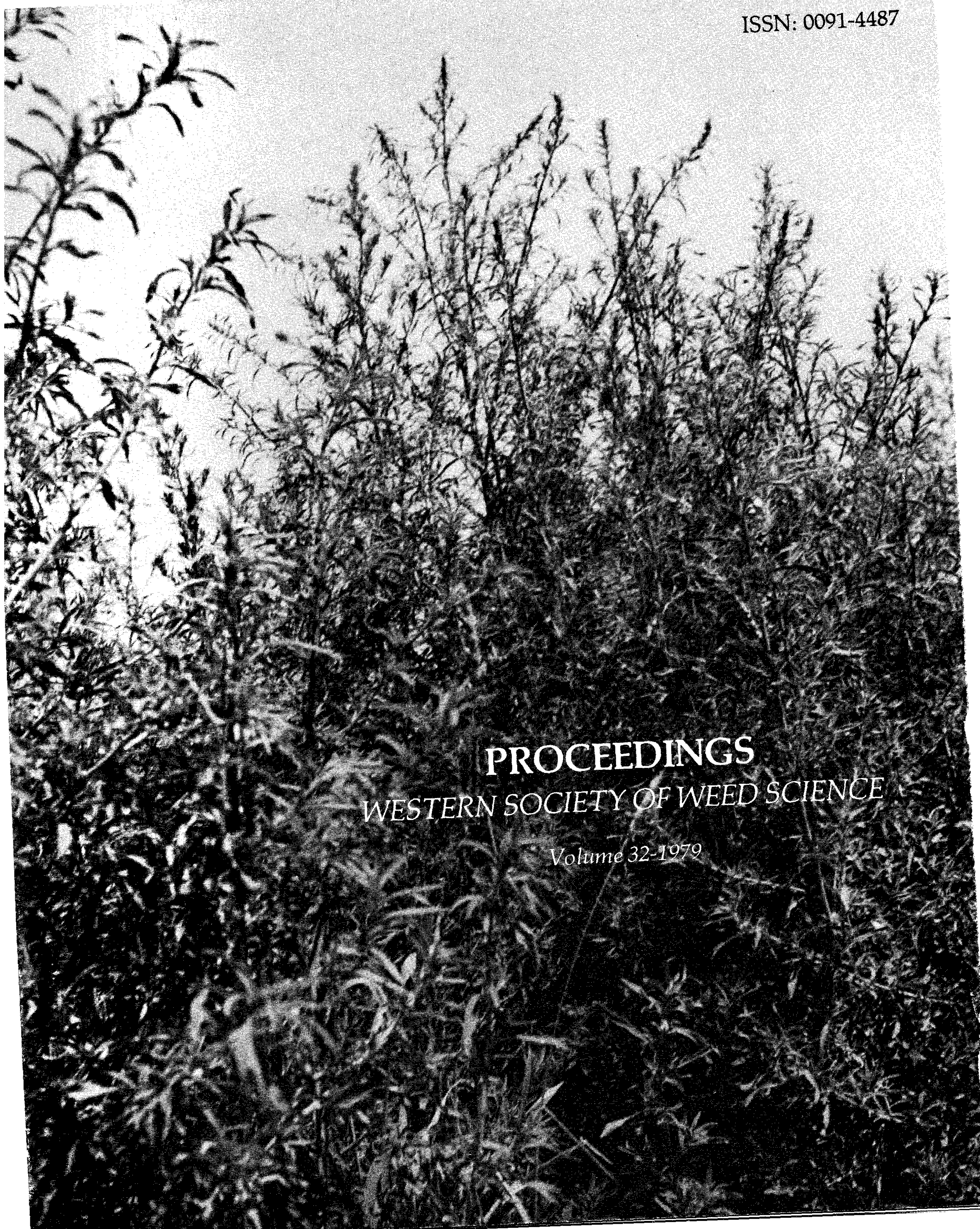
ISSN: 0091-4487



PROCEEDINGS

WESTERN SOCIETY OF WEED SCIENCE

Volume 32-1979

WSWS 1978-1979 OFFICERS AND EXECUTIVE COMMITTEE

President—R. D. Comes, USDA-SEA, IAREC, Prosser, WA

President-Elect—L.C. Burrill, IPPC, Oregon State University, Corvallis, OR

Secretary—R.L. Zimdahl, Weed Research Lab., Colorado State University, Fort Collins, CO

Treasurer—Business Manager—J.L. Anderson, Plant Science Department UMC 48 Utah State University, Logan, UT

Research Section Chairman—R.F. Norris, Botany Department, University of California, Davis, CA

Research Section Chairman-Elect—R.H. Callihan, University of Idaho Research and Extension Center, Aberdeen, ID

Education and Regulatory Section Chairman—J. Hill, Agronomy Department, University of California, Davis, CA

Education and Regulatory Section Chairman-Elect—J.O. Evans, Plant Science Deparment, Utah State University, Logan, UT

Immediate Past President—L.S. Jordan, Department of Plant Sciences, University of California, Riverside, CA

WSSA Representative—G.A. Lee, Department of Plant and Soil Science, University of Idaho, Moscow, ID

Member-At-Large—J.R. McKinley, Union Carbide Agricultural Products, Albany, OR

1979

PROCEEDINGS

OF

THE WESTERN SOCIETY OF WEED SCIENCE

VOLUME 32

PAPERS PRESENTED AT THE ANNUAL MEETING

MARCH 20, 21, 22, 1979

RODEWAY INN

BOISE, IDAHO

PROBRAM AND TABLE OF CONTENTS

PRESIDENTIAL ADDRESS

LET'S TAKE THE INITIATIVE

Richard D. Comes[1]

I would like to welcome each of you to this 32nd meeting of the Western Society of Weed Science. You will note from your program that some of the very early workers in weed science will be participating on the program this afternoon. It was not by design, but it is fitting that Boise is the city where we are honoring the retired and deceased "Old Timers" of our Society. It was here in Boise, at a meeting of the Western Plant Quarantine Board in 1936, that the formation of the Western Weed Control Conference, now the Western Society of Weed Science, was conceived. Two year later, in 1938, the first official meeting of the Conference convened in Denver, Colorado. We are indebted to these founders and early members of our Society for having the insight, enthusiasm, and drive to begin and foster the first weed control conference in the United States. Many of the early members are here today. I hope you graduate students and others who do not know these gentlemen personally will become acquainted during the next few days. They are a great group of pioneers, whom we are very pleased and proud to have with us today.

It has been a privilege to serve as President of your Society this year. I especially have enjoyed the relationships that were developed with many of you whom I had not been closely associated with in the past. The leadership provided by committee chairmen and members of the Executive Committee has been especially gratifying. I would like to take this opportunity to sincerely express my appreciation to all of these members for the cooperation, advice, and loyal support they have given to me. As long as members continue to give unselfishly of their time and talent to the affairs of the Society, we will remain in a strong position to meet the challenges that lie ahead.

Your Program Committee has developed what promises to be a very interesting and educational meeting. I hope each of you will take advantage of the time they have allotted for discussion during the conference. These discussion periods have been, and continue to be, something that makes our meetings different and, in my opinion, more productive than many other meetings that I attend.

This year was the first time that I had reviewed our Constitution critically. Our Constitution sets forth five objectives for the Society. What we are, or are not doing, to reach two of these objectives is what I would like to comment on this morning. My ideas are no better, and probably not as good, as many of yours, but I'll expose them for your consideration.

Article II, Section 2, states the objective, "To support the Weed Science Society of America and foster state and regional organizations of persons and agencies interested in weed control." I believe we do give our wholehearted support to the Weed Science Society of America. Many, if not most of us, are members of WSSA, many serve on various committees, and members of our Society have held every office in WSSA, including that of President. We elect a Respresentative to WSSA who serves on the Executive

---

[1]U.S. Dept. of Agric., Sci. and Ed. Admin., Prosser, WA 99350

Committee of that Society and provides liaison between the two Societies. I believe we are in good shape here.

But what about our influence, or being influenced by the various state weed organizations that exist within our region. We are fortunate to have some very strong state weed conferences in the Western United States. Many of us are also members, hold offices, etc, in these organizations. However, the majority of people at state conferences probably haven't even heard of the Western Society of Weed Science. I believe we need some liaison with these organizations also. Our concerns or actions may be of interest or benefit to them and vice versa. Yet we do not even communicate with one another.

Various groups within this great land seem to band together to block or hinder the use of sound, documented technology. It seems incredible to me that we in weed science specifically, and in agriculture in general, just continue "to do our own thing." How much more effective would we be in communicating our concerns and problems to decision makers everywhere if we were united in our efforts? I don't know how many people belong to the various state weed conferences in our region, but I would estimate at least 3,000. This represents the voices of seven times as many people as we have in our Society that have similar or identical goals in providing the necessary, safe, weed management tools for an efficient agricultural production system. All of us know how numbers influence decisions, and it seems to me that we must coordinate our efforts to the fullest extent possible.

The second objective that I would like to discuss is Article II, Section 4, of our Constitution. This section reads "To foster and encourage education and research in weed science." I believe we have done a good to excellent job of accomplishing this objective with our Society and within the various academic institutions represented by our membership.

One aspect that I believe we could and should strengthen is the participation of more graduate students in our meetings. Because some universities are on the quarter system, and final exam week frequently coincides with this meeting, many graduate students are unable to attend our meetings. Several years ago this problem was considered by our Society, and it was decided to retain the traditional dates of the 2nd or 3rd week in March. Perhaps we need to re-think these dates and survey our membership again to determine if scheduling this meeting at a time more convenient for all graduate students would pose any serious problems. If such a change was acceptable, it would be at least four years before it could be instituted. Dates of our meetings through 1982 have already been established at the traditional time.

Another facet of graduate student involvement that we have not pursued is a contest for the best paper presented at the meeting by a graduate student. Many excellent papers have been presented by students down through the years, and I am confident that some of the best presentations at this meeting will be made by graduate students. As a professional society, we should encourage these young people to excel and reward those who are judged to have presented the best papers at our meeting. Competition fosters excellence, and we should strive to set up the mechanism to provide the opportunity for these students to compete.

This, of course, would require another committee to establish guidelines and to oversee and judge the contest each year. Less than 10% of our membership serve on committees during any given year, so this would not be a burden, but an opportunity to get more people involved in the affairs of the Society.

Another area where I believe we are deficient in fostering and encouraging education in weed science is in the public sector. I doubt this interpretation was meant to be conveyed by Article II, Section 4, but in the day in which we live, these are the people who have a great deal to say about the way we do our jobs. We should be seeking every opportunity to accurately inform the public about the magnitude and significance of weed problems, the progress that has been made, the need for even better control or management techniques, and how weeds directly or indirectly affect every citizen.

A first step was taken in this direction at the Executive Committee meeting in Salt Lake City last July. At that meeting, the Executive Committee unanimously agreed that the Western Society of Weed Science should apply for membership in the Council for Agricultural Science and Technology, better known as CAST. We were accepted as a member society on July 24.

CAST was organized in 1971 to coordinate the efforts of scientific agricultural societies in providing information to the government and the public for solutions of problems of national and international concern. Seventy-seven reports, including ten that deal with weeds and pesticides, have been prepared and distributed to decision makers in government and to the public. The fifth national telephone dial-ogue sponsored by CAST last November attracted over 2,300 telephone calls from students and consumers. These activities are truly educational and are a giant step forward in keeping the public informed on agriculture and technology.

Some CAST participants answering questions posed during these dialogues have noted a substantial lack of knowledge among young people about what is meant by agricultural production, the balance of nature, the quality of the environment, etc. Many students are of the opinion that human beings are not a natural part of the ecosystem and, therefore, we are upsetting the balance of nature. There is virtually no appreciation of the fact that if American farmers were not the most efficient producers in the world, most of these students would be on a farm trying to eke out a subsistence.

Many high school biology teachers and program chairpersons for numerous civic groups would be receptive, or even delighted, to have a voluntary guest speaker. Yet how many of us seize this opportunity to explain how weeds affect the quantity and quality of our food crops and range, poison or malform our livestock, create health and safety hazards, and choke our waterways. We have not taken the initiative to explain these detrimental effects of weeds and the methods for their control to the people who are, or soon will be, making decisions concerning our discipline. We have a tremendous task to accomplish. We can no longer afford to depend on someone else to take on this responsibility. I urge each of you to get involved in the educational phase of weed science.

LIVING ON THE INTERFACE OR SLIDING DOWN THE RAZOR BLADE OF LIFE

Stewart Bledsoe[1]

I have a very simple thesis to put before you. Look around you. You are sitting in a room full of as much brain power as there is in the important field of weed science. We know our subject matter thoroughly. We are pros. As Dick Comes said, "The American agricultural and natural resource technologists are good at what we do." I have had a chance to traipse around the world a little bit and let me tell you we are as good as anybody else in the world at what we do. However, we are babes in the woods about what is done *about* what we do. This came as somewhat of a shock to me.

I used to be a politician, and gave speeches full of all the answers. No more of that! Instead of that kind of junk, let us just share some experiences.

The first one: I got down off a quarterhorse and stumbled into the Washington State legislature, green and scared to death, trying to pick my way through the legislative process. I found to my absolute consternation that here was a law-making body sitting together making permanent statutory decisions affecting the future of anyone who is a natural resource manager, whether he farms, ranches, grows fruit, or grows trees, etc. Here was a bunch of people sitting in judgment, mapping our the future of the natural resource industry of our small state, and for the most part, having absolutely no understanding of what we do. Some of the conclusions they would reach were absolutely nonsensical to someone like me, coming to town off a cow ranch and finding that our future was on the block. It wasn't that these people didn't like us. That's not it at all. It was that they just didn't understand what we did, or how we did it, and in some cases, why. More importantly, they dealt with us in comic-strip characterizations where they saw us in absolutely unreal image capsules. At that point I began to wonder why.

I found it almost impossible to explain to my legislator-colleagues, housewives, doctors, lawyers, teachers, labor organizers, what resource management was all about. I finally came to the conclusion that we weren't doing much of a job placing the order. Or if we did, we tried to communicate it in technical terms that often didn't make sense to them.

And then I really went to hell. I turned into a Bureaucrat and became a Director (in my case in the State Department of Agriculture). In this role I found that the solution to our problems wasn't as simple that, as a legislator, I felt it might be. Let me give you a case history of this one because we couldn't have come to an answer without many of you in this room. In the central part of Washington State lies one of the better areas for grape culture in the United States. We can grow not only table and labrusca grapes, but are taking off on a real stout run at the fine wine grapes, too. These dry wine grapes give us the future in our state of paralleling some of the fine culture of the Napa Valley in California. Our problem was this: We would receive complaints of damage and find on inspection a most unusual damage pattern. It was *not* the one where a neighbor sprays with too high a wind and the drift pattern spreading across the vineyard showed an absolute burn-out at the outside and then faded through the vineyard till finally at the tail end downwind, the damage was minimal. That's not what we were

---

[1]Executive Director, Washington Forest Protection Association, Olympia, WA 98501

finding. We would walk through hundreds of acres of grape vines and find the results of an absolute perfect even spray on *every* plant in the vineyard. We couldn't figure that out. As the administrator of the weed control program in the state of Washington and the regulator of all the chemical applications, it was my responsibility to try to find the answer. We tried to find the answer with weed science alone and there wasn't an easy answer.

We finally pasted together an answer, but it required the effort of a very strange interdisciplinary team. Before we got through we were up to our ears in conversation with meteorologists. We had spent considerable time sitting across the table from aeronautical engineers. We had chemists, not only analytical chemists but also formulating chemists. The final solultion involved not only bureaucrats but farm leaders and the whole thing keyed back to weed science with the crew at the Prosser Experiment Station.

The solution was a weird one. It started meteorologically. Research showed that in central Washington we had the highest rate of air inversion of any place in the United States. What would happen was that in the peripheral area (sometimes 40 to 60 miles away) the shortsighted regulations that we bureaucrats had been proposing, limiting the spraying to absolutely safe wind and temperature conditions, were forcing into the air during the very short available time a regular armada applying 2,4-D. Hundreds of thousands of acres of wheat would be sprayed for weed control because that was the only time available. As result, if that massive spray application took place when an inversion was forming and if the spray was a highly volatile type with a very low application rate per acre, a good share of our chemical was being lifted into the air. The droplets would crystallize in the wing-tip vortex and we filled the air with microscopic crystalline particles of 2,4-D, which would then rise to the inversion layer and sit there. We found that there was an envelope of air containing 2,4-D which wasn't more than 5 or 10 feet thick sitting against the inversion layer. As the inversion layer moved, there was not the dissipation that you would ordinarily expect. It was traveling as a neat, tight little packaged envelope, moving on 40, 50, 60, and in some cases 70 miles. And, get this, it was often moving against the surface wind. Then if the final resting place for the envelope was over a vineyard and if the inversion broke up in a warm front, you would have a perfect spray. We were losing a large percentage of the grape harvest every year because of this obscure phenomenon.

The answer was not a weed scientist's answer per se. It was an interdisciplinary solution which forced us to back up and change our regulations and redesign the spray machinery. We had to rethink the chemicals that we would use and ban the highly volatile forms. It involved a willingness on the part of many disciplines to live in this interface between what we know, what we do, and what is *done* about what we do because the threat was there and very nearly surfaced several times.

People living in some of the cities or large towns around there imagined terrible things were happening to them; being poisoned in their sleep or a wilting in their gardens. Suddenly we started dealing not with a fight between grape growers and wheat growers, but rather, the battle that no manager wins, the battle between urban and rural areas. Out of this I came to a couple of rather simple conclusions.

First, the conclusion that I came to as a practicing politician and now as a bureaucrat and finally as a manager for people who are interested in being able to grow wood fiber. It was written down some time ago by a cleaver Italian whose name has since become a synonym for cleverness, a chap by the name of Machiavelli. Machiavelli said (and thus beginneth the first lesson): "it is important for the *prince* to be honest. It is even more important for the prince to *appear* to be honest." It is not enough that we are good at what we do. It most be *perceived* that we are good at what we do, and that what we are doing is for the good of the general public. Those of us in this room who deal with farmers and ranchers and foresters know that they are basically decent people and it is not the will or wish of any of them to injure the general society or cause damage to themselves. Our practices are a survival battle. It is a matter of maintaining efficiency. It is a matter of being able to control invaders whether they be forbes or whether they be microbes, or whatever they might be. It is a matter of maintaining America's efficiency that gives us the ability to have the rest of our income spendable to provide the good life that everybody says that they want. That is efficiency based on continuing agricultural land management options or, as your President says: "It is back to the farms," for a scramble survival for many of the "now generation" who insist that they can have instant environmental solutions at no cost to anybody or to some imagined corporate farmer and timber baron.

I hesitate to cite any kind of a mandate because I stand before you probably as the least formally educated person in the room. But I have had a chance to get a fair education in the school of hard knocks and it is that that I want to share with you. The fact that we are technically competent is good enough to provide job security, and personal security but it is only openers for the future. Anybody who feels that he will be part of the natural resource team in the future is going to have to accept a broader job description. I deal daily with smart managers, agriculturists, foresters, who have convinced me that they are going to be around tomorrow and tomorrow and tomorrow. To a man or woman they have accepted the fact that to be good at what we do is *not enough*. We are really going to have to understand this interface and be confident, competent functionaries in the interface between the producing society and the comsuming society. The interface unfortunately is often in the field of politics or public relations or some other uncharted area which few of us in this room have a great feel for. If any of us envision being here 10 to 15 years from now as part of "what is happening in agri-business research" then that role must be part of our job description. A *new* job description.

Let's have a quick look at what I think is going to happen with 2,4,5-T. Here is a case of dealing with a simple chemical and a recent EPA ruling to suspend the forestry and pasture use of it. Interestingly enough this emergency ban which strikes sparks with people who are impacted as producers and those who are manufacturers is based (by our analysis) as much upon the politics of it as on the chemistry of it. The preliminary analysis of results discovered in Alsea, Oregon, discloses that by a standard scientific technical review there are still some serious holes in this evidence. Yes, there is cause for concern and cause for taking another look, but the immediate and full across-the-country ban of 2,4,5-T still has some rather heavy political overtones. Do you want to try one on for size? You can't use this chemical in the woods any longer and you cannot use it on your pastures, but if you are growing rice for the dinner table from the politically heavy southern United States, go ahead and use it, pal. That's okay. Why? Well, because you've got the political muscle, haven't you. If you think that this just involves sprays in the woods, just the helicopter ban and that's it, and you can sit on the sidelines and it doesn't affect you in central California or in mid-Oregon or in mid-Idaho or Colorado, I've got news for you. I've seen the shopping lists of chemicals that are tagged for withdrawal deal not only with forest applications but the field application of chemicals as basic and as necessary as 2,4-D. These people are dedicated, sincere and (you had better believe it) capable of accomplishing their goal. You see, they not only do not understand what we do, they don't *like* what they *think* we do. More importantly, they are not babes in the woods about doing something about it. As a result this chemical is banned for certain uses. The Douglas Fir seedling is a vigorous grower, a key to wood fiber production in the Coastal Pacific Northwest for the future. But it is a helpless little cripple if it's surrounded by more rapidly growing seed species, such as alder. When the alder is treated, that Doug fir sapling is released to the sunlight which it must have for survival. Once it has the sunlight, look out. But it's got to get its start. It's got to get the sun. The impact of withdrawal deals also with the wheatfields and encroaching sagebrush. The spectrum runs across the board.

