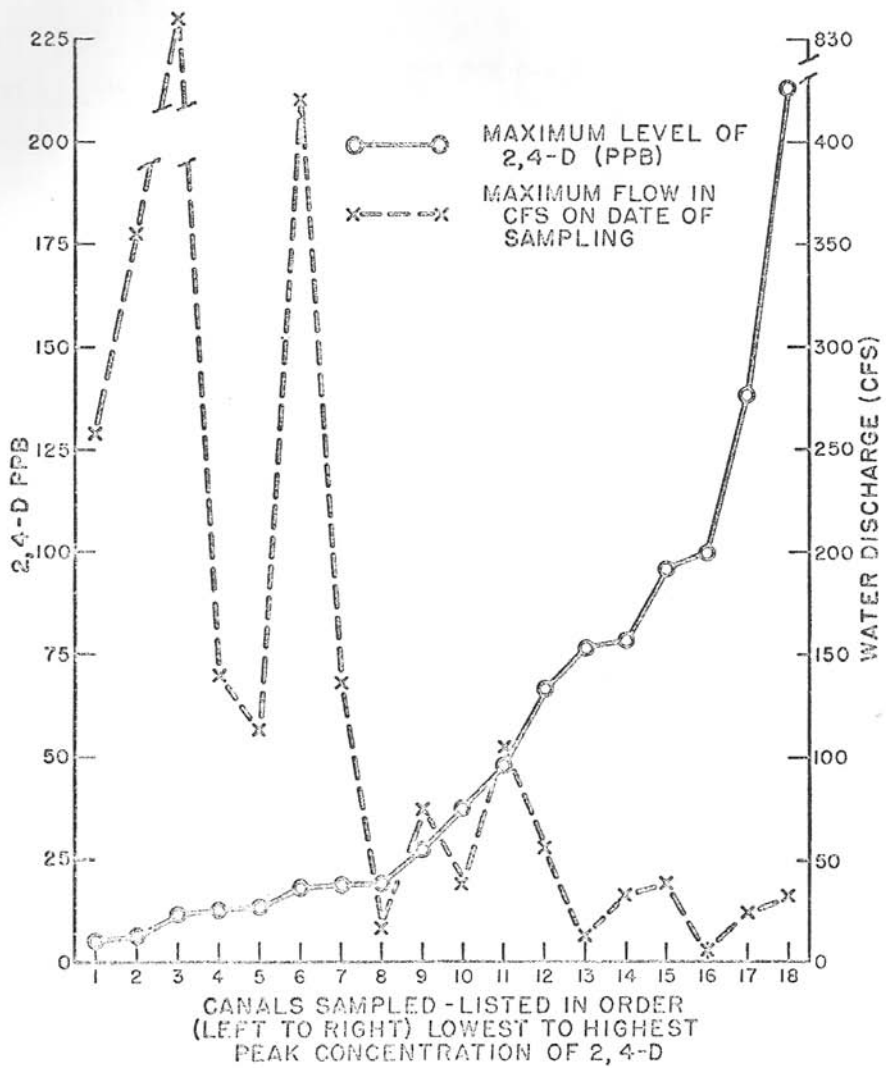


FIGURE II. PEAK CONCENTRATIONS OF 2,4-D FOUND IN THE IRRIGATION WATER CORRELATE INVERSELY WITH QUANTITY OF WATER DISCHARGED (CFS)

2.5 pounds per acre (1.57 to 2.8 kg/ha) with an average of 2 lb/acre (2.24 kg/ha). This factor was not a wide variant in this study. The amount of spray overlap varies continuously, and a real figure is hard to establish for any one time period. However, the overlap was estimated to range from 0 to 2 feet (0.0 to 0.6 m) in most cases and up to 4 feet (1.22 m) in some instances. The water discharged into each canal was measured and recorded on the date of sampling. The range for the 18 canals was from 6.8 to 840 cfs (0.19 to 23.79 m<sup>3</sup>/sec). In comparing the peak concentration of 2,4-D found in each canal with the water discharged, an inverse correlation is apparent. This relationship is illustrated in Figure 11 using graphs of the peak 2,4-D concentrations and the maximum water discharged in cfs. This correlation is expected since for a given herbicide input the reduction in concentration is directly related to the quantity of water available for dilution. Other canal parameters such as water depth and water surface width that are directly related to the water discharged also show a similar relationship to the 2,4-D levels.

This study of 2,4-D concentrations in irrigation water resulting from routine field ditchbank treatments indicates a number of trends such as the peak level of 2,4-D found varied from a few ppb to high of over 200 ppb; the higher concentrations of 2,4-D dissipate much more quickly than the low concentrations; irregularities in 2,4-D content of water samples result from variations in herbicide input during the spray operation; 2,4-D content of irrigation water correlated inversely with quantity of water discharged; herbicide application rate, herbicide input to the water, and quantity of water discharged are the most important factors influencing the herbicide content of the irrigation water; and canal flow characteristics are very important to the pattern of herbicide concentrations as the water moves downstream.

In irrigating a crop you may apply up to 3 inches (7.6 cm) of water at one irrigation. If the water contained 0.1 ppm 2,4-D, the temporary tolerance, throughout the entire period of irrigating a particular plot of land which is unlikely, the addition of 2,4-D would amount to 30.65 grams per acre (0.076 kg/ha) or a little over 1 ounce (28.35 grams) per acre.

The average 2,4-D concentrations shown for each sampling station in Table 1 were averaged for the total of 18 canals studied. This average showed a 31.9-ppb level at Station A as the highest of all the stations. Assuming that this highest average 2,4-D content for all the 18 canals studied was applied in the 3-inch irrigation, the field would receive 9.78 grams of 2,4-D per acre (0.024 kg/ha).

The temporary tolerance of 0.1 ppm for 2,4-D in water was exceeded in only 2 of the 18 canals studied. It is reasonable to assume that in low rate treatments

of ditchbanks where excessive overlap is avoided the tolerance for 2,4-D would not be exceeded in the irrigation water.

#### Acknowledgements

The authors extend their appreciation to the FWPCA for their financial support and interest in the program; to Mr. W. Dean Boyle, Agronomist, Bureau of Reclamation, Boise, Idaho, for his advice and direction on the field phase of the program; to Mr. Floyd Oliver, Project Agronomist, Columbia Basin Irrigation Districts, for his cooperation in working with Bureau personnel on the field phase of the program; and to Messrs. Victor S. Miyahara and Philip M. Turner, Agricultural Research Technician of the Agricultural Research Service, and Research Botanist of the Bureau of Reclamation, respectively, Denver, Colorado, for conducting the analytical work.

#### General Information

Concentration of 2,4-D as low as 1 ppb can be detected quite readily in 1-liter volumes of water. It should rarely be necessary to extract samples larger than 500 ml to obtain the data required. However, this procedure is described for extraction and analysis of 2,4-D in 1-liter samples. The quantities of solvents and reagents can be modified to apply to other sample volumes.

Amines of 2,4-D are readily split in moderately acidic or alkaline solutions. This behavior of the amines makes their extraction and analysis possible using the same method employed for the acid. On the other hand, attempts to separate intact amines from the acid were not successful.

Most residue studies involve analysis of large numbers of samples. The limiting factor in these studies is very often the number of samples that can be analyzed in a given period of time. Successful analytical methods must combine sensitivity, reliability, simplicity, and rapidity. A number of published analytical methods for 2,4-D and similar compounds are lacking in the latter two requirements. The method proposed here combines to a large extent all of the requirements, and has been used extensively for analysis of 2,4-D in natural waters from many different sources.

#### Reagents

- Hydrochloric acid, concentrated reagent.
- Chloroform, anhydrous reagent.
- Buffer solution (50 ml M/5 KH<sub>2</sub>PO<sub>4</sub> + 50 ml M/5 NaOH diluted to 200 ml with distilled water, approximately pH 8.5)
- Diazomethane 0.5% solution in diethylether. (See attachment)
- Benzene or iso-octane, distilled in glass.
- 2,4-D acid, purified.



#### Apparatus

Separatory funnels with Teflon stopcocks; 1000 ml, 250 ml, 60 ml capacities.

Centrifuge tubes, graduated, 15 ml.

Gas chromatograph equipped with electron capture detector (microcoulometric gas chromatography may also be used).

GC columns,  $\frac{1}{8}$  inch OD by 5 ft in length (glass and stainless steel are equally suitable), packed with 60-80 mesh Chromosorb W coated with 5% SE-30 liquid phase. Condition columns for 16 hours at 250 C. Flush column with 10 to 15 ml of purified  $N_2$  gas per minute during conditioning.

Recorder, potentiometric, 1 millivolt full-scale deflection in 1 second, chart speed 30 inches per hour.

#### Extraction Procedure

1. Thaw samples if frozen, and warm to room temperature. Shake well and transfer to 1-liter separatory funnel.
2. Rinse containers twice with 15 ml volumes of solvent and add to separatory funnel. Use acetone if samples are in glass, or acetonitrile if samples are in polyvinyl chloride. Care should be taken to accomplish complete rinse and transfer in this step.
3. Acidify sample to pH 1 to 2 with concentrated HCl. Shake well to disperse the acid.
4. Extract 3 times with 50, 25, and 25 ml volumes of  $CHCl_3$ .
5. Combine  $CHCl_3$  extracts in a 250 ml separatory funnel and extract 3 times with 20, 10, and 10 ml volumes of  $KH_2PO_4$ -NaOH buffer (pH approximately 8.5).
6. Combine the buffer extracts and acidify to pH 1.5 with HCl. Transfer to a 60 ml separatory funnel and extract 3 times with 5, 4, and 3 ml volumes of  $CHCl_3$ .
7. Combine  $CHCl_3$  extracts in a 15 ml centrifuge tube and evaporate to dryness using a gentle stream of dry filtered air. Evaporation may be hastened by warming tubes in a water bath at 30 to 35 C.

#### Esterification of 2,4-D Acid

1. To the 2,4-D acid residue in the 15 ml centrifuge tube, add 1 ml of 0.5% diazomethane solution. Use the diazomethane solution to wash down the inside walls of the tube. Add 1 ml of diethylether to complete rinsing of the tube wall. See attachment for preparation of diazomethane.
2. Allow the tubes containing 2,4-D and diazomethane to stand at room temperature for 10 minutes. The contents of the tube should have

a very faint yellow color remaining at this point.

3. Evaporate the ether and excess diazomethane under a gentle stream of dry air at room temperature. Excess drying or use of heat may result in some loss of the methyl ester of 2,4-D.
4. Add benzene, iso-octane, or other suitable solvent to the centrifuge tube. Shake or otherwise disperse the 2,4-D ester in the solvent. The volume of solvent required will depend on the quantity of 2,4-D in the original water sample. If necessary, additional dilution can be made.

#### Analysis of 2,4-D by Gas Chromatography

Any operable gas chromatograph designed for use with an electron capture, detector can be employed in the analysis of 2,4-D. Other detection systems may also be used; however, in most cases the sensitivity of these systems does not permit analysis of residue levels of 2,4-D.

1. One (or several) microliter of the solution containing the methyl ester of 2,4-D is injected into the chromatograph.
2. The peak height of the 2,4-D is determined and the quantity of 2,4-D in the injected sample determined from a standard curve. Standard curves are prepared by plotting peak heights against known quantities of 2,4-D methyl ester injected into the chromatograph.

The chromatograph operating conditions are as follows:

Column temperature — 200 C

Detector temperature — 210 C

Injector temperature — 235 C

$N_2$  carrier gas at a flow of approximately 35 to 40 cc/min.

Chart speed — 30 inches per hour.

Retention time — approximately 2.5 min.

Other instrument operating conditions are determined by sample size, background, and standing current of the detector.

#### Discussion

Partitioning 2,4-D acid from  $CHCl_3$ , through the buffer solution and back to  $CHCl_3$  has provided adequate cleanup for all water samples analyzed. However, in the event that an interfering substance is encountered, additional cleanup prior to analysis is possible through use of a suitable adsorption column.

The esterification method used in this procedure is rapid, simple, and complete. Some residue from the diazomethane remains in the sample and is chromatographed. This residue is eluted from the column in a very short time and does not interfere with the analysis.

The use of Chromosorb W and Gas-Chrom Q coated with SE-30 for analysis for 2,4-D has been reported in the literature a number of times. Perform-

DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION

COLUMBIA BASIN PROJECT

WASHINGTON

EXHIBIT B

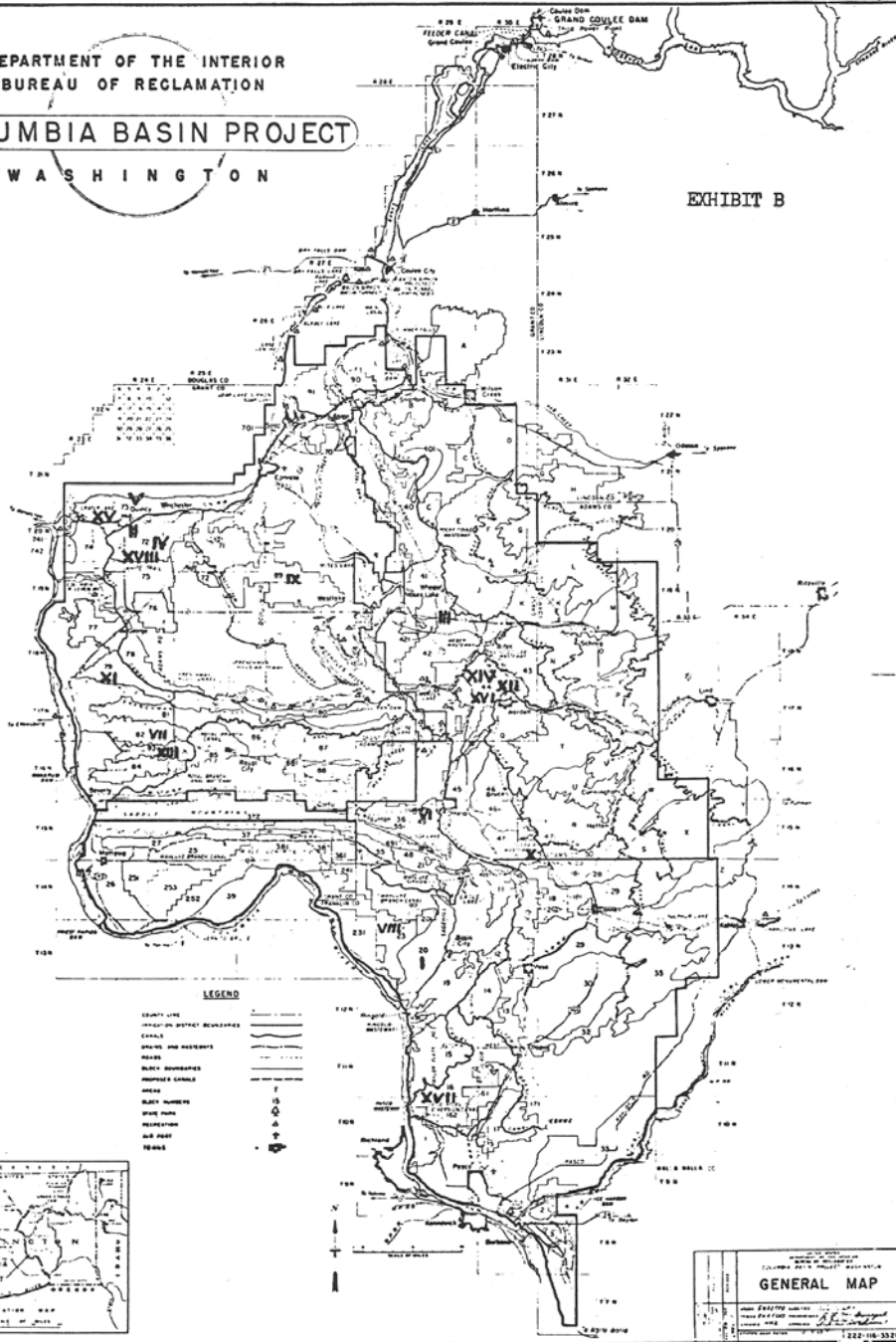
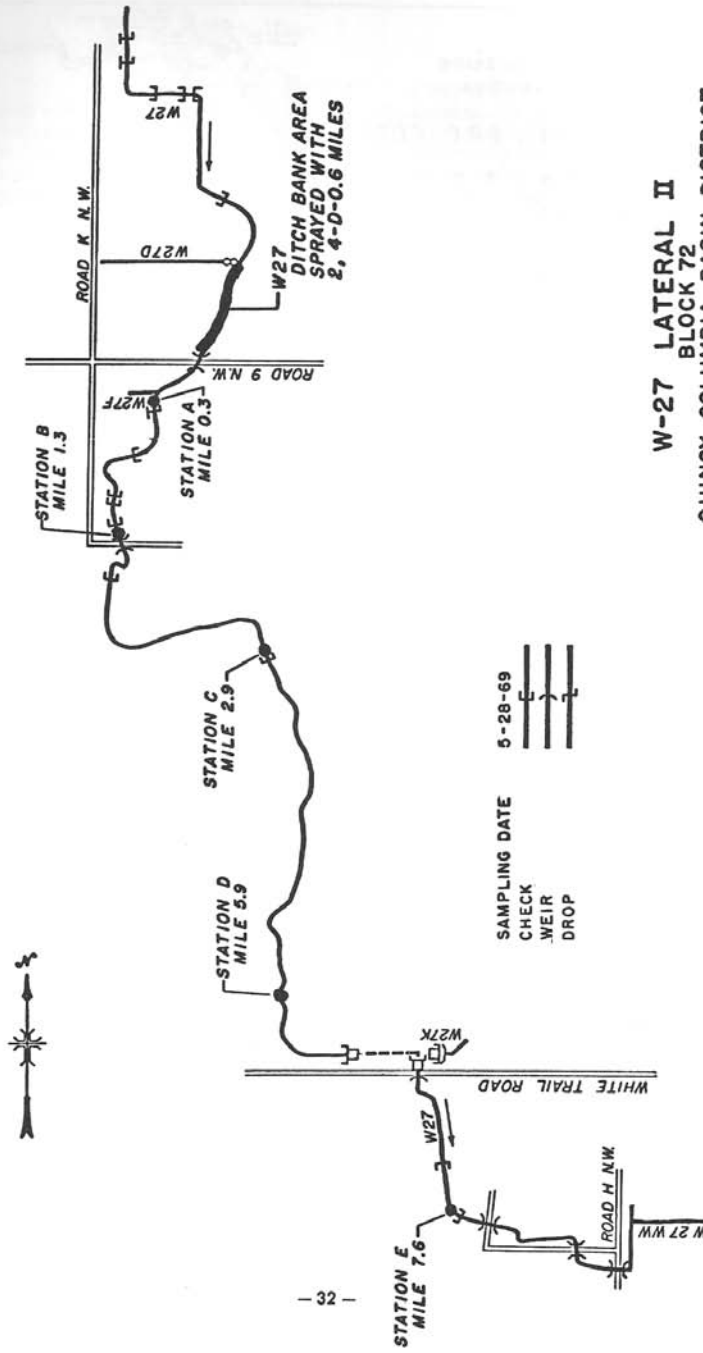


EXHIBIT C



W-27 LATERAL II  
BLOCK 72  
QUINCY COLUMBIA BASIN DISTRICT  
COLUMBIA BASIN PROJECT-WASHINGTON

ance of these materials has varied from mediocre to extremely poor, without additional column conditioning. Following bakeout of the columns, 4 to 6 injections of 3 to 5 microliter volumes of a 50 ppm solution of dalapon acid improved performance of these columns immensely.

#### BEHAVIOR OF DYE IN AN IRRIGATION CANAL AS A MODEL OF HERBICIDE DISSIPATION

R. J. Demint<sup>1</sup>

(Abstract) Three applications of Rhodamine B dye of 15, 30, and 56 min duration were made to Boulder Feeder Canal to provide 2500, 4400, and 6600-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 mi to 9 mi downstream from the application site. The curves were almost symmetrical at the first sampling station, but became increasingly skewed with greater downstream flow. Tailing edges were 15 to 20% longer than leading edges at the upstream station, and gradually increased to 200% or more at the last station. Reductions in maximum concentration with downstream flow were 71, 46, and 32% for the 2500, 4400, and 6600-ft applications, respectively. Elongations of the dye clouds with downstream flow were linear. Rates of elongation were 12, 18, and 18 min/mi of flow for the 2500, 4400, and 6600-ft applications, respectively.

<sup>1</sup>Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Denver Federal Center, Colorado.

#### WAYS TO TEST HERBICIDES IN THE GREENHOUSE FOR THE CONTROL OF SALT CEDAR

By P. C. Quimby, Jr., E. B. Hollingsworth and R. L. McDonald<sup>1</sup>

(Abstract) Techniques were developed for testing root- and shoot-applied herbicides on salt cedar under greenhouse conditions (*Tamarix pentandra* Pall.). Sub-irrigated potplant systems, which we have dubbed "phreatopots," were designed to simulate the field conditions under which phreatophytes grow. Variations of the basic system enable us to: 1) delete irrigation over the top so that we can apply herbicides to the foliage

<sup>1</sup>Research Plant Physiologist, Botanist, and Agricultural Research Technician, respectively. Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Rt. 1, Box 28, Los Lunas, New Mexico 87031.

and stems without danger of washing herbicides into the rootzone; 2) expose only part of the root system to soil-applied herbicides; 3) study the effect of various levels of soil moisture on the efficacy of soil-applied herbicides without altering plant water potential; and 4) sever the root system below the soil surface and concomitantly apply herbicide in the severance zone.

#### BEHAVIOR OF EMULSIFIED XYLENE IN WATER

P. A. Frank<sup>1</sup>

(Abstract) The stability of similar xylene emulsions varied widely among different canals. Rates of xylene loss from flowing water varied from about 90% at 3 mi in one canal to 78% at 10 mi in another. Water quality did not appear to be a major factor affecting the reduction in levels of xylene. Low water temperatures were observed by other workers to reduce the effectiveness of xylene as a herbicide. However, the persistence of xylene was both good and poor in water of 12 to 13 C. Canal characteristics such as water checks and turbulent pools were associated with high loss rates. Toxicity of xylene emulsions to trout and bluegills was observed by placing caged fish in two canals. While trout were more sensitive than bluegills to the xylene emulsion, both fish species were quickly killed at distances of 9 to 10 mi downstream from where the herbicide was applied.

<sup>1</sup>Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Denver Federal Center, Denver, Colorado.

#### A COMPARISON OF OXALATE CONTENT OF THREE WEEDY CHENOPODS

Lester B. Kreps and M. Coburn Williams<sup>1</sup>

(Abstract) In 1964 a *Salsola* L. new to Utah was found on the western shore of the Great Salt Lake. It was then hypothesized that the new plant was a hybrid between halogeton (*Halogeton glomeratus* (M. Bieb) C. A. Mey.) and Russian thistle (*Salsola kali* L. var. *tenuifolia* Tausch.). The new *Salsola* L. has been temporarily named *Salsola* 'X' until its taxonomic status has been determined.

Russian thistle, halogeton, and *Salsola* 'X' were collected between Lucin and Wendover, Utah at 1-week intervals from June 8 until frost in October. Samples of leaves, stems and whole plants were oven-dried,

<sup>1</sup>Crops Research Division, Agricultural Research Service, United States Department of Agriculture, in cooperation with the Utah Agricultural Experiment Station, Logan.

ground to 40 mesh, and total and soluble oxalates were determined.

Oxalate concentrations were higher in the leaves than in the stems in all samples. Leaf and whole plant samples of halogeton contained more oxalates than leaf and whole plant samples of Russian thistle or *Salsola* 'X'. Oxalate concentration in Russian thistle and *Salsola* 'X' were similar, with no intermediacy of *Salsola* 'X' oxalate concentrations, as would be expected in a hybrid. Oxalate content of stems of all three chenopods was similar.

#### BUDBREAK ON SALT CEDAR TREATED WITH U-29,449 AND 66-329

P. C. Quimby, Jr., R. L. McDonald and E. B. Hollingsworth<sup>1</sup>

(Abstract) The 2-[(4-chloro-o-tolyl) oxy]-2-(dimethylamino) ethyl ester of propionic acid (U-29,449) appeared to suppress budbreak and 2-chloroethylphosphonic acid (66-329) increased budbreak in saltcedar (*Tamarix pentandra* Pall.). One-year old saltcedar plants (greenhouse-reared) were clipped to about 6 inches in height and defoliated by hand. The bare stems were then painted with 1.7 ml of treatment solution per plant and observed for regrowth characteristics. We compared 5,000 and 10,000 ppm of Amchem 66-329 and 100, 500, 1,000, and 10,000 ppm of Upjohn U-29,449. Both dosages of 66-329 increased the number of nodes that produced shoots and the number of shoots per node. The two lower dosages of U-29,449 had little effect. The 1,000 ppm dose killed the upper stems but did not prevent basal sprouting. The 10,000 ppm dose of the U-29,449 completely inhibited regrowth for the 5-month duration of the experiment.