But what do you do about it. Well, the simplest way to describe it is you circle the wagons and put together your friends to figure out what you are going to do about the problem and identify the opposition. In our case the opposition is a very articulate and unfortunately misinformed individual from a cultural community who is convinced that every bad thing that has happened in his home town in the last decade is because of the impact of sprays. His migraine headache, his daughter's malaise - you have a list that runs forever. But don't tinker with this individual. A doctor in one of our communities, rather correctly perceived that the person is often agitated, and he is suing him. Voices like this rising in public meetings start the convinced beliefs that the things we are doing to manage our weed problems are poisoning everyone in their sleep.

We've got to expect that we will be dealing with a press that sees us as ogres. We deal with a visual media that sees us as 30-second sensations to be plugged into news broadcasts sometimes accurate, and unfortunately sometimes grossly inaccurate. There is also a general public that has some serious concerns about what we are doing. But we have got to understand the position that we are in. We must circle the wagons and let's start getting our act together.

In Washington we put together a group that involves the full user-spectrum. These are wheat growers, orchardists, foresters, cattlemen, anybody in the growing business who needs chemicals to be able to continue their operation. Applicators, formulators and regulators are also involved. The list of people involved covers groups like the Grange, the Farm Bureau, the aerial applicators, the forestry associations and the applicator's association.

If we have a legal problem, we hire a lawyer. We decided to go to a pro, a public relations chap who understands the problem and, more importantly, understands how to project an answer. It is not exactly what you would call a shoestring operation and it takes some money which was anted up by the people of the allicance.

We also enlisted experts who are highly articulate and very well informed. In this case, scientists with the USDA who are knowledgable about the dioxin effect on the human animal in the environment. We lean heavily on the institutions to which many of you belong, in our case Washington State University. You can't win the battle without facts so the fact accumulation began at our University. We started dealing with the State Department of Ecology and found out what their standards were so we could be a part of what was happening. We were able to use the report called the "Phenoxy Herbicides" prepared by CAST, an organization to which WSWS belongs. In western Washington we delineated the areas where 2,4,5-T is applied so that if complaints were raised, responses can be originated on a basis of facts, not supposition. We had to become completely familiar with rule and regulations dealing with the forest practices which are rather specific about the application of chemicals. We have become involved with government at the basic level where we deal with the county commissioner. We have the Board of Health in some counties in our state being pressured into taking positions, positions that many of them felt uncomfortable about. They needed background data so we involved them. It was our responsibility, our role and our pleasure in many cases to provide the data base so their decisions might be rational rather than emotional.

We also find a track back to our legislature where decisions are being demanded of legislators and even *by* some legislators who saw this as a new political horse to ride. And so we deal at the state level, too. You've got to expect the opposition to be there. These people are not freaks. They are smart, articulate. They come from a totally different direction, often totally disassociated with productivity. They believe totally that we are going to have an environmental purity and it should have no cost. They mean business and so far they have won more rounds than they have lost. I can show you smart attorneys, dedicated housewives, and intelligent professors who will stand and "amen" this above statement of intent.

We've got to be ready to place our order before hearings, boards, commissions. We've got to be ready to have just ordinary members from our group stand up and present the facts as we know them. We have scheduled press conferences where we can get the media to hear it straight. We met with about 250 weed supervisors from counties, foresters, orchardists, wheat growers; these were people who needed to know how to apply the chemical properly. What are the hazzards, the liabilities? We have to communicate back to our members with newsletters, with special reports, about the effect of herbicide or spell out the issues. There are many publications in periodicals that can be assembled so that you can start meeting emotion and supposition with fact and reality. It's being able to work with the media. The scenario is this--we find that they are hungry for the news; they burn up stuff at a prodigious rate. Given an honest change to take an honest look, amazingly enough, quite often you can expect an honest report.

These visitations take time to schedule. It's not easy to line up a heliocopter and camera crews; but when we did, we obtained half a dozen very effective releases that the general public saw. They pointed out that if there is going to be no weed control, no control of the alder and the salmonberry, then there isn't going to be much of a forest industry in western Washington or western Oregon. It's been proposed by many that the solution is not chemical but going in and slashing by hand. Anybody want to bolunteer for 100,000 acres?

Discussion following Bledsoe's talk:

Question: What effect does tansy ragwork have on game?

Bledsoe: Tansy ragwort is the damndest animal killer I've ever seen. If you get your herd of horses or cattle loaded up on that, you can take them away from it for a year and they will still continue to die. It's a virulent alkaloid poisoner.

I doubt if it has any effect on game for a simple reason. It's damn unpalatable. Your animals have to be in a stress situation before they begin to eat it. The effect we see on cattle, however, is that once they load up on it, it's like loco weed. They get a depraved appetite and start to crave it. You get a condition that resembles cirrhosis of the liver. The liver for all practical purposes is destroyed and that's the reason why your animals will continue to die for a year.

It also forces you out of commercial agriculture. Animals will graze around it if they have a chance. But if you make hay out of this stuff, they'll clean the bottom of the hay rack and eat the tansy. Not only are you going to lose animals but there is also some suspicion about what happens to the milk if you are in commercial milk production. It's a rotten weed.

We have made several approaches to it chemically; we have also tried integrated pest management. The cinnabar moth in the caterpillar form will eat tansy. We flew about 4 or 5 plane loads up from Oregon and settled them in the state of Washington. We had pretty good luck. The problem is that they are so voracious that they eat up their home and then they die, not only the plant but the cinnabar moth because it doesn't fly very far. So we are looking for a cinnabar moth factory.

Question: Do Oregon and Washington still have a tansy ragwort program with Pacific Northwest Regional funds?

Bledsoe: Yes. It is still basically funded by the legislatures of both states. It has been a starting point for the organization of weed districts in counties that heretofore paid little attention to weed control. But they are now faced with a sufficiently acute situation and it has formed a focal point whereby we have been able to organize, at least in our state, very comprehensive and fuctional weed control districts in counties. Some of the results have been significant and in other cases they have been pitiful. It depends largely on the personnel, on the degree of exposure and the number of livestock that are dying.

But, it is a pitiful thing. I've walked through the herds in tansy-trouble. The dying starts over night. They are happy and healthy one day. You go out the next morning and half of them are down and gone. And you can count on the rest of them being gone in 6 to 8 months. It's a brutal killer.

Question: How far will the airbourne particles of 2,4-D move?

Bledsoe: First you have got to set the stage where you have a tremendous volume of 2,4-D going on at a single time. Inclement weather delaying spray schedules back, everybody hot-to-go and then a sunny day, and Boom! It's just like D-Day. Those spray planes take to the air like a small armada. You set the stage by mass applications in the surrounding area.

We have tracked applications as far as 60 miles. Theoretically that shouldn't happen. By the laws of physics, the rules of dilution of that airmass say there shouldn't be any identifiable particles that drift that far. The key to it is, first, the extreme concentration. But the second is the kind of movement where it is being compressed against the inversion layer, held against the ceiling, being packed from below by continually rising air, so as a result the envelope doesn't dissipate. It travels in a package and it arrives as a package.

Then if you set the stage by a breakup of the warm front and rain through the envelope, you dissolve your crystalline particles in rain-water and produce a perfect spray. The concentration is infinitesimal. The grape is the most sensitive plant to 2,4-D that you could find. This explains the inexplicable phenomenon which we saw of plants being stunted or killed, fields being blitzed, when there was no 2,4-D spray application anywhere in the general neighborhood. It was a weird setup.

It is interesting how the Russians approached this thing aeronautically. They have never gone to the Grumman flying tank; the heavy, heavy spray-plane aircraft. They use a parasol wing type that's almost like a gypsy moth and just flutters around. The result is that they don't have this wingtip vortex that you could see magnified when you take a 747 off. That wing-tip vacuum is almost like a flash freeze. It forces a crystallization immediately, so you see that part of the problem is aerodynamics. We are working with NASA in some studies dealing with the aircraft, weight, speed, wing design and placement of the boom. One of the solutions, amazingly enough, is to put the spray boom on the top. When we put the spray boom on the top, we avoid the instant decompression.

We are doing things with the size of the orifices on the nozzle as well as the concentration. Let's face it, if we keep the concentration down on a highly concentrated mixture to start out with, we could fly a lot longer, right? That means less down time, ground time, fill time, cheaper spray-costs, so you knock about a buck and a half an acre off the spray price by being able to use one of these high volatile concentrations, and you create a serious problem. As we started to research this thing, we found something that we should have located a long time ago.

Comment: In coming from Bozeman, Montana, into Yellowstone Park you run into an area that probably consists of thousands of acres of devastated forest. They tell me that this is the blue spruce budworm. Why can't someone put up a big sign along the highway to tell everyone that this devastation is due to the blue spruce budworm?

Bledsoe: That's not a question. It's a statement and it is a *dandy*! Part of our problem is that the U. S. Forest Service is not in the advertising business. You will notice that the first withdrawal of the chemicals was from public managed lands. Why? Because of their hypersensitivity to political pressure. I agree with you. That on-site information is highly effective. On private lands in our state we are using that kind of on-site advertising where signs say that "This is a Douglas fir plantation plantedin 1972." It stands there with trees 20 feet high already and *that's* a good message. We try on private lands with great success not to have large spruce budworm kills. It's a manageable thing, but your point is well taken and we continue to work that problem.

Comment: Well, I think it's to the benefit of everyone here to know that this thing exists. If you want to see devastation, just go look at it.

Bledsoe: It breaks your heart, doesn't it? Everybody in this room, everybody in this country ought to hate waste, whether it is human talent or naturalresources. The amount of wastage is this country if this environmental epic is played to its last card without regard for its consequences is going to be saddening.

Eventually there will be a turn-around. I believe in the pendulum effect. In this country we tend to oscillate from extreme to extreme and we are about at this extreme point in dedication to land withdrawal, to abandoning vast acreage to insect invaders, etc. The pendulum eventually will swing back.

The problem we have in forestry is in working with a long-term crop. Most of you in this group work with annual crops. If you screw up this year, you can set things right nest year. You blow it in the woods, you don't find out about it for 20 years and then you've got 20 years of lost time to scratch back. In a nation that consumes more wood fiber than anyone in the world, this productioning could change a lot of economic equations. Not only economic and job equations, but things we have taken for granted, like having plenty of paper on which to read or for packaging or fiber for home construction. The energy cost of the alternatives, aluminum, steel, other fibers, will result in a difficult battle to fight where we deal with a basically uninformed public somewhat uncaring and we deal in future terms with a society that is accustomed by television to having problems laid out and the solution performed in 27 minutes so there is time for a commercial at the end.

Question: What are the abortion statistics at Alsea?

Bledsoe: I dont't have the numbers in front of me, but let me tell you what they have observed. In a comparison of two other sites in Oregon, one in the area around Eugene and one in eastern Oregon with the area in Alsea they have perceived in the month of June (which is about 60 days following the application of herbicides in the forest area surrounding Alsea) an aberration in the rates of spontaneous abortions. The question arises about the manner in which the statistical comparison was made. They are comparing hospital records. The question that has to be answered is what was the rate of referral to hospital on the control group. They know what the rate of referral was by gynecologists and obstetricians in Alsea. There was almost 100% referral which meant that any spontaneous abortion that occurred in the test area in Alsea appeared in the statistics. Similarity has yet to be shown to be the case in the referrals from the other two Oregon communities. Was there an across-the-board referral?

Our suspicion is that such is not the case because they are dealing with a substantially larger population and not as concentrated as with the particular vocal and verbal group who are arguing that we do have some problems. I'm not going to argue and prejudge the case because then I would be replicating the shortcomings as EPA, where I think they have erred in making judgement based on what I consider to be inadequate review. I'm not going to say they are right based on the same inadequate review. What I am saying is that there should be adequate review *before* a step as all-important and as impacting as a nationwide emergency ban on a chemical is taken.

More particularly the RPAR process (rebuttal presumption against registration) was in full swing. This is full scientific technical review before the EPA. One that the forest industry was backing with enthusiasm, not because we knew what the answer would be, but because we knew that if there were to be an answer it would be on the basis of honest scientific and technological appraisal. If the chemical is harmful and it can be shown to have a serious effect on the human environment then away it goes. I'll buy that. The last thing any of our people want to do is poison folks and hurt people. That is not our aim. The jury, as far as I am concerned, is still out on the final finding of the Alsea results. I'm not privileged to be able to tell you all of the groundwork that is being done, but there is a scientific re-review going forward, if not by the EPA, at least by concerned applicators.

Comment (Jim Burr, Malheur County Extension Agent): I received a phone call about two weeks ago from our Oregon State people who had requests from EPA to provide information for the 2,4,5-T study and at that time I learned that Malheur County was a check county. Alsea is a coastal type area which is under about an 80-inch rainfall. We happen to have about 8 inches in Malheur County. We have extremely hot temperatures. They said our terrain was the same, our population distribution was the same, and our urban versus rural area was the same distribution as Alsea and if any of the people around here know our situation, that is totally erroneous. They wanted to know how many people lived out in the sagebrush compared to those who lived over there in the woods. I told them that out of the whole county we probably had a half dozen, because people don't live out there. We have no forest, there is one tip in Malheur county that comprises around 150 acres--that's all the forest we have in Malheur county, and they are making these type of comparisons. When I sent the report back, I indicated to them that I thought the comparison was absolutely asinine. They wanted that information right away so I did send some data on abortions.

Bledsoe: Well, you will be the baseline against which the comparison will be made with relatively unexposed popylation as opposed to an exposed population. Unfortunately as you point out the disintegration of 2,4,5-T in the environment is an ultra-violet phenomenon. Your sunny days in Malheur dounty are totally different from the impact in the Alsea area. So the baseline is skewed. I say again (and this is a supposition not an accusation) that I have to believe that we are dealing with a largely politically motivated decision. If I wanted to guarantee the results I think I would probably establish a baseline about like the one you put up, right? What does that mean? What does that prove? Not much. And that's that.

Comment (Dow spokesman): It's an interesting situation that the first report that the EPA put together is a well documented report on this Alsea situation. It completely exonerated 2,4,5-T or forestry spraying from any effect on human health of any kind in the Alsea region. This was a deliberate, very expensive EPA investigation, with a large collaboration with local officials at various levels. Secondly, neither we (Dow) nor any of the people who are attempting to get this decision reversed have been able to get the basic data which EPA used for their documents.

Bledsoe: You have to be saddened when the process is skewed to produce the result that in some cases flies in the face of existing scientific evidence. In these strange days in which we live this is why the challenge is squarely on us. We are going to be dealing with these kinds of decision-making processes. We must be prepared to deal at that level with straight-on facts. If we had factual data about the impact of our chemicals on humans and animals as we do on the effects on plants, we'd have an arsenal of data that would be incontrovertible. But we don't. We have dealt with them as scientists and technologists and as a result we know all about what happens inside the plant when 2,4-D is applied; we know what happens when 2,4,5-T is applied; but we don't know an awful lot about what happens with the chemical in the rest of its life in the environment. Therein we find ourselves lacking and almost powerless to argue against predetermined research investigations.

WEED COMPETITION - DO WE KNOW ENOUGH?

R. L. Zimdahl[1]

Titles which pose direct questions obviously suggest direct and simple answers. If my answer is "no, we do not know enough," at least one course of action is obvious. We should continue to do the kind of competition research we have done in the past with perhaps some change in quantity or specific objectives. If my answer is "yes", the most obvious alternative is to stop doing competition research and move on to other things. It should be apparent to those of you have studied weed competition, examined the title of this paper, or considered the speaker that simple answers are not appropriate.

It is a burden of the scientific method that research always raises more questions than it answers. Science reveals our ignorance as it develops our knowledge. Studies of weed-crop competition are no exception and my answer to the question posed in the title must be an equivocal one. I think we do know enough about "what" happens when weeds compete with crops. Therefore, my answer is "yes". We do *not* know enough about "why" what we observe occurs, nor have we developed sufficient knowledge of weed-crop interactions to use it in our control methodology.

The process of arriving at this conclusion has been a long and arduous one. As a result of some internationalexperience and my own interest in the subject I decided that a review of the literature of weed competition would be useful. One reason was the general unavailability of the world weed literature to scientists in developing countries. It is the literature which enables development of an historical perspective which, when combined with the stimulation of current research, is important to development of research programs and their justification to administrators and funding agencies. Lack of access to the literature can severely impede development and necessary justification of weed research programs.

A second and equally compelling reason for undertaking the review was that no review had been prepared even though a wealth of data are available. Certain assumptions have been made about weed competition based upon what everyone *knew* about the subject and I was interested in examining these. In addition, weed competition data had not been translated into economic

---

[1]Professor, Weed Res. Lab, Dept. Botany and Plant Pathology, Colorado State University, Fort Collins, CO 80523.

terms to provide necessary justification for weed control. The cost of preparing and publishing the review has been underwritten by the International Plant Protection Center at Oregon State University.

Competition between and men and between plants is older than recorded history and was recognized long before a defined term was assigned to it. It is the predictable response of grouping organisms into communities. One of the most famous works on competition is the 1798 essay on the principle of population by the Rev. T. R. Malthus. Malthus discussed "the constant tendency in all animated life to increase beyond the nourishment prepared for it." Charles Darwin was among the first to derive a concept of competition in nature as a whole and considered it almost ubiquitous and omnipresent. In reviewing Darwin's exposition of competition in the Origin of Species, it is easy to overlook the fact that he regarded it as only one component of the struggle for existence, albeit possibly the most important one.

The Oxford English Dictionary defines competition as "the action of endeavoring to gain what another endeavors to gain at the same time; the striving of two or more for the same object--rivalry." There are many conflicting definitions of competition in biological literature. Harper (14) decided that many definitions proved excessively cumbersome and in his work adopted the inclusive term "interference" which had been suggested earlier by Muller (26). The term includes competition and allelopathy. This paper, and the review on which it is based, deals with weed-crop competition and specifically excludes allelopathy. Competition involves the removal or reduction of an essential factor from the environment and was precisely defined for the plant kingdom by Clements et al. (12). They suggested that "competition is keenest when individuals are most similar and make the same demands on the habitat and adjust themselves less readily to their mutual interactions." They also suggested "the closeness of competition between plants of different species varies directly with their likeness in vegetation or habitat form." Clements et al. regarded competition as a purely physical process arising from the reaction of one plant upon the physical factors about it and the effect of the modified factors upon competitors. In the exact sense, two plants, no matter how close, do not compete with each other so long as water, nutrients and light are in excess of the needs of both. When the immediate supply of a single necessary factor falls below the combined demand, competition begins.

Monocultures are rare in natural environments which favor communal life for plants. Nature does not recognize human categories like domesticated plant, weed, or the inalienable rights of man. In natural environments, living organisms are engaged in relentless competition with peers and other organisms with whom they share the environment. It is impossible to plant a crop without the certainty that weeds will compete with it. One of the better explanations of the competitive factors encountered by weeds and crops was schedmatically outlined by Bleasdale (8). He proposed that competition encountered by an individual plant was dependent upon the density, distribution, duration and species of its competitors. Climatic and edaphic conditions serve as modifiers. This generalized scheme is applicable to most crop-weed situations. The problem is that we do not know enough about specific elements of the scheme to quantitatively or even qualitatively describe them in many cases.

Descriptive Studies

Even a cursory review of a portion of the literature on weed competition leads one to the unavoidable conclusion that increasing weed density results in greater yield reduction. However, the relationship of weed density and crop yield is not linear. A few weeds usually do not affect yield and the maximum effect of total crop loss obviously cannot be exceeded and usually occurs at less than maximum weed density. The extant data support the hypothesis that weed competition can be represented by a schematic sigmoidal relationship (Figure 1). A curvilinear or linear relationship has been suggested in some reports. However, most data indicate that the relationship between weed density and crop yield is not linear, when the range from no weeds to a naturally achieved high density is observed. This point is amply illustrated by data showing the lack of linearity for the effect of varying weed densities on crop yield (Table 1).

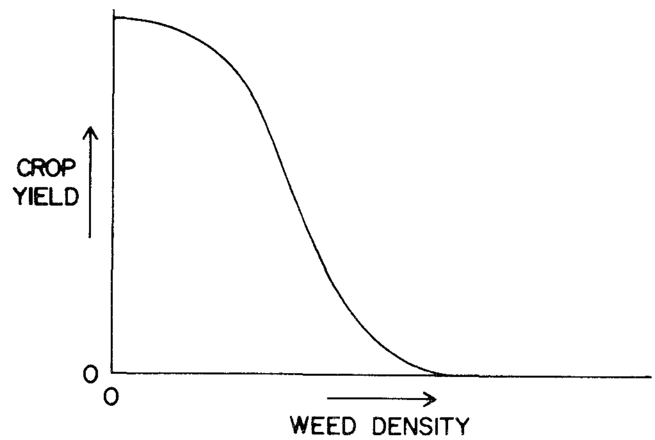


Figure 1. A schematic sigmoidal relationship depicting the effect of increasing weed density on crop yield.

The manuscript from which this paper is drawn includes detailed reviews of the effects of weed competition in many different crops. All of these emphasize the point that specific weed density is an important determinant of yield and increasing density usually increases yield loss. The data from Weatherspoon and Schweizer (36, 37) are a good illustration of the effect of increasing weed density on yield. Yield of sugarbeets was reduced when kochia (*Kochia scoparia*) competed more than 5 or 6 weeks and competition for the entire season reduced yield more than 95%. They also reported the effect of the crop on the weed and found weed weight was 59% greater when sugarbeets did not compete for the first three weeks. Sugarbeets reduced kochia weight by 92% when the weed was controlled the first four weeks after emergence. Kochia densities of the plant per 1, 2, 5, 10 or 25 feet or row reduced sugarbeet yield significantly in every case (Table 2). One weed per 25 feet of row reduced average root yield by 2.6 T/A and sugar by 960 lb/A. Similar data have been developed for several other crops to show that increasing weed density reduced yield but in a non-linear fashion.

The grower, and others, often erroneously assume that removal of weed competition at any time during the growing season will solve the problem. Evidence indicates that the time of removal is as important as the deed.

Table 1. The effect of increasing weed density of crop yield--selected studies.

Crop	Weed	Weed density	Percent yield reduction from control	Reference
Sugarbeet	*Kochia scoparia*	1/ft of row	79	37
		0.5	67	
		0.2	44	
		0.1	26	
		0.04	14	
Soybeans	*Brassica kaber*	1/ft of row	30	6
		2	36	
		4	42	
		8	50	
		16	51	
Wheat	*Avena fatua*	$70/yd^2$	22.1	7
		160	39.1	
Wheat	*Setaria viridis*	$721/m^2$	20	2
		1575	35	
Cotton	*Sida spinosa*	2/ft of row	27	18
		4	40	
		12	41	
Rice	*Echinochloa crus-galli*	$1/ft^2$	57	34
		5	80	
		25	95	
Soybean	*Xanthium pensylvanicum*	1335/A	10	4
		2671	28	
		5261	43	
		10522	52	
Corn	*Setaria faberii*	1/2 /ft of row	4	20
		1	7	
		3	9	
		6	12	
		12	16	
		54	24	

A justifiable assumption is that the earlier weeds are removed, the better. This may be true for economic or pragmatic reasons such as convenience, combination with other operations or preparation for irrigation. It may not be true if crop growth and ultimate yield are the operative criteria. It is true that the longer weeds compete after crop emergence the greater the potential effect may be. An effect does not occur (exclusive of the phenomenon of allelopathy) until competition begins and it will not begin as long as environmental resources are in excess of the needs of all plants in an area (12). Therefore, although the time of removal is as important as the deed, one cannot assume that weed presence automatically is damaging and mandates immediate control at any time.

Table 2. Effect of *Kochia scoparia* on sugarbeet root yield (37).

Distance (ft) between weed in row	Sugarbeet root yield (T/A)	
	1967	1968
1	5.0 f	5.0 f
2	8.9 e	8.1 e
5	13.7 d	13.7 d
10	17.1 c	18.0 c
25	19.8 b	20.9 b
no kochia	21.6 a	24.3 a

Means followed by the same letter within each column were not significantly different (1%) by Duncan's multiple range test.

The literature provides many references on the duration of weed competition specific crops can withstand. To illustrate, information on the length of weed competition tolerated without yield loss and the weed free period required to prevent yield reductions is presented for peanuts and corn in tables 3, 4, 5 and 6. The required periods are consistent when several reports are available for a crop. Inconsistencies in the length of weed competition tolerated or weed free period required can usually be explained by noting differences in identity or size of competing weeds or the geographic region in which the work was done. The data show that

Table 3. Length of early weed competition tolerated without yield loss in peanuts.

Competition tolerated after				
Seeding	Emergence	Competing weeds	Location	Reference
(weeks)				
6		*Amaranthus hybridus*	Oklahoma	17
		Digitaria sanguinalis		
	4 - 6	*Cassia obtusifolia*	Alabama	16
		Desmodium tortuosum		
	4	*Cassia obtusifolia*	Alabama	10
		Desmodium tortuosum		

peanuts can withstand 4 to 6 weeks of weed competition without yield reduction and that weeds which begin growth 8 to 10 weeks after peanuts emerge do not reduce yield (Tables 3 and 4). The data for corn are more

Table 4. Weed free period required by peanuts.

Weed free period required after emergence	Competing weeds	Location	Reference
(weeks)			
10	*Cassia obtusifolia* *Desmodium tortuosum*	Alabama	16
8	*Cassia obtusifolia*	Alabama	10

complex. Corn can tolerate 2 to 6 weeks of weed competition without yield reduction and weeds which begin to grow 3 to 5 weeks after corn seeding do not affect yield (Tables 5 and 6). One study showed that itchgrass (*Rottboellia exaltata*) could be tolerated for 8 weeks after corn emergence (35) (Table 5). In seeming contradiction nine weed-free weeks were required to prevent yield reduction from mixed annuals in Mexico (27, 28) (Table 6).

Table 5. Length of early weed competition tolerated without yield loss in corn.

Competition (weeks) tolerated after				
Seeding	Emergence	Competing weeds	Location	Reference
3		Mixed annuals	Veracruz, Mexico	27, 28
	4	Mixed annuals	Mexico City	1
4		Mixed annuals	Chapingo, Mexico	29
2 to 4		*Atriplex patula* *Veronica persica*	England	11
4		*Setaria viridis*	Ontario, Canada	33
6		*Setaria faberii*	Illinois	23
	6	*Amaranthus retroflexus*	Oregon	39
	2 to 3	Mixed annuals	New Jersey	24
	8	*Rottboellia exaltata*	Rhodesia	35

Table 6. Weed free period required to prevent yield reduction in corn.

Weed free period (weeks) required after				
Seeding	Emergence	Competing weeds	Location	Reference
	9	Mixed annuals	Mexico City	27, 28
5		Mixed annuals	Veracruz, Mexico	
3		*Setaria faberii*	Illinois	21

The preceeding data can be used to predict the "critical period" for weed control which is generally defined as the minimum period of time during which weeds can be present without affecting crop yield, or the period after which, growth of weeds will not affect crop yield (29). The term is also used to describe the early weeks of crop growth during which weeds must be controlled to prevent yield reduction. Because not all studies were designed to define a critical period, it is not possible to decide if such a period exists for all crops. If one assumes that a difference between the length of weed free period required and the length of weed competition tolerated indicates a critical period, some crops with critical periods can be identified (Table 7). An interesting working hypothesis was proposed by Kasasian and Seeyave (19) who suggested the required critical period is 1/4 to 1/3 of the crop's growing period. The data generally support this hypothesis but only with the caveat that while it is a useful generalization, specific weed-crop interactions must be considered.

Table 7. Crops with an apparent critical period for weed competition.

Crop	Weed free period required (weeks)	Length of competition tolerated (weeks)	Reference
Bean	5	8	13
Corn	3	6	22, 23
Cotton	6	8	9
Peanuts	4	8	16
	3	6	17
Potato	6	9	32
Rice, paddy	3	6	25
Soybean	3	8 to 9	22, 23

Methodology

When a scientific paper is published a few readers may peruse the abstract and conclusion. Some readers carefully read papers and dwell on the relationship between the experimental methods, results and conclusions drawn. Conclusions are, of course, a proper focus but the methods often are prime determinants of the validity of conclusions. Competition studies are no exception to this generalization and understanding results requires detailed examination of methodology.

The most common methods used in competition studies are: (1) allowing weeds to grow from crop emergence for varying lengths of time to determine when competition begins and (2) keeping the crop weed free for varying periods after emergence and then permitting weed growth to determine the length of a required free period. Determination of the onset of competition in method 1 unavoidably disturbs soil and crop plants when weeds are removed whereas the second method involves less soil disturbance but some plant disturbance. Crops may also compensate for early weed removal by more rapid growth. Peters (30) proposed a method in which only weeds emerging within predetermined time periods would be allowed to grow. This method determines which fraction of a competing population is most competitive and would be best for weeds with long emergence periods. Peters' main point was that the methodology employed in competition studies unavoidably includes artifacts which should be considered. He indicated some of the problems of precise quatitative interpretation of results based on imperfect methodology. In spite of the disadvantages of these techniques, they have been and will continue to be used for competition studies. The techniques do work and as long as the disadvantages are known and artifacts recognized the studies are valuable.

The Weed Scientist is concerned with the description of weed effects which determine crop yield and an analysis of causes which relate these effects to environmental changes. The literature supports the proposition that the vast majority of weed-crop competition studies have been descriptive and not very analytical. That is, we have been diligent in describing what the result of weed competition has been in terms of yield but have not been equally attentive to analyzing why observed effects occur with reference to specific weed-crop interactions or environmental changes. The aim of most studies has been to determine how much yield is reduced by weeds. I strongly suggest that we need to give more attention to the methods employed in competition studies so that valid comparisons of studies between areas and years can be made. Greater emphasis should be given to studies which include controlled densities of specific weeds. We need much more complete environmental data associated with every competition study. These data will permit comparison over locations and time and may explain some differences. Our methods should become more quantitative and utilized for their predictive and continuing value rather than for the more immediate and more easily obtained information that X weeds per unit area reduce yield a certain amount.

Conclusion

Even a cursory review of the literature of weed competition confirms one's opinion that there is a great deal of evidence that weeds reduce crop yields and have other detrimental effects on agricultural production. To justify continued research on weed competition, the researcher often must answer two questions. What is the extent of the problem? What is the importance of the problem? It is not appropriate to assess the extent of a weed problem from a review of weed competition. The diversity of citations on one crop or one weed species generally support the accepted proposition that weed problems are extensive. A review does answer the second question for specific weed densities and periods of competition but the answer is location and year specific. The grower recognizes the importance of knowing if a given weed density will reduce yield, but he is more interested in information that will tell him if he should implement control measures. The ability to forecast yield losses due to specific levels of weed competition is important because it helps to answer this question. If weed control is necessary, the grower must also decide how intensive a control program is required and how much money can be spent. It is important to remember when discussing economic questions in agriculture, that maximum yield is not always a shared or even a good goal. Marginal farmers and those in developing countries are more interested in minimizing risk than in maximizing yield. Farmers in the United States and other areas with developed agriculture are more interested in maximum profit than in maximum yield. To answer the "should I" question, it is necessary to understand the farmer's economic position as well as the components of biological yield and the economic effects of weed-crop competition.

A few papers have attempted to answer the question, "Should I control?" Wiese (38) found that one tansy mustard (*Descurainia pinnata*) plant/sq ft reduced winter wheat yield 10% in one year, 6% in a second year and had no effect in a third, very dry, year when the average yield was only 9 bu/A. He also found tansy mustard did not reduce yield if controlled with 2,4-D applied after tillering but before vigorous growth began in the spring. His study was reported in 1965 and the cost of control and crop value have changed but the methodology is still useful. The effect of several weed densities on wheat yield enabled him to estimate a percent yield loss. When these data were combined with potential wheat yield, cost of 2,4-D and its application and the value of wheat the potential profit or loss from control of tansy mustart could be calculated (Table 8). With this information the grower could confidently determine if control was profitable. With low wheat yields, only high weed densities justified control whereas if a high yield was expected it was profitable to control lower weed densities. Only at a projected yield of 60 bu/A was it profitable to control the lowest density when yield and cost of control were the criteria.

Bell and Naleweja (5) calculated the dollar loss per acre caused by various wild oat densities in average yields of barley, wheat and flax. Their data can be converted to show the probable yield loss (Table 9). By using current costs of control and crop values, growers can calculate their profit potential and answer the "Should I" question considering only costs and yield.

These analyses are useful but too few in number and limited in scope, because we do not have the data to go beyond consideration of cost of control and crop value. We also need to consider the less quantifiable factors such as ease of harvest, storage costs, dockage, crop quality and marketability, weed population in succeeding years and effects on disease and insect problems. Present answers to these questions are even more general and qualitative than current weed competition data.

The overwhelming weight of evidence in the literature undeniably affirms that weed competition reduces crop yield and that weeds at some densities will reduce yield over a predictable range when they are present for the entire growing season. To anyone who has considered weed-crop interactions, this is akin to proclaiming that the sky is blue and grass is green.

Table 8. Potential profit or loss from control of *Descurainia pinnata* in winter wheat (38).

Weeds density/ft^2	Estimated yield reduction (%)	Potential wheat yield (bu/A)		
		10	20	40
		----Profit or loss ($)[a]----		
1/4	2.5	-1.18	-0.87	-0.25
1/2	5.0	-0.87	-0.25	1.00
1	10.0	-0.25	1.00	3.50
2	20.0	1.00	3.50	8.50
4	40.0	3.50	8.50	18.50

[a] Profit or loss = value of yield if weeds controlled - spray cost. Wheat = $1.25/bu.; 2,4-D + application = $1.50/A.

Table 9. Yield loss caused by various densities of *Avena fatua* in barley, wheat and flax (5).

Avena fatua seedlings/yd^2	Yield reduction in bu/A		
	barley	wheat	flax
10	1.6	1.5	2.0
40	2.7	3.5	5.0
70	4.9	5.2	6.3
100	6.0	5.4	6.9
130	6.2	7.3	7.4
160	7.1	8.7	7.5

One of the original goals of the review on which this paper is based was to establish a firmer economic base for appraising the effects of weed competition. The operative premise was that if the range of effects on yield of a specific weed, or weeds in general, could be determined for a crop, a more precise estimate of weed losses could be obtained. Such information would be valuable in planning future research and justifying continuing weed research efforts. This goal has not been achieved for two reasons. The first reason is the great diversity of experimental designs employed in weed competition studies and the variability of results.

Yield reductions in competition experiments often vary due to uncontrolled weed populations, and experiments are often not conducted over a long enough period of time under a wide range of environmental conditions.

The second reason was the conclusion that results of competition studies are location specific. Appleby (3) has already cited this and mentioned the site specific factors of irrigation, weather, fertility and time of weed germination. His list could be expanded to include: soil type, pH, other competing weeds, crop cultivar, tillage and timeliness of cultural operations for an area. Although the extant data do not permit specific economic conclusions, there is no reason to deny the general conclusion that weeds are detrimental.

In fact, the general effect of weeds on crops has been so well described that the emphasis on such descriptive studies should be reduced. In addition, the aforementioned fact that such studies usually are site specific lessens their universality. We have been very diligent in describing "what" the result of weed competition has been but have not been equally attentive to analyzing "why" observed effects occur for specific weed-crop interactions or environmental conditions. The great emphasis on describing "what" the result of competition is has also led to the erroneous impression that is nearly as axiom among weed scientists. This is that early competition is the worst and therefore early weed control is mandatory. This generalization is not true. Almost all crops will withstand weed competition for a period of weeks before weeding is needed. Those who have considered the problem know what competition is for but often fail to realize that it does not occur when the supply of the fundamentals of growth is in excess of the needs of the species present. Early competition is important but only when one or more environmental factors has become limiting early in the season. Yet, even if one environmental factor is in short supply competition won't occur unless plants interact. That is, if all plants in a community are short of a given factor and the environment of each is independent of its neighbors, there will be no competition.

It is concluded that we do not need many more data to show that X weeds/Y area reduce yield of a crop by Z. Having said this, two immediate retractions are in order. The first is that as new weed species become dominant, a determination of their specific effects will be appropriate. Secondly, it seems that weed scientists should develop and utilize competition data appropriate to their regions to justify their endeavors in economic terms. Weed scientists have traditionally operated as though everyone knew weeds were a problem and have therefore, failed to use available data or to generate data required to vigorously stress just how important weeds are in monetary terms, which everyone understands. Weeds will always be with us. They lack the glamour and publicity of sudden and severe outbreaks of disease (e.g. - Southern corn leaf blight in 1970) or insects (e.g. - grasshoppers in 1978). Weed scientists know this, others do not, and competition data, expressed in economic terms, are indispensible to the educational process.

Beyond the important but crude economic reason for producing and using competition data there is an important reason for saying we do not need more "routine" competition studies. This is that our attention can now appropriately and more profitably (in the non-monetary sense) be devoted to studies in two, more fundamental areas:

1. Weed biology - descriptive studies of weeds.
2. Weed ecology - studies of the interactions of weeds in their environment.

Harper(15) has said "The essential qualities which determine the ecology of a species may only be detected by studying the reaction of its individuals to their neighbors and the behaviour of individuals of the species in isolation may be largely irrelevant to understanding their behaviour in the community."

Harper specifically intended "to focus attention on the reaction of a plant to its neighbors as a critical, often the most critical, part of the autecology of a species and to suggest that this type of study has a cementing and unifying function in the science of plant ecology."

The approach of those who work on biological weed control suggests populations generally expand in new edaphic or climatic environments because of escape from a predator or pathogen. Therefore, regulation of population size may be from agents acting from above in the food chain rather than through limits of resources from below (31). The recent and increasing interest in shifts in weed populations and development of herbicide resistance in formerly susceptible species is evident of the credence of this point of view.

The point is that plant populations are regulated. We have a reasonably good understanding of how "we" do the regulation, whether it be by chemical, mechanical or biological means. We do not have a good understanding of the behavior of organisms in their home. Weeds are much more at home than crops in the world and because of the fine record of weed scientists, weeds have achieved some credibility in the halls of academia. Thus, it is a propitious time to focus our attention of the more difficult but potentially much more beneficial question of how and why weed-crop competition occurs and how and why the respective populations are regulated.

Literature Cited

1. Alemán, F. and J. H. Nieto. 1968. The critical periods of competition between weeds and corn in the high valleys of Toluca, Mexico. Weed Sci. Soc. Amer. Abstr. p. 150.

2. Alex, J. F. 1967. Competition between *Setaria viridis* (green foxtail) and wheat at two fertilizer levels. Res. Reprt., Canadian Nat. Weed Comm., West. Sect. p. 286.

3. Appleby, A. P. 1977. Role of weeds and their effect on yield and quality. Calif. Weed Conf. pp. 10-24.

4. Barrentine, W. L. 1974. Common cocklebur competition in soybeans. Weed Sci. 22:600-603.

5. Bell, A. R. and J. D. Nalewaja. 1967. Wild oats cost more to keep than to control. No. Dakota Farm Res. 25:7-9.

6. Berglund, D. R. and J. D. Nalewaja. 1969. Wild mustard competition in soybeans. Proc. North Cent. Weed Cont. Conf. p. 83.

7. Black, J. N. 1958. Competition between plants of different initial seed sizes in swards of subterranean clover (*Trifolium subterraneum* L.) with particular reference to leaf area and the light microclimate. Aust. J. Agric. Res. 9:299-318.

8. Bleasdale, J. K. A. 1960. Studies on plant competition, pp. 133-142. *In*: The Biology of Weeds, ed. J. L. Harper. Blackwell Sci. Publ., Oxford, Eng. 256 pp.

9. Buchanan, G. A. and E. R. Burns. 1970. Influence of weed competition on cotton. Weed. Sci. 18:149-154.

10. Buchanan, G. A., E. W. Hauser, W. J. Ethredge and S. R. Cecil. 1976. Competition of Florida beggarweed and sicklepod with peanuts. II. Effects of cultivation, weeds, and SADH. Weed Sci. 24:29-39.