We also compared 8 lb ae/A of U-29,449 with a standard treatment of 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) in an oil-soluble-amine formulation of 8 lb ae/A in 100 gpa of carrier (oil-water emulsion) sprayed on foliated saltcedar plants in the greenhouse. These treatments defoliated all plants. After 6 weeks, regrowth had occurred on 5 out of 6 plants treated with U-29,449 and on 3 out of 6 plants treated with silvex.

<sup>1</sup>Research Plant Physiologist, Agricultural Research Technician, and Botanist, respectively. Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Rt. 1, Box 28, Los Lunas, New Mexico 87031.

#### RESPONSE OF MESQUITE TO HERBICIDES UNDER LABORATORY, GREENHOUSE, AND FIELD CONDITIONS

J Wayne Whitworth and John Norris<sup>1</sup>

(Abstract) Poor kills of mesquite when using 2,4,5-T may be due to inadequate absorption of the herbicide, to poor translocation or to inadequate toxicity of the herbicide after it arrives at critical sites within the plants.

Field research at this station with <sup>14</sup>C labeled 2,4,5-T has indicated better absorption and translocation during periods of peak susceptibility. However, even during these peak periods, field kills have been disappointing. With the advent of picloram, mixtures of picloram and 2,4,5-T were tested and showed a definite increase in the percentage kill of mesquite as compared to 2,4,5-T alone.

Translocation studies involving foliage applications of herbicides to year-old mesquite plants growing in glass-faced boxes showed that picloram, alone or in combination with 2,4,5-T, caused more rapid and prolonged inhibition of root growth than did 2,4,5-T. Greater or improved translocation was not an adequate explanation for these differences as indicated by tissue culture experiments which minimized the effects of translocation. Excised root tips of mesquite growing in nutrient solution showed that picloram or picloram combinations were inherently more toxic to root tissue than 2,4,5-T alone. Similar results were obtained when the herbicides were compared by placing herbicide-impregnated agar blocks directly onto root tips of intact plants growing in glass-faced boxes.

Whether the improved performance brought about by the addition of picloram to a mixture is due mainly to increased toxicity at the cellular level or to improved translocation will be determined by experiments utilizing various combinations of labeled herbicides.

<sup>1</sup>Department of Agronomy, New Mexico State University, Las Cruces.

#### SURFACTANT ENHANCEMENT MAY NOT BE RESTRICTED TO CUTICULAR PENETRATION

Jack P. Corkins<sup>1</sup>

In a comprehensive MH-surfactant enhancement study all available surfactant groups were tested in a manner that provided for the evaluation of each member of every homologous series. The principle experiments were conducted on Kanota oats using a marginal rate of MH for growth inhibition.

<sup>1</sup>Unifroyal, Inc., Porterville, California.

Some degree of enhancement was found within nearly every surfactant group tested. The well known concentration reversal was evident in most cases:

LITTLE ENHANCEMENT 0.01 to 0.10% of Surfactant	GOOD ENHANCEMENT 1 to 2% of Surfactant	LITTLE ENHANCEMENT 2 to 4% of Surfactant
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The potassium and diethanol amine salts of MH were compared using the same series of surfactants with each salt and the functional surfactant enhancement was found to be essentially the same.

The polyoxyethylene branched aliphatic ether group was the only group which provided the degree of surfactant enhancement which had been set as the objective of this study. Substitutions in the branched aliphatic moiety, such as a ring structure; and substitutions in the ether linkage, such as an ester or thioether, greatly reduced the enhancement activity. The optimum polyoxyethylene chain length tended to be shorter for the smaller branched aliphatic moieties and longer for the larger branched aliphatic moieties. Some of the branched ether types, such as trimethyl heptyl, were too phytotoxic for practical use. Polyoxyethylene (10) trimethyl nonyl ether was found to be consistently the best surfactant in a series of laboratory and field experiments conducted on a number of different plants.

It was assumed that the enhancement of MH by polyoxyethylene (10) trimethyl nonyl ether was the result of more efficient cuticular penetration. Radio-tracer studies were conducted to verify this hypothesis. The results showed that there was no appreciable improvement in the rate of cuticular penetration as measured by the disappearance of carbon-14 labeled MH from the surface of the leaves. There was, however, a substantial increase in the amount of MH that translocated away from the site of application on the leaves.

#### MUCILAGINOUS COATINGS ON WEED SEEDS<sup>1</sup>

James A. Young<sup>2</sup>, Raymond A. Evans<sup>2</sup>  
and P. C. Martinelli<sup>3</sup>

(Abstract) A mucilaginous coating greatly aids the germination of yellow pepperweed (*Lepidium perfoliatum* L.) seeds on the surface of media under low (0.05 to 0.20 bars) moisture tensions. The copious mucilage

<sup>1</sup>Cooperative investigation of the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, the Agricultural Experiment Station, University of Nevada, and the Nevada Department of Agriculture, Reno, Nevada.

<sup>2</sup>Range Scientists, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, University of Nevada, Reno, Nevada.

<sup>3</sup>Agricultural District Coordinator, Nevada Department of Agriculture, Reno, Nevada.

burst from epidermal cells as they imbibe water. The mucilage apparently limits moisture loss from the seed to the atmosphere giving the same effect as soil coverage. The mucilage might play a role in increasing surface area of the seed during imbibition of water. Two other species of Cruciferae—tumble mustard (*Sisymbrium altissimum* L.) and tansy mustard (*Descurainia pinnata* (Walt.) Britt.) have detectable amounts of mucilage. Neither of these species can germinate on the surface of media subjected to moisture stress. Mucilage is not restricted to Cruciferae. Seeds of the noxious weed Mediterranean sage (*Salvia Aethiopsis* L.), develops a copious glob of mucilage while imbibing moisture. Several of the ubiquitous weedy species of *Plantago* have mucilaginous seeds. Seed mucilage may be an important characteristic of a number of weedy species. Understanding the role of mucilage in germination will advance our knowledge of the ecology of these species.

#### WEED CONTROL BY LEGISLATION OR EDUCATION

Eugene Heikes<sup>1</sup>

My remarks will be directed to problems and conditions in Colorado, but I am sure our farmers and ranchers think much the same as yours and we do have most of the same weeds as other states. I have had experience with weed control legislation in Colorado and Montana and have worked with three different kinds of weed legislation and before long may add a fourth to this. We may have a little different situation in Colorado in that we may have more inaccessible areas than some states and more low-value or waste lands and public lands, than some states do.

Weeds are one of Colorado's most critical agricultural problems. Survey's show that over 65% of the irrigated farms are infested with field bindweed or Canada thistle; 30% with whitetop or povertyweed and 25% with Russian knapweed. The annual cost of controlling common weeds in Colorado is over \$21,000,000 annually; this does not include the cost of controlling perennial noxious weeds. If reduced yields, dockage, reduced land values and the cost of perennial weeds are included, Colorado farmers and ranchers are losing approximately \$65,000,000 annually. Each year weeds cost the average Colorado farmer over \$2,000. Obviously weeds are a major factor in Colorado's economy. In many areas, the weed situation is getting worse—not better.

At the present time, we have two laws on the state

<sup>1</sup>Extension Weed Specialist, Colorado State University, Fort Collins, Colorado.

statutes by which organized weed control programs can be put into operation. The first we refer to as the "Voluntary Act"; this simply states, "The boards of County Commissioners of the several counties of the State are hereby authorized to purchase materials and equipment which in their opinion is necessary for the control and eradication of noxious weeds." This is an effective bit of legislation but has no mandatory powers. A second law known as the "Mandatory Act" is enabling type legislation, whereby, through the petition and ballot process, mandatory weed control districts can be formed. These are administered by the County Commissioners, and an appointed advisory committee.

The "Mandatory Act" was passed in 1953. At that time some of the University people questioned if the mandatory approach was right and whether such a law could be enforced. Most of them favored stepped-up education. At that time there were some farm leaders that thought the program should be state-wide rather than on a district basis, but knowing that enforcement would be difficult, decided a program based on cleaning up local areas would be more workable and all that could be policed. Also, they thought this would be more likely to receive public support than one that included the entire state. So the "Colorado Pest Act" is on a County and District basis.

We have had problems, County Commissioners and County Attorneys often hesitate to enforce the law. There are questions as to whether the mandatory provisions are constitutional. Most counties lack sufficient budget to administer and conduct a mandatory type program that is workable and can show real progress.

During the past two years, attempts have been made to write a new weed law for Colorado that would include the entire state. The "Model Law" has been used as a pattern. According to the new proposal, the State Department of Agriculture would be responsible for enforcement "Local Control Authorities" would have jurisdiction over lands within the county with rules and regulations prescribed by the Commissioner of Agriculture.

There seems to be just as much question now as twenty years ago whether the mandatory approach is right or whether an intensive stepped-up educational program would be better and accomplish just as much. So from here on I would like to discuss the advantages and disadvantages of a mandatory weed control program.

One of the major problems with Colorado's present mandatory law is unwillingness by County Commissioners to provide adequate funds for weed districts to operate effectively. In counties where the commissioners have been educated on the importance of weed control, weed district programs operate fairly effectively, but in counties where the Commissioners are not weed-minded, the mere formation of a district has made very

little difference. The Commissioners still control the budgets and put the money where they think it is most needed. So the first thing toward making a weed district successful is educating the County Commissioners, and this would be true for any kind of weed control legislation that depends on county money. Also, County Commissioners are much more apt to listen to their taxpayers than they are to University or State Department people. This is one reason why education must come first.

As one mingles with farmers and other land owners with weed problems, and listens to their questions and conversations, it becomes obvious that there are some good reasons why farmers fail to do what we think they should. In many cases we would probably do the same as they do if we were in the same position. So I would like to discuss why there is this tendency of complacency on the part of some farmers about weed control. Success of modern day farming is based on the ability of putting all production factors together in the right combination for maximum dollar return. Whether a farmer succeeds in today's agriculture depends on how well he manipulates all the factors that go into producing and marketing the end product. In other words, he is a skilled business man. Much of the complacency we see with respect to weeds is the inability of the farmer to fit weed control into this package of farm management factors and see where it will make him a profit. Weed control is much more than just putting chemicals on weeds and doing the job in a cook-book fashion. Farmers know this and unless we can show them how to work weed control into their overall farming program, we will continue to see complacency. Weed control is not black and white. For example, we are only fooling ourselves to think we can eradicate field bindweed or Canada thistle in many areas, with the methods we have today. Maybe something better will come along but now the best method of controlling weeds is through good farming practices combined with chemicals. In many areas in Colorado it would be impossible to eradicate weeds, in fact, even control may be questionable from a practical view point. Instead, I think the good farmer must think in terms of protecting himself and less in terms of what's being done up on the headwaters of the rivers or what Jones' is doing across the road.

As mentioned earlier, I have had experience with three weed laws and maybe a fourth in the near future and at no time have I seen one that worked as it was originally intended or where enforcement was possible. Technically, the man that lets a half-acre of field bindweed go to seed breaks the law just as much as the man that lets a half-section go to seed. No law I have seen gives consideration to the severity of the infestation. There are very few farms that do not have some noxious weeds on them, but we usually point our finger

at the man that has the large infestations. Some farmers in Colorado have told me that if they were forced to control all their weeds, they would turn the land back to the county, and I am sure they are not bluffing. In a democracy we must treat everyone alike, so for such a law to be constitutional, the same degree of enforcement must be put on the man with a small patch as one with 40 acres solid.

The fact we have not been able to enforce the law on a district basis, it certainly does not make sense to think we can do a better job on a state-wide basis.

I personally feel the restrictions placed on perennial weed herbicides by the USDA and FDA, have seriously restricted the effectiveness of perennial weed control programs, but I do not think we should look on the situation as hopeless and sit back and do nothing. In the past, the good farmer has protected his land and stopped weed infestations at fence lines. This has been done by means of good farming practices with the help of herbicides. I think we are going to have to revert back to some of these tried-and-true methods. We must sell the idea that weed control is an important factor in the overall farm management program and that there is no such a thing as one-shot treatments or that there is any easy, cheap way of controlling weeds or that legislation will make the job easier, or that by involving the county or state that this will relieve the individual landowner of the responsibility. In many cases, farming practices will have to be changed if weed infestations are cleaned-up. Every situation must be considered on its own. This is one practical reason why I do not think state-wide mandatory programs are the solution to the problem.

I am highly in favor of organized weed control programs, but I think much more effort should be put on the educational approach than on policing and enforcement. Instead of a weed supervisor being hired primarily as a policing agent, he should be hired as an educator; instead of large sums of money being spent on chemicals and spray equipment, money should be spent hiring well trained field men to work with farmers to advise them on economics of weed control and to help them work out individual farming programs, that will lead to cleaning up individual fields or maybe entire farms. I think there is a strong need for more personalized service and selling ideas by personal contacts, rather than through mass media. We have all seen cases where the right persons can persuade people to do things. People with the right personality, that are courteous, are honest, and are respected, can do much more than someone using the strong-arm approach. Much more can be done through neighborly persuasion than with police powers. It is easy to pass laws but it is very hard to make laws work as they are intended, usually because we do not take into consideration

human nature. No person likes to be forced to do something that he does not believe in.

Another factor that confuses farmers is that we who are supposed to be experts do not have nearly all the answers. All we can tell a landowner is that he must control his weeds, but we don't know how he should do it. I think research and extension education should be directed more toward the overall farming picture rather than singling out individual parts. Much more consideration should be given to economics. Many things work if you do not have to consider cost.

In conclusion, I think each weed problem is different and must be considered individually. Perennial weed control cannot be handled in cook-book style. Weed laws assume that noxious weeds can be controlled in all situations either by spraying or by mowing. This is questionable both from the technical and practical standpoint. Laws do not take into consideration inaccessible areas, cost vs. land values, or the fact that many of the worst weed infestations are on public lands. I think that if landowners are made to believe that weed control is good business and are informed on the most effective control measures and are given help on an individual basis, we would see more progress than by passing new and stronger laws. I am not insinuating that there is not need for weed control legislation, but I think the mandatory approach should be minimized and more effort put on education. I think landowners should be encouraged and given help with solving weed problems in the manner that best suits them. Many will say the educational approach has been tried and has not worked so we must have laws. I do not think the kind of educational approach I have tried to outline has been given a fair trial.

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#### PLANNING AND CONDUCTING MORE EFFECTIVE COUNTY AND DISTRICT WEED CONTROL PROGRAMS

Louis A. Jensen<sup>1</sup>

Controlling weeds is a major problem to everyone owning or managing land, so in reality, everyone is concerned. Threat of weed invasion, especially by those that are most difficult to control, makes it important that they be controlled and, if possible, eradicated. All this is in the public interest and takes on a community or area aspect.

There are so many aspects to weed control and so many people of diverse interests involved that an organized approach and a team effort seems imperative. County weed committees or weed district boards can perform an important function in planning and helping to conduct a total, over-all long-range weed control

<sup>1</sup>Extension Agronomist, Plant Science Department, Utah State University, Logan, Utah.



program. This includes education, regulatory, and many other important features.

County weed committees have existed in Utah for many years. Some have been quite effective while others have had serious limitations. In working throughout the state with county weed programs and county weed committees, a lack of understanding was observed on many things such as duties and functions of the committee, membership how to organize or re-organize and similar items so necessary for the effective functioning of any leadership group. To fill this need, a "Handbook for County Weed Committees" was prepared. Before it was printed, most of the procedures in it were tried and tested on a pilot basis. It brings together the good features proven by the most successful county weed committees in the state. Perhaps some of the ideas in it might be useful to others. Some of the main parts of the handbook are: Duties and functions of the county weed committee and its individual members, suggested committee organization, special duties of officers and key individuals, outline for meetings, procedure for organizing the committee and providing training. This handbook has been approved and endorsed by Utah State University, Utah State Department of Agriculture and Utah Association of County Officials.

In line with procedures outlined in "The Handbook", weed committees are being organized or re-organized in every county and consist of 20 to 25 key individuals representing the major groups, organizations and agencies in each county to help committee members learn their duties and function effectively. Ten basic facts are stressed as a sound basis for every weed control program as follows:

1. The individual or group owning or having control or supervision of land and property is responsible for the weeds present.
2. It pays to control weeds. We can't afford the cost of letting them grow.
3. Under most conditions, a combination of methods is needed to effectively control or eradicate weeds.
4. Prevention is the cheapest and the most effective method of weed control.
5. Most weeds on farm lands can be efficiently controlled by use of known facts on control methods.
6. By using good farming methods, any farmer can keep weeds under control on his farm even though weeds are allowed to grow and produce seed on adjacent land or on watersheds.
7. Weeds are more easily controlled while they are young.
8. Farmers should plant only seed that is free from weeds.
9. The biggest source of new weed infestations is from weeds that are permitted to go to seed on your own property.

10. Weeds create a community problem and definitely affect the economy of any locality.

Committee meetings include lively group discussions on serious weed problems and specific suggestions to help solve them. As part of the training, specially prepared material is placed in the hands of each weed committee member consisting of the "Handbook for County Weed Committees", current "Chemical Weed Control Guide" and issues of "The Weeders Digest" as prepared periodically.

It is believed that county weed committees properly organized and trained can do much to help plan and conduct effective long-range over-all county weed control programs. Copies of the handbook are available from the author upon request.

#### THE WEED SCIENCE PROGRAM IN THE U.C. AGRICULTURAL EXTENSION SERVICE

W. B. McHenry, C. L. Elmore, W. A. Harvey<sup>1</sup>

The responsibility for herbicide testing and recommendations by the University of California has been established by an administrative directive, Communication No. 18, issued jointly by the directors of the Agricultural Experiment Station and the Agricultural Extension Service. The policy applies to all pesticide chemicals, food and feed additives, plant growth regulators, and to veterinary drugs.

Prior to making recommendations, performance and, in the case of food or feed commodities, residue data must be obtained to substantiate both usefulness and safety. On the Davis Campus, food and feed samples are submitted to the Department of Environmental Toxicology for analysis. Farm advisors cooperate in the field tests and collect and submit samples through an extension weed specialist or an experiment station worker and only on a priority basis established annually. On the Riverside Campus, residue analyses are conducted by laboratories in the Departments of Horticultural Sciences, Agronomy, and Vegetable Crops. Often, coded samples are analyzed in company laboratories and the code broken when the data is returned. The data are developed from Agricultural Extension or Experiment Station testing sometimes in cooperation with the USDA, other agencies, and companies. A close liaison with chemical companies during the developmental stages of a new herbicide is important. When testing is conducted by U.C. personnel on crops with non-registered herbicides or herbicide uses, arrangements must be made to insure that none of the treated commodity enters market channels.

<sup>1</sup>Agricultural Extension Service, University of California, Davis.

There are four basic requirements to be met before the University of California will issue an herbicide recommendation. The herbicide must have (1.) Federal and (2.) State registration. The staff member suggesting the U.C. recommendation must support his proposed U.C. recommendation with University (3.) performance data and with (4.) residue data on any food or feed crop. In the case of some minor uses, U.C. recommendations may be based upon data from other sources.

A Statewide Intramural Weed Group constitutes the weed science team and includes experiment station, state office and county agricultural extension service staff as well as three USDA weed workers headquartered in California. The Intramural Group was initially organized by experiment station and extension weed workers on the Davis and Riverside campuses to coordinate statewide testing and recommendations. Later, as county farm advisors became more active in field experimentation, they were included. Today, the Intramural Weed Group is composed of an executive committee comprising extension and experiment station workers, plus six research committees for vegetable crops, seven for agronomic crops, five for orchard and vineyard crops, one ornamental and turf committee, two non-crop committees, and one on aquatic weeds. Farm advisors are on all the research committees and often head them. The Intramural research committees review U.C. weed control recommendations, submit proposed additions or changes to the executive committee, and plan experimental work for the coming season. Final administrative review of new recommendations is made by Dr. J. E. Swift, a statewide pesticide coordinator.

The success of the U.C. herbicide testing program in California rests heavily on the interest and initiative of the county farm advisor. Experiment station and weed specialist staff depend upon him to select cooperative farmers, irrigation district managers, park superintendents, etc., who provide the necessary experimental sites. Farm advisors conduct field experiments on their own, or cooperatively with extension weed specialists and/or experiment station personnel, take weed control, phytotoxicity (injury), and yield data, and are responsible to see that crops receiving non-registered herbicide treatments are destroyed at harvest. If residue analyses are required to fulfill the requirements of U.C. policy for issuing recommendations, the farm advisor collects these and submits them to the appropriate campus, U.C., Davis, or U.C., Riverside.

First hand involvement in herbicide testing by farm advisors greatly enhances both their competence and confidence in answering weed control questions that more often than not require a complex of considerations for the best alternative. The background experience also provides the county worker a base from which

to better analyze problems of poor weed control or crop injury that result from the misuse of herbicides.

Herbicide testing is of two general types, county evaluations of registered herbicides to assess applicability to local conditions, and the testing of non-registered herbicides or uses. Typically, non-registered compounds are compared with registered materials in the same experiments to measure advantages and disadvantages of the new candidates. The plots provide data for subsequent recommendations and at the same time are utilized by farm advisors for county demonstration meetings for farmers, ranchers, nurserymen, turf managers, etc. In a few counties with particularly active test plot programs, annual day long tours are held by farm advisers for farmers, chemical company representatives, applicators, and dealers. Extension weed specialists are usually invited to participate to lend regional or statewide experience to the discussions.

In recent years, a growing number of farm advisors have organized and conducted weed schools for their county publics. These have been day long or evening sessions held once a week for three or four weeks and are well attended. Topics such as the characteristics of weeds (annuals, perennials, narrowleaf, broadleaf), classification of herbicides, application and incorporation equipment, safe use of herbicides, fate of herbicides, application and incorporation equipment, safe use of herbicides, fate of herbicides in soil, foliar penetration, etc., are explored in some depth. Experiment station and extension specialist staff participate. A few years ago, one farm advisor held a school at the request of herbicide dealers solely on weed taxonomy. In the Central Valley counties particularly, farm advisors often hold training meetings specifically for local herbicide applicators and dealers and thus "wholesale" weed science knowledge of growers and other herbicide users.

County farm advisors who have relatively minor responsibilities in weed control normally are equipped with knapsack type sprayers. More active county weed programs are conducted with engine driven or compressed air units. Often grower tractor-mounted sprayers or sled mounted incorporator-sprayer units are used in row crop testing.

Plot sizes used in early evaluation testing are limited in size. Single row plots 25 to 50 feet long are used or 10x20-foot and 20x20-foot plots in solid seeded crops such as alfalfa. In orchard or vineyards, strip treatments usually encompass one or three trees or vines. Plot size would then vary by plant spacing. Trials are replicated a minimum of three times at each location. In more advanced testing when registration is a reality or reasonably assured, larger plots are used to accommodate harvester swath widths. If the particular field scale use of an herbicide fits aerial applications such as

in alfalfa, corn, wheat, and barley, plot evaluations include aircraft treatments on even larger plots.

Much of the plot work is organized into uniform testing in which the same herbicides and rates are tested on a given crop or weed species under a variety of environmental conditions and cultural practices. Extension specialists work up a suggested uniform trial proposal, usually in consultation with farm advisors and experiment station staff. The suggested trial outline is then mailed to appropriate farm advisors who have interest in weed control activities.

Not only is data easier to summarize when uniform rates and chemicals are evaluated in all major crop area of the state, but there is also greater reliability of resultant recommendations.

Publications may originate with and be a joint effort of farm advisors, specialists, and experiment station personnel. County trials are often summarized in a county publication but all recommendations must have state approval. Trial data may be published in progress reports or in *California Agriculture* before publication is prepared for technical journals.

It should be apparent from the discussion that there is considerable cooperation and interplay of ideas as well as research in the weed control program at all levels in California. There is a great degree of dependence upon farm advisors and their cooperation in a total program. Because weed control specialists are closely associated with experiment station personnel it is a short distance from the laboratory to the grower and back to the laboratory.