11. Bunting, E. S. and J. W. Ludwig. 1964. Plant competition and weed control in maize. Proc. 7th Brit. Weed Cont. Conf. 1:385-388.

12. Clements, F. E., J. E. Weaver and H. C. Hanson. 1929. Plant competition - an analysis of community function. Carnegie Inst., Wash. D.C. 340 pp.

13. Dawson, J. H. 1964. Competition between irrigated field beans and annual weeds. Weeds 12:206-208.

14. Harper, J. L. 1960. Factors controlling plant numbers, pp. 119-132. *In*: The Biology of Weeds. J. L. Harper, ed. Blackwell Sci. Publ., Oxford, Eng. 256 pp.

15. Harper, J. L. 1964. The individual in the population. Brit. Ecol. Soc. Jubilee Symposium. A. Macfayden and P. J. Newbould (eds.), pp. 149-158.

16. Hauser, E. W., G. A. Buchanan and W. J. Ethredge. 1975. Competition of Florida beggarweed and sicklepod with peanuts: I. Effects of periods of weed-free maintenance on weed competition. Weed Sci. 23: 368-372.

17. Hill, L. V. and P. W. Santelmann. 1969. Competitive effects of annual weeds on Spanish peanuts. Weed Sci. 17:1-2.

18. Ivy, H. W. and R. S. Bollen. 1972. Prickly sida control and competition in cotton. Weed Sci. 20:137-139.

19. Kasasian, L. and J. Seeyave. 1969. Critical periods for weed competition. PANS 15:208-212.

20. Knake, E. L. and F. W. Slife. 1962. Competition of *Setaria faberii* with corn and soybeans. Weeds 10:26-29.

21. Knake, E. L. and F. W. Slife. 1965. Giant foxtail seeded at various times in corn and soybeans. Weeds 13:331-334.

22. Knake, E. L. and F. W. Slife. 1968. Effect of time of giant foxtail removal from corn and soybeans. Proc. North Cent. Weed Cont. Conf.

23. Knake, E. F. and F. W. Slife. 1969. Effect of time of giant foxtail removal from corn and soybeans. Weed Sci. 17:281-283.

24. Li, Ming-Yu. 1960. An evaluation of the critical period and the effects of weed competition on oats and corn. Ph.D. Thesis, Rutgers Univ., New Brunswick, N.J.

25. Lubigan, R. T. and M. R. Vega. 1971. The effect of yield on the competition of rice with *Echinochloa crusgalli* (L.) Beauv. and *Monochoria vaginalis* (Burm. F.) Presl. The Philippine Agriculturist pp 210-215.

26. Muller, C. H. 1969. Allelopathy as a factor in ecological process. Vegetatio, Haag 18:348-357.

27. Nieto, J. 1960. Elimine las hierbas a tiempo. Agric. Tecnica Mexico 9:16-19.

28. Nieto, J. 1970. The struggle against weeds in maize and sorghum. *In* FAO Internat. Conf. Weed Cont. Davis, Calif., p. 79-86.

29. Nieto, J., M. A. Brando and J. T. Gonzalez. 1968. Critical periods of the crop growth cycle for competition from weeds. PANS 14:159-166.

30. Peters, N. C. B. 1972. Methods for evaluating weed competition using systems of hand-weeding or hoeing. Proc. 11th Brit. Weed Cont. Conf. 1:116-118.

31. Sager, G. R. and A. M. Mortimer. 1976. An approach to the study of the population dynamics of plants with special reference to weeds. Appl Biol. 1:1-47.

32. Saghir, A. R. and G. Markoullis. 1974. Effects of weed competition and herbicides on hield and quality of potatoes. Proc. 12th Brit. Weed Cont. Conf., pp. 533-539.

33. Sibuga, K. P. and J. D. Bandeen. 1978. An evaluation of green foxtail [*Setaria viridis* (L.) Beauv.] and common lambsquarters (*Chenopodium album* L.) competition in corn. Weed Sci. Soc. Amer. Abstr. 142.

34. Smith, R. J., Jr. 1968. Weed competition in rice. Weed Sci. 16:252-254.

35. Thomas, P. E. L. and J. C. S. Allison. 1975. Competition between maize and *Rottboellia exaltata*. J. Agric. Sci. 84:305-312.

36. Weatherspoon, D. M. and E. E. Schweizer. 1969. Competition between kochia and sugarbeets. Weed Sci. 17:464-467.

37. Weatherspoon, D. M. and E. E. Schweizer. 1971. Competition between sugarbeets and five densities of kochia. Weed Sci. 19:125-128.

38. Wiese, A. F. 1965. Effect of tansy mustard and 2,4-D on winter wheat. Texas Agric. Expt. Sta. Bull. MP-782.

39. Williams, C. F. 1971. Interaction of crop plant population with weed competition in corn (*Zea mays*), bush and snap beans (*Phaseolus vulgaris*) and onion (*Allium cepa*) at different stages of development. Diss. Abstr. 32(4). 1944-B, 1945-B.

Discussion Following Zimdahl's Talk

Norris (Univ. Calif., Davis): Research in New York or somewhere else doesn't carry very much weight with our legislators in terms of convincing them that we need to do weed control or that there is a certain dollar loss. Only research actually done under our conditions is convincing and that is not a very good reason for doing research. On the other hand, perhaps it is the most important reason.

Zimdahl: I think it's a very good reason because if you don't provide the necessary justification you won't have the money to do anything. As I was preparing this paper and thinking about that very comment, the meeting program arrived. I have a paper in it entitled "Canada Thistle in Two

Colorado Counties." It is a report of the extent and importance of the Canada thistle problem in Colorado. I thought in view of my comments in this paper, the second one appeared contradictory. However, you can always rationalize your own behavior. I say that we were forced to do the Canada thistle study because our experiment station director said: "Why are you doing weed research?" He didn't know why it was important and certainly the legislature doesn't know it's important. I maintain that we have a lot of the data in the literature which provided justification for weed control in certain crops. It may not justify your work on alfalfa around Davis, but we can do a better job of justification than we have done in the past.

Norris: What I think I'm getting at is that we are having specific questions concerning our local convictions, and I'm just not sure how much weight it carries to cite data from other parts of the country or other parts of the world. I agree in terms of principles of weed science but we are not really gaining very much. In terms of convincing our local people that there is a problem we probably are gaining a lot.

I've got another question and a comment. Have you come across much information in the literature on the significance of different biotypes of weeds in terms of competition? We have been doing straight density-type work on barnyardgrass competition in sorghum and we happened to change seed sources last year from what I call a dryland biotype. We ended up getting seed from a rice biotype and the density level where we began to see competition changed about ten-fold. It is still barnyardgrass, but apparently it is competing very differently and I just wondered how much this is entered into the literature?

Zimdahl: There are a few reports. Hopefully yours will swell the number.

Callihan (Univ. Idaho, Aberdeen): Regarding the site specificity of research, I think that both kinds of research are necessary, but the problem is that we tend to regard site specific research as fundamental basic research, that is research which has the broadest possible application when in reality it is applied and has narrow application. As long as we understand the difference between the two and do not pretend that narrowly applied research is of broad application we'll be all right. Both are necessary, but you need to distinguish between them.

Zimdahl: I would agree that both are necessary. I'd also go back to the comment that I made that in any competition study we need more complete data than we have been presenting in the past. We need much more environmental data associated with your site specific study so I can compare what you do on potatoes in Idaho with what I do on potatoes in Colorado. A lot of the studies don't allow that comparison, because the environmental data just aren't there.

Fertig (USDA/SEA, Washington D.C.): I think the topic of competition and weed losses, or to put it more broadly, pest losses, is particularly significant and needs more emphasis than it has received. It is particularly timely from the standpoint of the rebuttable presumption atainst registration (RPAR) process of EPA. In defending the use of herbicides or pesticides for agriculture our assessment teams are having extreme difficulty coming up with the biological and economic information to support the benefit side of the benefit-risk equation which EPA is emphasizing so strongly. I think your calling this to the attention of the scientists in this region is most important at this time.

Zimdahl: The reason we did our Canada thistle study is because when I was on sabbatical leave I got a letter from the director of the experiment station and he said "Justify your research." I thought there was an agreement that a weed problem existed. Apparently the rules of the game have changed now and there isn't agreement that there is a weed problem in Colorado unless I define that problem in monetary terms. In addition to the RPAR process you've got the problem of ever increasing competition for ever reducing dollars.

Gibson (Utah State Univ.): My responsibility is to gather use and benefit data for RPAR in Utah. When we compared the agriculture of Utah and California we saw that Utah really has a need to demonstrate a continued need for pesticide applications on a particular crop. My responsibility is to act like some kind of government lawyer and put together this kind of data. May I stress what Stan Fertig just said, I really have a hard time sometimes presenting a case. The rules have changed and we should realize that we are crucial in deciding if a chemical is going to remain in use in a particular state on a particular crop. First case - industry as perceived by Mr. Bledsoe's other side is in a position where the data that they present is automatically viewed as being suspect. Secondly, scientists are also viewed in that way. I think that scientists themselves are the ones who are going to be responsible for putting this information together. We really need to know what the economic impact of a particular weed on a particular crop is and we need similar data for other pests.

Warren (Dow Chemical Co.): I want to deal with two points very briefly. One from the standpoint of developing data. You mentioned collecting more information on the environmental relationships and this is an extremely important factor. We depend on many people in research to develop a lot of detailed information on compounds prior to registration. We have to supply this infromation to EPA and we think we have established a considerable amount of credibility with them. The lack of information which comes in with reports is appalling. I'm not criticizing, except that I want to emphasize the point that not only from the standpoint of collecting data for establishing the relationship between a crop and pest with respect to competition, but to establish this for the overall relationship and you need facts. Even soil pH is hardly ever reported. The other point is that a form is being developed for more uniform reporting, and I would exhort all researchers to give that a great deal of attention and give as much environmental information as possible.

Muzik (Washington State Univ.): Something has bothered me about competition studies for a long time and maybe you can clear this up. You talk about a plant per square foot, and to me that is not terribly meaningful because that plant could be six inches away from the nearest crop plant or it could be right on top of it. If it's right on top of it, you are going to get competition very soon. If it's six inches away, it may take two or three weeks. Is this an important factor in looking at some of these papers or not?

Zimdahl: In the review and the data presented today I have reported data as cited in the paper. I committed the cardinal sin of not going metric and I stuck with the dimensions that everybody had reported and they varied from weeds per square yard to weeds per hectare and weeds per foot of row. Some of the work by DeWit in Holland speaks to the question that you raised, specific densities, with a defined relationship between plants. I think most of the weed-crop competition data available do not address that question at all. It is merely a density. Very often it is an undefined density of undefined weeds which is not very valuable. You are right, a weed in the row is very different from a weed between rows. That is one of the things we need to pay much more careful attention to in defining densities.

County Agent: One of the important values of weed control is the seed for next year. Weeds are like cancer, and I think probably as important as the cost relationship on this year's crop is seed and future effects. Weeds do function just like a cancer and perpetuate themselves, so we have to look into more than one year's cost analysis.

Kogan (University of California, Davis): I would like to know if the review has some data about different cultivars or varieties within species?

Zimdahl: Yes, there is some information in the literature on cultivar competitive ability. I did not cite it in this paper, but it will be in the review. Very little has been done.

Norris: I wonder whether I want to disagree with you about early competition in relationship to nutrient uptake. You might say that nitrogen is not limiting, as everything is germinating, but if the weeds are taking up nitrogren and are cultivated and lying on top of the soil surface, they have tied up the nitrogen. In California in the summer there is no water to leach nutrients back into the soil. They may have used up a resource which is not limiting now, but may be limiting in a few months when the crops' demands increase.

Zimdahl: That is an interesting and true hypothesis. Very often weeds can use up a resource that is necessary later on. That is a measure of competition that we do not have, but it is certainly something that could be examined. There is nothing in the literature about that.

Norris: Then coming back to the question of population dynamics, how much are you finding that people have recorded about the effect of the crop competiton on the weed?

Zimdahl: Usually it is the weed on the crop because that is the most important to us. The effect of crops of weeds has not been studied extensively.

Norris: If we are ever going to start talking about long term population dynamics we need to think of weed control in terms that are more inclusive than saving this year's crop. If we try to look at a farm or a community approach then we need to start looking at the other side of the coin.

Zimdahl: We might want to discard the term weed-crop competition. What we really should be studying is community dynamics or plant competition and consider population as a whole rather than bad guys vs. good guys.

Appleby (Oregon State Univ.): Should we be saying "interference" instead of "competition" because we are not separating out allelopathy, are we?

Zimdahl: That is true. In the review I chose only papers that said they were studying competition. I recognize that people who said they were studying competition may not have been studying only competition. I did not choose to review any papers that said they were studying allelopathy. Interference is an umbrella term, that has been selected to cover competition and allelopathy. I have specifically selected competition as the focus of the review, but if you are talking about the general phenomenon that you observe in the field, you cannot separate by observation, one from the other. In general terms you should use the term interference rather than competition because we do not know if one or both may be operative.

CONTROLLED DROPLET APPLICATION WORKSHOP

Harold M. Kempen, Chairman[1]

One year after introduction of a British pedestrian applicator, the Micron Herbi, a summary of research studies was reported at this workshop at Boise, Idaho.

Approximately 12,000 units have been purchased by farmers, small land holders, commercial applicators and ranchers in the United States. Major usage has been with the herbicide, glyphosate, a readily translocated herbicide. Most users have utilized it for spot treating perennial weeds, in orchards and vineyards, field ends, sprinkler mainlines, reservoir bands and equipment yards.

Below are some characteristics of the Herbi:

Application rate: 1 gpa at 2 mph
Optimum flow rate: about 60 ml/minute
Droplet size: 250 microns
Gravity flow (with no shut-off valves).
Container volume: 3.5 liters
Rotary atomizer speed: 2000 RPM
Power source: eight "D" dry cell batteries
Duration of power: about eight hours
Spray pattern: annular
Orifice: three plastic sizes for differet viscosities.

Researchers at the Weed Research Organization have experimented with the Herbi in evaluating controlled droplet application (C.D.A.). Bill Taylor has reported at recent British Weed Control Conferences on their studies. Interested researchers should review their studies. Also reports by E. Bols of Micron Sprayers Limited, Three Mills, Bromyard, Herefordshire HR7 4HU, United Kingdom, should be reviewed.

Other innovative research and commercialization of the C.D.A. concept in no-till farming in Nigeria has been accomplished by engineer Ray Wijewardene and weed scientist O. I. Okabundo at the International Institute of Tropical Agriculture at Ibadan. Nigerian farmers have successfully used

---

[1]University of California Cooperative Extension, P. O. Box 2509, Bakersfield CA 93303

Wijewardene and weed scientiest O. I. Okabundo at the International Institute of Tropical Agriculture at Ibadan. Nigerian farmers have successfully used C.D.A. applicators and jab planting to overcome severe erosion and weed problems, thereby permitting culture of 4 to 5 hectares a season compared to 1/2 hectare. Weeding costs had previously consumed 60 percent of the farmers' time.

An evaluation of the limits of the Herbi is desireable. One is the angle one holds the unit. We have found that flow rate varies considerably if held at 45° versus 30°. Water temperature did not appear influencial on flow rates. Emulsifiable concentrates and soluble formulations flow well; flowable formulations (oryzalin) did not appear to flow well at 50:50 mixes. Wetting agent is needed with water solutions to get a distinct annular pattern. Oils probably will aid in producing a good pattern.

Further research is needed on the flowability of various formulations. Many herbicides are especially formulated by English companies for use in the Herbi and a sister C.D.A. applicator, the Micron ULVA. Other companies formulate flowable herbicides such as simazine and atrazine for use in Africa. The Forestry Commission, United Kingdom, has published results and suggestions on how to use the Micron ULVA for control of brush, bracken fern and heather in forests with specially formulated 2,4,5-T and also glyphosate and asulam.

In America, major interest has focused on application of glyphosate with the Herbi. Oregon studies reported by Dr. Burrill at Boise indicated better top kill of quackgrass occurred with glyphosate applied by the Herbi than by conventional sprays. Regrowth had not been evaluated. One study on johnsongrass in a vineyard near Bakersfield, California indicated equal but not superior control in a comparison of C.D.A. (1 gpa) versus conventional spray at 35 gpa. A second trial on maturing foxtail barley showed equal results. Heathman in Arizona, reported on a study where C.D.A. did not penetrate the canopy of weeds and kill small seedling weeds. My observations on an assortment of annual winter weeds which were sprayed with glyphosate on three dates a week apart did not indicate that. However, new weed seedlings did germinate immediately after treatment. Weeds such as 12 inch foxtail barley, London rocket, horseweed, sour clover, red brome, nightshade, mustards and atriplex were controlled with rates over 1/4 lb/A. Nettle and *Malva* were not controlled.

Droughtiness appears to affect glyphosate efficacy on all weeds. Low volume spraying does not appear to enhance control of moisture-stressed weeds.

Solutions of 25% glyphosate have not caused injury to woody grapevine canes. I cannot report enough usage or observations on trees to verify safety of such concentrated solutions on various tree varieties. Monsanto researchers indicate that some damage has occurred in orchards where users tilt the hand applicator upward before turning off the atomizer, resulting in spraying of tree foliage. Improvements are needed here.

Little research has been reported (that is, received by me) on usage of other herbicides. The consensus is that the truly contact herbicides usually do not work well at 1 gpa, whereas systemic ones can do equally well as conventional sprays.

Modification of the Herbi and the ULVA is inevitable. Taylor reported that by shrouding a series of three or more vertically arranged rotary atomizers, he can produce an acceptable distribution spray pattern from boom-mounted units. Further research is under way on this modification.

This enables volumes of 10-20 liters/hectare to be applied at greater forward speeds. We have constructed an orchard/vineyard unit on a light tractor which had two atomizer heads in tandem, permitting 2 gpa applications at 2 mph. Solenoid valves, a twelve volt battery and switches permit control of flow to each atomizer. Gravity flow is still employed. Results from glyphosate applications at 1/2 lb/A in 2 gph look favorable so far.

We also have put a "T" on the end of a Micron Herbi pedestrian unit so that two atomizers are used. This permits an 8 foot band for field ends or ditchbanks.

Micron West, Inc. of Houston will introduce a larger unit called the Micro-max in 1979. It will permit a flow of 1 liter/minute (versus 60 ml/minute for the Herbi) but will require tractor mounting and will cover a seven foot band.

Researchers at the International Institute of Tropical Agriculture, Ibadan, Nigeria, are studying the use of a solar helmet to replace the battery operated Herbi or ULVA.

The concept of controlled droplet application is a decade old but it offers exciting potentials in the future. Researchers can foresee usage of much lower volumes in pesticide application and yet less drift loss to non-target areas. With optimum droplet size and with all droplets of that size, better efficiency should be achievable. Pesticides could be formulated for use directly from the container (as is done in African formulations) instead of being diluted with water of various qualities.

Other methods of producing uniform droplets are being researched by Yates and co-workers at the University of California, Davis and by industry researchers. Commercialization of these methods have not taken place as yet but no doubt they will be, in view of increased public and industry concern about drift hazards from aerial and ground sprays.

Bibliography

1. Brown, R. M. 1975. Ultra low volume spraying. Leaflet 62. Alice Holt Lodge, Wrecclesham, Farnham, Surrey GU10 4LH, U.K.

2. Kempen, H. M. 1978. Controlled droplet application - New tool for your grower? Agri-fieldman & Consultant 34:36-38.

3. Wijewardene, R. 1978. Systems and energy in tropical farming. Amer. Soc. Agr. Engr. Winter Meeting, Chicago, Ill. Paper 78-1511.

CONTROLLED DROP APPLICATION OF HERBICIDES

W. A. Taylor[1]

Abstract. This paper reviewed work the the Weed Research Organization on developing more efficient systems for applying herbicides to crops--in particular controlled drop application (CDA) in ceaeals.

To introduce the need for change, reference was made both to the restriction of conventional sprayers such as water haulage, weight and drift prone drops, and to the importance of timeliness of herbicide usage. Reduced water volumes together with less proneness to drift were identified as major objectives. Equipment developed for field use was based on rotary atomizers which allowed a narrow size range of drops to be produced. Low

[1]ARC Weed Research Organization, Yarnton, Oxford, U.K.

ground-pressure vehicles were used to gain access onto wet soils and for high (>20 km/h) speeds of travel. Observations of several years' field trials have showed no loss of efficacy with spray volumes down to about 20 L/ha when using herbicides that are applied to the soil or are systemic within target plants. More detailed investigations with drop size, herbicide concentration, formulation and location on target prevented general conclusions being made--for example, some herbicides respond with different location on target and many are not affected by drop size (within the range 150 to 350 μm).

The influence of many application variables on spray deposition was described. Lower spray volumes from rotary atomizers or hydraulic nozzles allowed more spray to be retained and drop size was only important at higher (about 50 L/ha) volume rates with smaller drops (150 μm) being more readily retained. Surfactant concentration could have marked effects on retention by wild oats but not radish. Distribution of spray on plants showed large differences between sedimenting drops from rotary atomisers and those from hydraulic nozzles. Spray deposits on the ground from both systems showed a "clumped" rather than a random or uniform distribution.

Finally, reference was made to the commercial development of CDA in Britain where equipment for pedestrian usage and tractor mounting is available and some 60 pesticides approved for use.

"OLD TIMERS" SECTION

Retired workers who were instrumental in establishing weed science in the western United States were invited to attend a "reminiscing" session at the Boise, Idaho meetings. Dr. F. L. Timmons chairmaned the section and was largely responsible for obtaining the following reports. Summaries of deceased workers' activities were prepared and presented by the spokesmen indicated.

H. FRED ARLE, 1913 - 1978

(Spokesman: K. C. Hamilton)

Fred Arle was a member of the Western Society of Weed Science from 1948 to 1978. Fred attended every meeting from 1954 to 1978. During this time he was author or co-author of 115 papers in the Research Progress Report. In 1972, Fred was elected an Honorary Member of this Society.

In 1946, Fred joined the Bureau of Plant Industry (later the Agricultural Research Service of the U.S. Department of Agriculture) working in weed research in Mississippi. On April 10, 1948, he was transferred to Phoenix, Arizona to work on control of weeds in irrigation systems. His early research developed aromatic solvents for the control of submerged weeds and petroleum oils for the control of weeds on ditchbanks.

Fred's greatest contribution to Arizona and world agriculture was the development of modern weed control programs in cotton. Working with the University of Arizona he developed "layby" herbicide techniques for late-season weed control, then preplant applications for early-season control, and finally herbicide combinations for season-long control of annual weeds. In his research and the extension of his ideas, Fred showed a rare ability to work with farmers and industry, extension and research personnel. Fred conducted weed research in all of the crops grown in Arizona; including alfalfa, barley, corn, safflower, sorghum, sugarbeets, wheat, lettuce, melons, potatoes, and citrus. He adapted many agricultural herbicides for use in urban areas.

The example Fred Arle set in his work and life, his honesty, his energy, his imagination gives us a goal to try to equal. H. Fred Arle died in Phoenix, Arizona on April 7, 1978.

ROBERT B. BALCOM

Greetings to all WSWSers in general and to the "Old Timers" in particular. It would be great to see all of you again, but I will be with you in spirit. To say in a few lines all one feels about his chosen profession covering a period of 35 year, is a tougher assignment than working up a program for ditchbank and waterweed control. Because the challenge and the need are so great, the control of undesireable plants is a very satisfying endeaver, as all of us realize. I have never been sorry. I started in plant control in 1934 with the Bureau of Reclamation on the North Platte Irrigation Project in Nebraska. In 1940 I was transferred to the Bureau's Denver office, and in 1945 to the Washington, D.C. office where I retired in 1969.

Back in those early days, weed control was quite different than now. Chlorates were about the only chemicals used. Shoot cutting, or using blades to cut the roots of perennial weeds under ground every two weeks or so was quite popular. Men wore hip boots to cut water weeds with scythes in irrigation canals, or the weeds were dragged out with heavy chains attached to a tractor on each bank. As chemicals began to show more promise, several county, state and government agencies, and the chemical companies, realized the need for more percise and extensive experiments, and for the exchange of the information being obtained. This lead to the formation of weed committees composed of workers of these organizations. The success of these groups showed the desireability of organizing regional areas with similar common weed problems. This resulted in the formation of the Western Weed Control Conference, now the Western Society of Weed Science. After the other regions organized, the several regional societies formed the Weed Society of America, which became the Weed Science Society of America in 1968. I had the pleasure of attending the first Western Weed Control Conference which was held in Denver on June 16-17, 1938. I mention these things to show some of the changes and progress I have seen.

But Tim asked for a statement, not a book; I can see him now getting out his shears. I do wish I could have been with you in person to say hello to all of you. I have always been proud to be a member of the WSWS of which, on March 18, 1968, I was elected to Honorary Membership. Good luck and best wishes to all of you, especially those with whom I have worked closely.

W. DEAN BOYLE

Regional Agronomist, Bureau of Reclamation, Boise, ID, Retired 5-31-71

We appreciate the thoughtfulness of the officers of the Western Society of Weed Science in providing a place in this conference for us "old timers." We appreciate also the work and organizational efforts of our good friend and associate, F. L. Timmons for organizing this "old timers" session.

It has been suggested that we summarize our accomplishments and contributions to the society and the Bureau or Agency for whom we worked. First, I wish to express my appreciation to the Western Wociety of Weed Science for its assistance to me and the Bureau of Reclamation. Information and direction received from this society and from so many of its members provided the stimuli, information, and direction which were essential in carrying out the weed and other agricultural programs associated with irrigation districts, canal companies, and the Bureau of Reclamation in the Northwest.

I served WSWS on several occasions as Chairman of the section on aquatic weeds. I was given the privilege of presenting several papers depicting improved practices in the eradication and control of weeds in irrigation systems.

I find it most difficult to list what I consider the most important accomplishments during the period in which I was responsible for the Bureau of Reclamation weed program over the Northwest. I enjoyed my work and really loved and respected every man with whom I worked.

The greatest satisfaction came from organizing all the irrigation districts and canal companies in the Pacific Northwestern states into an association for the purpose of sharing and disseminating information and improved practices in the control and eradication of weeds in and on irrigated systems. Foremost among the improved practices adopted was the control of aquatic weeds with chemicals, replacing mechanical methods and saving millions of dollars and tremendous quantities of water or improved quality.

With the help of Jesse Hodgson of the Agricultural Research Service, I applied the first barrel of xylene to a canal for aquatic control. Purchase of 5,000 gallons of xylene for the Vale and Black Canyon Irrigation Districts was the beginning of the pool purchasing program which was eventually expanded to the purchase of 800,000 gallons per year by 60 irrigation districts and canal companies in the Northwest.

I applied the first barrel of acrolein for the control of aquatic weeds. Through the cooperative efforts of men like Jesse Hodgson, Vic Bruns, Tom Bartley, F. L. Timmons, Delbert Suggs, Floyd Oliver and many others, this practice is universally used for aquatic weed control.

For 12 consecutive years I was privileged to organizd and teach the weed section of the Reclamation workshop at Denver, Colorado, for personnel from all irrigation districts and canal companies in the United States. On two occassions I was called by Utah State University to participate in their annual Irrigation Operators Workshop in which I taught "Weed control and eradication on and in irrigation systems." Several times I served the WSWS as chairman of the Aquatic Weed Section. Numerous papers were given on subjects relating to aquatic weed control. I have enjoyed and appreciate each of you. Your assistance and counsel has always been appreciated.

VICTOR F. BRUNS (1947-1975)
(Spokesman: Richard D. Comes)

Vic Bruns began his career in Weed Science at the Fort Hays, Kansas Experiment Station in 1941, as an assistant to F. L. Timmons. Upon competion of college in 1944, he accepted the position of Superintendent of the

State Bindweed Experimental Farm at Conton, Kansas. In 1947 he moved to Prosser, Washington, where he was in charge of a cooperative research program with the U.S. Department of Agriculture, Washington State College, and the U.S. Bureau of Reclamation. Vic Bruns was one of the first four men assigned by the U.S Department of Agriculture to conduct research on the control of aquatic and ditchbank weeds in the West.

Vic developed, or helped develop, many of the practices that are currently used to control aquatic vegetation in irrigation systems. His classic studies on the response of crops to herbicides in irrigation water are cited widely. In 1972 he received the U.S. Department of Agriculture's Superior Service Award for his research on this subject. He was meticulous and thorough in his work and was an excellent writer.

Vic became active in the Western Weed Control Conference immediately upon his arrival in the West. However, because numerous severe health problems limited his ability to travel, he was unable to accept major responsibilities in the Conference. Vic was a charter member of the Weed Science Society of America and the Washington State Weed Conference. He served as President of the Washington State Weed Conference in 1968, was elected an Honorary Member in 1974, and received the first "Weed Warrior of the Year" award from that association.

Vic retired from the U.S. Department of Agriculture on August 30, 1975. Thirty days later he lost his third and final battle with cancer.

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 Director of the Department of Agriculture.

One of Lee's first assignments with the department was a complete survey of the state to learn what noxious weeds had gained a firm footing. At this time, one of the principle noxious weeds was puncture vine and fuel oil found to be the best control. He was also active in the *Halogeton* program in the state and published several pamphlets and articles on its control.

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 in 1945, is on the Board of Governors of the National Agricultural Hall of Fame and is an Honorary Member of the Western Society of Weed Science. He has long been active in numerous other regional and national agricultural work.

Mr. Burge retired from the department in 1971.

VERL A. COX, 1887-1963
(Spokesman: Lambert C. Erickson)

Verl was raised in Texas, a state known for its size. Verl was known for his large ideas. The family moved to Caldwell in the depression 30's and Verl went to work with the Canyon County Weed Control Unit. This was in the era when weed control meant soil sterilization. Thousands of gallons of carbon bisulfide and hundreds of tons of the chlorates and borax were applied annually in the state.

Verl's heart condition dictated that he reduce his physical activity. He was then hired as the weed control supervisor for Ada County in 1940 and remained there until his retirement in 1958. He was an organizer of the pool whereby the counties purchased the soil sterilants. He was present and helped organize the Idaho Noxious Weed Association in 1944 and he was its president in 1954. It was during these 18 years that he became known as the Dean of Weed Control in Idaho.

Verl had trained himself to be observant, to take advantage of every successful result, to learn by trial and error, in not only using the new chemical, but how to apply it under the prevailing environmental conditions. Verl knew that people were the main contributors to the weed problem and he therefore devoted great effort to human persuasion.

Verl was a leader of men! The records verify his contributions at innumerable meetings, always concerned with improving the environment of the community, be it weeds, water, schools, space, places or people.

LAMBERT C. ERICKSON

Do you know him? In recent years I have changed my ways in introducing a speaker from the common "you all know Mr. X," to actually unveiling the speaker's background to the audience. It may tell you more than the speech.

As for me, I was born in 1910 and raised on a farm in the sub-marginal semi-swamps of northern Minnesota. Nine years in a one-room grade school, then to the Northwest School of Agriculture, one year and three years to the Central School of Agriculture in St. Paul. The schools of agriculture were designed to send trained boys and girls back to the farm as rural leaders. Perhaps above all they were taught citizenship.

Then to the U.S. Steel Works, then barberry eradication work, then a dairy farm, student seed analyst, Federal Land Bank, then weed laboratory teaching assistant. These jobs were interspersed in eight years devoted to getting a B.S degree. The struggle for survival was common in the depression years. But there was one thing different for me. It was working for genius pioneer in weed science. A. H. Larson, a walking encyclopedia, who quit his Ph.D. effort because, "If that damn fool can get it, I don't want it."

I then got my B.S., married Hazel Marie Markuson and moved to Wyoming as State Seed Analyst and seed advisor to the coutry pest inspectors. Then I moved with my wife, a two-year-old son and 2,4-D to Idaho in 1945. I think I was the first full-time weed control researcher in the United States hired by a university (Alden Crafts says he was first!). Let me not encroach on the four horsemen, Timmons of Kansas, Seely of Idaho, Stahler of Minnesota and Bakke of Iowa, who were the first full-time weed research scientists employed by the USDA.

But things were different then--2,4-D came as a white powder. It was dissolved in carbowax 1500 which diluted in water stayed in solution. And alcohol came as a water simulated liquid.

Today 2,4-D comes as a liquid and an alcohol as a powder.

I need not tell you about me in my intervening years from 1945 to 1975 because that's how and when we met. My career years were your career years. The WWCC and the WSWS were an indispensable part of all our lives. *Those were the years my friends and colleagues*, a common bond which has no end. Two major highlights in my life were with Jess Hodgson, getting the Honorary Membership from this society, and last summer when the International Farmhouse gave me their highest award--Master Builder of Men. We should remember that we belong to the world's largest fraternity--the Land Grant College system!

R. J. EVANS
(Spokesman: Louis A. Jensen)

Dr. R. J. Evans was born in Lehi, Utah in 1881. He graduated from Brigham Young University at Provo, in 1907 and earned another Bachelors of Science degree at Utah State University in Logan, Utah, two years later. He received his Ph.D. at Cornell University in 1912.

He operated a farm for a time and later was director of the Utah Extension Service. He was head of the Agronomy Department at Utah State University for 16 years. During this time he became very concerned about weeds and attended some meetings of the Western Society of Weed Science. While at Utah State University he encouraged state appropreations for state and county weed control programs especially clean cultivation for creeping perennial noxious weeds such as whitetop, field bindweed, Canada thistle and Russian knapweed. He retired from U.S.U. in 1947, doing some farming and persued church, civic and other interests until him death in 1967 at the age of 86.

JESS FULTS

I was first introduced to the Western Weed Control Conference at Reno, Nevada in 1946. I attended 22 regional and national meetings between then and my retirement from Colorado State University in 1974. During that time I published 60 papers or abstracts in the Proceedings and Research Progress Reports alone, with co-workers or 15 graduate students.

While attending WSWS meetings I have particularly vivid memories of the Sacramento Girl's Choir in 1948, recent vegetation near Tucson and Phoenix, Arizona, flowers and tropical vegetation of Hawaii and southern California, and excellent food and music at Reno and Las Vegas!

Last May, I married Amy Arnold, a long time nurse, and acquired a whole new second family of two stepsons, two stepdaughters, and now a new stepgrandson. These complement my own family of three sons, a daughter and nine grandchildren. When we get together we really have a ball.

I do a limited amount of consultant work and answer a world of questions about gardens, grass, trees and ornamental plants. We have lots of company and visits from ex-students and friends which we enjoy a great deal.

Althought I am retired from the Botany and Plant Pathology Department, I am still very active and not retired from plant research. My special interests are in breeding and marketing seed, seedlings and plants of columbine (*Aquilegia*). I still have a large introduction garden on the University-owned Bay Farm where I have about 20 species of *Acquilegia* from all over the world plus about 30 inbred lines of Colorado columbine

(*A. caerulea*). Here on my own land I am producing strictly blue-white columbine in a polycross of most of my inbred blue-white lines. I expect to sell seed, seedlings and plants in bloom both wholesale and retail.

I also spend much time in my apple orchard (20 trees) and in general gardening.

CECIL GRAHAM

Cecil went to work for the Bureau of Reclamation, Region 2, at Sacramento, California, in June of 1946 after almost 4 years in military service. His assignments were numerous, challenging and interesting as he established the first weed and pest control program for the Bureau in Region 2.

His work involved the organization of Bureau personnel in operation, maintenance and construction, together with water user organizations in planning and conducting weed, rodent, and pest control programs on and in irrigation systems. He served Region 2 in establishing research programs with the University of California at Davis, and the California Department of Agriculture in search of solutions to problems in controlling weeds, insects and plant diseases on reclamation projects in Region 2. Supervision of similar programs were also among his responsibilities as head of the Lands Branch of the Columbia Basin Project, Washington.

Cecil represented the Bureau of Reclamation in establishing cooperative weed control research projects at the University of California, Agricultural Research Service, and at the California Department of Water Resources.

Cecil was instumental in organizing and conducting the annual weed control workshop for Bureau operations and maintenance personnel, for the Department of Water Resources and for the water user organizations.

Another accomplishment was the development of research programs with the University of California at Davis in the study of anti-transpirants for the control of water loss from Salt Cedar.

His work also led to a research program at the University of California at Davis to find a substitute for mercury compounds used in control of fungus diseases in grain being grown by water users.

GEORGE HARSTON
(Spokesman: Dale W. Bohmont)

George Harston was active in weed control programs and associated with the Western Weed Control Conference from the late 1930's until the early 1950's. He was a native of Wyoming, the family farm being near Cowley. He was the State Entomologist for Wyoming, and his responsibilities included weed control. George Harston had a keen interest in the control of perennial weeds; before World War II he investigated methods that included burners, borax and various sterilants. He later used 2,4-D in seeking control of field bindweed. Mr. Harston was Acting Commissioner of Agriculture for Wyoming in the late 1940's and early 1950's. He was a key person in the development of a noxious weed law for the state. A dedicated and enthused worker, he considered the sale of weed-contaminated crop seed to be intolerable. George Harston was a crusader for weed control.

ROBERT E. HIGGINS

Robert E. Higgins received his B.S. in 1941 and M.S. in 1958 from the University of Idaho. He taught vocational agriculture at Wilder in 1941-42. Bob farmed for a year in Rupert before serving in the U.S. Navy from 1943 to 1946. After leaving the navy he joined the University of Idaho Extension Service and was County Agent in Gooding County 1946-1952 and Bonneville County 1952-1955. Bob was appointed Extension Agronomist and Weed Specialist in 1955 then in 1973 Extension Weed Specialist where he served until his retirement in 1979.

Bob was actively involved with county and state weed control problems during his entire Extension career. He worked on dodder, range weeds, weed control in beans, sugarbeets, alfalfa, yards and gardens and authored many publications. He started the work on control of Juniper with picloram. He was secretary for the Idaho Weed Control Association for 25 years. Bob is also a member of WSSA, ASA, CAST and Sigma Xi. He attended and participated in most Western Weed Control Conference and then WSWS meetings from 1955 to 1978.

GEORGE HOBSON
(Spokesman: L. A. Jensen)

Mr. Hobson was headquartered in the State Capitol Building in Salt Lake City. He began supervising the state weed program at a time when there were very few herbicides available. Under his direction, cooperative programs were established between the State Department of Agriculture, Utah State Agricultural College and the various counties. They consisted of three different types of control measures, to control creeping perennial weeds such as whitetop, field bindweed, Canada thistle and Russian knapweed. One method used was where whole fields were infested, to lay the field out from cropping for a period of 2 to 3 years. During that time "clean cultivation" was practiced which consisted of going over the field every two weeks all during the growing season with a "duck foot" cultivator. This controlled the weeds by preventing photosynthesis and depleating the energy stored in the creeping rootstocks. A second method was to dig out small patches of noxious weeds by hand with shovels, while a third method consisted of treating small infestations with so called "soil sterilants" such as atlacide and carbon bisulfide. Much of this was done with WPA labor during the great depression of the 1930's. Mr. Hobson attended meetings of the Western Weed Control Conference during the 40's at the time when 2,4-D was being introduced and used rather extensively in state and county weed programs.

JESSE M. HODGSON
(Spokesman: F. L. Timmons)

Jesse Hodgon began his career in weed control research with the U. S. Department of Agriculture early in 1947. He was in charge of the cooperative research program with the Idaho Agricultural Experiment Station, the U.S. Bureau of Reclamation and the Ada County Weed Control Department at Meridian, west of Boise. Emphasis of his early research was on the control of weeds in irrigation canals and of white top and perennial smartweed on irrigated land.

Jesse immediately became active in the Western Weed Control Conference and quickly established himself as a thorough investigator in weed control affairs. After five years at Meridian, Mr. Hodgson was transferred to Bozeman, Montana in 1953 to develop a cooperative research program for the USDA, USBR and the Montana Agricultural Experiment Station. At Bozeman, Jesse's program emphasized control of aquatic and ditchbank weeds in irrigation canals and the control of Canada thistle in irrigated crops. In addition to his extensive research program, Jesse completed the requirements for his Ph.D. degree from Montana State University. He also took time to help his son build a brick home for the family as he had done previously at Meridian. Dr. Hodgson's thorough and excellent publications on the life history and control of Canada thistle caused him to be generally recognized as "Mr. Canada Thistle" throughout the USA and Canada.

Jesse was a leader in the WWCC and a prolific contributor to the Research Progree Reports. He was President of the WWCC in 1965. His presidential address that year gave an outstanding summary analysis of the WWCC after 27 years. Jesse was largely responsible for writing the Constitution of WWCC. Dr. Hodgson was elected an Honorary Member of the Conference in 1969 and later received the Presidential Award of Merit from WSWS.

Jesse Hodgson always found time from his busy professional schedule, church and civic activities to spend time with his family and be a pal to his sons. One evening late in 1974, after Jesse returned home from a basketball workout with his sons, he had a fatal heart attack which ended his fruitful and victorious life.