#### EASTERN WASHINGTON EXTENSION WEED PROGRAM

Dean G. Swan<sup>1</sup>

This weed science position is a joint appointment; 75 percent of the time is concerned with extension work and 25 percent with research projects. The extension responsibilities are very much the same as is common in most areas and is concerned mainly with working with other specialists and working with agents in eastern Washington, preparing publications, coordinating the revision of the chemical weed control handbook, assisting with short courses, and work with the 4-H Club. Site evaluations of local weed problems with county extension agents provides a visual opportunity to impart information.

The specialist works with the research personnel. About 25 percent of the time is spent in research activities. Research equipment consists of a pickup truck, bicycle wheel plot sprayer, back pack sprayer, com-

<sup>1</sup>Extension Weed Specialist and Associate Agronomist.

pressed air sprayer, granular spreaders, cub tractor, and a flexible tined harrow.

The budget is provided by the Washington Experiment Station and industry grants.

Most of the work is related to the control of annual weeds in winter wheats. Herbicide screening on winter wheat is one of the main activities. Others include studies on plant competition and downy brome control. Some work is done with peas and lentils, as well as with alfalfa.

#### COMMUNICATIONS AND THE CARLSON-FOLEY BILL

Peter S. Illoway<sup>1</sup>

Weeds are one of land's worst enemies. Weed losses in the United States are estimated to cost 4½ to 5 billion dollars annually or approximately \$450 per farm. Weeds cost more to control than the combined destruction by insects and plant diseases. Weeds destroy the land for recreation, cropping practices, livestock production and water and soil conservation, and with more people needing to be fed in the country, more land being removed from agriculture for highways, city expansion and industrial sites; it is of vital concern that we help agriculture in controlling and/or eradicating this problem of weed infestations.

The Carlson-Foley Act or Public Law 90-583 provides ". . . for the control of noxious plants on land under the control or jurisdiction of the Federal Government."<sup>1</sup> This bill permits ". . . state officials to destroy noxious plants on Federal lands, subject to approval of the head of the Federal agency having jurisdiction over the land and under the procedures applicable to private lands. The State would be reimbursed to the extent of available Federal funds."<sup>1</sup>

This bill was signed by President Johnson on October 17, 1968, and climaxed a 16-year effort by ". . . the Weed Society of America and the National Association of State Departments of Agriculture."<sup>1</sup> The bill was originally developed and introduced by the Republican Senator from Kansas, Senator Carlson. Each new session of Congress he reintroduced the bill and in 1968 he was assisted by the Democratic Representative from the State of Washington, Representative Foley. The last version of the bill was introduced on November 17, 1967. It finally was passed by the U.S. Senate on September 20, 1968, and the U.S. House of Representatives on October 7, 1968.

This bill is only a piece of legislation and is only as good as people want to make it. Although the bill ". . . authorizes suitable appropriation of funds by

<sup>1</sup>State Agronomist, Wyoming Department of Agriculture, Cheyenne.

Congress to Federal Departments or agencies to conduct (an) adequate and effective noxious plant control (program) on federally administered lands in cooperation with those states in which there is in effect a noxious plant control program."<sup>2</sup> States or state agencies very likely will do little control work where reimbursement is not immediately forthcoming. It is therefore imperative that federal agencies be suitably funded to undertake the necessary control procedures. The only methods that the federal agencies have of obtaining more funds is twofold. First, it will be necessary for the agencies concerned to make noxious weed control a separate "line item" in their budgets so that the Congress can fully understand where the money will be spent. Secondly, the cooperating state agencies must help supply to the Federal agencies a detailed description of known noxious weed infestations. Areas should be delineated as to acres, section, range, township and specie of weeds. An estimated cost of eradication or control would also be beneficial to the Federal agencies concerned. "This bill is therefore an opportunity for the Federal and State governments and the farmers and ranchers to get together and create enough steam to hopefully get some money behind it. The fact that the bill has been enacted doesn't make any money available; funds still have to be appropriated by Congress and every Federal agency is facing tight money controls. It will be necessary to focus attention on the noxious weed problem and the bill does give us this opportunity."<sup>3</sup>

Now that we've understood what the bill is, how it was passed and what it was designed to do, let's find out how we get the job done. What is communication? Webster defines it as "... an exchange of information . . . , a process by which meanings are exchanged between individuals . . ."<sup>4</sup> "Society is based on the possibility of men living and working together for common ends—in a word, on cooperation. But without communication, cooperation is impossible. Through communication men share knowledge, information, and experience, and thus understand, persuade, convert, or control their fellows."<sup>5</sup>

Let's not sit back and expect the Federal agencies to get the ball rolling and implement the Carlson-Foley Bill themselves. You are going to have to make the first step in your individual localities and make the initial contacts. Explain your purpose for being there and express the desire to help in accumulating the desired information. Nobody from a Federal agency is going to be the push factor. To get this project off on the right foot you have to make the first move. Most of these agencies have field personnel who do a considerable amount of traveling in the summer and in their travels they could make some notes regarding infestations, weed species, approximate acreage and the location. You should not set this project up so that it will

require many man hours of labor but a simple method of recording what is seen. In many cases the infestations are already known but no attempt or method has ever been made to record them. Each individual weed district supervisor or inspector should be the local coordinator, while the overall coordination should be in the hands of the state weed control supervisor. Any assistance you can lend your Federal colleagues will, I'm sure, be greatly appreciated. Since this project should be started in states where the weed control program is state orientated the state weed control supervisor should coordinate all local weed personnel into the mapping, recording, and final accumulation of the data in conjunction with the work done by the cooperating Federal agencies.

This program of weed control on Federal lands will aid all states having an active weed control program. The place to begin is at the local level since at the Washington level, all they really want to see is the final figures showing acreage, weed specie, and estimated cost of control.

To summarize, this program is only going to be as good as you make it. We're not after a total out and out destruction of weeds program, because this will never happen. What we're after at the present time is "to begin" a control program on Federal lands I think with good communications and a concentrated effort, we can get this job started. But "to begin" we've got to evaluate the problem. So let's get busy and get down on a local level and see what these agencies need, how we can help them and then get the job done.

<sup>1</sup>Letter from Byron G. Allen, Assistant to the Secretary, United States Department of Agriculture, Washington, D.C. October 23, 1968.

<sup>2</sup>Considerations for Implementing PL 90-583 prepared by Interagency Ad Hoc Committee.

<sup>3</sup>Talk by Paul Howard, Department of the Interior, Washington, D.C. at the North Central Weed Control Conference, Sioux Falls, South Dakota, December 10, 1969.

<sup>4</sup>Websters Seventh New Collegiate Dictionary, G. & C. Merriam Co., Publishers: Springfield, Massachusetts.

<sup>5</sup>Doubleday Pictorial Library of Communications and Language, Editorial Board: Sir Gerald Barry, Dr. J. Bronowski, James Fisher, Sir Julian Huxley. 1965, Doubleday & Co., Inc., Garden City, New York. pp. 16.

#### THE INFLUENCE OF HERBICIDES RESTRICTIONS ON PERENNIAL WEED CONTROL IN MONTANA;

Leslie W. Sonder<sup>1</sup>

The restrictions on the use of the herbicides fenac, 2,3,6-TBA and picloram on cropland has slowed down the progress of perennial weed control in Montana.

<sup>1</sup>Extension Weed Specialist, Montana State University, Bozeman, Montana.



The most extensive effect being felt is probably on the control of leafy spurge *Euphorbia esula*, a serious problem on rangeland. The material picloram is the best compound which has been found to kill leafy spurge and was being used to eliminate many of the smaller potential problem areas.

The loss of fenac and 2,3,6-TBA on cropland has had its greatest effect in the control of small patches of field bindweed *Convolvulus arvensis* in the dryland grain producing area of the state. Each of the materials was utilized for control of Canada thistle but the restriction will probably have less total effect in this area as 2,4-D and cultivation can be utilized to a greater extent.

Regardless of the total effect on overall perennial weed control in Montana and on other states, there are two other factors which have resulted. One factor is a blessing, the other possibly a curse.

These restrictions have brought about a better understanding that herbicides must be used properly and that residues of these materials in the soil can be a problem. Producers are asking questions about use and application and seem to be more concerned about accuracy and possible crop and soil residues. This is all very good and maybe the restrictions in one way have been a blessing; however, there is a temptation to use a compound in the same way and manner as before even though this registration has now been canceled. This is, of course, a risk that we must all face and sincerely hope that all people can be convinced to apply materials according to the present clearances and restrictions.

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**EFFECT OF CERTAIN HERBICIDES ON THE PRODUCTION OF ALFALFA (MEDICAGO SATIVA) AND SAINFOIN (ONOBRYCHIS VICIAEFOLIA SCOP.)**

V. R. Stewart<sup>1</sup>

Alfalfa cultivar 'Vernal' and sainfoin cultivar 'Eski' were treated with herbicides to study productivity and weed control from the herbicide treatment.

Pre-planting incorporated treatments of N-butyl-N-ethyl-alpha, alpha, alpha-trifluoro-2,6-dinitro-p-toluidine (benefin); and ethyl N, N,—dipropylthiol-carbamate (EPTC), post emergence treatments of 3,5-dichloro-4-hydroxybenzotriazole (bromoxynil); 4-(2,4-dichlorophenoxy)butyric acid, (2,4-DB) and 4 [(4-chloro-o-tolyl)oxy] butyric acid, (MCPB) were compared with a companion crop treatment and a check.

<sup>1</sup>Northwestern Montana Branch Station, Agricultural Experiment Station, Montana State University, Kalispell, Montana.

The treatments were evaluated on the basis of population counts of legumes and weeds, forage yields the seeding year and the following year and an economic evaluation of the production of legume forage for the two years.

Bromoxynil at 1/4, 5/16 and 3/8 lbs/A controlled all broadleaf weeds except chickweed, which had not emerged at time of application. EPTC at 3, 4; and 5 lbs/A and benefin at 2, 3 and 4 lbs/A effectively controlled all the grass species. EPTC effectively controlled night flowering catchfly and chickweed. Benefin was not effective in control of fanweed and shepherdspurse.

Alfalfa stands were significantly reduced in the benefin treated plots, however this could have been in part mechanical, this occurred at 3 and 4 lbs/A. Sainfoin stands in all plots were more variable than alfalfa, ranging from 71 percent to 83 percent. These reductions could be due to weed populations since this species is very sensitive to competition.

Correlation coefficients of crop yields and weed populations were calculated for alfalfa and sainfoin. As the weed population decreased the yields of alfalfa and sainfoin increased. The "r" value for alfalfa and weeds was —.555\* and for sainfoin and weeds was —.666\*.

Alfalfa plots treated with bromoxynil at 1/4 lb/A gave 79 percent weed control and yielded 8.97 T/A of alfalfa over two years resulting in a net profit above the check of \$83.34/A and \$18.74/A<sup>2</sup> above the companion crop treatments.

Sainfoin yielded 8.40 T/A after treatment with 3 lbs/A of benefin, which gave 89 percent weed control. Net profit above check was \$49.00/A and \$46.00/A respectively for the check and companion crop treatment.

<sup>2</sup>Based on alfalfa at \$20.00/T and barley at \$40.00/T.

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**BROMOXYNIL FOR BROADLEAF WEED CONTROL IN SEEDLING ALFALFA**

W. R. Sallee and Louis Whitendale<sup>1</sup>

Approximately 300,000 acres of new alfalfa are planted in California each year. One of the most critical factors in establishing a high-producing stand is good weed control while the crop is in the seedling stage. High quality early market first-cutting alfalfa commands \$15.00 to \$25.00 more per ton if it is free of weeds. However, weed-infested alfalfa is sometimes given to whomever will cut it. In Tulare County, a few of the broadleaf weed problems in seedling alfalfa are

<sup>1</sup>University of California, Tulare County Farm Advisor and Amchem Products, Inc., Visalia, California.

mustard, fiddleneck, pigweed, speedwell, chickweed, and lambsquarters. 2,4-DB is presently used post-emergence on seedling alfalfa, but fiddleneck control is weak when 2,4-DB is applied during the cool damp conditions of San Joaquin Valley winters.

Five years of field experiments have provided evidence that bromoxynil controls broadleaf weeds in seedling alfalfa, although the crop may be damaged if temperatures are high and humidity is low. To determine the range of humidity and temperatures under which bromoxynil could be used safely, a series of field experiments was conducted as five trials from November 1968 to April 1969, with applications approximately every month. Separate plantings were established for each treatment date so application could be made at the 2- to 4-trifoliolate stage of alfalfa growth. Treatments included bromoxynil at rates of  $\frac{1}{4}$ ,  $\frac{3}{8}$ , and  $\frac{1}{2}$  lb ai/A, 2,4-DB ester at  $\frac{3}{4}$  lb ai/A, and a check plot. The first four sets of plots were treated when daytime temperatures were below 65°F and humidity was above 30%. The last set was treated April 8 when daytime temperatures were 70°F and above, with 20 to 30% humidity. The soil was a Foster fine sandy loam. 100 units of phosphate was applied and the alfalfa planted at 20 lb/A. December through April was extremely wet, so the alfalfa grew with natural rainfall through April 7. Stand and vigor of alfalfa and each weed species present were rated visually. Harvesting was done when regrowth at the crown of the alfalfa plant was  $\frac{1}{2}$  to 1 $\frac{1}{2}$  inches tall.

The most satisfactory treatment in this series was bromoxynil at  $\frac{3}{8}$  lb/A, which produced excellent control of mustard, pigweed, fiddleneck, and shepherds-purse. Neither bromoxynil nor 2,4-DB controlled chick-

weed, speedwell or redmaids. When weather was cool,  $\frac{3}{8}$  lb/A bromoxynil produced only slight alfalfa injury, but as the temperatures increased, so did injury. The amount of rain had only a slight effect except where water had been standing prior to treatment. There, the alfalfa was completely destroyed. There was noticeable damage from 2,4-DB ester under the damp conditions of January and February.

When bromoxynil was applied to alfalfa in bright sunlight with temperatures above 65°, on April 8, there was severe leaf burn and stunting. Bright sunlight appeared to increase alfalfa injury as chlorosis on the outer portion of the leaves and as leaf drop. Leaf burn was detectable for 3 to 6 days after treatment. Stunting was noticeable 3 to 5 weeks later. Under these warmer drier conditions, 2,4-DB alfalfa injury was slight.

Harvest results are given in Table 1. In these plots, weed control abilities of bromoxynil and 2,4-DB appeared quite similar except that bromoxynil controlled fiddleneck much better. Yields from the fifth treatment were slightly reduced by both bromoxynil and 2,4-DB.

Bromoxynil is not presently registered for use on alfalfa, but data is being collected. In the tests just cited,  $\frac{3}{8}$  lb/A bromoxynil in 10 to 20 gpa water controlled weeds in seedling alfalfa when applied at the 2- to 4-trifoliolate stage of alfalfa growth. Applications should be made when day temperatures are below 65°F and humidity is high. If sunlight is bright, it is advisable to delay treatment until the light is hazy. Leaf chlorosis may occur under cool conditions, but yields will not be affected. With bromoxynil or 2,4-DB treatment alfalfa yields are comparable, but bromoxynil produces hay free of fiddleneck.

Table 1. Influence of herbicide treatment on yields (pounds of dry weight per acre).

	Date applied				
	11/14/68	1/7/69	2/26/69	3/24/69	4/8/69
<b>Alfalfa</b>					
bromoxynil @ 4 oz/A	3434.2	3254.7	4308.3	4328.8	2598.9
bromoxynil 6 oz.	3481.8	3536.8	4077.0	4728.5	2488.1
bromoxynil 8 oz.	4058.2	3366.0	4158.6	4022.5	2296.8
2,4-DB ester $\frac{3}{4}$ lb.	3002.5	3347.6	4213.1	4485.3	2921.3
Check	1776.4	3197.6	3655.0	4083.8	2786.8
<b>Mustard</b>					
bromoxynil 4 oz.	554.5	1089.0	00.0	10.1	00.0
bromoxynil 6 oz.	476.5	13.6	00.0	20.1	00.0
bromoxynil 8 oz.	177.0	00.0	00.0	00.0	00.0
2,4-DB ester $\frac{3}{4}$ lb.	81.7	00.0	00.0	00.0	00.0
Check	5534.9	952.9	1762.7	3827.8	571.7
<b>Fiddleneck</b>					
bromoxynil 4 oz.	00.0	9.2	00.0	00.0	00.0
bromoxynil 6 oz.	18.5	18.5	00.0	00.0	00.0
bromoxynil 8 oz.	00.0	00.0	00.0	00.0	00.0
2,4-DB ester $\frac{3}{4}$ lb.	796.1	138.9	61.6	00.0	111.7
Check	1896.8	324.0	81.7	00.0	00.0

THE EFFECT OF TEMPERATURE AND  
PRECONDITIONING UPON THE PERFORMANCE OF  
PHENMEDIPHOM IN THE CONTROL OF  
WEEDS IN SUGAR BEETS

Stanley Heathman<sup>1</sup>, H. P. Alley and G. A. Lee<sup>2</sup>

The objectives of this study in 1969 were: (1) to determine the efficacy, under controlled temperature conditions, of combination treatments of 3-methoxycarbonylamino-phenyl N(3<sup>1</sup>-methylphenyl) carbamate (phenmediphom) applied postmergence and S-ethyl N-ethylthiocyclohexanecarbamate (cycloate) applied pre-emergence for the control of four important weed species in sugar beets (*Beta vulgaris* L.); (2) to determine the degree of phytotoxicity these conditions may induce upon sugar beets; and (3) to study the effect of various rates and combinations of phenmediphom and cycloate upon sugar beets and weeds under field conditions.

Temperature influenced the rapidity and percentage control of all weed species included in the experiment. At 80° F., control was rapid and all rates of phenmediphom were effective. At 65° F., control was less rapid. With 50° F., the rapidity of control was reduced, as well as the percentage control. Preconditioning effect of cycloate helped reduce differences of tolerance to the phenmediphom by most of the weed species.

Sugar beets were affected by cycloate preplant and phenmediphom post-emergence combination treatments, as well as the higher application rates of phenmediphom. This was particularly true when temperature was at 80° F. and when phenmediphom rates were applied at 3.0 lb./A or more.

The field tests indicated that the complementary treatment of cycloate 3.0 lb./A and phenmediphom 1.5 lb./A would control 96% or more of all weed species in the test.

WEED CONTROL WITH BROMINAL  
IN NEWLY SEEDED TURF

James R. McKinley

Brominal (octanoic acid ester of bromoxynil) is a postemergence herbicide which has recently received label clearance for broadleaf weed control in seedling grasses grown for turf and seed production. Brominal, unlike phenoxy compounds, will control many annual broadleaf weeds and grasses soon after they emerge without injuring young seedling grasses. Bromoxynil rates of  $\frac{3}{8}$  to  $\frac{1}{2}$  lb/acre usually are adequate to con-

trol most susceptible broadleaf weeds if applied when weeds are small and in the 3 to 4 leaf stage. As weeds become larger, susceptibility to the herbicide decreases.

Brominal appears to be taken up rather quickly by the foliage. Rainfall or overhead irrigation soon after application does not appear to reduce its activity. In fact, increased activity has been observed in several cases where rain fell within an hour after application. Brominal is effective under a wide range of temperatures. The weed kill may be slower under cooler temperatures, but the overall control under warm and cool temperatures is fairly equal.

Broadleaf weeds can become a serious problem in newly seeded turf because they are usually more aggressive than the desirable grass species. The high levels of soil nutrients and moisture needed for turf establishment make weeds flourish. Early elimination of these weeds will aid in establishing a vigorous, attractive turf which can compete with any later germinating weeds that try to become established.

Grass seed growers have also found that as a result of eliminating competition early in the establishment period, Brominal helps assure weed-free turf that will provide earlier and higher yields.

HERBICIDE — PLANT PATHOGEN  
INTERACTIONS

Jess Fults and Antonios Antonopoulos

(Abstract) Low altitude color aerial photography Herbicides studied were picloram and dicamba used as soil incorporated materials. Plant pathogens studied were several soil inhabiting forms of *Fusarium* (*F. oxysporum* f. *cepeae*, *F. oxysporum* f. *dianthi*, *F. roseum* f. *cerealis* and *F. solani* f. *phaseoli*) and *Rhizoctonia solani*. Host plants involved included both pathogen susceptible and resistant varieties of pinto beans (*Phaseolus vulgaris* L.), sugar beets (*Beta vulgaris* L.) and tomatoes (*Lycopersicon esculentum* Mill.) Metabolic and pathogenic activities of the fungi tested in the presence or absence of herbicides were measured and studied by means of bioassays. Data were statistically analyzed. Thirteen main experiments were conducted. A few of the significant findings included:

- 1) Dicamba at 5 ppm strongly restricted the growth of both *Rhizoctonia solani* and *Verticillium albo-atrum* both important soil borne plant pathogens.
- 2) Picloram greatly stimulated chlamydo-spore formation by *Fusarium* sp.
- 3) Spores of *Fusarium oxysporum* f. *lycopersici* and *F. solani* f. *phaseoli* showed normal germination when low concentrations of picloram or picolinic acid or dicamba were present. Neither the absence of carbon or nitrogen sources nor the presence of both in different media influenced the germinability of *Fusarium* spores.

<sup>1</sup>Extension Weed Specialist, University of Arizona, Tucson (formerly graduate assistant, University of Wyoming).

<sup>2</sup>Plant Science Division, University of Wyoming, Laramie.

- 4) Although picloram was applied at a concentration ten times lower than dicamba to a soil with a high potential for meeting bean root rot due *Fusarium solani* f. *phaseoli*, it (the picloram) increased the number of propagules to a much higher level than dicamba.
- 5) *Aspergillus niger* and *Penicillium* sp. were found to grow on the surfaces of both picloram and picolinic acid solutions without any other source of available nutrient. This suggests the possibility of using these organisms in critical and sensitive bioassays. Colorado Agricultural Experiment Station, C.S.U., Fort Collins.

#### A LOW TEMPERATURE GRADIENT BAR FOR WEED SEED GERMINATION STUDIES<sup>1</sup>

Raymond A. Evans<sup>2</sup>, James A. Young<sup>2</sup>  
Robert Henkel<sup>3</sup> and Gerald J. Klomp<sup>2</sup>

(Abstract) Many of the seeds of annual weed species of western rangelands germinate under low temperatures. Periods of adequate moisture for germination usually occur late in the fall or early in the spring, when diurnal seedbed temperatures fluctuate below and above 0 C with daytime maximums of 10 to 15 C.

These temperature requirements are difficult to meet with germinators in the laboratory, especially when a range of temperatures is studied. To overcome these difficulties, we constructed a low temperature germination bar with minimum temperatures below 0 C, and with a span of about 15 C. In our germination investigations, the desired range was from -5 to 10 C.

Two parallel aluminum sheets 3/8 inch thick, 10 inches wide, and 10 ft long insulated with styrofoam (with one end a heat exchanger placed in the cooling source, and with the length of the sheets utilized as the heat dissipator) made up the basic design. We compared an independent compressor and tank of propylene glycol with a chest-type deep freeze as the cooling source. Aluminum foil Petri dishes were best for transferring exact temperatures from bar to seeds.

<sup>1</sup>Cooperative investigation of the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the Agricultural Experiment Station, University of Nevada, Reno, Nevada. ....

<sup>2</sup>Range Scientists, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, University of Nevada, Reno, Nevada.

<sup>3</sup>Formerly, Agricultural Research Technician, Crops Research Division, U.S. Department of Agriculture, Reno, Nevada.

#### CHEMICAL CONTROL OF CLUBMOSS SELAGINELLA DENSA, RYDB

Laurence O. Baker<sup>1</sup>

(Abstract) *Selaginella densa*, Rydb. is a mat forming, spore producing, low growing plant common to the Northern Great Plains and foothill mountain regions bordering the plains. It is very slow growing and extremely drouth tolerant. Clubmoss may provide up to 90 percent ground cover and its densely matted, shallow root system intercepts and uses much of the precipitation otherwise available to associated vegetation.

Selective chemical control experiments were carried out at three locations in Montana representing different soil types and a range in precipitation from 11.25 to 15.05 inches. Applications were made in the spring, and in the fall during a three-year period to plots 8 1/4 x 16 1/2 feet, or larger. All treatments were triplicated in a randomized block design. Clubmoss control was evaluated visually. Forage yields were sampled by hand clipping all vegetation except clubmoss to ground level. The vegetation was separated by species or groups of species.