HERBERT M. HULL

I recall with great fondness attending many of the WWCC/WSWS meetings since the early 50's, along with the often associated technical committee meetings for regional projects W-11, W-52, W-77 and W-108. Much of the research under these projects is now accomplished with the aid of models, but we managed somehow to get along pretty well in those days even without modeling. One of my early trips to Boise I especially remember. To fly there from Tucson then required four different airlines. On about the third leg we ran into some of the roughest turbulence I had ever experienced, including many hours as an old Air Force pilot. About two-thirds of the passengers had become violently airsick. I began to feel a bit woozy myself, but remember thinking "what's to worry--pilots *never* get airsick." However, I now know differently. At the last moment I was forced to grab for the carton provided for such problems, only to find that it was upside down--but alas, it was already too late. K. C. Hamilton was sitting next to me as I recall; hopefully he has forgiven me.

In the WSWS I served as project chairman for chemical and physiological studies in 1956 and '57, as vice chairman and later chairman of the research committee from 1960 to '63, and as a chairman of the woody plants section during 1968-69. In the WSSA I was chairman and vice chairman of the monographs and annual reviews committee from 1962-69, and have especially enjoyed my continuous association on the editorial board for the Herbicide Handbook, the first edition of which was created in 1967, and which is now in its fourth edition. I have also been the Arizona representative for WSSA for the past 15 years.

I have not really retired, but have just shifted gears. I am still a Collaborator with the USDA and have maintained my faculty appointment as Professor of Watershed Management at the University of Arizona. I have however, changed my line of work from weed science to marine algae. This is an area in which my wife and I have had an interest for many years--in fact we both took an excellent course on the subject this spring semester at the U. of A., under Prof. Bob Hoshaw. There are other advantages to algae also. For example, one doesn't have to file an EIS before examining the intricate skeleton of a marine diatom under the electron microscope. All of this, however, does not mean that I have lost interest in weeds, absorption and translocation, and cuticle ultrastructure, nor in the many good friends I have made over the years in WSWS. I will hope to see you again, especially when our meetings are held down here in sunny Arizona.

EARL HUTCHINGS
(Spokesman: L. A. Jensen)

Earl Hutchings supervised the inspection work in Utah for over 30 years, during which time the quality of crop seed was improved and landowners were encouraged to control weeds. Several inspectors under his direction, were instrumental in getting county weed control programs operating.

Earl attended many of the first meetings of the Western Weed Control Conference and served as its President in 1944 when the Conference met in Salt Lake City. He retired from state employment in 1967 and died just two years ago.

WILFORD LEO JENSEN
(Spokesman: L. C. Erickson)

Wilford was born at Preston, Idaho, August 22, 1887, married in 1912 and moved to the vicinity of Rexburg with his family in 1916. He was wholly involved in community organizations, church, REA, school board, SCS district organization and in many instances he was the pioneer.

He was the first County Weed Supervisor appointed in the State--in Madison County, 1936. Thereby, he pioneered in clean cultivation, sodium chlorate, borax, calcium chlorate, carbon bisulfide, 2,4-D and the vast number of chemicals that followed. He remained County Weed Supervisor until his death, about 40 years, probably the longest tenure as a County Weed Supervisor in this state.

Wilford was a natural organizer. He never met a stranger! His record in the community and the state was a series of successes. To this organization it can be said, he brought the weed problem from a state of chaos to a state of control in Madison County.

BUHFORD KUHNS

Buhford was born in Missouri in 1896. He farmed in Twin Falls from

1916-1922. He completed his work at the University of Idaho in 1924 and started teaching Vocational Agriculture at Gooding. He then served as County Agent in Minidoka, Gem and Canyou Counties during the time from 1926 to 1944. In 1944 he was appointed Extension Agronomist and State Seed Commissioner. In about 1947 he left this position and took a position with the U.S. Bureau of Reclamation in Euphrata, Washington.

He, along with Dean Boyle, did some short term foreign assignments in Ghana. Buhford was actively involved with Idaho weed control efforts and attended the Western Weed Control Conference in 1944-1946. He served as President in 1946. He now resides in Wenatchee, Washington.

GEORGE G. SCHWEIS
(Spokesman: Lee M. Burge)

George G. Schweis was appointedJuly 1, 1927 by the Nevada State Board of Stock Commissioners. His first duties were in the field of insect pest and plant disease work. George was made Director of the newly created Division of Plant Industry in 1929. Noxious weed control work was authorized by the Legislature in 1929.

The 1932-34 Department Biennial Report reports that efforts were being made by the Western Plant Quarantine Board to have the federal government, through its Bureau of Plant Industry, do some real basic research in this particular field. Mr. Schweis was very active in drafting a weed control project to secure help from the WPA in control of noxious weeds in Nevada.

The first annual conference of WWCC was held in Denver, Colorado in June of 1938 as an offshoot of the Western Plant Quarantine Board. Mr. Schweis attended the first five meetings of WWCC and was President in 1941. George Schweis died January 7, 1957.

CLARENCE I. SEELY

Clarence Seely's professional career started in 1934 when he became the superitendent of the Dry Land Branch Experiment Station at Lind, Washington. Two years later he joined the USDA on the bindweed research project at Genesee, Idaho as an Assistant and later Associate Agronomist. He continued in this position until he joined the University of Idaho Agricultural Experiment Station at Moscow as Agronomist in 1947. He joined the reaching staff at the University as Professor and Agronomist in 1955 where he worked until he retired July 1, 1976. During this period he also held Extension and administrative positions at various times. Although weed research was his major activity, he had time to give over 2000 talks at Extension type meetings and serve on numerous committees and answer innumerable telephone calls, letters, etc. on weed control questions. In between times to taught over 700 students weed control, crop ecology, statistics, research methods and properties and factions of herbicides.

Among his major contributions in weed research were the following: (1) working out the behavior of carbohudrate root reserves in creeping perennial weeds and correlating this with applications of weed control measures, (2) the discovery that low volumes of spray solutions, down to a gallon per acre, of 2,4-D could be as effective as the formerly used 80 to 160 gallons per acre, (3) proving that the application of dry 2,4-D to susceptible plants was effective also had a material bearing on later usage of herbicides, (4) the principles and use of soil incorporation so widely used today were worked out in getting propham to kill wild oats under dry land conditions; (5) demonstrating that over 60 strains of wild oats varying in seed dormancy, growth characteristics and chemical tolerance existed in the native wild oat population. Similar studies have since shown the same situation exists with many species of weeds and herbicides. (6) The discovery that diuron could be used as an early post emergent broad-leaved weed killer in winter wheat and the large increases in yield that could be obtained from its use triggered the search for other materials that could be used similarly both in the U.S. and abroad. And (7) the development of wild oat control in peas and lentils with diallate and triallate.

Clarence has been associated with the Western Society of Weed Science since he first presented a paper on root reserves in creeping perennial weeds to the 1939 meetings of WWCC in Seattle. Since that time he has served on many committees such as resolutions, nominating and terminology. He served as vice president of the Society for one year and succeeded to the presidency upon the death of Dr. W. W. Robbins. He was then elected President and served for two years. It was during his presidency that commercial representatives were given full membership. He represented the WWCC on the Board of the Assoc. of Regional Weed Control Conferences and on the Executive Committee of WSSA. He was elected a Fellow of WSWS in 1975.

Clarence has served as a consultant on crop production problems and crop losses to many firms for a number of years. He also spent six months in Australia and New Zealand studying and lecturing on weed control. Since his retirement in 1976 he has devoted considerable time to travel and consulting.

H. L. SPENCE, JR.
(Spokesman: R. E. Higgins)

Harry Spence was Idaho Extension Agronomist and State Seed Commissioner from 1933-1942 and Extension Agronomist and Assistant Extension Director from 1942-43. He joined Mesa Seed Company's Mesa Orchards as manager in December 1943. He held this position until 1946. He then accepted a position with FAO and worked in Afghanistan and Indonesia. His date of retirement is not known, but he passed away on June 25, 1969. His wife Helen now resides in Walnut Creek, California.

Harry was actively involved with the educational and technical aspects of the WPA weed control program. Harry was chairman of the first two meetings of WWCC in 1938 and 1939. He was a key promoter for the organization of the conference. He also attended the 1940 and 1942 meetings.

BRUCE THORNTON

The first thing I would like to do is to add my words of appreciation for the great and inspirational services rendered this Society from its inception by Walter S. Ball, whose presence in missed so much today.

Weed control became one of my major interests, both research and Extension, in 1929, when "Walt" left Colorado to join the staff of the

California Department of Agriculture, and continued until my retirement in 1962, which was followed by my putting out the third revision of the bulletin "Weeds of Colorado" (which, more recently, has been again revised by Bob Zimdahl), and also three seasons of field work in weed control in Weld County.

Actually, my first real concern was initiated many years earlier when we found Canada thistle growing on the family farm. We had managed to live with bindweed as far back as my memory serves me, but the thistle was something different.

Tim suggested including some unusual experiences. Apparently only two impressed me sufficiently to be readily recalled. In one incident, an assistant who had been mixing sodium chlorate solutions in buckets all morning decided to relax and have a smoke after lunch. The instant flame, substituted for the "smoke," resulted in instant action, for he got out of his clothes quicker than a Houdini, with little damage being down except to his clothes and to his pride.

On another occasion, a helper, just having filled the tank of the gasoline engine, located in the trunk of *my* car, was also greeted by instant flames when he pulled the starter rope. He also responded with alacrity, throwing the burning engine with attached pump and equipment into the hinterlands. Again, no serious damage, the anticipated explosion apparently being prevented by the tank being completely filled.

The zaniest development with which I came in contact, (figuratively), and which created considerable interest in several states, was the "electrovator." In limited tests (demonstrations) it was only partially effective in killing perennial weeds and gave little promise. However, one operator was reported to have been electrocuted and also a cow, the latter at considerable distance, contact being made via a wire fence. As early suspected, it proved to be primarily a promotional deal with little, if any, merit as "conducted."

Although, due to the snow storm, we missed the "Old Timers" section on Tuesday afternoon, we did enjoy the informal session that evening where we "Oldsters" had the opportunity of really getting together with Bill Harvey key-noting the occasion. Attending the various Sections recalled old times, but above all we appreciated the consideration and warn hospitality extended us by the officers and other members of the organization. We were glad we came.

F. LEONARD TIMMONS

When Mr. Timmons attended his first meeting of the WWCC in 1946, he was almost an old timer in weed control. In 1935, he established the first USDA-state weed research project in the United States located at Hays, Kansas. After 13 years on that project, he was transferred to Logan, Utah as Regional Coordinator of weed control research programs in the elevan Western States in cooperation with the U.S. Bureau of Reclamation and six state agricultural experiment stations.

While in Kansas, he had helped organize the NCWCC in 1944 and was Chairman of the Research Committee during 1944-47. In 1951 he became Chairman of the WWCC Research Committee. That year 14 regional research projects were initiated on various phases of weed control. Summarized reports from 68 investigators on 14 project committees were published in our first WWCC Research Progress Report in 1952.

Two of the first five members to be elected to Honorary Membership in the Weed Society of America from the six regional seed conferences in the United States and Canada were from the WWCC. They were Alden S. Crafts and R. Leonard Timmons.

Probably Dr. Timmon's best known contribution in the WWCC were his 19 Newsletters issued from Logan, Utah and Laramie, Wyoming in 1949-54. As Regional Coordinator, he made two or three tours each year of the cooperative research projects in Arizona, Idaho, Montana, Nevada and Washington. During those trips, he also toured weed control projects by the U. S. Bureau of Reclamation, the U. S. Bureau of Land Management and the U. S. Forest Service and also saw weed problems, research and control at other state experiment stations in the region. His first mimeographed newsletter was issued in June, 1949 to a list of 50 Federal, state and commercial weed workers, with whom he has traveled and conferred. The newsletters summarized weed problems, research results and new control developments and listed recent regional and national publications on weeds. Because of frequent visitors and other contacts from other states in the USA and other countries, the requests for his Newsletter increased rapidly. By 1954, the mailing list for his Newsletters had increased to more than 500 weed workers in 35 states in the USA, five Canadian Provinces and 15 other countries representing every continent. The Western weed workers and weed problems were receiving almost world wide publicity.

Finally, in 1955, Dr. Timmons was able to "let loose of the tiger's tail" after the WEEDS Journal and other national and regional publications began to fill the needs for publication by and communication between weed workers. His 19 Newsletters now bound in three volumes will be deposited at the WSSA Archives and Library, Ames, Iowa or at a similar WSWS Library if one is established.

Dr. Timmons was among the first five members to be elected as Honorary Members in the WWCC in 1968. He considers his most distinctive contribution to Weed Science to be his article, "A History of Weed Control in the United States and Canada", published in Weed Science in March, 1970 before his retirement July 31, 1970.

DELMAR C. TINGEY

Del Tingey was born in Brigham City, Utah in 1897. He earned his BS and MS degrees in Agronomy at Utah State Agricultural College now known as Utah State University. Upon graduation he joined the staff in the agronomy department at that school and served there for 43 years, except for 3 short periods. During most of his time at the University he had 3 assignments - 1/3 wheat breeding, 1/3 weed control research and 1/3 teaching. In wheat breeding, he developed and released 4 new winter wheat varieties resistant to smut which has been a serious problem in Utah. His major courses taught regularly for many years were: Weeds, Plant Breeding, Grain Crops and Biometery which was the forerunner to statistics. In weed research, he emphasized control of creeping perennial weeds through a combination of cultural practices and herbicides.

Del was an active member of the Western Weed Conference (now Western Society of Weed Conference) for many years, attending the meetings, regularly and contributing to the Research Progress Report and the Proceedings.

He enjoyed sports of all kinds, especially fishing and hunting. As a side line and hobby he managed a 160 acre farm 20 miles west of Logan, for 16 years. On his farm that was heavily infested with noxious weeds, he used practical methods of controlling them until it was essentially weed free.

Del retired 12 years ago and still lives in Logan, Utah, with his wife Mable. Ill health has greatly hampered his activities and enjoyment of life in recent years.

RAY WHITING

Ray Whiting was employed as a District Agricultural Inspector with headquarters at Ogden, Utah for over 25 years, where he did inspection work and assisted in carrying out the provisions of the seed and weed laws. In addition to his regulatory work, he also served as county weed supervisor for Weber County.

He had the responsibility of supervising and helping to operate the county weed program. Whenever possible, he attended the WWCC meetings to help keep up-to-date on new chemicals. During the 1940's and 50's quite a few new herbicides were released. Ray started to use them and built up quite an extensive spray program with 2,4-D and other compounds to control noxious weeds in Weber County.

Ray retired from the Utah Department of Agriculture in 1972 and is enjoying himself operating a small fruit farm in his home town of Springville, Utah.

GEORGE WORNHAM
(Spokesman: L. C. Erickson)

George was born July 22, 1900, in Beaver, Utah. He was raised in Southern Utah, attended school at Utah State University in Logan, Utah. He worked at the University Experiment Station at Logan for a few years and then went to Fillmore, Utah, where he was County Agent for Willard County. He served in that capacity for 12 years. Of all the phases of agriculture in which he was involved, weed control became the most challenging when the miracle 2,4-D was announced in December 1944. Due to the new challenge he went to work for the American Chemical Paint Company (Amchem) in 1946. He was in charge of sales and promotions in Idaho, Utah, Colorado, Wyoming and Montana. He set out numerous demonstration plots especially in the upper Snake River Valley and then throughout the intermountain area, as he introduced the new herbicide. George always made two sets of field notes, one for the field and one for the office. He learned that due to once losing his only notes, his field notes.

He was active in Idaho noxious weed organization and promoted weed control at all levels: private, public, commercial, scientific, county and state. He operated out of Idaho Falls, Idaho. He passed away March 14, 1964.

MBR 18337--A NEW HERBICIDE/PLANT GROWTH REGULATOR FOR WEED CONTROL IN COTTON AND OTHER CROPS

G. D. Massey, 3M Company, Fresno, CA.

Abstract. MBR 18337 (chemistry not released) has shown promise as a selective herbicide in cotton and other crops. It is an unusual compound in that it has both pre- and post-emergent activity. It can be soil incorporated (at higher rates); it can be surface applied and watered in; or it can be foliar applied and still give good to excellent weed control of certain grasses and other weeds.

Cotton shows good tolerance while other crops such as lettuce, safflower, cantaloupes, rice, turf, cole crops, alfalfa, trees and vines are still under investigation.

Weeds showing susceptibility include johnsongrass, bemudagrass, most annual grasses and certain broadleaf weeds.

Its place of greatest use may be in the area of an early post emergence herbicide to control perennial grasses in such crops as cotton.

In addition it has shown excellent growth regulator activity on turf and will be greatly expanded for evaluation in this area in the future. The compound also shows growth regulator potential in a number of other agronomic and horticultural crops as well as in ornamentals.

MBR 18337 is formulated as a 2 lb/gal emulsifiable concentrate. Present toxicological information indicates that the compound has on oral LD_{50} of $\lesssim$ 3500 mg/kg.

PHYTOTOXICITY OF DICLOFOP-METHYL, DINITRAMINE, AND TRIFLURALIN IN WHEAT (*TRITICUM AESTIVUM*), DOWNY BROME (*BROMUS TECTORUM*), AND RIPGUT BROME (*BROMUS RIDGIDUS*) AS INFLUENCED BY INCORPORATION DEPTH

G. A. Mundt and G. A. Lee[1]

Abstract. Studies were initiated to determine the influence of incroporation depth on the herbicidal activity of diclofop-mehtyl, dinitramine, and trifluralin in winter wheat, downy brome and ripgut brome. Berbicides were incorporated to a depth of 2.5 cm and 5.0 cm in the soil with a flextine harrow and a disk, respectively. Plant emergence, hight, biomass and wheat yield were monitored to evaluate the influence herbicide incorporation had in relation to crop tolerance and control of the two species.

Deep incorporation of the herbicides reduced wheat tolerance with no significant increase in annual brome control. Herbicidal activity of dichlofop-methyl was generally reduced with deeper incorporation depths indicating a dillution of this compound in soil. Dinitramine and trifluralin incorporated to a depth of 5.0 cm were most phytotoxic to wheat. Diclofop-methyl gave the best annual brome control under field conditions, whereas treatments of dinitramine and trifluralin resulted in the best brome control in the greenhouse studies.

---

[1]Idaho Agricultural Experiment Station, Moscow.

HERBICIDAL WEED CONTROL IN ECO-FALLOW SYSTEMS

M. E. Coleman-Harrell and G. A. Lee[1]

[1]Idaho Agricultural Experiment Station, Moscow.

Abstract. Field investigations were conducted in southern Idaho to determine the potential of herbicidal weed control in eco-fallow systems. Herbicides were applied in both fall and spring for the control of winter annual and summer annual broadleaved and grassy weeds.

Data obtained during a two year period indicates that atrazine, atrazine + cyanazine and atrazine + dalapon provides excellent broad spectrum weed control. The longevity of residual weed control is compatible with mechanical seed-bed preparation which is initiated in mid-July or early August. Spring application of cyanazine + glyphosate and atrazine + glyphosate provides excellent initial weed control as well as residual weed control when adequate rainfall occurs.

Soil moisture in the top 12 inches of the soil profile was monitored during summer months subsequent to herbicide applications. Percent soil moisture was substantially higher in the 0-6 inch and 6-12 inch profile in herbicide treated areas compared to untreated areas. This indicates that there is an advantage in moisture conservation utilizing herbicides for controlling undesirable vegetation in a fallow system.

INFLUENCE OF DEPTH OF INCORPORATION OF PREPLANT HERBICIDES ON CONTROL OF DOWNY BROME AND WINTER WHEAT TOLERANCE.

G. A. Mundt and G. A. Lee[1]

Abstract. Diclofop, dinitramine, and trifluralin were compared to identify the best potential downy brome herbicide in winter wheat. The effect of depth of incorporation was also studied to determine the influence on wheat stand, yield and downy brome control.

Trifluralin at both 1 inch and 2 inch incorporation depths significantly reduced the emergence of winter wheat. Dinitramine was next in crop tolerance regardless of the incorporation depth. Diclofop had excellent crop tolerance and did not significantly reduce crop stand.

Trifluralin resulted in excellent downy brome control at the 1 inch incorporation depth. Diclofop resulted in excellent downy brome control, but wheat from these areas produced substantially higher yields than grain from areas treated with trifluralin. Crop tolerance is the limiting factor of trifluralin and dinitramine for downy brome control in winter wheat.

[1]Idaho Agricultural Experiment Station, Moscow.