Clubmoss control was obtained with several chemicals. The most complete control with least injury to associated vegetation was provided with ammonium sulfate (ammate), 2-chloro-4-ethylamine-6-isopropylaminotriazine (atrazine) and 3-(p-cholophenyl)-1,1-dimethylurea (monuron). Results with monuron were more complete and less variable than with ammate or atrazine.

Yield and species composition were affected by herbicidal treatment. Forage yields continued to increase through the fourth growing season following selective control of clubmoss. Shallow rooted grass species were injured most by atrazine and monuron. These chemicals also gave good control of fringed sage-wort (*Artemisia frigida*) with seedling control extending through the second growing season.

<sup>1</sup>Plant and Soil Science Department, Montana Agricultural Experiment Station, Bozeman, Montana.

#### CONTROL OF WESTERN FALSE HELLEBORE

M. Coburn Williams and Lester B. Kreps<sup>1</sup>

(Abstract) A number of chemicals were evaluated for control of western false hellebore (*Veratrum californicum Durand*) in southeastern Idaho. Those providing optimum control were the dimethylamine salt of

<sup>1</sup>CRD, ARS, USDA, in cooperation with the Utah Agricultural Experiment Station, Logan, Utah.



(2,4-dichlorophenoxy)-acetic acid (2,4-D), propylene glycol butyl ether esters of 2,4-D, butoxy ethanol ester of 2-(2,4,5-trichlorophenoxy)propionic acid (silvex), and 2-[(4-chloro-o-tolyl)oxy]propionic acid (mecoprop). Optimum date of treatment was after the last leaf had expanded and before bud initiation.

Mecoprop, 2,4-D amine, 2,4-D ester, and silvex provided 100 percent control when applied at 4 lb/A in 1965 followed by retreatment with 2,4-D amine only at 4 lb/A in 1966.

The 4 chemicals were applied in 1967 at 2, 3, and 4 lb/A. All plots were retreated with 2,4-D amine only in 1968 so that those plots which received 2 lb/A were retreated with 2 lb/A; those treated with 3 lb/A were retreated with 2 and 3 lb/A; and those treated with 4 lb/A were retreated with 2, 3, and 4 lb/A. Mecoprop at 2 lb/A followed by 2,4-D amine at 2 lb/A provided 99 percent control. The 3 other herbicides gave equally good control when applied at 3 lb/A followed by 2 lb/A of 2,4-D amine. For complete eradication, spot treatment with 2,4-D amine at 2 lb/A for 1 or 2 additional years, particularly on waterlogged sites, might be required.

#### AN APPLICATION OF REMOTE SENSING TO WEED RESEARCH<sup>1</sup>

James A. Young<sup>2</sup>, Raymond A. Evans<sup>2</sup>  
and Paul T. Tueller<sup>3</sup>

(Abstract) Low altitude color aerial photography provided a fast and precise method of delineating medusahead (*Taeniatherum asperum* (Sim.) Nevski) infestations in a variety of plant communities. Areas of medusahead infestation and density of trees and shrubs can be determined directly on 70-mm transparencies. The camera shutter, film speed, frame rate, and air speed are synchronized so that successive film frames serve as stereopairs. Ground control must provide means of identifying key species and for an indication scale on the exposed film. High altitude oblique photographs were used to map patterns in utilization of herbaceous vegetation by cattle in plant communities infested with medusahead. Both color and color infrared photography were employed in evaluating rabbitbrush (*Chrysothamnus viscidiflorus* (Hook.) Nutt.) control in complex shrub communities treated with

<sup>1</sup>Cooperative investigation of the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the Agricultural Experiment Station, University of Nevada, Reno, Nevada.

<sup>2</sup>Range Scientists, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, University of Nevada, Reno, Nevada.

<sup>3</sup>Associate Range Ecologist, College of Agriculture, University of Nevada, Reno, Nevada.

(2,4-dichlorophenoxy) acetic acid (2,4-D) and 2,4-D plus 4-amino-3,5,6-trichloropicolinic acid (picloram).

Remote sensing permits the investigator to collect a great deal of data when vegetation is at a specific state of development or stage of response to treatment. These data can be stored for interpretation over a period of time.

#### SEASONAL EFFECTS OF HERBICIDES ON NORTHWESTERN CONIFERS AND BRUSH SPECIES

H. J. Gratkowski<sup>1</sup>

(Abstract) Aerial applications of herbicides during early spring are used to release Douglas-firs from brush competition in western Oregon, but such sprays damage intermingled pines. Research and observation, however, indicate that ponderosa pines become resistant to phenoxy herbicides in early fall; while many brush species remain susceptible. An experiment was designed to determine when pines develop this resistance and to measure susceptibility of several native shrubs at that time.

Douglas-firs and ponderosa pines in southwestern Oregon were treated with low volatile esters of 2,4-D and 2,4,5-T as foliage sprays on 10 dates beginning in late June and ending in mid-September. Water and oil-in-water emulsions were tested as carriers. Brush species selected for comparison were snowbrush ceanothus (*Ceanothus velutinus* Dougl.), varnishleaf ceanothus (*Ceanothus velutinus* var. *laevigatus* (Hook.) T. & G.), and Pacific madrone (*Arbutus menziesii* Pursh). Brush was sprayed with a formulation known to kill that species during the growing season.

Douglas-firs proved more resistant than ponderosa pines when foliage-sprayed with phenoxy herbicides. As in other studies, ponderosa pines were damaged less by 2,4,5-T than by 2,4-D. With both herbicides, oil-in-water emulsions increased damage over that incurred with water carriers.

Ponderosa pines' resistance to herbicides increased rapidly after cessation of height growth in July, and no damage was caused by sprays applied in late August and early September. In contrast, snowbrush ceanothus was still highly susceptible to herbicides during that time. Varnishleaf ceanothus and Pacific madrone, although not as susceptible as snowbrush ceanothus, were adequately controlled to release intermingled pines. These results indicate that early fall may be suitable for application of aerial sprays to release pines from brush competition in southwestern Oregon.

<sup>1</sup>Pacific N.W. Forest and Range Expt. Sta., Forest Service, U.S. Department of Agriculture, Roseburg, Oregon.

## "BROWN AND BURN" AS A MEANS OF SITE PREPARATION

J. M. Finnis<sup>1</sup>

Slash disposal following logging has long been part of the overall picture in the Pacific Northwest and burning has been the most common method of accomplishing it. Traditionally, the main reason for slash burning has been hazard abatement but in the last two decades with an increasing interest in reforestation and sustained yield forestry, burning as a means of site preparation has increased in importance.

A more recent occurrence has been the increase in hardwood logging, principally alder. The problem following hardwood logging is not hazard abatement, but site preparation. Alder sites are inherently brushy and have the potential of "exploding" into a jungle when the overstory is removed. The volume of slash is small by comparison with old growth conifer logging. We have added to the amount of material on the ground by requiring all trees over 4" DBH to be felled, regardless of merchantability.

But the hazard is low and slash burning is generally not required. In fact, due to the nature of the material, it is very hard to get it to burn, except under extremely dangerous conditions.

But reforestation is well nigh impossible without the removal of all this material from the area. It is very hard to get around over the area to plant trees and the brush present rapidly overtops the trees and crowds them out. Scarification, or mechanical removal of the brush by a tractor using a toothed blade, is one method of site preparations. It is expensive, running around \$45 an acre. It is usually advisable to burn the windrows and this is an additional cost.

Merely killing the vegetation with chemicals is not the answer as the dead material is still an impediment to planting. The material must be removed and burning is one method of removal.

A typical situation would be spotty patches of hardwood slash covered by lush, green herbaceous vegetation. (The problem, then, is to render the brush and slash flammable enough to burn.)

Much pioneer work on this problem was done by Bill Schmitt of Weyerhaeuser. The first step was to "brown up" the vegetation so that the sun could get to the slash and dry it out. This is the main objective of the browning operation. The fuel contributed to the fire by the browned vegetation is rather minor.

We have used 1 gallon of Dinitro in 9 gallons of water per acre, applied by helicopter, to brown up the vegetation. We have made limited tests with diesel and mixtures. One company has used 1/2 gallon of Dinitro

<sup>1</sup>Silviculturist, Department of Natural Resources, Olympia, Washington. Forest Land Management Division Contribution #122.

in 9 1/2 gallons of diesel per acre. Costs are just about the same either way.

Our browning effects using water as a carrier were effective and, by visual examination, we could not see any difference between the carriers used in our small scale tests.

Dinitro, of course, is just a contact herbicide and its effects last about 3-4 weeks and after that time the vegetation starts to resprout. The earliest we burned after spraying was five days and the results were excellent.

Even after opening up the slash to the sunlight, burning is a marginal proposition because of the amount and type of slash; so browning is only half the answer. The other half is mass ignition. We string cans of jellied gasoline through the slash using primacord. We can put as many or as few cans on one line as we wish. We found an average of seven cans an acre to be satisfactory. By this mass ignition or area ignition, we can get a lot of fire going in a short time and build up a miniature fire storm. To illustrate the speed, on one 60-acre unit, we ignited the whole area in 25 minutes and the burn was essentially over in one hour. It would have taken dozens of men with drip torches to have produced the same amount of fire in such a short time (and without this short, sharp fire, we would not have gotten a burn) in this type of fuel. The fire would have crept around burning a patch here and a patch there and creating a great deal of smoke.

Our results to date have been very encouraging and we plan on treating over 400 acres this next summer. We have gotten a clean burn which allows the planting crew to do a good job. We conservatively estimate a saving of \$20 an acre on planting costs because of improved ground conditions. The planting quality will also be greatly improved. Follow-up treatment, including spot replanting and brush control, will be greatly reduced because of the clean burn.

Two other advantages are that because the burn is so quick, potential soil damage is eliminated and air pollution is greatly reduced. Instead of smoke hanging about at low elevations, the convection column produced by the fire storm forces the smoke into the upper atmosphere. I believe, myself, and I am no authority on this, that the fire storm produces more complete combustion and so less smoke.

Costs for materials and layout, up to the time of ignition, vary from \$12-\$24 an acre, depending on experience and the individual situation.

Burning costs vary again and depend on the amount of mop-up necessary. Burning costs are between \$15-\$25 an acre so total costs are from \$30-\$40 an acre. This is less than scarification costs and the cost of burning windrows must be added to this later.

"Brown and burn" is no all-round panacea but it is another tool for the versatile forest manager.

## STUDIES RELATED TO CONTROL OF TREE ROOTS IN SEWER LINES

O. A. Leonard, J. F. Ahrens and Neal Townley

These studies were undertaken because of the economic importance of root problems in sewer lines of urban areas.

Eucalyptus (*E. camaldulensis*), willow (*Salix* sp.), and grape (*Vitis vinifera*) were grown in 15-cm diameter pots containing a sand-peat mix. A hole, 2.5 to 4.0 cm in diameter, was made in the bottom of each pot to enable the roots to grow into the moist air beneath them; the latter was possible because the pots were placed on 1500 ml-capacity cans having vermiculite at the base, but with holes to prevent the accumulation of free water. The trees were fertilized to promote vigorous shoot and root growth. When root growth had developed abundantly in the cans, the herbicide treatments were made for periods of 1 minute to 24 hours, with most of the treatments being for 1 hour. This was done by placing the roots in similar cans containing 1000 ml of herbicide solution, thus soaking all roots 4.8 cm and further from the base of the pots. After being treated the roots were either washed with tap water to remove unabsorbed herbicide or were allowed to drain without washing. The pots containing the plants were then placed on the original cans. Records were kept on injury to roots and shoots for six weeks, at which time the plants were harvested for obtaining more detailed information on the nature and extent of injury to the plant.

Although several herbicides were employed in these trials, the most promising results were with metham and dichlobenil (wetttable powder), or a combination of the two. Some of the following comments on results are (1) roots could be killed by a 1-minute dip with metham under some conditions and root killing extended from 0 to 13 cm above the point treated, (2) killing was related to the concentration of metham used, being greater at 5000 ppm than at 2000 ppm and being greater with a combination of metham and dichlobenil than by either herbicide alone, (3) killing was reduced by reducing water uptake by transpiration (by removing the leaves), (4) upward kill of roots above the point treated was related to the percentage of the whole root system that was treated, (5) shoot injury could be encountered by extended treatment with metham but not with dichlobenil, (6) one hour of treatment seemed desirable when using dichlobenil alone, with 100 ppm being superior to 10 ppm, (7) dich-

lobenil was more effective in suppressing root regrowth than metham, (8) washing the roots following treatment reduced the kill.

A replicated trial in the sewer lines of Sacramento County produced some promising results. Briefly stated it appears that root in sewer lines flooded for one hour were killed by metham at 5000 ppm or by metham at 5000 ppm plus dichlobenil at 100 ppm; dichlobenil at 100 ppm appeared promising but further observations are needed. In addition to killing roots in the lines, roots were usually killed in the joints, and even outside of the joints for 3 to 15 cm. In one instance, a mulberry was injured. In lathhouse trials it was noted that metham was transported in the wood and did not always kill the overlying bark. When not killed, rather rapid recovery appears to take place. It is hoped that by reducing the concentration of metham in the lines and the period of treatment that injury to trees will be rare.

## 2-CHLORO-N-(ISOBUTOXYMETHYL)-2',6'- ACETOXYLIDIDE A NEW PRE-EMERGENCE HERBICIDE

C. H. Slater\*, W. D. Carpenter\*, D. A. Brown\*

CP 52223, [2-Chloro-N-(isobutoxymethyl)-2',6'-acetoxylylidide], is a pre-emergence herbicide which exhibits excellent phytotoxicity on annual grass and broad-leaf weeds, while showing a substantial margin of safety on sugar beets and winter wheat.

CP 52223 is a colorless, viscous liquid with a water solubility of 59 ppm. It has a low order of mammalian toxicity with the acute oral LD<sub>50</sub> for male and female rats being 1,775 mg/kg. The minimum lethal dose by skin absorption is greater than 1,000 mg/kg. CP 52223 has a half-life of approximately 21 days under normal soil conditions, and has good residual weed control for about 60 days.

Biological activity appears to be directly related to soil type and organic matter. Unit activity decreases with an increase of soil organic matter over 3%. There is also a rate response dependent upon clay content of the soil. As clay content increases, there is a slight decrease in unit activity.

CP 52223 is moisture sensitive and requires some water, either as rainfall or irrigation, between application and weed emergence. When used in the spring of the year on sugar beets, under furrow irrigated conditions, shadow incorporation improves overall weed control. Fall application on winter wheat, or spring

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sprinkler irrigation on sugar beets, eliminates the need for incorporation.

CP 52223 shows excellent safety on sugar beets at rates above those required for good control of many annual-grass and broadleaf-weed species. Preliminary data indicates the same degree of selectivity on winter wheat for the control of annual ryegrass (*Lolium multiflorum*), downy brome (*Bromus tectorum*) and annual broadleaf-weed species. The spectrum of weeds controlled is similar to that of alachlor. CP 52223 shows more activity on lambsquarters (*Chenopodium album*), knotweed (*Polygonum aviculare*), black nightshade (*Solanum nigrum*) and dog fennel (*Eupatorium capillifolium*).

Rates for good weed control vary between .5 to 2.0 lb ai/A and would depend upon soil type, organic matter and available moisture.

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#### EL-179, A PROMISING NEW SOIL-INCORPORATED HERBICIDE FOR DIRECT-SEEDED AND TRANSPLANT TOMATOES AND PEPPERS

G. D. Massey, P. L. Steenwyk<sup>1</sup>, and W. J. Polzin<sup>2</sup>

##### Introduction

EL-179, 4-isopropyl-2,6-dinitro-N,N-dipropylaniline, is a new selective preplant, soil-incorporated herbicide for use in direct-seeded and transplant tomatoes (*Lycopersicon esculentum*), peppers (*Capsicum frutescens*) and other solanaceous crops including tobacco and white potatoes. It is an orange liquid at room temperature. It has a solubility of greater than one gram per milliliter in acetonitrile, benzene, acetone, chloroform, methanol, hexene, and ether. The solubility in water is less than 0.5 ppm at 25°C. The acute oral LD<sub>50</sub> of technical EL-179 for mice and rats is greater than 5 g/kg. The acute oral LD<sub>0</sub> is greater than 2 g/kg for rabbits, chickens, and dogs, and the dermal LD<sub>0</sub> for rabbits is 2 g/kg (the highest rate tested). The LD<sub>50</sub> of technical EL-179 for fathead minnows in 96 hour aquaria tests is in the range of 50 to 150 ppb. EL-179 is strongly absorbed to the soil and is, therefore, not likely to be toxic to fish under practical usage conditions. Laboratory studies have shown that in a submerged or anaerobic condition, EL-179 rapidly disappears when mixed with soil. Under field conditions, EL-179 appears to degrade to non-phytotoxic levels during the growing season. It is resistant to leaching in soil.

Field experiments with EL-179 have been conducted on a variety of agronomic and horticultural

crops during 1968 and 1969 in several western states by Eli Lilly and Company scientists. Several of these crops are tolerant to EL-179 at rates in excess of that required for satisfactory weed control; however, when crop tolerance and herbicidal effectiveness are considered collectively, direct-seeded and transplant tomatoes and peppers and white potatoes are the crops of interest for further research and development with this compound. Only tomatoes and peppers are discussed in this paper.

##### Materials and Methods

Thirty-one direct-seeded and one transplant tomato and three direct-seeded and one transplant pepper experiments were conducted with EL-179 during 1968 and 1969. These were conducted in Arizona, California, Oregon and Utah. The experimental design used was randomized complete block with 3 or 4 replications. Additional untreated check plots were included in each replication to increase the precision of treatment versus control comparisons. Application rates of EL-179 were 0.75 to 4 lb/A. Reference herbicides were used in all experiments. Soil-incorporation of EL-179 and the reference herbicides (trifluralin, trifluralin plus diphenamid, and diphenamid) was accomplished with power-driven rotary hoes, tandem discs and rolling cultivators. In areas of bedded culture, the herbicides were applied and incorporated pre and postbedding.

Weed control was evaluated by counting weeds 4 to 5 weeks after planting the crop, followed by subsequent late season visual ratings. Due to the large number of experiments conducted data will only be presented from representative direct-seeded experiments conducted in the major production areas of California. The experiment selected to represent the northern California tomato district (clay loam soil) was conducted on a commercial farm. The trial was preplant soil-incorporated, prebedding, using an offset disc followed by bedding and direct-seeding of the tomato variety VF-145-7879. The experiment selected to represent the central California tomato growing area (loam soil) was also located on a commercial farm. This trial was preplant soil-incorporated, postbedding, with a power-driven rotary hoe followed by direct-seeding of the tomato variety VF-145. The pepper experiment was conducted on a loam soil at the Eli Lilly Research Station at Fresno, California, as a preplant soil-incorporated, postbedding, experiment in which incorporation was accomplished with a power-driven rotary hoe followed by direct-seeding of the pepper variety California Wonder.

##### Results

Statistical analyses were performed on the data and all treatment comparisons were made using the Dunnett's Method of Multiple Comparisons.

<sup>1</sup>Plant Science Representatives, Eli Lilly and Company, 7521 West California Avenue, Fresno, California.

<sup>2</sup>Statistician, Eli Lilly and Company, P.O. Box 708, Greenfield, Indiana.



#### Weed Control

Weed control data collected from these experiments are summarized in Tables 1, 2, and 3. Satisfactory to excellent control of both grasses and broadleaf weeds was provided by EL-179 at rates of 1 lb/A and above in all experiments. The 1.5 lb/A rate of EL-179 provided commercially acceptable season-long weed control in both loam and clay loam (medium and heavy soils), respectively. EL-179 did not provide satisfactory control of the weed species *Physalis lanceifolia* (ground cherry) at rates of 0.75 to 2 lb/A.

#### Crop Response

Tomato plants and roots were evaluated for any effects from the herbicide. The first observation was made approximately one month after seeding or transplanting and continued up to tomato harvest. Only a trace of crop injury or root inhibition was observed on direct-seeded tomatoes treated with EL-179 at rates up to 3 lb/A.

Visual crop injury rating ranges from the two direct-seeded tomato experiments discussed in this paper are found in Tables 4 and 5. EL-179 did not influence the stand of tomato seedlings when treated with EL-179 at 1 to 1.5 lb/A in both experiments. No injury was noted on direct-seeded tomatoes treated with EL-179 at rates of 0.75 to 1.5 lb/A. Slight early season stunting occurred from the 2 lb/A or higher rates of EL-179. This early injury from EL-179 was of short duration. By comparison, 1 lb/A and higher rates of preplant soil-incorporated trifluralin caused slight to severe injury to direct-seeded tomatoes. Stand count and crop injury ratings for direct-seeded peppers are found in Table 6. No stand reduction or crop injury was noted from any rate of EL-179 tested in this study.

Fruit maturity and total yield data for the tomato trials are reported in Tables 7 and 8. Mature, marketable processing tomatoes were harvested and graded for green, pink, and ripe tomatoes. The percent of red (ripe) tomatoes provides a measure of crop maturity. Analysis was made of each category and of the total

yield. No significant differences in the maturity of direct-seeded tomatoes were found at any rate of EL-179 tested in either experiment. One and one-half pounds of trifluralin and above delayed maturity as depicted by percentage of red tomatoes and also reduced yields in each trial. The combination of trifluralin and diphenamid did not affect maturity of yield in either study.

Total yield and fruit maturity data for the pepper trial are reported in Table 9. Harvests were made 14 weeks and 16 weeks after planting and each was graded as to number 1, number 2 and culls. Analysis of the individual grades in each harvest indicated no differences between any of the treatments and the controls. However, analysis of the two harvests combined by grades indicated trifluralin at rates of 1 and 2 lb/A reduced yields of number 1 peppers below those found with the hoed controls. Treatment differences in number 2 peppers, culls, and total yield exhibited the same pattern for these two treatments but were not significantly below the controls. None of the rates of EL-179 affected total yield nor fruit quality in this experiment.

#### Summary

In summary, field experiments conducted over the past two years in the Western United States have shown that EL-179 at rates of 1 to 2 lb/A provided commercially acceptable control of watergrass (*Echinochloa crusgalli*), foxtails (*Setaria* sp.), crabgrasses (*Digitaria* sp.), johnsongrass from seed (*Sorghum halepense*), ryegrass (*Lolium* sp.), common lambsquarters (*Chenopodium album*), pigweeds (*Amaranthus* sp.), and common purslane (*Portulaca oleracea*). EL-179 did not adversely affect growth, development, yield, or quality of direct-seeded and transplant tomatoes and peppers at recommended rates. Data from these experiments indicate that effective herbicidal rates for EL-179 are 1 lb/A on sand and sandy loam (light), 1.5 lb/A on loam, silt loam, and silt (medium) and 2 lb/A on clay loam, silty clay, and clay (heavy) soils.

**Table 1. Grass and broadleaf weed control in a clay loam soil in Northern California 3 and 6 weeks after application of EL-179, trifluralin, trifluralin + diphenamid and diphenamid.**

Treatment	Rate Lb/A			Barnyardgrass <sup>a/</sup>	Weed Control Rating <sup>b/</sup>	
				Percent Control (3 weeks)	Barnyard- grass <sup>a/</sup> (6 weeks)	Smart- weed <sup>c/</sup>
EL-179	6EC	1	PPI <sup>d/</sup>	75	8.5*	8.2*
		1.5	PPI	95*	9.5*	9.2*
		2	PPI	99*	9.7*	9.7*
		3	PPI	100*	10.0*	10.0*
Trifluralin	4EC	1	PPI	99*	10.0*	10.0*
		2	PPI	100*	10.0*	10.0*
Trifluralin+ Diphenamid	53.1W 80W	0.25+4	PPI	98*	9.5*	9.3*
		6	PPI	71	2.8	0
Control		0		0	0	0
				(9.3) <sup>e/</sup>	(39.3) <sup>e/</sup>	(6.2) <sup>e/</sup>

<sup>a/</sup> Echinochloa crusgalli

<sup>b/</sup> Weed Control Rating 0-10:

<sup>c/</sup> Polygonum sp.

0 = zero percent control  
10 = 100 percent control

<sup>d/</sup> PPI is preplant, prebedding soil-incorporation with a spring-tooth harrow operated at 4 mph at a depth of 2 inches immediately after herbicide application followed by a 21-foot offset disc operated twice in the same direction at 4 mph at a depth of 4 inches.

<sup>e/</sup> Weeds per square foot based on counts made in two, five-square foot quadrats per plot.

\* Significantly greater than controls ( $P \leq .05$ ). Dunnett's Method of Multiple Comparisons.

**Table 2. Grass and broadleaf weed control on a loam soil in Central California 4 and 11 weeks after application of EL-179, trifluralin, trifluralin + diphenamid and diphenamid.**

Treatment		Rate		Percent Weed Control		Weed Control Rating <sup>c/</sup>	
				Barnyard- grass <sup>a/</sup> (4 weeks)	Pigweed <sup>b/</sup>	Barnyard- Pigweed <sup>b/</sup> (11 weeks)	grass <sup>a/</sup>
EL-179	6EC	0.75	PPI <sup>d/</sup>	100*	98*	10	10.0*
		1	PPI	100*	83*	10*	10.0*
		1.5	PPI	100*	93*	10*	9.9*
		2	PPI	100*	98*	10*	10.0*
Trifluralin	4EC	3	PPI	100*	99*	10*	10.0*
		0.75	PPI	100*	99*	10*	10.0*
		1.5	PPI	100*	100*	10*	10.0*
Trifluralin+ Diphenamid	53.1W	0.25+4	PPI	100*	100*	10*	10.0*
		3	PPI	100*	93*	10*	10.0*
Diphenamid	80W	5	PPI	100*	97*	10*	10.0*
Control		0		0	0	0	0
				(0.6) <sup>e/</sup>	(24.5) <sup>e/</sup>	(1) <sup>e/</sup>	(20) <sup>e/</sup>

<sup>a/</sup> Echinochloa crusgalli

<sup>b/</sup> Amaranthus sp.

<sup>c/</sup> Weed Control Rating 0-10:

0 = zero percent control

10 = 100 percent control

<sup>d/</sup> PPI is preplant, postbedding soil-incorporation with a PTO-driven rotary tiller operated at 2 mph at a depth of 5 inches immediately after herbicide application.

<sup>e/</sup> Weeds per square foot based on weeds counted in two, four-square foot quadrats per plot.

\* Significantly greater than controls ( $P \leq .05$ ). Dunnett's Method of Multiple Comparisons.

**Table 3. Grass and broadleaf weed control on a loam soil in Central California 4 and 8 weeks after application of EL-179, trifluralin and diphenamid.**

Treatment	Rate Lb/A	PPI <sup>a/</sup>	Percent Weed Control			Weed Control Rating <sup>d/</sup>		
			Barnyard- grass <sup>a/</sup> / (4 weeks)	Pig- weed <sup>b/</sup> / (4 weeks)	Barnyard- grass <sup>a/</sup> / (8 weeks)	Pig- weed <sup>b/</sup> / (8 weeks)	Ground cherry <sup>c/</sup> / (8 weeks)	
EL-179	6EC	0.75	PPI <sup>a/</sup>	95*	97*	9.3*	10.0*	0.6
		1	PPI	97*	100*	9.3*	10.0*	1.7
		1.5	PPI	97*	100*	8.8*	9.3*	2.3
		2	PPI	99*	100*	10.0*	10.0*	5.7*
		3	PPI	99*	100*	10.0*	10.0*	8.7*
Trifluralin	4EC	0.5	PPI	97*	89*	10.0*	10.0*	4.0*
		1	PPI	99*	97*	10.0*	10.0*	7.8*
		2	PPI	100*	100*	10.0*	10.0*	10.0*
Diphenamid Control	80W	6	PPI	98*	100*	6.7*	9.2*	0
		0		0 (5.6) <sup>f/</sup>	0 (1) <sup>f/</sup>	0 (1.5) <sup>f/</sup>	0 (1.5) <sup>f/</sup>	0 (1) <sup>f/</sup>

<sup>a/</sup> *Echinachloa crusgalli*

<sup>b/</sup> *Amaranthus* sp.

<sup>c/</sup> *Physalis lancefolia*

<sup>d/</sup> Weed Control Rating 0-10:

0 = zero percent control

10 = 100 percent control

<sup>e/</sup> PPI is preplant, postbedding soil-incorporation with a PTO-driven rotary tiller operated at 2 mph at a depth of 5 inches immediately following herbicide application.

<sup>f/</sup> Weeds per square foot based on four, two-square foot counts per plot.

\* Significantly greater than controls ( $P \leq .05$ ). Dunnett's Method of Multiple Comparisons.

**Table 4. Influence of EL-179, trifluralin, trifluralin + diphenamid and diphenamid on crop stand count (3 weeks after planting) and crop injury (6 weeks after planting) of direct-seeded tomatoes on a clay loam soil in Northern California.**

Treatment	Rate Lb/A	PPI <sup>c/</sup>	Stand Count <sup>a/</sup> / (3 weeks)	Crop Injury Rating <sup>b/</sup> / (6 weeks)	
EL-179	6EC	1	PPI <sup>c/</sup>	94	0
		1.5	PPI	112	0.7
		2	PPI	98	1.8
		3	PPI	82	2.3*
		4	PPI	74	3.3*
Trifluralin	4EC	1	PPI	60	5.3*
		2	PPI	59*	9.0*
		0.25+4	PPI	93	1.0
Trifluralin+ Diphenamid	53.1W				
Diphenamid	80W	6	PPI	96	0.7
Control		0		89	0

<sup>a/</sup> Number of tomato seedlings counted in 20 linear feet of row per plot.

<sup>b/</sup> Crop Injury Rating 0-10:

0 = no injury; 1-3 = slight;  
4-6 = moderate; 7-9 = severe;  
10 = death

NOTE: Injury was manifested as a general stunting of the tomato plants.

<sup>c/</sup> PPI is preplant, prebedding soil-incorporation with a spring-tooth harrow operated at 4 mph at a depth of 2 inches immediately after herbicide application, followed by a 21-foot disc operated twice in the same direction at 4 mph at a depth of 4 inches.

\* Significantly different than controls ( $P \leq .05$ ). Dunnett's Method of Multiple Comparisons.

**Table 5. Influence of EL-179, trifluralin, trifluralin + diphenamid and diphenamid on crop stand count (4 weeks after planting) and crop injury (8 to 15 weeks after planting) of direct-seeded tomatoes on a loam soil in Central California.**

Treatment		Rate Lb/A		Stand Count <sup>a/</sup> (4 weeks)	Crop Injury Rating <sup>b/</sup> (8 weeks)	Crop Injury Rating <sup>b/</sup> (15 weeks)
EL-179	6EC	0.75	PPI <sup>c/</sup>	67	0.3	0
		1	PPI	61	0.3	0
		1.5	PPI	52	0	0
		2	PPI	63	0.6	0.3
Trifluralin	4EC	0.75	PPI	44*	3.0*	0
		1.5	PPI	66	0.3	0
		3	PPI	50	4.3*	1.0*
		3	PPI	44*	6.7*	3.0*
Trifluralin+ Diphenamid	53.1W	0.25+4	PPI	67	0	0
Diphenamid	80W	5	PPI	60	0	0
Control		0		68	0	0

<sup>a/</sup> Number of tomato seedlings counted in 16 linear feet of row per plot.

<sup>b/</sup> Crop Injury Rating 0-10:

0 = no injury; 1-3 = slight;  
4-6 = moderate; 7-9 = severe;  
= death

NOTE: Injury was manifested as a general stunting of the plants and a loss of stand.

<sup>c/</sup> PPI is preplant, postbedding soil-incorporation with a Ferguson power-driven rotary tiller operated at 2 mph at a depth of 5 inches immediately after herbicide application.

\* Significantly different than controls ( $P \leq .05$ ). Dunnett's Method of Multiple Comparisons.

**Table 6. Influence of EL-179, trifluralin and diphenamid on crop stand (3 weeks after planting) and crop injury (6 weeks and 16 weeks after planting) of direct-seeded peppers on a loam soil in Central California.**

Treatment		Rate Lb/A		Stand Count <sup>a/</sup> (4 weeks)	Crop Injury Rating <sup>b/</sup> (6 weeks)	Crop Injury Rating <sup>b/</sup> (16 weeks)
EL-179	6EC	0.75	PPI <sup>c/</sup>	83	0	0
		1	PPI	84	0	0
		1.5	PPI	85	0	0
		2	PPI	96	0	0
		3	PPI	96	0	0
Trifluralin	4EC	0.5	PPI	92	0	0.7
		1	PPI	93	1.0	1.0
		2	PPI	110	5.7*	2.3*
Diphenamid	80W	6	PPI	92	0	1.7
Control (Hoed)		0		72	0	0

<sup>a/</sup> Number of pepper seedlings counted in 9 linear feet of row per plot.

<sup>b/</sup> Crop Injury Rating 0-10:

0 = no injury; 1-3 = slight;  
4-6 = moderate; 7-9 = severe;  
10 = death

NOTE: Injury was manifested as a general stunting of the plants and loss of stand.

<sup>c/</sup> PPI is preplant, postbedding soil incorporation with a PTO-driven rotary tiller operated at 2 mph at a depth of 5 inches immediately following herbicide application.

Significantly greater than hoed control ( $P \leq .05$ ). Dunnett's Method of Multiple Comparisons.



**Table 7. Influence of EL-179, trifluralin, trifluralin + diphenamid and diphenamid on maturity and total yield of direct-seeded tomatoes on a clay loam soil in Northern California.**

Treatment		Rate Lb/A		% Red Tomatoes <sup>a/</sup>	Yield Tons/Acre
EL-179	6EC	1	PPI <sup>b/</sup>	88	43
		1.5	PPI	88	40
		2	PPI	87	38
		3	PPI	84	43
		4	PPI	80	40
Trifluralin	4EC	1	PPI	81	33
		2	PPI	29*	26*
		2	PPI	90	40
Trifluralin+ Diphenamid	53.1W	0.25+4	PPI	90	40
Diphenamid	80W	6	PPI	89	40
Control (Hoed)		0		86	39

<sup>a/</sup> Yield of ripe tomatoes expressed as a percentage of the total yield.

<sup>b/</sup> PPI is preplant, prebedding soil incorporation with a spring-tooth harrow operated at 4 mph at a depth of 2 inches immediately after herbicide application followed by a 21-foot offset disc operated twice in the same direction at 4 mph at a depth of 4 inches.

\* Significantly less than controls ( $P \leq .05$ ). Dunnett's Method of Multiple Comparisons.

**Table 8. Influence of EL-179, trifluralin, trifluralin + diphenamid and diphenamid on maturity and total yield of direct-seeded tomatoes in a loam soil in Central California.**

Treatment		Rate Lb/A		% Red Tomatoes <sup>a/</sup>	Yield Tons/Acre
EL-179	6EC	0.75	PPI <sup>b/</sup>	77	42
		1	PPI	71	37
		1.5	PPI	61	38
		2	PPI	61	31
		3	PPI	63	34
Trifluralin	4EC	0.75	PPI	78	36
		1.5	PPI	46*	16*
		3	PPI	73	38
Trifluralin+ Diphenamid	53.1W	0.25+4	PPI		
Diphenamid	80W	5	PPI	71	39
Control (Hoed)		0		68	35

<sup>a/</sup> Yield of ripe tomatoes expressed as a percentage of the total yield.

<sup>b/</sup> PPI is preplant, postbedding soil incorporation with a PTO-driven rotary tiller operated at 2 mph at a depth of 3 inches.

\* Significantly less than controls ( $P \leq .05$ ). Dunnett's Method of Multiple Comparisons.

**Table 9. Influence of EL-179, trifluralin, and diphenamid on grade and total yield of direct-seeded peppers on a loam soil in Central California.**

Treatment		Rate Lb/A		Two Harvests Combined		Total Yield Tons/Acre
				Tons/A	No. 1 Pepper <sup>a/</sup> %	
EL-179	6EC	0.75	PPI <sup>b/</sup>	1.4	39	3.6
		1	PPI	1.9	40	4.8
		1.5	PPI	1.7	36	4.8
		2	PPI	2.1	39	5.4
		3	PPI	2.3	40	5.6
Trifluralin	4EC	0.5	PPI	2.1	43	4.8
		1	PPI	1.2*	26*	4.6
		2	PPI	1.0*	30*	3.4
Diphenamid	80W	6	PPI	1.4	41	3.5
Control (Hoed)		0		2.5	47	5.4

<sup>a/</sup> Yield of U.S. Number 1 grade peppers as a percentage of the total yield.

<sup>b/</sup> PPI is preplant, postbedding soil-incorporation with a PTO-driven rotary tiller operated at 2 mph and set to cut to a depth of 5 inches.

\* Significantly less than controls ( $P \leq .05$ ). Dunnett's Method of Multiple Comparisons.

**SANDOZ-WANDER, Inc.**  
**EXPERIMENTAL COMPOUND 6706**

Zenas B. Noon, Jr.<sup>1</sup>

San 6706 is a fluorinated dimethyl pyridazinone, selective, long-lasting herbicide. San 6706 is especially good in the control of annual and perennial grasses, some annual problem broadleaf weeds and nutsedges. The material is stable with low water solubility and low vapor pressure. Experimental material is available as an 80 percent wettable powder.

The mode of action of the material is through root and shoot absorption in the soil. San 6706 is applied as a preemergence spray on light soils where vertical leaching is expected, or as a preplant incorporation to a depth of 2" on heavier soils or where no appreciable leaching is expected. Postemergence activity is limited.

The rate of application for control of annual grasses and broadleaves is 1/2 to 2 lbs/A while perennial grasses and nutsedge are controlled at 4 to 8 lbs/A. The variation in dosage is dependent upon soil type.

Selective weed control has been achieved with San 6706 in a number of crops. Below are listed a number of crops and problem weeds controlled by San 6706:

Cotton (watergrass, annual morningglory, ground-cherry)  
Asparagus (nutsedge, perennial grasses)  
Alfalfa (summer annual grasses)  
Citrus (annual and perennial grasses and nutsedge)  
Nuts (annual and perennial grasses)  
Deciduous fruits (annual and perennial grasses)  
Small fruits, i.e. berries (annual and perennial grasses)

The compound is now being evaluated for the control of weeds in ornamental plantings and other non-crop areas.

San 6706 has long residual activity and care should be exercised prior to planting crops such as corn, sorghum, small grains, and crops of the mustard family in areas previously treated with San 6706.

Sample material is available to qualified research personnel and can be obtained from Sandoz-Wander, Inc., P.O. Box 1489, Homestead, Florida, 33030.

<sup>1</sup>Manager, Biological Research, Sandoz-Wander, Inc., Homestead, Florida.

**BAY 94337 — A NEW HERBICIDE FROM  
THE CHEMAGRO CORPORATION**

J. W. Warren<sup>1</sup>

(Abstract) Bay 94337 is a new herbicide being developed by Chemagro Corporation. The chemical name is 4-Amino-6-t-butyl-3-(Methylthio)-as-triazin-5

<sup>1</sup>Chemagro Corporation, 3 North 7th Ave., Suite B, Yakima, Washington.

(4H)-one. It is currently available as a 70% w.p. It has been found to be a very active herbicide for application either pre-emergence or post-emergence. Soil incorporation is not necessary. Moisture, either as rain or light irrigation improves the weed control from pre-emergent application, but considerable activity has been noted even when moisture was not applied for several days after treatment. Post-emergence application is even more active, pound-for-pound, than pre-emergence application. Most of the common broadleaf and grass annual weeds are controlled at rates of 0.25 to 1 lb. active/acre, depending on soil type, either pre- or post-emergence. Selective weed control has been obtained on several crops such as potatoes, soybeans, tomatoes, large seeded legumes, sugarcane and certain small grains. A residue method has been developed, and registration on certain crops is anticipated soon. Activity against some aquatic weed species has been observed, and further testing at rates of 0.25 to 5 lbs. active/acre is suggested; rates of 1 to 5 lbs. active per acre also have shown promise against several species of perennial weeds and further research is suggested as a non-selective "industrial" herbicide. It may also have usefulness as an orchard herbicide, rates of up to 4 lbs. active/acre are suggested.

**PREDICTABLE SHORT TERM VEGETATION CONTROL  
WITH KLEER-LOT**

Louis Whitendale<sup>1</sup>

KLEER-LOT is a new single-package combination of chemicals for short-term vegetation control in areas where cultivation or landscaping is anticipated. KLEER-LOT is a wettable powder combination of the pre-emergence herbicide linuron and the trans-locating post-emergence herbicide amitrole, formulated as 25% of each one.

Neither amitrole nor linuron has a long residual life in soil but together they provide total vegetation control for a predictable period of time. The residues usually disappear from the soil within six to eight months when KLEER-LOT is used at recommended rates.

Short-term seasonal control of annual broadleaf weeds and grasses has been obtained without risk of chemical residue buildup in the soil. Suggested places for use include vacant lots, substations or yards where lawns or shrubs are to be planted within the next nine to twelve months. Alleys and driveways may also be treated safely, as runoff from KLEER-LOT treated areas will not injure trees or shrubs when the compound is applied at the recommended rates of 4 to 8 pounds per acre.

<sup>1</sup>Anchem Products, Inc., Agricultural Research, Fremont, California.

The length of acceptable weed control depends on application rate, soil type, and weather conditions. Eight pounds per acre is required for nine to twelve months control and where weeds are 4 to 8 inches high at time of application. Twelve to sixteen pounds per acre are being investigated for longer term vegetation control.

Weeds controlled by KLEER-LOT include wild oats, lambsquarters, pigweed, henbit, chickweed, peppergrass, barnyardgrass, foxtail, crabgrass, fillarce, groundsel, bromegrass, fiddleneck, lupine, mustard and curly dock. Preliminary studies with 12 to 16 pounds per acre show good control of bermuda grass; further research is progressing.

#### MAINTAIN<sup>®</sup> CF 125 AS A GROWTH RETARDANT RESULTS OF FIELD TESTS

Gordon K. Harris<sup>1</sup>

(Abstract) Greenhouse and preliminary field testing of a new growth retardant, methyl 2-chloro-9-hydroxyfluorene-9-carboxylate, was begun by U. S. Borax Research Corporation in 1966. This material was discovered by E. Merck AG of Darmstadt, West Germany. The trade name, MAINTAIN CF 125, was selected for the product. In April, 1968, a temporary permit was issued by the U. S. Department of Agriculture for the testing and distribution of MAINTAIN CF 125. Research plots were established in 1968 to determine dates and rates best suited for various grass species in the major oil and climate zones in the United States and Canada. In 1969 field scale equipment and the optimum combination rate of one lb/A of MAINTAIN CF 125 plus 3 lb/A of MAINTAIN 3 (maleic hydrazide) was widely field tested in the United States and Canada.

Registration for use on turf and associated broad-leaved weeds has been obtained for MAINTAIN CF 125 and MAINTAIN 3.

MAINTAIN CF 125 was treated in five different types of formulations in 1969 to determine the extent of its effectiveness in retarding woody plant growth in the year-round pruning practices used by maintenance personnel. Results of these tests showed that the asphalt formulation was the most universally accepted treatment and that it gave consistently good results. It is, we believe, possible that the asphalt tended to release the MAINTAIN CF 125 slowly for utilization by the plant and, in addition, protected the active material from degradation by sunlight. The affects of the asphalt formulation were noted for several months.

<sup>1</sup>Gordon K. Harris, Agricultural Research and Development Department, U.S. Borax Research Corporation, 412 Crescent Way, Anaheim, California 92803.

The invert emulsion and solvent system formulations which were applied as continuous bands around tree trunks clearly showed that MAINTAIN CF 125 penetrates through the bark and translocates throughout the upper plant to inhibit new plant growth. An increase in activity of the invert emulsion and solvent system formulations was noted when they were applied to a cut surface, thus providing ready entry into the sap stream. Observations of the cut treatments show that MAINTAIN CF 125 translocates primarily upward with very little radial movement.

Granular and spray applications to the soil did not prove to be satisfactory. Recent studies by U.S. BORAX RESEARCH have shown that MAINTAIN CF 125 is rapidly degraded in sunlight and is readily tied up in the soil surface, which may explain the poor response from granular treatments and MAINTAIN CF 125 spray solutions applied to the soil.

MAINTAIN CF 125 applied as a foliar application was more effective in retarding the growth of woody species than any other method of application.

## II. TURF GRASSES AND ASSOCIATED HERACEOUS WEEDS

### Materials and Methods

In 1968, MAINTAIN CF 125 and MAINTAIN 3 were used at several rates and dates, alone and in combination, throughout the United States and Canada in four major regions — the Northwestern, North Central, Northeastern, and Southern. Plots were 100 sq. ft., with either a three or five-foot control strip adjacent to each side of the plot to provide maximum accuracy in plot evaluations. Seventeen grass species were tested and some 35 broadleaf weed species which were associated with the grasses tested.

In 1969, emphasis was placed on test plots of one acre or more which were applied with field-scale equipment available to the cooperator.

### Results and Discussion

Use of MAINTAIN CF 125 in combination with MAINTAIN 3 has been found to be economically effective in retarding grasses. Figures 1 and 2 summarize the results of this combination treatment applied by various cooperating agents with their own equipment on a field-scale basis. The shaded areas in the graph illustrate effective retardation even under extreme weather conditions. Carlisle, Pennsylvania, had excessive rain, and Vancouver, Washington, experienced drought.

Optimum retardation is obtained when treatments are made after spring mowing.

The MAINTAIN combination treatment does the following:

1. Causes interference with the development of early growth stages of grasses, keeping the veg-

RESULTS OF THE MAINTAIN SYSTEM APPLIED THE SPRING OF 1969  
 (AVERAGE TEST PERIODS 8 WEEKS - RANGE 4 - 14 WEEKS)

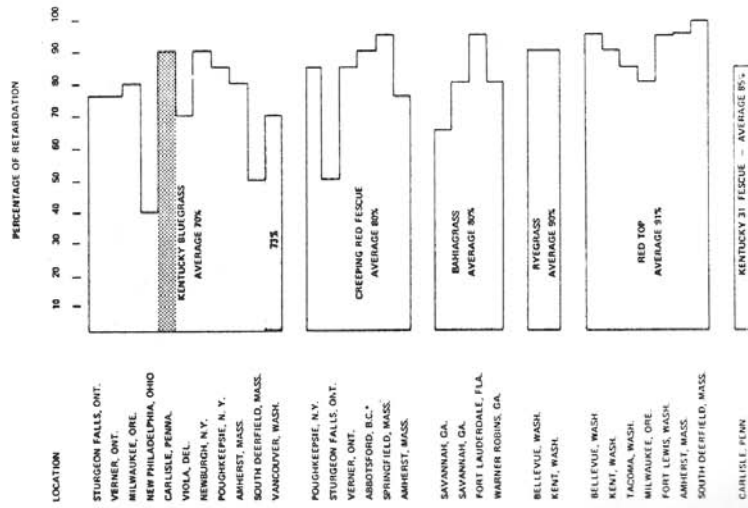


FIGURE 1

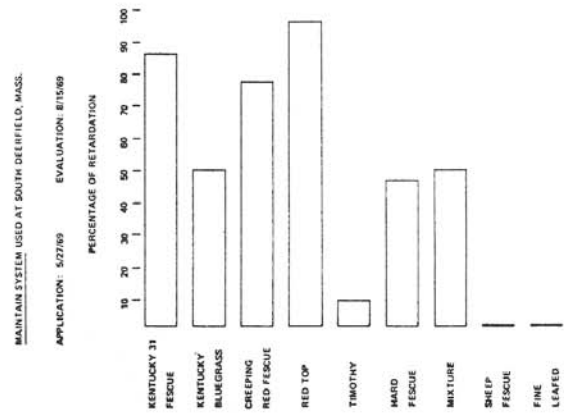


FIGURE 2

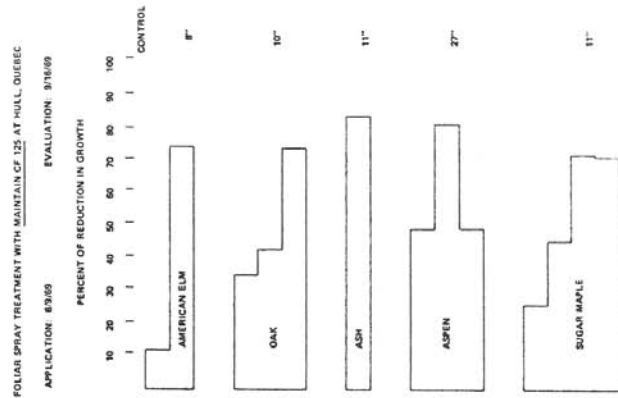
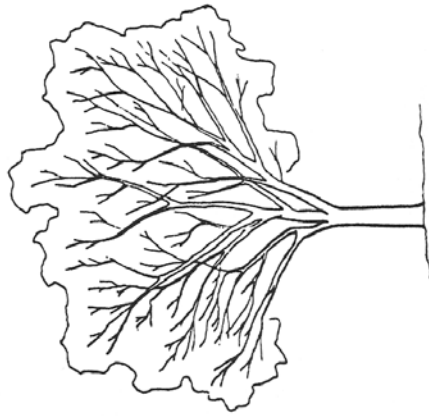


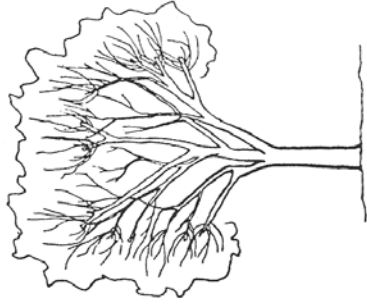
FIGURE 3

\*THREE WEEKS ONLY

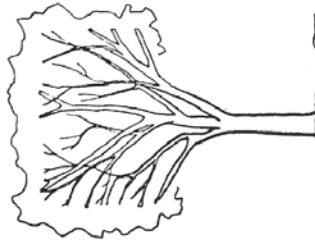
TREE PRUNING METHODS



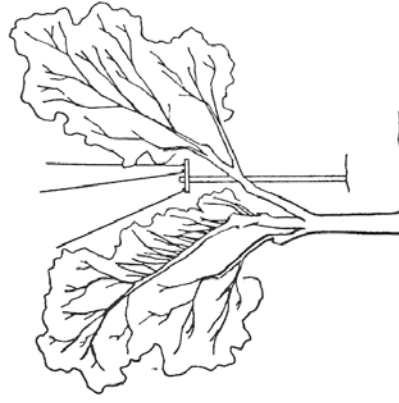
BEFORE PRUNING  
FIGURE 4



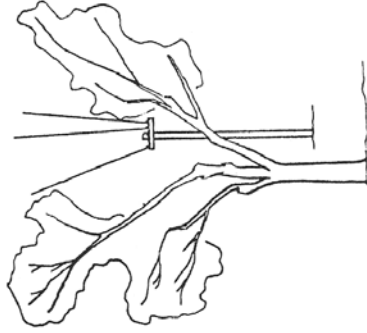
4 - aa VIGOROUS UPRIGHT SHOOTS



4 - a HEADED



4 - bb OPENS UP TREE, RETAINS  
NATURAL APPEARANCE



4 - b THINNED



etative growth short and inhibiting the development of seed heads.