COMPARISON OF ASSAY METHODS FOR MEASURING SOIL RESIDUES OF ATRAZINE

R. Brattain and P. K. Fay[1]

Abstract: Summerfallow, holding land out of production for a crop season, is a common farming practice in the semi-arid regions of the Great Plains. Approximately 16-18 million hectares are summerfallowed in the United States each year. Chemical fallow is a system of controlling weeds using herbicides, or a combination of herbicides and tillage.

[1]Department of Plant and Soil Science, Montana State University, Bozeman, MT 59717.

Atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine] is an effective inexpensive herbicide for chemical fallow. The possibility of crop injury as a result of herbicide carryover is a major deterrent to the use of atrazine as a fallow aid. Farmers cannot predict if crop injury will occur after seeding at the end of a fallow period. The purpose of this study was to compare the assay techniques used in the past for measuring soil residues of atrazine. This study is an attempt to develop a rapid routine assay which could be offered as a service to Montana farmers by the M.S.U. Soil Testing Lab.

The assays compared were: 1) the standard pot assay, 2) the Stanford-Dement assay, 3) a petri dish assay, 4) microbiological assays. An assay utilizing *Chlorella sorokiniana* will be presented which proved to be rapid, inexpensive and accurate.

EFFECTS OF NITROFEN ON FOURTEEN WHEAT CULTIVARS

D. L. Shaner, W. H. Isom, J. L. Lyon and M. Vilchez[1]

Nitrofen is a pre-emergence herbicide that shows considerable potential for use in wheat to control several troublesome annual grassy and broadleaf weeds. However, if notrofen is to be registered for use, it is imperative that wheat cultivar responses to applications of the herbicide must be obtained in addition to weed control data.

Tests were established to determine the effects of three rates of nitrofen (0, 3.36, and 6.72 Kg/ha) on fourteen different wheat cultivars. Individual plots were 1.5 X 5.5 meters for each cultivar arranged as sub plots in a split plot design with nitrofen rates as main plots. The cultivars tested consisted of eight common wheats (*Triticum aestivum* L.): Anza, INIA 66R, Tanori 71, Portola, Shasta, W 444, MP 54, and Yecora Rojo; and six durum wheats (*Triticum durum* Desf.): WS 3, Modoc, Cocorit 71, Mexicali 75, Produra and Crane.

In 1977 the plots were all planted on January 21 at a constant seeding rate of 89.6 Kg/ha for each cultivar with a 6-row Øjyord plot drill. In 1978, adjustments for seed sizes were made so that all plots had the same numbers of seeds per plot based on 89.6 Kg/ha of the median-sized seed.

Nitrofen was applied at the appropriate rates to the soil surface immediately after planting and was incorporated by a sprinkler irrigation of 2.5 cm. Sprinkler irrigations were made both years to supply water needs of the crop.

Stand counts were made on 1 m of row located within each plot.

All plots were treated with 0.56 Kg/ha bromoxynil at the 4-5-leaf stage of the wheat to control any broadleaf weeds missed by the nitrofen treatments and to control the broadleaf weeds in the zero nitrogen treatment plots.

Variables used to measure nitrofen effects on cultivars were: seed yield (Kg/ha), plant height, test weight of grain, stand count, crop injury rating, and seed protein content. Crop injur was evaluated one month after planting.

---

[1]Asst. Plant Physiologist, Extension Agronomist and Staff Research Associates, respectively, University of California, Riverside.

planting.

The response of the wheat cultivars to nitrofen was somewhat different in each of the two years of the study. When yields were averaged over all fourteen varieties, it can be seen that the yields in general were much lower in the second year than in the first, probably due to the later planting date (Table 1). Secondly, yields were significantly reduced in the second year by both rates of nitrofen, while in the first year there was no significant effect even by the highest rate of nitrofen (Table 1). Crop injury was also greater in the second year than in the first. This response was at least partially due to the rains encountered in the second year which resulted in puddling of water that increased the phytotoxicity of the nitrofen to the wheat. This increase in injury could also explain the decrease in yield in the second year. The stand count in both years was significantly reduced by both rates of nitrofen, although the total stand count was higher in the second year due to compensation for the differences in seed size of the various varieties in the second year.

Table 1. Effect of nitrofen on wheat[1]

Parameter	Nitrofen (Kg/ha)					
	0		3.36		6.72	
	1977	1978	1977	1978	1977	1978
Yield (kg/ha)	5064a	3911c	5403a	3651d	5162a	3640d
Crop injury (0 = none)	0.6a	0.4a	1.8b	3.0b	3.2c	4.3c
Stand count (plants/m)	28.5a	37.1a	25.9b	34.1b	24.0b	33.7b
Seed protein (%)	12.6a	16.7a	15.0b	17.3b	14.4ab	17.4b

[1]Numbers followed by different letters within a row within each year are significantly different at the 5% level with Duncan's Multiple Range Test.

Seed protein showed a much greater greater increase in the first year with nitrofen treatment, although seed protein content did increase significantly in the second year with nitrofen treatment. The reasons for these increases in seed protein were different for the two years. In the first year the plots were heavily infested with annual bluegrass which was controlled in the nitrofen-treated plots but not in the non-treated plots. Control of the annual bluegrass resulted in more available nitrogen for the wheat and resulted in more grain protein. In the second year the increased grain protein content was related to the suppression in yield as there was virtually no annual bluegrass competition.

Due to the competition from the annual bluegrass in the first year, nitrofen toxicity to the cultivars was masked, especially at the lower rate because of the release of competition from the annual bluegrass. The second year's data is more useful in comparing the response of the different cultivars to nitrofen. When the fourteen cultivars were compared it was found that the response to the nitrofen broke out into three groups. In the first group, the lower rate caused a slight decrease in yield while the higher rate had no effect, and, in fact, the yield from the higher rate of nitrofen was greater than at the lower rate (Figure 2, Table 2). The cultivars showing this response were Shasta, Tanori, and Yecora Rojo. The second group consisted of cultivars whose yields were depressed to about the same degree by both rates of nitrofen (Figure 1). These cultivars included Anza, INIA 66R, Portola, Modoc, Cocorit 71, Crane, WS 3, and W 444. The final group consisted of cultivars which showed increased yield losses as the rate of nitrofen increased. These included MP 54 and Mexicali. When the crop injury rating and yields at the different nitrofen treatments were compared, it was found that the decreased yields were highly correlated with increased crop injury and that both MP 54 and Mexicali showed the most injury of all the varieties tested (Table 2).

Table 2. Effect of nitrofen on four wheat cultivars (1978)

Cultivar	Nitrofen (kg/ha) 0		3.36		6.72	
	Injury (0= none)	Yield (kg/ha)	Injury (0= none)	Yield (kg/ha)	Injury (0= none)	Yield (kg/ha)
Anza	0.0	5266	1.5	5027	4.0	4925
Shasta	0.0	3760	1.5	3522	1.7	3945
MP 54	0.0	3912	3.0	3432	6.0	3102
Mexicali	1.5	3791	5.5	3618	7.0	3214
LSD 0.05	1.2	401	1.2	401	1.2	401

However, the usefulness of the groupings of cultivars in their response to nitrofen is questionable, since the response of Shasta was completely different in the first year, showing yield loss at both rates of nitrofen, although the higher rate of nitrofen seemed less injurious than the lower rate (Figure 2 and Table 3). Group B, represented by Anza, responded in the first year with a slight increase in yield at both rates of nitrofen, due to release of competition from the annual bluegrass (Figure 2 and Table 3). Group C, represented by Mexicali, showed a large increase in yield at the low rate of nitrofen due to the release from bluegrass competition, but greatly reduced yield at the higher rate of nitrofen due to phytotoxicity (Figure 2 and Table 3). MP 54, on the other hand, showed no response at the lower rate of nitrofen, but a depression in yield at the higher rate (Table 3). In the first year the two cultivars most affected by nitrofen at the higher rate did show the greatest degree of crop injury (Table 3).

In conclusion, it appears that the most sensitive wheat cultivars to nitrofen were MP 54 and Mexicali, since their yield was depressed the most significantly at the highest rate of nitrofen. The other cultivars, except for Shasta, do not appear to be too sensitive to nitrofen, particularly at the 3.36 Kg/ha rate. Shasta appears to have a variable response to nitrofen depending on the environmental condition. The 1978 data show that nitrofen can significantly decrease the yield in all the varieties,

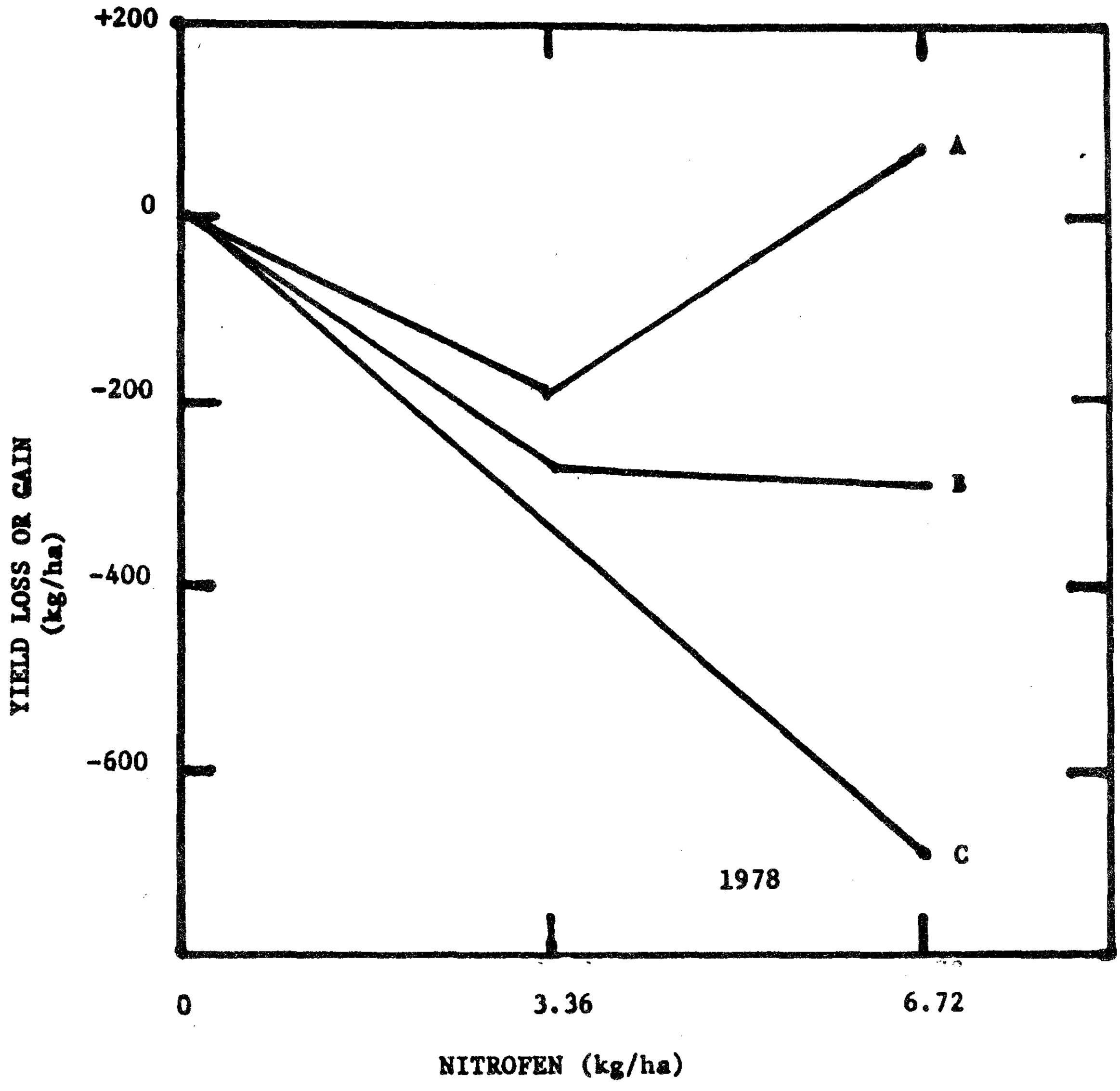


Figure 1: Effect of nitrofen on yield loss or gain of different wheat cultivars. A=Ave. of Shasta, Tanori, and Yecora Rojo; B=Ave. of Anza, INIA 66R, Portola, Modoc, Cocorit 71, W444, WS 3, and Crane; C= Ave. of MP 54 and Mexicali.

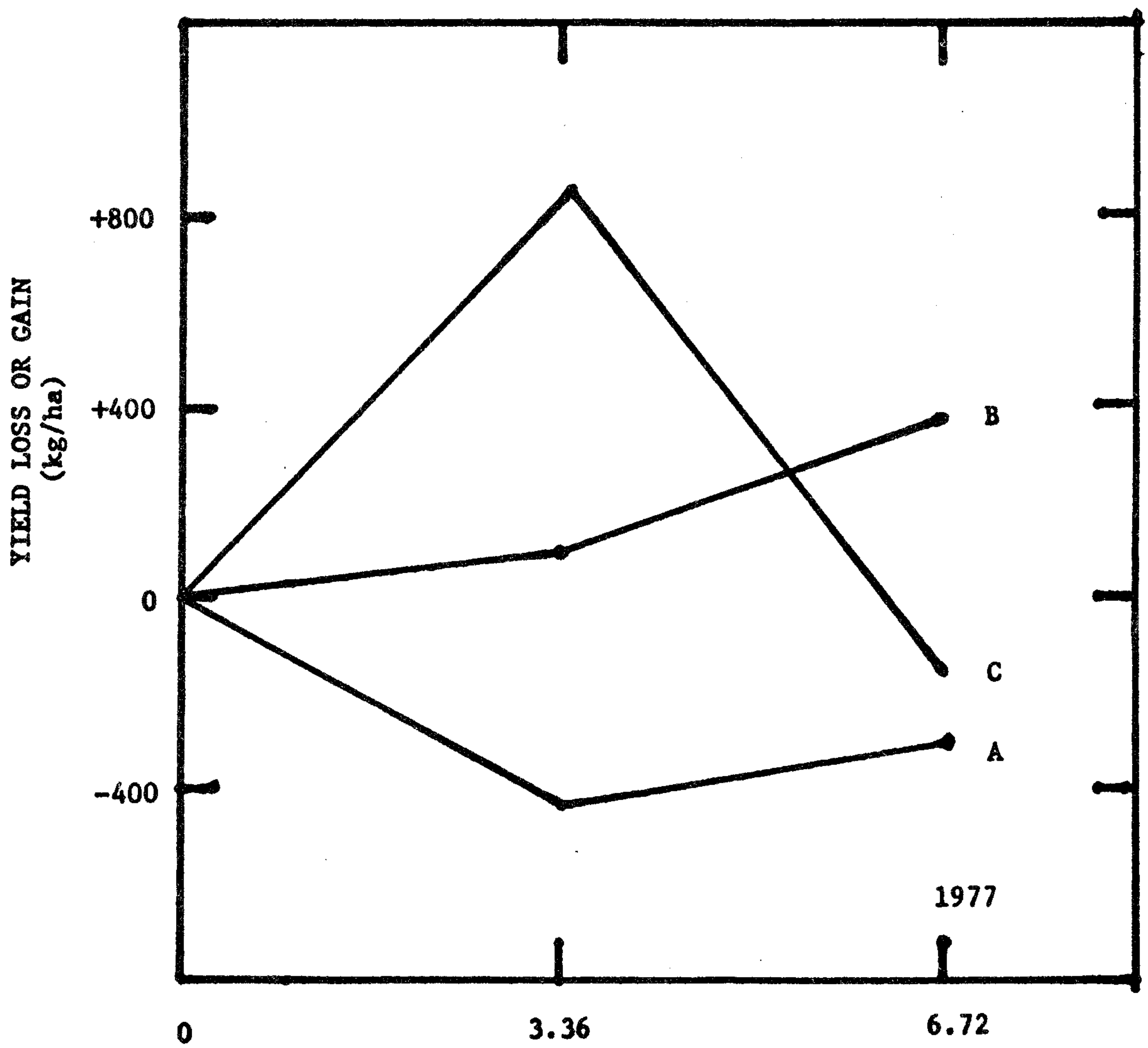


Figure 2: Effect of nitrofen on yield loss or gain of three wheat cultivrs. A=Shasta; B=Anza; C=Mexicali.

Table 3. Effect of nitrofen on four wheat cultivars (1977)

Cultivar	Nitrofen (kg/ha)					
	0		3.36		6.72	
	Injury (0= none)	Yield (kg/ha)	Injury (0= none)	Yield (kg/ha)	Injury (0= none)	Yield (kg/ha)
Anza	0.1	6089	1.2	6197	2.7	6457
Shasta	0.4	5117	1.1	4683	2.4	3945
MP 54	0.6	5138	2.8	5143	3.6	4859
Mexicali	2.0	4587	4.1	5464	6.6	4438
LSD 0.05	1.2	363	1.2	363	1.2	363

but this slight depression is more than overcome if there is a heavy infestation of a susceptible weed as can be seen from the 1977 data. From our results it appears that nitrofen could be used both effectively and selectively on most cultivars of wheat for pre-emergence weed control.

THE RESPONSE OF WHEAT GROWN WITH THREE POPULATION LEVELS OF CANARYGRASS TO VARIOUS HERBICIDE TREATMENTS

David W. Cudney and James E. Hill[1]

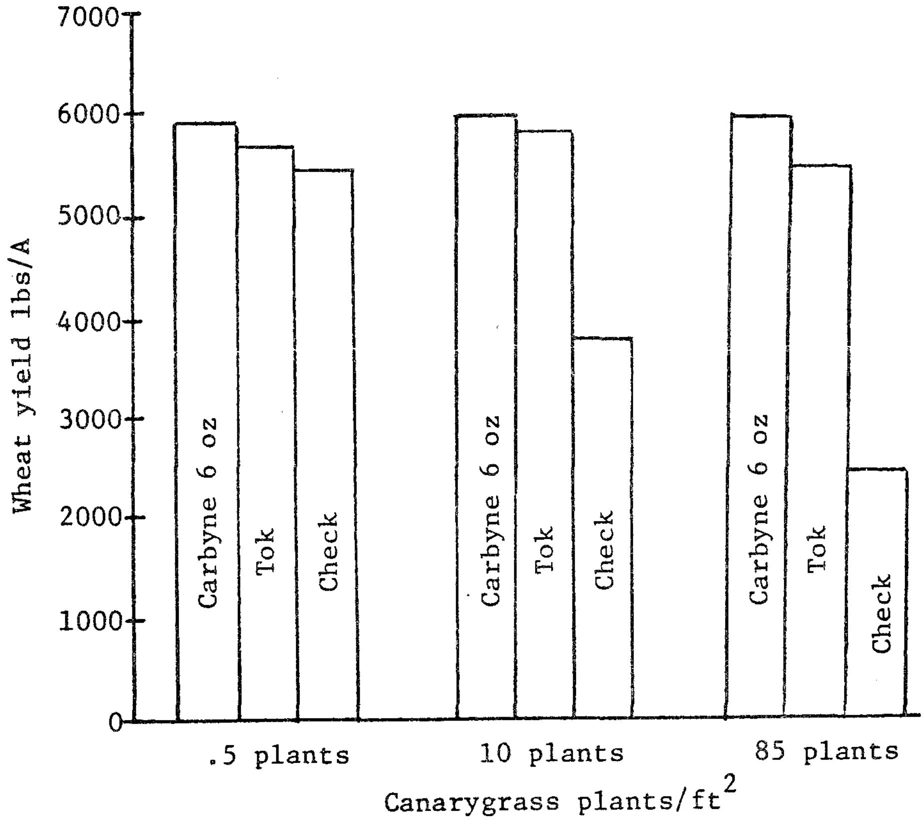
Abstract: Yields of Yecora Rojo wheat were reduced by 60 percent at the highest population (85 plants/square ft) of littleseed canarygrass, *Phalaris minor*. The intermediate canarygrass population (10 plants/square ft) caused a 40 percent reduction in yield. Preemergence treatment of nitrofen and postemergence treatment of barban were effective in controlling canarygrass. Hand removal of canarygrass in trials conducted in 1976, 1977 and 1978 was not an effective means of control and resulted in a 24 percent yield reduction in 1978.

Table 1. Percent reduction in yield at University of California Imperial Valley Field Station.

	1976 $2/ft^2$	1977 $10/ft^2$	1978 $49/ft^2$
Best herbicide treatment	0	0	0
Hand weeded	2	9	24
Unweeded control	10	31	63

[1]Extension Weed Scientist and Extension Agronomist, University of California Cooperative Extension.