2. The active material translocates to the growing points of grass and primarily retards the top growth, thus leaving the root system vigorous for a healthy turf.
3. It keeps turf greener for an extended period of time.
4. It controls unwanted annual grasses and broad-leaved, herbaceous weeds in the turf, thus improving the turf appearance and making moisture and nutrients available to the turf which would otherwise be utilized by undesirable weeds.
5. It gives consistent season-long control of a broad spectrum of broadleaved weeds, such as dandelion, dock, black medic, oxalis, etc.
6. It enables the more efficient use of men and equipment.
7. For practical purposes it is nonvolatile, therefore, much safer in use than such products as 2,4-D.
8. It has a short life in the soil, thus eliminating the residual problem associated with many pesticide products.

### III. WOODY PLANTS

#### Materials and Methods

Preliminary tests in 1966 and 1967 with foliar applications of MAINTAIN CF 125 indicated that it was a very active and effective growth inhibitor of woody plant species. It was merely a question of rate, dates, and type of application and variations in species response which had to be resolved. Therefore, major research effort in 1969 was directed toward the woody plant program. Outstanding cooperation was received for extensive testing on numerous species at several stages of maturity, using several treatment dates and application techniques throughout the United States and Canada.

The formulations used in the program were:

1. MAINTAIN CF 125  $\frac{1}{4}\%$  in asphalt carrier.
2. MAINTAIN CF 125  $\frac{1}{4}\%$  in an invert emulsion.
3. MAINTAIN CF 125  $\frac{1}{8}$ ,  $\frac{1}{4}$ ,  $\frac{1}{2}$  and 1% in a solvent system.
4. MAINTAIN CF 125  $\frac{1}{2}\%$  on clay granules.
5. MAINTAIN CF 125 12 $\frac{1}{2}\%$  emulsifiable concentrate.

Species selected in the various areas were those considered to be major problem trees in the cooperator's area of operation.

Foliar applications were made from 10 ppm to 1,200 ppm. Soil applications ranged from 250 ppm to 4,800 ppm. The invert emulsion and solvent formula-

tions were applied directly to the bark, or, to a cut in the bark to assure more ready entrance into the sap stream.

#### Results and Discussion

**MAINTAIN CF 125 IN AN ASPHALT CARRIER:** This formulation was well received by most of the people in the tree trimming industry as they are conditioned to painting cuts or "shiners" to keep them inconspicuous to casual observers, and to prevent infection by bacteria and fungi. Sprouts frequently develop from the cambial layer of pruning cuts, or, epicormic branches develop close to the cuts, which grow with great vigor and soon fill the space previously occupied by the pruned out portion of the tree. MAINTAIN CF 125 in asphalt has effectively retarded the growth of sprouts from pruning cuts by inhibiting new sprout development, reducing the number and length of growth of developing sprouts, and by inhibiting the development of epicormic branches in the area near the treated cut (Figure 4).

MAINTAIN CF 125 in asphalt has effectively retarded sprouting and/or epicormic branching in the following species:

1. American elm	<i>Ulmus americana</i>
2. Bigtoothed aspen	<i>Populus grandidentata</i>
3. Black locust	<i>Robinia pseudacacia</i>
4. Black walnut	<i>Juglans nigra</i>
5. Box elder	<i>Acer negundo</i>
6. Decorative olive	<i>Oleaceae</i> spp.
7. Golden willow	<i>Salix lasiandra</i>
8. Hickory	<i>Carva</i> spp.
9. Live oak	<i>Quercus virginiana</i>
10. Post oak	<i>Quercus stellata</i>
11. Red oak	<i>Quercus rubra</i>
12. Salt cedar	<i>Tamarix gallica</i>
13. Silver maple	<i>Acer saccharinum</i>
14. Sycamore	<i>Platanus</i> spp.
15. Water oak	<i>Quercus nigra</i>
16. Wild cherry	<i>Prunus emarginata</i>
17. Yellow poplar	<i>Liriodendron tulipifera</i>

**Persistence:** The asphalt applied as an aerosol was observed to remain and cover the wound for the entire length of the time in which observations were made on the tests. Some weathering of the asphalt application was noted on the hard wood of the treated cuts, indicating light applications had been made.

Of particular interest is the comparison noted between heavy asphalt tree paint which cracked after a few months, allowing moisture, insects, and disease organisms to enter the wound, compared to the intact seal of the aerosol treatments.

**MAINTAIN CF 125 IN AN INVERT EMULSION OR SOLVENT SYSTEM AEROSOL:** The concept of using a growth retardant as a trunk banding

treatment was well received by people in the tree trimming industry.

Species in which growth has been effectively inhibited by MAINTAIN CF 125 in an invert emulsion or a solvent system include big toothed aspen, silver maple, red ash (*Fraxinus* spp.), and black locust.

Application dates for MAINTAIN CF 125 in an invert emulsion or solvent system have been from early spring prior to bud break throughout the year as used by cooperating tree trimming crews in their "year-round" trimming program. The most outstanding retardation evaluated to date developed as a result of applications prior to the vigorous early spring growth.

The size of the tree did have a bearing on the effectiveness of MAINTAIN CF 125 in these systems. The larger trees of a 6-inch trunk diameter and larger are more readily retarded than are the vigorous juvenile size trees of  $\frac{3}{4}$  to 2-inch trunk diameter.

Special adaptation of this type of application may be in (1) banding limbs, on which growth is desired to be controlled, (2) on limb surfaces exposed to sunlight as a result of pruning which would normally be subject to stimulation of new sprout growth (Figure 4-bb).

**MAINTAIN CF 125 SOIL APPLICATIONS:** Recent studies by U.S. BORAX RESEARCH have shown that MAINTAIN CF 125 is rapidly degraded in sunlight and is readily tied up in the soil surface, which may explain the poor response from granular treatments and MAINTAIN CF 125 spray solutions applied to the soil.

**FOLIAR APPLICATIONS OF MAINTAIN CF 125:** There is no doubt of the effectiveness of MAINTAIN CF 125 in retarding the growth of woody species when applied as a foliar application (Figure 3). It acts very rapidly and is particularly severe on tender new growth. As an example, young silver maple trees which were treated without trimming showed twisting of the tender new growth. However, comparable trees which were trimmed prior to treating suffered no twisting and were effectively retarded throughout the season.

#### **WEED PROBLEMS IN CALIFORNIA SUGAR BEETS** **Jack Brickley<sup>1</sup>....**

Sugar beets are planted during all seasons in California. July is the only month which is not suitable for planting in most areas.

There are basic time periods which are most suitable for the establishment of beets in each area. This can be generalized to be mid-winter for the coastal valleys and the south San Joaquin Valley, early to late spring for the northern San Joaquin and Sacramento

<sup>1</sup>Spreckles Sugar Company, Woodland, California.

Valleys, and late summer for the Imperial Valley. However, due to harvest scheduling, beets in the San Joaquin and Sacramento valleys are planted throughout the year.

This wide range of planting dates means that beets are in competition with certain weeds at many stages of growth. Some weeds are competing with beets in one area and are of no commercial consequence in another.

Sound cultural practices are the most important aspect of weed control. This begins with field selection. If the field is known to be foul it is advisable to plan on using pre-emergence chemicals. If the field is thought to be clean the utilization of mechanical tools is adequate; however, the use of post-emergence chemicals on an area basis could be the most economical.

Proper preparation of the seed bed is necessary in order that the best possible weed control program can be utilized whether it be mechanical or chemical. Irregular or unlevel seed beds are not uncommon and are often responsible for poor cultivation. Large clods usually result in poor chemical weed control, as well as difficulty in pre-emergence incorporation. Although many seed beds in California tend to be cloddy and horrify those from other states, they are acceptable.

A good job of cultivation is as important when using pre-emergence chemicals as when not. Often weeds in the furrow are allowed to grow to enormous size before cultivation. Even when there is good in-the-row control the resultant trash problems make any subsequent operation, especially irrigation, more difficult.

Chemical weed control is now used throughout all of California. There are several good materials for each area, but an herbicide is only as good as its application. Proper application is very important but usually it is a matter of chance rather than planning. Many times fields have been seen with either one untreated row across the entire field or blocks of untreated rows scattered throughout. If the chemical industry doesn't have time to impress, or more precisely demand an accurate and precise application they should not sell the materials. Almost all materials applied could be guaranteed to work if those distributing the herbicide would spend a greater effort to assure correct application.

Almost all methods of chemical weed control thus far developed are used commercially to some extent in California. These methods include: 1) preplant incorporation, 2) post plant pre-emergence on top of the bed, 3) post-emergence to both the beets and weeds, and 4) post thinning pre-emergence to the weeds.

The preplant incorporated materials are either banded over the row at planting time or the entire field is treated and the material is double disced in. Some areas utilize the first method almost 100 percent while others utilize the latter to a greater degree. The primary material used with these methods are Ro-Neet

and Tillam. These materials are utilized primarily in the northern San Joaquin, Sacramento and Imperial Valleys.

These materials are applied at rates of from four to six pounds per acre depending on soil textures. The primary weed controlled is water or barnyard grass with pigweed and lambs quarter control also being important.

There is an increasing amount of herbicide being applied as a post plant, pre-emergence treatment. Pyramin or Pyramin plus TCA is being band applied over the beets in the winter planting of the south San Joaquin and Sacramento Valleys. Rainfall or sprinkler irrigation is used to incorporate the material into the soil surface. The TCA is added to Pyramin when grasses are thought to be a problem. Usually four pounds of Pyramin is applied and if TCA is added it is at the rate of eight pounds per acre.

TOK is banded post plant on considerable acreage in the Imperial Valley. This material does a good job of weed control but cannot tolerate any rainfall or sprinkler irrigation or a drastic reduction in beet stand will result. TOK is sometimes used as a surface treatment in conjunction with incorporated Ro-Neet for control of a broader spectrum of weeds in the Imperial Valley.

In those areas which plant from late October until February many acres are being treated with post-emergence herbicides. The primary material used is Pyramin plus Dalapon. This material has been very successful in controlling winter weeds, both broadleaves and grasses. A band treatment of the materials is the most economical and should be applied by ground equipment at a rate of four pounds Pyramin plus two pounds of Dalapon. At times an aerial application of Dalapon at four pounds per acre is necessary to retard weed growth until ground sprayers can move in the field.

In the Salinas Valley Pyramin is mixed with oil instead of Dalapon and results are usually very good.

The most radically successful post-emergence herbicide treatment has been the use of a small amount of 2,4-D when mustard has completely canopied the beets.

Many acres will be treated with Treflan in the Sacramento and San Joaquin Valleys in 1970. This material is applied after thinning and prior to the emergence of the weeds. It is used primarily after the field has been cleaned up by mechanical means or a pre-thinning herbicide. The material is sprayed over the entire area and then incorporated with a rolling cultivator or other tool which thoroughly mixes the surface soil.

In the Imperial Valley most of the acreage is treated with IPC which is applied after the crop has been layed-by. The IPC is sprayed into the furrow and then furrow irrigation pushes it up into the bed. This

material is used primarily for the control of canary grass and kills established grass as well as preventing any more from emerging.

There are some other materials such as Betanol, Endo-hal, and Eptam which are used on a very limited acreage but these materials are either in the development state or are only for specific conditions.

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#### PRECONDITIONING AND TEMPERATURE INFLUENCE ON BETANAL ACTIVITIES

Stanley Heathman  
University of Arizona

*(Abstract)* This study was undertaken to determine the effect of preplant applications of cycloate (Ro-Neet) upon the performance of phenmedipham (Betanal), a postemergence herbicide for the control of weeds in sugar beets. By utilizing the attributes of these two herbicides, it may be possible to increase the spectrum and the longevity of weed control.

The predominate weed species present in this test were black nightshade, green foxtail and redroot pigweed. Cycloate at 3.0 lb/A preplant followed by phenmedipham at 1.5 lb/A postemergence controlled 96 percent or more of the weed species present. Sugar beet stands were not reduced at these rates. Black nightshade and green foxtail were effectively removed with lower rates of cycloate and phenmedipham. Redroot pigweed was the most difficult species to control and required the highest rate of both herbicides. Data indicated that reduced rates of cycloate and phenmedipham, applied as complementary treatments would be effective for control of a known susceptible weed species complex. Phenmedipham at 3.0 lb/A postemergence resulted in stand reductions to sugar beets when applied alone or with cycloate as a complementary treatment.

Previous studies indicate that the herbicidal activity of Betanal depends upon temperature. There are, however, under field conditions, numerous temperature fluctuations in every series of days. Temperatures at time of phenmedipham application should be considered. Temperature fluctuations occurring after application can influence the response of weeds and beets to the herbicide.

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#### ECONOMIC EVALUATION OF HERBICIDES USED IN SUGAR BEET PRODUCTION

G. A. Lee, P. J. Ogg and H. P. Alley

Although sugar beet producers have the herbicides at their disposal to initiate successful weed control

programs, little or no information is readily available on the economics of herbicidal weed control versus hand labor. What is the return on investment for herbicides? Does hand labor really cost more than herbicides for removal of weeds? Can I afford to buy the necessary equipment for herbicide applications? These are only a few questions asked by sugar beet farmers. The scarcity of hand labor has forced the sugar beet farmer to utilize herbicides. However, the economic impact comparing various herbicide treatments in relation to hand labor has never been fully exploited.

Studies by the University of Wyoming have been conducted to evaluate the economics of various herbicide treatments used for weed control in sugar beets. The primary objectives for studying preplant, post-emergent and complementary preplant-postemergent treatments were to: 1) determine their effects on percentage control of weed species, stand and vigor of sugar beets, percentage sucrose in beet roots, and tonnage yields, 2) determine labor requirements necessary to remove weeds after the treatments, 3) determine the equipment and herbicide costs, and 4) determine gross and net returns for the treatments.

#### Results and Discussions

The weed population at the study location consisted of black nightshade (*Solanum nigrum* L.), redroot pigweed (*Amaranthus retroflexus* L.), Kochia (*Kochia scoparia* (L.) Roth) and green foxtail (*Setaria viridis* (L.) Beauv.). A lesser population of common lambsquarters (*Chenopodium album* L.), common purslane (*Portulaca oleracea* L.) and wild buckwheat (*Polygonum convolvulus* L.) were categorized as others.

Cycloate at 3.0 lb/A and CP-52223 (2-chloro-N-(isobutoxymethyl)-2', 6' acetoxydide) at 1.5 lb/A resulted in 94 and 97 percent total weed control, respectively (Table 1). However, CP-52223 caused severe sugar beet stand reduction which was reflected in number of beets at harvest and tonnage yields. Pre-Beta I (pebulate + diallate) at 5 pt./A gave 70 percent initial total weed control, but the preconditioning and stunting of the remaining weeds was evident resulting in lowered yields of beets at harvest.

Phenamedipham, phenamedipham + pyrazon and Pyramin Plus (pyrazon + dalapon + W.A.) alone as postemergent treatments resulted in 77, 52 and 48 percent total weed control, respectively. This may be attributed to the size and vigor of the weeds at time of application. At the time of postemergent applications, weeds present in the preplant treated plots were in the cotyledon to two-leaf stage of growth whereas undesirable plants in the nontreated plots were in the full four-leaf stage of growth. Yields from postemergent treated plots were 1.4 to 2.7 tons greater than the nontreated check.

Complementary treatments of cycloate preplant with the postemergent treatments resulted in consistently excellent total weed control and high tonnage yields. CP-52223 preplant with Pyramin Plus gave acceptable total weed control but caused moderate sugar beet stand reductions. Pre-Beta I preplant with phenamedipham and Pyramin Plus did not result in excellent total weed control. However, Pre-Beta I preplant with phenamedipham treated plots yielded 29.2 Tons/A. The nontreated check plot had 68 beets per 100 ft. of row at harvest time and yielded 22.3 Tons/A.

Table 1. Effect of preplant, postemergent and complementary preplant-postemergent treatments upon total weed control, percent stand of sugar beets, beets at harvest, tonnage yields and percent sugar.

Treatment	Rate lb/A	Total weed control	Percent stand sugar beets	Beets at <sup>2</sup> harvest	Yield tons/A	Percent sugar
<b>Preplant</b>						
cycloate	3.0	94	100	122	26.6	15.1
CP-52223 <sup>1</sup>	1.5	97	52	78	19.4	15.7
Pre-Beta I (pebulate + diallate)	5 pt.	70	100	124	24.7	15.3
<b>Postemergent</b>						
phenamedipham	1.5	77	100	118	23.8	15.7
Phenamedipham + pyrazon	1.5 + 3.0	52	100	104	25.0	15.5
Pyramin Plus (pyrazon + dalapon + W.A.)	12 lb. form.	48	100	112	23.7	15.9
<b>Complementary</b>						
cycloate + phenamedipham	3.0 + 1.5	99	100	106	26.4	15.9
phenamedipham + pyrazon	1.5 + 3.0	97	100	114	26.6	15.2
Pyramin Plus	12 lb. form.	95	100	124	29.4	13.9
Pre-Beta I + phenamedipham	5 pt. + 1.5	85	100	124	29.2	15.9
phenamedipham + pyrazon	1.5 + 3.0	96	100	122	28.5	15.4
Pyramin Plus	12 lb. form.	77	100	138	22.7	15.3
Nontreated check		0	100	68	22.3	14.5

<sup>1</sup> 2-chloro-N-(isobutoxymethyl)-2', 6'-acetoxydide

<sup>2</sup> Number of sugar beets per 100 ft. of row harvested.

Equipment costs for preplant, postemergent and complementary preplant-postemergent treatments and no chemical treatment were \$20.40, \$20.55, \$21.90 and \$22.25 per acre, respectively. Costs for equipment for complementary treatments are higher because of the preplant and postemergent sprayers required. The no chemical treatments had a higher accrued cost as a result of increased numbers of cultivations necessary for weed control.

Preplant herbicide costs were \$3.47/A for Pre-Beta I and \$3.82/A for cycloate and CP-52223. Phenamedipham, phenamedipham + pyrazon and Pyramin Plus treatment costs were calculated to be \$11.00, \$16.00 and \$10.88/A, respectively, based on a hand application. Complementary treatment costs were comparatively higher as a result of combined expenses for preplant and postemergent herbicides.

Labor required to weed and thin the plots reflects the efficiency of the herbicide treatments. Cycloate with phenamedipham treated plots required \$7.99/A for hand labor compared to a cost of \$30.13/A to work the nontreated check plots. The cost of weeding and thinning the postemergent treated plots were higher than either the preplant or complementary preplant-postemergent treated plots.

A partial budget analysis was used to derive the total production costs. Fixed costs such as taxes, irrigation water, fertilizer and labor for irrigation were omitted since expenditures would be constant in individual farming operations. The lowest total variable expenditures accrued were for Pre-Beta I at 5 pt./A and CP-52223 at 1.5 lb/A which were \$38.65 and

\$39.80/A, respectively. The highest total variable cost was \$56.55/A for plots treated with phenamedipham + pyrazon at 1.5 + 3.0 lb/A postemergent. The costs accumulated for the nontreated check plots were \$52.38/A.

The net return per acre varied from \$234.38 for plots treated with CP-52223 preplant with Pyramin Plus postemergent to \$414.38 for plots treated with Pre-Beta I preplant with phenamedipham postemergent (Table 2). There were only two herbicide treatments which resulted in net returns below the nontreated check plots. This was attributed to excessive sugar beet damage early in the growing season which reduced the tonnage yields at harvest. Pre-Beta I preplant with phenamedipham postemergent, Pre-Beta I preplant and phenamedipham + pyrazon postemergent and cycloate preplant with phenamedipham postemergent treated plots gave increases in net returns of \$142.63, \$113.40 and \$103.88, respectively, over the net return from the nontreated check plots.

In conclusion, two of the herbicide treated plots did not result in economic returns greater than plots receiving only hand labor. All other herbicide treated plots gave additional net returns of \$24.51 to \$142.73/A. For a capital outlay of \$3.47 to \$19.82/A for herbicides, the return is exceptionally high for investment. Even though farmers have been forced to use herbicides as a result of a shortage of hand labor, increased income has been their reward. Money invested in sugar beet herbicides pays higher dividends than stocks and bonds.

**Table 2. Total costs and returns for preplant, postemergent, and complementary preplant-postemergent treatments.**

Treatment	Rate lb/A	Pounds of sugar/A	Gross <sup>1</sup> return/A	Net return/A	Variation from check
<b>Preplant</b>					
cycloate	3.0	8039.2	\$401.96	\$360.86	+ \$ 89.21
CP-52223	1.5	6079.0	\$303.95	\$264.17	- \$ 7.48
Pre-Beta I (pebulate + dillate)	5 pt.	7570.4	\$378.52	\$339.89	+ \$ 68.24
<b>Postemergent</b>					
phenamedipham	1.5	7488.9	\$374.44	\$323.55	+ \$ 51.90
phenamedipham + pyrazon	1.5 + 3.0	7746.9	\$387.34	\$330.79	+ \$ 59.14
Pyramin Plus (pyrazon + dalapon + W.A.)	12 lb. form.	7530.2	\$376.51	\$324.03	+ \$ 52.38
<b>Complementary</b>					
cycloate + phenamedipham	3.0 + 1.5	8404.7	\$420.24	\$375.53	+ \$103.88
phenamedipham + pyrazon	1.5 + 3.0	8083.4	\$404.17	\$350.31	+ \$ 78.66
Pyramin Plus	12 lb. form.	8178.8	\$408.94	\$359.11	+ \$ 87.46
CP-52223 + phenamedipham	1.5 + 1.5	7659.4	\$382.97	\$334.07	+ \$ 62.42
phenamedipham + pyrazon	1.5 + 3.0	7050.2	\$352.51	\$297.36	+ \$ 25.71
Pyramid Plus	12 lb. form.	5634.2	\$281.71	\$234.38	- \$ 37.27
Pre-Beta I + phenamedipham	5 pt. + 1.5	9285.6	\$464.28	\$414.38	+ \$142.73
phenamedipham + pyrazon	1.5 + 3.0	8790.3	\$439.52	\$385.05	+ \$113.40
Pyramin Plus	12 lb. form.	6943.1	\$347.16	\$296.16	+ \$ 24.51
Nontreated check		6478.6	\$323.93	\$271.65	

<sup>1</sup> Based on \$.05 per pound of sugar produced per acre



23rd WESTERN SOCIETY OF WEED SCIENCE  
MINUTES OF PROJECT 6 — AQUATIC AND  
DITCHBANK WEEDS

W. Dean Boyle, Bureau of Reclamation, Boise, Idaho, Chairman of Project 6, Aquatic and Ditchbank Weeds, opened the meeting with some timely and informative remarks. He pointed out the fact that if aquatic weeds in Bureau of Reclamation irrigation systems are not controlled by July 1 of any year, at least 50 percent of the irrigated lands under these systems cannot be adequately served during the remainder of the irrigation season.

Mr. Boyle then stated that the first order of business was to elect a Chairman-Elect for the Project 6 Research Project Committee to serve during 1972. Mr. Tom Bartley nominated Jim McHenry. The nomination was seconded by Mr. Robert Demint. Dr. Timmons then moved that nominations be closed and that a unanimous ballot be cast for Mr. Jim McHenry. The motion was seconded by Mr. O. J. Lowry. The motion carried with a unanimous vote.

Mr. Boyle then asked Dr. E. A. Walker, Chief Staff Officer, Pesticides Regulation Division, U.S. Department of Agriculture, Washington, D.C., to give us the latest status of herbicides registered for aquatic sites and ditchbanks. Dr. Walker stated that the list of 37 herbicides which Dr. T. T. McClure, Agriculture Research Service, Washington, D.C., furnished committee members at the 1969 annual meeting in February 1969, at Las Vegas, Nevada, are still registered on an interim, no residue, basis during calendar year 1970. He further pointed out that after December 31, 1970, the present registrations will no longer apply. After this date, each herbicide registered for aquatic sites or ditchbank use will have to have a finite residue tolerance or an exempt registration such as copper sulfate or xylene which are compounds that have been used as herbicides in water over a long period of time and do not have a history of harmful effects.

A discussion on the status of registration of herbicides for the suppression and eradication of aquatic and ditchbank weeds—what remains to be done and who will do it—was led by Dr. Timmons. Dr. Timmons pointed out that crop residue studies have been and are being made by ARS at the Prosser, Washington, station on (1) foliage, (2) stems and (3) seeds of many agricultural crops. Details of the residue studies completed to date are in a paper published by Iowa State University, following a symposium Dr. Timmons participated in November 1969. No toxicological work on aquatic herbicides has been done by ARS. Following is a resume of the status of registration of each herbicide discussed:

1. *Acrolein*—Magna Corporation did not have anything to report on status of registration. Bill Hughes, Shell Oil Company, is collecting data needed for reg-

istration, such as the data ARS has available on residue in crops. So far the ARS data indicates that only a small amount of residue is in the irrigation water when it reaches the irrigated crops. Tolerances for different crops are expected to be determined during 1970. Outside of crop residue studies being conducted by ARS, Shell Oil Company will be responsible for obtaining other required data and to file the application for registration of acrolein to be used as an aquatic herbicide.

2. *Copper Sulfate*—ARS and the Bureau of Reclamation have data on the fate of copper sulfate in irrigation water. They do not have, however, any data on residue in crops since crops normally use small amounts in their normal growth cycle. Based upon its long history of use in water with no apparent harmful effects, the Pesticides Regulation Division, U.S. Department of Agriculture, is going to request exemption status for copper sulfate in irrigation water, recognizing that residues must be kept at or below that allowable by the U.S. Public Health Service, 1 ppm. of copper in potable water.

3. *Xylene*—Dr. E. A. Walker, Chief Staff Officer, Pesticides Regulation Division, U.S. Department of Agriculture, reported that on February 2, 1970, the Pure Food and Drug Administration determined xylene to be exempt from tolerances for food use. A request is going to be submitted to the Pure Food and Drug Administration by the Pesticide Regulation Division, U.S. Department of Agriculture, in the near future to exempt xylene from residue tolerances in irrigation water since it is a nonfood use. Even though an exemption status is being requested for xylene in irrigation water, Dr. Walker indicated that the Pure Food and Drug Administration may require residue data on crops irrigated with irrigation water that was treated with xylene; therefore, he suggested that ARS make crop residue studies at the Prosser Station in 1970 in case this information is requested.

4. *Dalapon*—It was reported by Dow Chemical Company that a request for registration of dalapon has been submitted to the Pesticides Regulation Division.

5. *Dichlobenil*—Mr. D. A. Shadbolt, Kansas City, Missouri, reported that Thompson Hayward Chemical Company plans to submit the petition for registration of this herbicide on aquatic sites within the next few weeks.

6. *2,4-D and Silvex*—A letter from Mr. C. L. Dunn, Hercules Inc., and the paper he was to present at the Project 6 meeting giving a progress report on registration of Phenoxy herbicides were furnished Chairman Dean Boyle. The letter stated that the Task Committee on Phenoxy herbicides has not made any effort toward registering 2,4-D for use on aquatic sites.

7. *Amitrole*—Stanley Fertig, Amchem Chemical Company, stated that amitrole and amitrole-T were being studied by a select Committee of the National Academy of Sciences and that their decision will be final in regard to whether or not this herbicide will continue to be registered for use on aquatic sites.

8. *Arsenates (MSMA)*—Bob Lucas, Ansul Chemical Company, reported that data is now being collected and a petition for registration is to be submitted in the near future.

9. *Diquat*—No report.

10. *Endothall*—Ed Bowles, Pennsalt Chemicals Corporation, reported that his Company is filing a petition for registration which requests 10 ppm. tolerance in potable water for the dipotassium and disodium salts of endothall.

Following reports on the status of registration of herbicides for use on aquatic and ditchbank weeds, Dr. E. A. Walker, Chief Staff Officer, Pesticides Regulation Division, U.S. Department of Agriculture, and Dr. Timms, Leader, Weed Investigations—Aquatic and Noncrop Areas, Crops Protection Research Branch, U.S. Department of Agriculture, made several pertinent remarks concerning registration of herbicides, residue tolerances, toxicology, etc. Dr. Walker pointed out that the list of herbicides published in the Federal Register March 6, 1970, cancelling the registration of these herbicides did not include any herbicides now registered for use in irrigation or drinking water. He also told the group that water is a vital element in plant and animal life and that someone has to set a standard on what are safe levels of pesticides for plants and animals in water. As of now, this is a rather confused area with no one federal agency assuming this responsibility. It was further stated that we could anticipate the Pure Food and Drug Administration requiring toxicological studies on water, meat, milk, and fish for herbicides used to control aquatic and ditchbank weeds. It is expected that toxicological data submitted with future registration petitions will have to be included for not only the herbicide, but also the inert ingredients contained in each herbicide.

The remaining papers presented to Project 6, including the following subjects, were given to the Chairman:

1. "Progress of Herbicide Monitoring in Irrigation Systems"—Thomas R. Bartley and Allen Hatrup, Bureau of Reclamation.
2. "Progress Report on Continued Registration of Phenoxxy Herbicides"—C. L. Dunn, Hercules, Inc.
3. "Information Needed by the Department of Agriculture—Department of the Interior Ad Hoc Committee on the Use of Herbicides in Aquatic Sites"—John E. Knoll, Bureau of Reclamation.

4. "Development of Criteria for Herbicide Registration and Use"—Robert Lewis, California Department of Health.
5. "Fish and Wildlife Aspects of Aquatic Weed Control"—Jack Linn, Pesticide Investigations Project, California Department of Fish and Game.

#### ABSTRACT OF PROGRESS REPORT ON HERBICIDE MONITORING

T. R. Bartley<sup>1</sup>

We have monitored quantities of 2,4-D, arsenic, copper, and xylene in irrigation water and copper in hydrosols, agricultural soils, and submersed aquatic weeds in cooperative programs with a number of irrigation districts, Bureau of Reclamation offices, Agricultural Research Service, and the Federal Water Pollution Control Administration during 1968 and 1969.

Nineteen canals having wide variations in hydraulic characteristics were sampled on the Columbia Basin Project for 2,4-D content in irrigation water following ditchbank applications of the 2,4-D dimethylamine salt. Peak 2,4-D concentration found in each canal varied as follows: below 50 ppb in 12 canals, between 50 and 100 ppb in 5 canals, and above 100 ppb in 2 canals. The temporary tolerance of 0.10 for 2,4-D in water was exceeded in only two of the canals. It is reasonable to assume that in low rate treatments of ditchbanks where excessive overlap into the canal water is avoided this tolerance would not be exceeded.

Seven canals on the Rio Grande Project have been monitored for arsenic in irrigation water following treatment of ditchbanks with MSMA. The canals were dewatered during the treatments and the initial water over the treated area was sampled for the first 4 hours for arsenic content. The maximum arsenic concentration found varied as follows: 0 ppm in 1 canal, less than 0.01 ppm in 2 canals, 0.01 ppm in 3 canals, and 0.48 ppm in 1 canal.

Concentrations of copper resulting from copper sulfate pentahydrate (CSP) treatments to the water for algae and pondweed control are influenced by application technique and amount applied. When the CSP crystals are dumped or sacked for application, crystal size, water temperature and velocity all affect the dissolution rate and hence the copper concentration. A peak copper concentration of 6 to 8 ppm in water usually results when the CSP is dumped into canal water at the rate of 1 pound per cubic foot per second (cfs) of water flow. In introducing copper by the sack

<sup>1</sup>Head, Biological Investigations Section, Research Division, Bureau of Reclamation Engineering and Research Center, Denver, Colorado.

method where only a portion of the CSP crystals are initially submerged to extend the dissolution time, peak copper concentrations fall in the 3 to 4 ppm range. In using a feeder to dispense CSP crystals into the irrigation water on a continuous or intermittent daily basis for algae control, the computed copper concentrations range from 2 to 12 ppb; and where this technique is used for pondweed control the maximum copper level in water may range from 0.1 to 0.2 ppm. The dump and sack method of CSP application for algae control results in a peak concentration of copper that exceeds the 1.0 ppm maximum for copper as established in the 1962 Public Health Service Drinking-water Standards. Controlled feeding of CSP for algae and pondweed control results in copper concentrations much below this standard. Hydrosol samples showed a copper increase of as much as 6 to 8 times over that of untreated samples in a 3-year study. In this same study, agricultural soils receiving the CSP treated water showed no accumulation of copper. Submersed aquatic weeds exposed to daily applications of CSP at a concentration averaging about 0.1 ppm as copper in the irrigation water showed a great capacity for absorbing copper. Filamentous green algae, sago and leafy pondweed, and elodea contained copper concentrations ranging from 340 to 4820 ppm on a dry weight basis. Untreated specimens had a copper level of about 20 ppm.

Two canals in Washington, one on the Yakima Project and one on the Columbia Basin Project were sampled following typical aquatic weed control field treatments with xylene to determine xylene concentrations and dissipation rates. In both cases the xylene concentration declined rapidly as the treated water moved downstream. Xylene concentrations were in the 500 to 600 ppm range from the initial treatments. Following a booster treatment downstream in each treatment, the xylene concentration declined to near a zero level at about 17 miles downstream from the first treatment.

#### PROGRESS REPORT ON REGISTRATION OF PHENOXY HERBICIDES

C. L. Dunn<sup>1</sup>

The National Agriculture Chemical Task Force on Phenoxy Herbicide Tolerances late in 1967 submitted petitions to the Food and Drug Administration and to the Pesticides Regulation Division of the U.S. Department of Agriculture for the establishment of negligible tolerances for crop uses of 2,4-D, 2,4,5-T, MCPA, and Silvex previously registered on a no-residue basis.

<sup>1</sup>Chairman, NACA Industry Task Force on Phenoxy Herbicide Tolerances.

The task force has been submitting additional data to all four petitions in the interim as requested by the F.D.A. in regard to metabolites and residues. Three of these petitions are still on file and pending.

On March 4, the task force was notified that its request to withdraw the 2,4,5-T petition without prejudice to future filing was granted. Also on March 4, the U.S.D.A. notified the task force that current 2,4,5-T registrations were extended to January 1, 1971. These include uses on apples, blueberries, cereal grains, pastures (grasses), rangeland clearance, rice and sugarcane found on pages I-T-8.1 and I-T-8.2.

All registered uses of 2,4-D, MCPA and Silvex in the meantime continue on the basis of the petitions now pending. Resubmission of the 2,4,5-T petition with new data from milk residue, meat residue, and teratology studies is expected.

Range and pasture grass clearance presented questions and interpretations requiring concurrence of both the F.D.A. and the U.S.D.A. Work on this problem was postponed until most of the crop residue studies had been completed or at least well underway.

Now milk residue studies are in progress and nearing completion. Studies on residues in meat have also been planned and protocols drawn up in cooperation with the Agricultural Research Service, U.S.D.A., but these are held in abeyance by the A.R.S. pending the final decision on 2,4,5-T. Hopefully U.S.D.A. approval will allow this study to start by May 1.

Setting of water quality standards and/or tolerances for various waters is presently highly uncertain. Our phenoxy herbicide task force is not presently involved in such an effort, and we have recommended that a water tolerance task force be established to deal with this matter in a comprehensive way.

#### INFORMATION NEEDED BY THE INTER-AGENCY AD HOC COMMITTEE ON THE USE OF HERBICIDES IN AQUATIC SITES

John E. Knoll<sup>1</sup>

The interagency ad hoc committee was established to resolve questions about the status of registration and use of herbicides in aquatic sites. Its objectives are to investigate the extent of use of herbicides in aquatic sites, develop the necessary information to fill the information gaps; and establish a protocol to registration, particularly for those herbicides that no longer have proprietary positions with manufacturers.

Registration has been obtained by manufacturers for about 40 herbicides for use in aquatic sites, but the labels on all but three (acrolen, copper sulfate, and

<sup>1</sup>Hydraulic Engineer, Bureau of Reclamation, Washington, D.C.

xylene) have restrictions that make it impractical to use them in most irrigation operations. In 1968, the Pesticide Registration Division of the Department of Agriculture rejected the Bureau of Reclamation's application for registration of four 2,4-D formulations and two silvex formulations for use in aquatic sites because they did not include sufficient data on residues. Since that time the committee has been defining these data requirements and suggesting methods for obtaining the needed information for registration through government research and from manufacturers. The type of data needed to support registration by the Pesticides Registration Division and to petition for residue tolerance limits to be established by the Food and Drug Administration are as follows:

- (1) The identification of the physical and chemical properties, formulations, and manufacturing processes.
- (2) The amount, frequency, timing of application and other conditions or restrictions on use as proposed by the label.
- (3) Complete data on the toxicity and efficacy of the chemical to the target as well as to the nontarget organisms under the various conditions prescribed by its use.
- (4) Residue data on potable water, irrigated crops, fish, shellfish and other meat, poultry, milk, or eggs that may become contaminated.

The committee has requested and obtained some residue data from manufacturers. It plans to submit revised labels on 2,4-D and silvex using residue data from manufacturers along with the residue data in crops and water that has been obtained through studies by the Agriculture Research Service and the Bureau of Reclamation.

#### FISH AND WILDLIFE ASPECTS OF AQUATIC WEED CONTROL

Jack D. Linn<sup>1</sup>

In preparing for this talk, I came across the definition that a weed is an obnoxious plant species that is unwanted, nonuseful, often prolific and persistent, which interferes with agricultural operations, increases labor, adds to costs, and reduces yields. The definition goes on to say that some of these species are weedy in certain situations but may be useful plants in others. I think many of the aquatic plant species fall into this

<sup>1</sup>Presented by Jack D. Linn, Associate Fisheries Biologist, at the 23rd Meeting Western Society of Weed Science, March 18, 1970, Sacramento, California. A contribution of Federal Aid in Wildlife Restoration Project FW-1-R, Pesticides Investigations, California Department of Fish and Game.

latter category. Perhaps the definition that a weed is a plant out of place is more appropriate. The native aquatic plants are vitally important in the ecology of aquatic habitats. The perpetuation of our natural marsh lands is impossible without them. They form mechanical support, shelter, breeding places and food for numerous invertebrates and some vertebrates. The dependence of animals upon green plants for food and cover holds true in water as it does on land.

With respect to fish and game animals the most important contribution of aquatic plants, excluding algae, is food for waterfowl. Emergent aquatics such as the bulrushes, smartweeds and spikebrush make up a third to over 70 percent of the food eaten by dabbling ducks. These are the mallard, pintail type ducks. Submerged aquatics such as sago pondweed and ditch grass are less important to dabbling ducks in the Sacramento Valley but make up as high as two-thirds of the food eaten by ducks in northeastern California. For diving ducks, such as canvasback and scaup, the submerged aquatics are appreciably more important than to dabblers. In northeastern California these plants were from 10 to over 95 percent of the diet of diving ducks and in the Sacramento Valley the percentage of the diet ranged from 3 to over 37 percent.

The higher aquatic plants are much less needed by fish than waterfowl. Actually, over-abundance of these plants can be detrimental to fish production. However, algae in the form of phytoplankton is the primary energy source for fish production.

While certain aquatic plants are necessary for proper management of wildlife habitat, selective removal of unwanted plant growth can be very useful to wildlife. Much effort is expended each year on the State's Wildlife Management Areas to control undesirable plants. Of the plants controlled, cattails are the only aquatic weeds. Cattails are controlled by grazing, mowing, discing, burning or chemicals.

Aquatic weed control has been an important fisheries management tool in many parts of the country though not so much here in California. The control of the higher aquatic plants for fisheries management is for the purpose of opening dense vegetative growth to provide living space for fish and fishing access for fishermen. Control of vegetation can also serve to prevent fish kills caused by oxygen depletion. Oxygen depletion can occur on cloudy days when dense vegetation uses rather than produces oxygen or when dense vegetation dies and decays in winter. The higher aquatics are also controlled to free nutrient material for phytoplankton production.

Aquatic weed control can have adverse effects on fish and wildlife depending on the methods used. Mechanical weed control primarily affects food and cover. The destruction of food and cover is also the major affect on wildlife caused by chemical weed control.

With fish there is a different kind of problem with chemical weed control. Aquatic weed control chemicals can kill fish directly, cause physiological damage and adversely affect phytoplankton and invertebrates upon which fish depend for food.

The most dramatic effect, of course, is a direct fish kill. The prevention of direct losses is the area which the Department of Fish and Game puts most of its efforts.

There is a wide selection of chemicals that are effective in controlling aquatic weeds. Many of these can be used effectively without causing direct fish losses. Our problems arise when the particular weed species, or, the conditions under which they are controlled, dictate that a chemical acutely toxic to fish must be used.

Specifically, the chemical control of aquatic weeds in flowing water is the most critical hazard to fish. We are told that in the flowing water of irrigation ditches it is essential that the chemical used to control weeds have the ability to kill the plants upon relatively brief contact and then dissipate rapidly. In this way the weed control operation does not interfere with other uses of the water, except of course, as habitat for fish. The two chemicals we are most often confronted with in this type of control are Acrolein and emulsified xylene. Both these chemicals are highly toxic to fish and other aquatic life at concentrations needed to kill weeds. In such cases when chemical treatment is the only feasible method it comes down to the decision of either fish or weed control. I want to touch on this particular subject again later.

In static water, the situation is somewhat different. In most instances there are chemicals that will control weeds at concentrations that are not acutely toxic to fish. However, even in static water, chemical weed control is not without its hazards to fish. Studies have shown that long-term exposure to a number of aquatic herbicides can have pathological effects on fish. The herbicides that have caused pathological effects are 2,4-D (Cope, 1970); Kuron (Cope, 1965); Caseron (Cope, 1965); Hydrothol 191 (Eller, 1969); and sodium arsenite (Cope, 1965). It should be pointed out that in many of these studies the herbicide concentrations that caused pathology were much higher than normal treatment levels. The pathology generally affects liver, kidney, gills and/or gonads. Many of the effects observed are reversible and disappear without causing mortality. Some of the aquatic herbicides also affect the growth of fish and inhibit plankton production. These effects are not permanent.

As a general rule, weed control in static water has not been a serious problem to fish in California for the reason that the practice is not widespread. Also, since there are alternative chemicals available which

do not cause direct losses, the safer chemicals are generally used.

I will conclude my presentation by getting back to the problem of aquatic weed control in irrigation ditches. This is a rather special problem here in California. We have over 7,500 miles of irrigation canal and drains in the State. Some of these contain important fisheries resources. The State Attorney General has ruled that the water contained in these canals and drains are included in the legal definition of "waters of the state." Paraphrasing a section of the Fish and Game Code, "It is unlawful to put any material into waters of the State, that is harmful to fish life." Thus it is the responsibility of the Department of Fish and Game to protect the fishery resources found in irrigation systems. The protection of fishery resources and the need to control aquatic weeds in irrigation canals potentially presents a serious conflict between the Department and irrigation interests. Fortunately this conflict has been minor.

The Department recognizes that it would be impossible and unreasonable to try to protect the fish in all portions of an irrigation system. Fish are generally present wherever there is water of suitable quality. In the major portions of irrigation systems, particularly the smaller laterals and drains the fish present are mostly minnows or other so-called "trash fish," which are of no real significance to the State's fishery resources. It would be unreasonable to protect these fish to the detriment of other water users. In some of the larger canals and drains, however, there are some rather important fisheries. We feel that these should be protected. It is fortunate that aquatic weeds are usually not a problem where important fisheries exist. The Department has expressed its position on this matter in a policy statement distributed among all the State's water districts. In addition we have worked closely with the districts in identifying the portions of the irrigation systems where we feel we have an interest. So far, we have not been confronted with a situation where weed control was absolutely necessary in an area with a significant fishery. I am happy to report that this has been a workable solution to a problem that could be a dilemma. At least every one seems to be happy. A more satisfactory solution though will be the development of herbicides or other aquatic weed control techniques that will take care of the weed problem without being harmful to fish.

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## MINUTES OF THE BUSINESS MEETING

MARCH 19, 1970

The meeting was called to order by President Alley at 11:03 a.m. A motion to dispense with the reading of the Minutes of the previous meeting was seconded and carried.

NOMINATION COMMITTEE REPORT — J. M. Hodgson, Chairman—R. A. Fosse, Stan Strew.

Chairman J. M. Hodgson reported the results of the balloting. Officers elected by the Society are:

President-Elect .....A. P. Appleby  
Secretary .....D. E. Bayer  
Chairman-Elect  
(Research Section) .....P. A. Frank  
Chairman-Elect (Extension and  
Regulatory Section) .....H. Agamalian

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

FINANCE COMMITTEE REPORT — J. W. Whitworth, Chairman—E. E. Schweizer, James McKinley.

The report of the Finance Committee was given by Chairman Whitworth. He reported that the books kept by the Treasurer-Business Manager were in good order. Income since the last meeting had totaled \$1,610.88 and expenditures had totaled \$1,303.36. Recommendations of the Finance Committee were:

1. That business manager, J. LaMar Anderson, be commended for his efficient handling of the financial affairs of the Society,
2. that the bank certificates be renewed at a higher rate of interest,
3. that the charge for the Research Progress Report be such that the current margin of profit of \$.50 per copy is maintained, and
4. that the assets of the Society be maintained at a level sufficient to cover the expenditures of one year of operation. These expenditures amounted to approximately \$2,100 according to past records.

A motion to accept the Finance Report was seconded and carried.

TREASURER-BUSINESS MANAGER REPORT — J. L. Anderson.

Treasurer-Business Manager Anderson reported that on February 10, 1969, we had on hand \$2,838.85. Liquid assets now stand at \$3,143.37. He reported that net income this past year was somewhat reduced because only one publication had been printed. A special report to the membership was distributed at no charge. Costs of publication of the Research Progress Report are increasing. Eventually the price charged for the Research Progress Report will need to be increased.

LOCAL ARRANGEMENTS 1970 REPORT — Harry Agamalian, Chairman.

Chairman Agamalian praised his committee of Dave Bayer, Lee Smith, Clyde Elmore, and Art Lange for their hard work on the 1970 meeting.

RESEARCH COMMITTEE REPORT — J. A. Dawson, Chairman.

Chairman Dawson reported that the number of individual reports submitted to the Research Progress Report totaled 117 in 1967, 85 in 1968, 77 in 1969, and 73 in 1970.

A brief report was offered by each section chairman.

*Project 1—Perennial Herbaceous Weeds.* Report given by Clyde Elmore. The new chairman is Les Sonder and the chairman-elect is Ron Collins.

An informal discussion session was held which seemed to be an effective format. There were 37 registered. Uses of weed control districts, herbicide combinations and single treatments, and specific weeds were discussed.

*Project 2—Herbaceous Range Weeds.* Report given by Bill Currier. New chairman is Bob Martin and the chairman-elect is Bill Currier.

There was good participation in a discussion-type meeting. Sixteen persons registered. Only two reports were submitted for the Research Progress Report. Recommendation was made that the 1971 chairman appoint a representative in each state who will contact persons to send in reports. Several individual weeds were discussed. There was general agreement that there should be more emphasis on biological control of weeds. Possibly life processes could be changed with chemicals. Some discussion was held on over-lap of the various project sections. It was agreed to keep the committees separate but not concurrent, particularly the herbaceous range weeds and the woody plants.

*Project 3—Undesirable Woody Plants.* Report given by Lisle Green. New chairman is Howard Morton. Chairman-elect is Walter Gould.

There were 27 registered with an active discussion being held. The chairman had prepared an agenda but this was needed only infrequently as members in the discussion participated actively. Ten progress reports had been submitted from seven authors. It was generally agreed that informal sessions are preferred rather than highly structured meetings.

*Project 4—Weeds in Horticultural Crops.* Report given by James McKinley. New chairman is Art Lange. Chairman-elect is Garry Massey.

There were 27 persons registered with good interest shown by those attending. Two panels were conducted, one on vegetables and one on fruits. Topics discussed were minimum tillage for vegetables, high-density planting, new herbicides needed for tree fruits. A session evenly divided between prepared presentations and informal discussion was suggested.

*Project 5—Weeds in Agronomic Crops.* Report given by Gary Lee. New chairman is Larry Slater. Chairman-elect is Jack Evans.

Good discussion was held. A more formal discussion was presented on sugarbeets. There were 84 registered. Other agronomic crops were also discussed.

*Project 6 — Aquatic and Ditchbank Weeds.* Report given by Dean Boyle. New chairman is Dick Comes. Chairman-elect is Jim McHenry. There were 54 registered for this session. Three hours were more adequate than one hour as in previous years. A workshop-type discussion was held on maintaining authority to use herbicides around or in water systems. Papers were also presented. It was considered a successful session. Perhaps a different seating arrangement would facilitate discussion.

*Project 7—Chemical and Physiological Studies.* Report given by Tom Muzik. New chairman is Ed Schweizer. Chairman-elect is Jack Corkins.

There were 95 registered for this session. An informal symposium on uptake of soil-applied herbicides seemed to be successful.

Discussion was held on the possibilities of combining Projects 1 and 2. The opinion was offered from the floor that these groups should be kept small and that combining them would not be in the best interests of good discussion.

EXTENSION AND REGULATORY SECTION — Eugene Heikes reported for Rex Warren.

A two-and-one-half hour session was held which included six formal papers. Attendance was 25 to 30.

Bert Bohmont gave a brief review of the papers presented.

RESOLUTION COMMITTEE—L. E. Warren, Chairman—J. L. Fults, W. A. Harvey.

Several suggestions for resolutions had been submitted but had not been forwarded in the form of resolutions by the Resolutions Committee. Chairman Warren read eight resolutions dealing with the following subjects:

1. Establishment of a standing committee dealing with students and Weed Science curricula.
2. Recommendation that studies dealing with effects of ag chemicals include practical dosage ranges and that benefits of these chemicals be considered.
3. Publicity to legislators and laymen on the importance of agricultural chemicals.
4. Separate definition of crop land and range land.
5. Incorporation of realistic dosage relationships in pesticide regulations.
6. Recommendation that responsible people in government refrain from condemning registered products until more facts are known.
7. Definition of the term 'persistence.'
8. Investigation of the establishment of a relationship with the AAAS and AIBS.

A comment made from the floor indicated that many of the resolutions involved highly complicated procedures and wording needs to be worked out carefully. A motion to accept, in principle, these resolutions with the understanding that they be re-worded so that they are accurate to the satisfaction of the Executive Committee and that the Executive Committee be authorized to make the final decision was seconded and carried.

1971 MEETING—The 1971 WSWS meeting will be held at the Denver Hilton Hotel, Denver, Colorado, on March 16-18, 1971.

WSSA REPRESENTATIVE—K. C. Hamilton.

Representative Hamilton gave a report on WSSA business conducted at the Montreal meeting in February 1970. A copy of his report is included in the Proceedings.

President Alley thanked those responsible for making the 1970 meetings a success. The presidency was transferred to incoming President Ken Dunster who adjourned the meeting at 12:22 p.m.

Respectfully submitted,  
Arnold P. Appleby,  
Secretary

**FINANCIAL STATEMENT OF  
WESTERN SOCIETY OF WEED SCIENCE  
FEBRUARY 10, 1969 — MARCH 10, 1970**

<b>Income</b>	
On hand, February 10, 1969 .....	\$2,838.85
Registration, Las Vegas Meeting .....	190.00
1969 Research Progress Reports .....	927.60
Sale of Old Publications .....	254.20
Payment of outstanding accounts .....	30.00
Dues, persons not attending meetings .....	67.10
Interest on savings .....	112.50
Univ. of Calif., refund on printing mats....	29.48
	\$4,449.73
<b>Expenditures</b>	
Annual meeting incidental expenses .....	62.07
1969 Research Progress Report .....	530.00
1970 Research Progress Report .....	280.49
Office Supplies .....	63.00
Postage (mailing to membership \$87.00) .....	217.30
Plaques for honorary members .....	27.00
Refunds .....	5.50
1969 Minutes .....	118.00
Gratis Publications (17)	
	\$1,303.36
Liquid Assets .....	3,146.37
Savings (\$1,800.00)	
Checking (\$1,296.37)	
Cash on hand (\$50.00)	
Accounts Receivable .....	24.00
Potential Net Worth .....	\$3,170.37
Old Publications on hand (407)	

**REPORT OF THE FINANCE COMMITTEE  
Before the Business Session of the 23rd Meeting of the  
Western Society of Weed Science  
March 17, 18, and 19, 1970  
Sacramento, California**

The Finance Committee met with the Treasurer-Business Manager, J. LaMar Anderson on March 16, 1970, and audited the books and reviewed the financial condition of the Society. The books were in order and in accord with the financial statement as prepared by the Business Manager. According to the attached financial statement, income of the Society from February 11, 1969 to March 10, 1970 amounted to \$4,449.73 with expenditures of \$1,303.36 leaving a balance of \$3,146.37 in liquid assets, which assets consisted of

\$50.00 cash on hand, \$1,296.37 in checking and \$1,800 in Bank Savings Certificates.

It is the recommendation of the Finance Committee that:

- (1) The Business Manager, J. LaMar Anderson, be commended for his efficient handling of the financial affairs of the Society.
- (2) That the bank certificates be renewed at a higher rate of interest.
- (3) That the charge for the Research Progress Report be such that the current margin of profit of \$.50 per copy is maintained.
- (4) That the assets of the Society be maintained at a level sufficient to cover the expenditures for one year of operation which expenditures amounted to approximately \$2,100 according to past records.

J. Wayne Whitworth, Chairman  
Respectfully submitted,  
James McKinley  
Robert L. Zimdahl  
(Acting for Edward Schweizer)

**REPORT OF THE RESOLUTIONS COMMITTEE  
1970**

Various suggestions for resolutions from members of the Conference have been considered carefully by the Resolutions Committee. Following are the resolutions offered for adoption:

**Resolution No. 1**

Our Conference officers during the past year—President H. P. Alley; Vice President and Program Chairman K. W. Dunster; Secretary A. P. Appleby; Business Manager J. L. Anderson; WSSA Representative, K. C. Hamilton; Member at Large D. E. Bayer; and Chairman of the Research Section J. H. Dawson—have given generously of their time and discharged their duties most effectively.

Be it resolved that we express to them our keen appreciation for their services.

**Resolution No. 2**

The Local Arrangements Committee, Harry Agamalian, Chairman, and D. E. Bayer and Art Lange, provided very well for the needs and benefits of the Conference and the visiting members.

Be it resolved that we express our gratitude and appreciation to them for their efforts.

**Resolution No. 3**

Weed Science, an important part of crop production, is not formalized into a curriculum leading to

degrees in that subject in any Western universities, and

Relatively few students are attracted to pursue Weed Science as a career, and

Discussions by WSWs membership have indicated a great need for an increase in students studying Weed Science,

Be it resolved that a Standing Committee be appointed by the Executive Committee of the Western Society of Weed Science to interest students in Weed Science as a career, attract student interest in WSWs, act as a clearing house for student employment, assist in developing curricula or departments in Weed Science at various Universities, and enlist the support of various grower organizations in this endeavor.

This committee should be composed of members for 2 or 3 years with overlapping tenure to provide continuity of effort. Its members should be instructed to work with various State Weed Conferences, Deans of Colleges of Agriculture, grower organizations, etc., to attain these goals.

#### **Resolution No. 4**

Several instances have occurred recently of allegations against herbicides that were based on erroneous information, premature results or even speculation, and

All of the herbicides approved by the Pesticides Regulation Division for sale in the United States have been reviewed in detail by the Food and Drug Administration and the responsible companies concerning toxicity to animals and humans, and

The USDA Pesticides Regulation Division and the USDI Sports Fisheries and Wildlife Service review all these products for utility or need, and

These products are needed tools in efficient production of food and fiber or vegetation management at reasonable costs,

Be it resolved that Presidential aides, government officials and legislators be urged to obtain all available facts on benefits as well as hazards from these registered products before issuing news releases and that such statements be based on scientific evaluation of these facts.

#### **Resolution No. 5**

There is a need to exchange important information on weed and brush control with scientists in other disciplines, and

The nature, use, benefits and potential hazards of herbicides must be understood and supported more generally by the scientific community,

Be it resolved that Western Society of Weed Science investigate the establishment of a close working relationship with the Pacific Section of the AAAS and AIBS and that

WSSA be urged to consider the possible association with national AAAS and AIBS.

#### **Resolution No. 6**

Agricultural chemicals are needed by growers to produce acceptable yields and quality of crops, and

Many of these chemicals are valuable aids in forestry and range management, and

Most of the public and news media have little awareness of the role these chemicals play in supplying food and fiber, and

Much anti-pesticide sentiment is developing because of this ignorance,

Be it resolved that the Western Society of Weed Science strive to alert and join with grower and marketing organizations in appraising appropriate state and federal officials and legislators of the importance of agricultural chemicals in maintaining adequate supplies of food and fiber.

Be it further resolved that joint efforts be made to publicize, through suitable media, to the laymen and the housewife the environmental safety of these chemicals when properly employed.

#### **Resolution No. 7**

The Food Additive (Delaney) Amendment to the Food, Drug and Cosmetic Act prescribes withholding from food use a compound if it is shown to be carcinogenic, and

No provision is made in this restriction for dose or degree of exposure, and

Nearly any material, at some dosage, can be made to produce carcinogenic or other adverse effects,

Be it resolved that legislators, USDA Pesticides Regulation Division, FDA and other appropriate agencies be urged to adopt a dosage relationship as recommended by the Mraz Commission Report on Pesticides and Their Relationship to Environmental Health (Part I), Recommendation Number 8, page 14.

Be it further resolved that herbicides previously considered carcinogenic be retested under this revised dose concept.

#### **Resolution No. 8**

Persistence of agricultural chemicals has become a national concern, and

"Persistence" of some materials beyond a year is desirable in certain uses, and

A suitable definition of "persistence" as it relates to various practical uses must be developed,

Be it resolved that USDA and PRD be urged to establish a definition that takes into account the dose, the crops or situation of use and effects of the environment on the persistence and to establish the limits of acceptance for each compound as related to these factors.

**REPORT OF WSSWS REPRESENTATIVE TO  
WSSA, 1970**

**K. C. Hamilton**

The 1970 meeting of the Weed Science Society of America (WSSA) was on February 3, 4, and 5 at the Queen Elizabeth Hotel in Montreal, Canada. Six hundred people attended. Excellent facilities and the friendliness and helpfulness of the local people contributed to the success of the meeting. Interest in the relation between weed control and the quality of the environment (pollution) was evident in many discussions.

The Executive Committee of WSSA met on February 3 with President G. C. Klingman and on February 5 with the new President, L. L. Danielson. New officers for WSSA are:

D. L. Klingman ..... President-Elect  
R. P. Upchurch ..... Vice-President  
A. P. Appleby ..... Secretary

New members of the Executive Committee are:

G. T. Dickerson ..... NEWSS Rep.  
G. A. Buchanan ..... SWSS Rep.  
J. D. Bandeen ..... CWC Rep.  
R. E. Frans ..... Member-at-large  
R. D. Ilnicki ..... Member-at-large  
T. J. Sheets ..... Member-at-large

The Finance Committee and Business Manager reported WSSA expenses exceeded income by more than \$5,000 during the past year. This was largely due to increases in the cost per page of printing Weed Science and the large number of papers published. The following actions, effective January 1, 1971, were taken to improve the finances of WSSA.

Increase membership of WSSA from \$12.00 to \$15.00 per year.

Increase graduate student membership from \$5.00 to \$7.50 per year.

Increase subscription for Weed Science from \$15.00 to \$20.00 per year.

Increase page charges in Weed Science from \$20.00 to \$25.00.

Increase cost of Abstracts from \$3.00 to \$5.00.

The WSSA is being incorporated.

The Editor reported that the number of papers submitted to Weed Science in 1969 was 216. This was a new record and an increase of 88% over 1967. The Executive Committee directed the Editor to add several Associate Editors to the Editorial Committee to reduce his work load.

Starting a popular publication on Weed Science was considered. The feasibility of having a private publisher handle printing, distribution, and advertising is being

studied. WSSA would help create a mailing list, provide all copy, and control editorial policy. If a popular publication is created another Editor will be appointed and will contact you for papers and ideas.

An International Weed Science Conference sponsored by FAO will be held at Davis, California on June 21 to July, 1970. WSSA plans to publish the background papers presented by weed workers from the U.S.

W. C. Shaw and F. W. Slife received the award of Fellow of WSSA. The outstanding paper in 1969 award was to J. B. Weber, S. B. Weed, and T. M. Ward. In the future WSSA also plans awards each year to the outstanding teacher and extension worker.

All other member conferences of WSSA now meet annually and report increasing interest and attendance.

WSSA is selecting meeting sites through 1978. A five-year rotation of meeting sites is being considered. The 1971 meeting of WSSA will be at the Statler Hilton in Dallas, Texas on February 9, 10, and 11.

**NECROLOGY**

Dr. Lyle W. Weldon, U.S. Department of Agriculture scientist who was stationed at the University of Wyoming during 1956-59, died in an accident near Orlando, Florida recently. His death is believed to have resulted from the chain of events started by the shock from encountering a snake while he was making a scuba diving survey of underwater weed growth in a lake for the U.S. Department of Agriculture and the Navy.

Dr. Weldon, a native of Oregon, obtained his Master of Science and Ph.D. degrees in Plant Science from the University of Wyoming in 1956 and 1959. His research in Wyoming during 1956-59 involved experiments on control of aquatic and bank weeds and of weeds in beans and alfalfa seed crops. He became well known to farmers, county agents, and irrigation company officials in Albany, Goshen, Fremont, Bighorn, Park, and Sheridan Counties, where his field experiments were conducted.

In February 1960, Dr. Weldon was transferred by his supervisor, Dr. F. L. Timmons at Laramie, to Fort Lauderdale, Florida, to become a member of the 3-scientist team stationed there to conduct research on control of aquatic weeds in Florida and other Southeastern States. Dr. Timmons said that during his 10 years in Florida Dr. Weldon developed a national and international reputation for his valuable research and numerous publications on the control of aquatic weeds.

Mrs. Weldon was employed by the Bank of Laramie for several years while her husband was a graduate student at the University. She and her three children Kara, Kathy and William plan to continue living at Fort Lauderdale, Florida.



## HONORARY MEMBERS

### Lee M. Burge

Lee M. Burge is a native of California where he graduated from Fresno High School.

He is a graduate of the University of Nevada, College of Agriculture where he majored in animal husbandry and biological sciences.

An employee of the Nevada State Department of Agriculture since 1929, he was, in 1957, named Director of the Division of Plant Industry. On January 1, 1961, he was named Executive Director of the Department of Agriculture.

Mr. Burge is a former vice-president of the Agriculture Committee of the Regional Council of State Governments, former member of the executive board of the National Association of State Departments of Agriculture, past-president of the Western Association of State Departments of Agriculture, past-president of the Western Weed Control Conference, and is on the Board of Governors of the National Agricultural Hall of Fame. He has long been active in numerous other regional and national agricultural work.

### Bruce J. Thornton

Bruce Thornton was born in Berthoud, Colorado on August 9, 1895. He received his B.S. degree in Animal Husbandry from Colorado State University in 1918 and his M.S. degree in Botany and Plant Pathology in 1927 from the same institution. He also did graduate work at the University of California at Berkeley in 1939-1940.

He managed a fruit farm in Oregon in 1920 and an irrigated farm in Colorado from 1921-1925. He joined the Colorado State University teaching faculty and experiment station staff in 1927 and served in the department of Botany and Plant Pathology until his retirement in 1962. He was in charge of weed control investigations, both chemical and cultural, during that time. Also, he was head of the Colorado State Seed Laboratory from 1940-1961.

Bruce Thornton made many contributions to the field of weed science. He was one of the pioneers in the investigation and introduction of sodium chlorate, 2,4-D, and many other chemicals for weed control. He helped organize the Western Weed Control Conference in Denver in 1938, serving as its President and in various other capacities. He helped organize the Western Seed Officials Association at Salt Lake City in 1944, serving as its President for three years and subsequently in other capacities.

In 1964, Bruce Thornton was made an Honorary Member of the Association of Official Seed Analysts. He is a charter member of the Colorado-Wyoming Academy of Science and has been granted Honorary

Membership in that organization. He is a Fellow of the American Association for the Advancement of Science, member of the Board of Directors of CSU Alumni Association, and numerous other organizations. In 1965, he received the CSU Alumni Award for Outstanding Service.

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## OFFICERS OF WESTERN SOCIETY OF WEED SCIENCE 1970-1971

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

President-Elect: A. P. Appleby, Farm Crops Department, Oregon State University, Corvallis, Oregon 97331

Secretary: D. E. Bayer, Department of Botany, University of California, Davis, California 95616

Chairman, Research Section: G. A. Lee, Plant Science Division, University of Wyoming, Laramie, Wyoming 82070

Chairman, Extension and Regulatory Section: D. G. Swan, Department of Agronomy, Washington State University, Pullman, Washington 99163

Chairman-Elect, Research Section: P. A. Frank, USDA, ARS, Room 213, Building 56, Denver Federal Center, Denver, Colorado 80225

Chairman-Elect, Extension and Regulatory Section: Harry Agamalian, 118 Wilgart Way, Salinas, California 93901

Immediate Past-President: H. P. Alley, Plant Science Division, University of Wyoming, Laramie, Wyoming 82070

Representative to WSSA

Executive Committee: K. C. Hamilton, Department of Agronomy, University of Arizona, Tucson, Arizona 85721

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

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## CHAIRMAN AND CHAIRMAN-ELECT PROJECTS 1 THROUGH 7

### *Project 1—Perennial Herbaceous Weeds*

Chairman — Les Sonder, Plant Science Division, Montana State University, Bozeman, Montana 59715

Chairman-Elect—R. L. Collins, 529 N. E. 17th Street, Hillsboro, Oregon 97123

### *Project 2—Herbaceous Range Weeds*

Chairman—R. D. Martin, Bureau of Land Management, P.O. Box 3861, Portland, Oregon 97208

Chairman-Elect—Bill Currier, U.S. Forest Service, Albuquerque, New Mexico

*Project 3—Undesirable Woody Plants\**

Chairman—Howard Morton, 2000 E. Allen Road, Tucson, Arizona 85705

Chairman-Elect—W. L. Gould, Agronomy Department, New Mexico State University, Las Cruces, New Mexico 88001

*Project 4—Weeds in Horticultural Crops*

Chairman—Art Lange, Horticultural Department, University of California, Riverside, California 92502

Chairman-Elect—Garry Massey, 7521 W. California Avenue, Fresno, California 93706

*Project 5—Weeds in Agronomic Crops*

Chairman — Larry Slater, E. 12821 25th Street, Spokane, Washington 99216

Chairman-Elect — Jack Evans, Plant Science Department, Utah State University, Logan, Utah 84321

*Project 6—Aquatic and Ditchbank Weeds*

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*Project 7—Chemical and Physiological Studies*

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**WEED CONTROL RESULTS IN CORN  
AT SIX COLORADO LOCATIONS**

**P. E. Heikes**

Herbicides were evaluated at six locations with soil types ranging from sand to clay loam and organic matter from 0.4 to 2.0 percent. The major weed species were sandbur (*Cenchrus pauciflorus Benth*), Kochia (*Kochia scoparia*) (L.) Roth), pigweed (*Amaranthus retroflexus*) (L.), lambsquarters (*Chenopodium album*) (L.), purslane (*Portulaca oleracea*) (L.), groundcherry (*Solanum nigrum*) (L.), and foxtail species (*Setaria sps*).

All materials were applied broadcast with a plot sprayer in 40 gals. of water per acre, before the corn was seeded; half of all plots was soil incorporated; the other half was not incorporated. Butylate (Sutan) was soil incorporated with a tandem disk, twice over. Plots were 1000 sq. ft. — 8 rows spaced 30" apart, 60 ft. long. 6, 2ft. x 4 ft. weed counts were made in each plot. Results of this series of corn herbicide evaluations are shown in Table 1. (Extension Professor, Weed Science, Botany and Plant Pathology Department, Colorado State University, Fort Collins, Colorado).

Table 1. Pre-emergence Corn Herbicides Evaluations, Colorado, 1969.

Common Name	Trade Name	Rate per Acre	Percent Weed Control Average 6 Locations			% Crop <sup>1</sup> Thinning
			Grasses	Brdlf Weeds	Total	
1. atrazine	AAtrex	1½ lbs	84	93	89	
2. atrazine	AAtrex	2 lbs	89	97	93	
3. SD-15418	Bladex	1½ lbs	76	75	76	
4. SD-15418	Bladex	2 lbs	87	87	87	
5. SD-15418	Bladex	4 lbs	92	89	91	
6. EPTC/2,4-D	Knoxweed	2 qts	90	85	88	
7. butylate	Sutan	4 lbs	89	84	87	
8. butylate/ atrazine	Sutan/ AAtrex	2 + 1 lbs	69	85	77	
9. butylate/ atrazine	Sutan/ AAtrex	3 + 1 lbs	76	93	85	
10. atrazine/ prometryne	Primaze	¾ + ¾ lbs	78	87	83	
11. atrazine/ prometryne	Primaze	1 + 1 lbs	82	90	86	15/1
12. linuron/ propachlor	Londax	5 lb pkg mix	73	77	75	
13. DCPA/2,4-D	Rowtate					
14. DCPA/2,4-D	Rowtate	6 + 1½ lbs	83	75	79	18/6
15. DCPA	Dacthal	7.2 + 1.8 lbs	87	84	86	26/6
16. DCPA/atrazine	Dacthal/ AAtrex	8 lbs 4 + 1 lbs	83 92	62 97	73 95	27/6 13/2
17. propachlor	Ramrod	6 lbs	69	50	60	
18. alachlor	Lasso	2 lbs	88	84	86	
19. alachlor	Lasso	3 lbs	88	87	88	
20. alachlor	Lasso	4 lbs	91	84	88	
21. alachlor/ atrazine	Lasso/ AAtrex	1½ + 1 lbs	88	88	88	
22. alachlor/ atrazine	Lasso/ AAtrex	2 + 1 lbs	92	91	92	
23. propachlor/ atrazine	Ramrod/ AAtrex	5 lb pkg mix	79	92	86	
24. propachlor/ atrazine	Ramrod/ AAtrex	6 lb pkg mix	80	97	89	
25. C-6313	Maloran	4 lbs	77	94	86	40/6
26. C-6989	Preforan	4 lbs	66	69	68	
27. S-6115		1½ lbs	93	97	95	
28. S-6115		2 lbs	97	99	98	
29. BAS-2903		4 lbs	78	86	82	
30. alachlor/ linuron	Lasso/ Lorox	1.33 + .66 lbs	82	86	84	
31. alachlor/ linuron	Lasso/ Lorox	2 + 1 lbs	87	94	91	22/3

<sup>1</sup> Crop thinning and number of locations where thinning occurred.

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