Figure 1. Canarygrass polulation study[1]



[1]Trial conducted at University of California Imperial Valley Field Station, 1978.

A COMPARISON OF PRONAMIDE WITH THREE EXPERIMENTAL HERBICIDES FOR QUACKGRASS CONTROL IN ALFALFA

A. M. Nojavan and J. O. Evans[1]

Abstract: The herbicidal performance of pronamide [N-(1,1-dimethylpropynyl)-3,5-dichlorobenzamide], R-24315, HOE-29152, and VEL-5026 for selective control of quackgrass (*Agropyron repens* L. Beauv.) in established alfalfa (*Medicago sativa*) was investigated in the field. In this experiment, the effects of herbicide treatment with various dosages and plitting the dosage to make mutiple sequential applications were studied.

Introduction

Alfalfa, the queen of forage crops, has a production potential which exceeds most other forage species. It is a protein concentrate that is

[1]Plant Science Department, Utah State University, Logan, UT 84322

also high in energy, vitamins, and minerals. Factors which reduce the quantity and quality of alfalfa have a tremendous impact on agriculture and economy in general.

Quackgrass is one of the serious weed problems in cool, humid regions of the United States, Canada, Western Europe, and Northwestern Asia. In Utah, about 20 percent of cultivated lands are infested with this perennial weed. It competes dramatically with alfalfa and can seriously reduce the crop yield and its quality.

It is urgent to develop a control program for quackgrass in alfalfa and the most likely area of success is a selective herbicide which will complement the current tillage operations for the crop.

The purpose of this study was to evaluate the effects of pronamide on quackgrass and its potential as a herbicide in alfalfa fields. Further, to study the role of sequential applications on weed and crop growth and to compare three new candidate herbicides which show activity on quackgrass and some promises of selectivity for alfalfa.

Materials and Methods

A natural infestation of quackgrass in an established alfalfa field at North Logan, Utah, was selected as the site of field experiments. The design of the experiment was a split plot where the whole plots, 15 x 20 feet, were in randomized complete block design of 22 treatments each with four replications. The whole plots were further divided into three parts to make a split plot 5 x 20 feet, to test split dosage application. One whole plot in each block (replication) received no treatment and served as a control.

The whole plot treatments were applied in three different ways. First, the total dosage to be applied was administered as a single treatment in the late fall. The second method of applying the treatments was to divide the total dosage into two parts and make sequential applications about four months apart, one- half applied on November 5, 1976 and the other half on March 31, 1977. The third method of applying the herbicides was to divide the dosage into four equal parts and make four sequential treatments.

The evaluations were made twice during the season. They were made before the alfalfa blocked the quackgrass from view. Each plot was evaluated on two basis of 10 total points. The proportion of alfalfa and quackgrass was visually determined and numerical ratings assigned to the two components so that the sum of the components equalled 10. For example, a 5 - 5 evaluation signified an equal stand of alfalfa and quackgrass while a 9 - 1 rating meant approximately ninety percent of the plot area was occupied by alfalfa and ten percent by quackgrass.

Results and Discussion

For the first cutting of alfalfa, there were significant differences among the herbicide treatments. Splitting the dosage into multiple sequential applications did not produce meaningful differences. Quackgrass control was observed with all treatments (Table 1). Consequently, the total forage yield was reduced since quackgrass was a major component of the hay. Duke (1) and Fawcett and Harvey (2) found that by reducing quackgrass in alfalfa that forage quality was improved probably due to the reduced crop competition and increased availability of nutrients for the

Table 1. Response of alfalfa and quackgrass to different rate of pronamide, R-24315, and HOE-29152 at first and second cuttings of alfalfa; North Logan, Utah.

Herbicide treatments	Rate (kg/ha)	First alfalfa cutting			Second alfalfa cutting		
		Estimated plot area occupied by*		Quackgrass control (%)	Estimated plot area occupied by*		Quackgrass control (%)
		Alfalfa	Quackgrass		Alfalfa	Quackgrass	
Pronamide	1.12	8.1 ef	1.9	64.2	6.7 de	3.3	40.0
Pronamide	2.24	8.9 fg	1.1	79.2	9.0 gh	1.0	81.8
Pronamide	3.36	9.0 fg	1.0	81.1	9.6 h	0.4	92.7
R-24315	1.12	6.0 bc	4.0	24.5	5.5 a-d	4.5	18.2
R-24315	2.24	6.5 cd	3.5	33.9	6.7 de	3.3	40.0
R-24315	3.36	7.2 cde	2.8	47.2	7.2 ef	2.8	49.1
R-24315	4.48	7.4 de	2.6	50.9	8.6 gh	1.4	74.5
HOE-29152	1.12	5.3 ab	4.7	11.3	4.4 a	5.6	00.0
HOE-29152	2.24	6.0 bc	4.0	24.5	4.9 ab	5.1	7.3
HOE-29152	3.36	6.4 cd	3.6	32.1	5.6 bcd	4.4	20.0
Pronamide + R-24315	1.12 + 1.12	8.4 fg	1.6	79.8	8.5 gh	1.5	72.7
Pronamide + R-24315	2.24 + 2.24	8.7 fg	1.3	75.5	9.7 h	0.3	94.5
Pronamide + HOE-29152	1.12 + 1.12	7.4 de	2.6	50.9	6.5 de	3.5	36.4
Pronamide + HOE-29152	1.12 + 3.36	8.6 fg	1.4	73.6	8.0 fg	2.0	63.6
Pronamide + R-24315	3.36 + 1.12	8.8 fg	1.2	77.4	9.4 gh	0.6	88.7
Pronamide + HOE-29152	3.36 + 1.12	9.1 fg	0.9	83.0	9.7 h	0.3	94.5
Pronamide + HOE-29152	3.36 + 3.36	8.7 fg	1.3	75.5	9.2 gh	0.8	85.5
Pronamide + R-24315	2.24 + 1.12	9.2 fg	0.8	84.9	9.3 gh	0.7	87.3
Pronamide + HOE-29152	2.24 + 1.12	8.8 fg	1.2	77.4	8.6 gh	1.4	74.5
Pronamide + HOE-29152	2.24 + 3.36	9.1 fg	0.9	83.0	9.0 gh	1.0	81.8
R-24315 + HOE-29152	1.12 + 1.12	7.1 de	2.9	45.3	6.0 cde	4.0	27.3
Untreated control		4.7 a	5.3	0.0	4.5 ab	5.5	0.0

* Each value is the mean of 12 observations and represents the estimated plot area occupied by alfalfa or quackgrass on a 0 to 10 scale.

Values followed by the same letter are not significantly different at the 5 percent level as determined by Duncan's multiple range test.

crop.

Pronamide showed the best degree of quackgrass control at 3.36 kg/ha. R-24315 and HOE-29152 were less effective. When the herbicides were combined, the degree of quackgrass control increases slightly as compared to the single herbicide treatments in most cases, but the observed increases were not totally additive. Generally, neither synergism not antogonism were observed between herbicides in combinational treatments (Table 1).

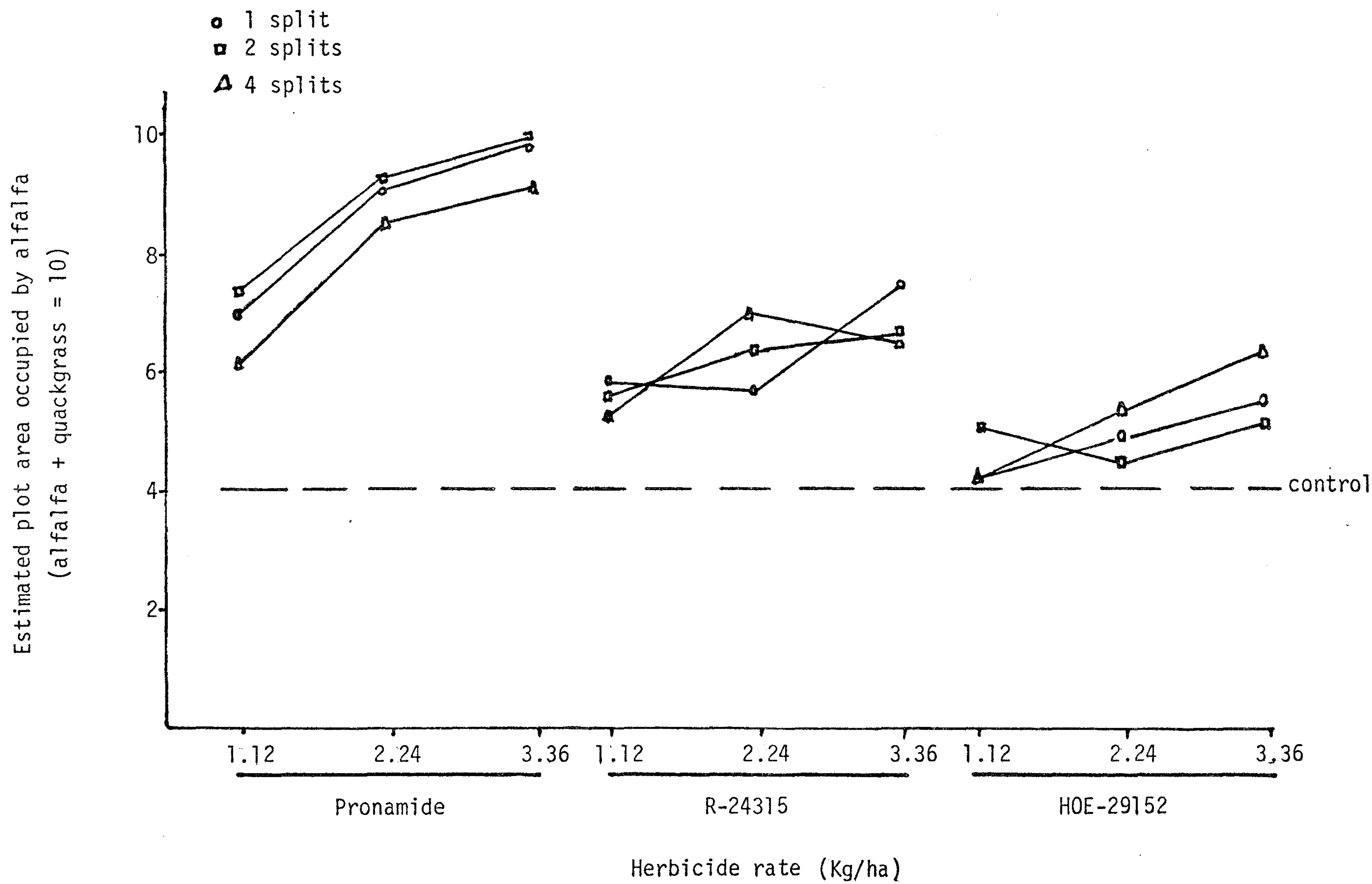
In the second alfalfa cutting, both the treatments and splitting the dosage and making multiple sequential applications were significant as shown in Table 1. Weed control with HOE-29152 decreased in all rates, whereas, control by pronamide and T-24315 increased slightly. Duncan's multiple range test revealed that splitting the dosage into two parts was more effective in controlling quackgrass than single dosage application or splitting the dosage into four parts (Figure 1). This is probobaly because applying half of the chemical in late fall gave some quackgrass control by killing some rhizome buds and the second half of the herbicide treatment applied in the early spring caused additional toxicity to the newly growing buds which survived the fall treatment. Another factor may have been less leakage of the herbicide when half of the total dosage was applied in each of two applications. Consequently, more chemical would have been present in the root zone when the rhizome buds started to grow and resulted in a higher degree of quackgrass control. VEL-5026 was tested along with other herbicides in the second field experiment. The treatments were made after the first cutting of alfalfa. Treatments containing VEL-5026 injured alfalfa severely. The older alfalfa leaves turned white and wilted, but the plants did not die. Eventually, the alfalfa recovered but was noticeably behind the untreated control in development. The results of this trial led to the conclusion that WEL-5026 must only be applied when alfalfa is dormant since the alfalfa foliage tissue is too sensitive to this herbicide.

Summary and Conclusions

All treatments reduced the amount of quackgrass to varying degrees, depending upon the herbicide being evaluated. Pronamide demonstrated the greatest potential when applied at 3.36 kg/ha as a pre-emergence herbicide. HOE-29152 as a pre-emergent chemical demonstrated poorer control of quackgrass when it was applied in the field. It appears necessary to apply it in the early spring when quackgrass rhizome buds start to sprout. Subsequent studies revealed its foliar activity with contact burning injury on quackgrass while it was extremely safe to non-dormant alfalfa. R-24315 was less effective under field conditions. VEL-5026 caused injury to non-dormand alfalfa but showed great promise for quackgrass control when applied properly. Splitting the dosage into two parts and making two sequential applications in late fall and early spring resulted in better quackgrass control in the field. There appeared to be very little benefit from combinational treatments of the herbicides in the field with no evidence of synergism or antagonism.

Literature Cited

1. Duke, W. B. 1970. Effects of RH-315 on quackgrass in established alfalfa. Proc. Northeast. Weed Control Conf. 24:220-226.



1 split
2 splits
4 splits
Estimated plot area occupied by alfalfa
(alfalfa + quackgrass = 10)
10
8
6
4
2
control
1.12
2.24
3.36
1.12
2.24
3.36
1.12
2.24
3.36
Pronamide
R-24315
HOE-29152
Herbicide rate (Kg/ha)

2. Fawcett, R. S. and R. G. Harvey. 1975. Long-term studies with pronamide for quackgrass in alfalfa. Northeast. Weed Control Conf. 30: 45-46.

ALFALFA IMPROVEMENT WITH METRIBUZIN HERBICIDE

Allen C. Scoggan[1]

Abstract: Two formulations of metribuzin were applied in large plot trials to evaluate performance and yield effects on three alfalfa seed fields in southwest Idaho. Results showed no differences between formulations or between December and March applications. No detrimental effects on yield and excellent weed control of many species were observed.

In addition, replicated small plots in two locations were used to evaluate three rates and two formulations of metribuzin for yield and quality of alfalfa hay. Use of metribuzine improved net alfalfa yields, and improved quality under heavy weed pressure.

A post-dormant application was used to evaluate any detrimental effects on yield of alfalfa sprayed after active growth began. No adverse effect was seen at 0.5 lb active metribuzin, but at 1.0 lb AI slight yield reduction of gross yield was measured.

[1]Mobay Chemical Corp. Boise, ID

USE OF CANADA THISTLE RUST AS A BIOLOGICAL CONTROL AGENT

K. L. Ososki, P. K. Fay, B. K. Sally, E. L. Sharp and D. C. Sands[1]

Abstract: Canada thistle (*Cirsium arvense* Scop.) is a major weed problem of cropland, range and pasture in the northern United States and Canada. It is a long lived perennial weed with a massive rhizome system. Canada thistle is an excellent candidate for biocontrol since 1) it thrives in many inaccessible habitats which are not easily treated with chemicals and 2) it produces abundant seeds which are widely disseminated by wind.

Puccinia obtegens is a host specific, autoecious rust pathogen of Canada thistle which occurs worldwide. It has been looked at as a possible biological control agent several times, starting first in 1895. Three independent attempts have been unsuccessful, however, recent developments in the field of biocontrol warrant a new effort at this time

Two spore stages have been compared as a means of controlled infection. Tests with urediospores indicate there is no spore dormancy and germination percentage is high; however, plants inoculated with urediospores produce only small localized pustules. Teliospores possess a dormancy mechanism influencing germination. Teliospore inoculation leads to a systemic, permanent infection which prevents seed production and reduces the competitive ability of Canada thistle. Techniques of dispersing spores in the field will be discussed.

[1]Agricultural Experiment Station, Montana State University, Bozeman MT 59717.

CANADA THISTLE (*CIRSIUM ARVENSE* L. SCOP.) IN TWO COLORADO COUNTIES

R. L. Zimdahl, C. H. Donahue and M. H. Jackson[1]

During the summer of 1977 personnel of the Colorado State University Weed Research Laboratory conducted a survey to determine the extent of Canada thistle infestation on irrigated cropland in Larimer and Weld Counties. In 1978 a study was conducted to determine yield losses caused by Canada thistle in three important irrigated crops. This paper reports the results of these two studies and establishes the fact that Canada thistle infestations are extensive in the two counties and by implication on the irrigated acreage of the Colorado Front Range counties. In addition, yield reductions caused by Canada thistle are very high.

In designing the initial survey, County Agents and Weed District personnel were consulted in each county and a route was planned through the irrigated cropland of the county. We predetermined the interval at which we would stop to survey cropped fields. The plan was followed except when designated sites were not agricultural, not irrigated or could not be surveyed because the crop was too large. The 1977 survey covered about 1% of the irrigated land in each county, with very little surveyor bias in site selection. Each field was covered on foot and Canada thistle (and other perennial weeds) was recorded as: 1 = absent, 2 = present but not reducing crop yield, or 3 = present and reducing crop yield. It is important to remember that these were visual estimates and no yield data were taken in 1977. Each survey site was recorded and we will be able to survey the fields in the future to determine the increase or decrease in infestation level.

As a result of the 1977 survey we project that Canada thistle was present on 5.6% of Larimer County's 102,447 irrigated acres (Table 1). Assuming our survey accurately reflects total acreage in the county, we

Table 1. Perennial weed survey - Larimer County - 1977

Weed	Infested[a] acres surveyed	Projected irrigated acreage infested
Cirsium arvense	56.2	5752
Convolvulus arvensis	41.6	4260
Franseria tomentosa	4.5	460
Euphorbia esula	8.2	839

[a]1001 irrigated acres were surveyed. Total irrigated acres in county = 102,447.

projected 5,752 acres of Canada thistle on the irrigated acreage in Larimer County. In Weld County we found only 3.7% of the 367,491 irrigated acres infested with Canada thistle but this equalled 13,965 acres of thistle (Table 2). We further project that about 80% (4,590 acres) of the land in Larimer County and 75% (10,473 acres) in Weld County had Canada thistle

[1]Professor and Res. Asst., Weed Res. Laboratory, Colorado State University, Fort Collins, CO 80523.

at a level high enough to significantly reduce crop yield.

Table 2. Perennial weed survey - Weld County - 1977

Weed	Infested[a] acres surveyed	Projected irrigated acreage infested
Cirsium arvense	118.9	13,672
Convolvulus arvensis	53.1	6,105
Franseria tomentosa	7.3	839

[a]3196 irrigated acres were surveyed. Total irrigated acres in county = 367,491.

The level of infestation for some crops is shown for the counties in tables 3 and 4. We recognize that the low acreage of some crops presents an inaccurate picture of the problem. Thus, we are not confident of the bean (*Phaseolus vurlagis* L.) and sugarbeet (*Beta vulgaris* L.) figures for Larimer County and the bean, onion (*Allium cepa* L.) and potato (*Solanum tuberosum* L.) data for Weld County.

Table 3. Perennial weed infestation by crop - Larimer County - 1977

		Percent of acres surveyed			
Crop	Acres surveyed	*Cirsium arvense*	*Convolvulus arvensis*	*Ambrosia tomentosa*	*Euphorbia esuls*
Corn	307	3.5	6.4	0.0	1.9
Sugarbeets	65	0.8	3.2	2.0	0.0
Barley	149	12.7	4.8	0.6	0.1
Beans	41	8.0	1.2	2.4	0.0
Alfalfa	298	3.3	0.2	0.1	0.8
Sorghum	91	0.2	1.2	0.0	0.0

These data illustrate that Canada thistle is as extensive as anyone thought it was. The infestation would have been larger if we had surveyed the dryland and ditchbank areas in each county which are regarded as sources for irrigated land. The data show the problem was most serious in barley (*Hordeum vulgare* L.) (representative of spring grains), corn (*Zea mays* L.) and sugarbeets. We are confident that our survey techniques accurately represent the two counties. Our results could be refined by surveying a larger acreage but this would not change our conclusions about the magnitude of the problem.

Although these data do establish the extent of the Canada thistle problem on the irrigated acreage of Larimer and Weld Counties they do not show how important the problem is. That is, they do not tell us the yield loss and therefore the dollar loss caused by Canada thistle in different crops. Data to answer these questions were collected during 1978, by selecting four barley, four sugarbeet and 7 corn fields which contained thistle patches and areas free of thistle. During harvest we returned to

Table 4. Perennial weed infestation by crop - Weld County - 1977

Crop	Acres surveyed	Percent of acres surveyed		
		Cirsium arvense	*Convolvulus arvensis*	*Ambrosia tomentosa*
Corn	1598	3.6	2.6	0.0001
Sugarbeets	188	16.3	0.0	0.0
Barley	244	15.2	1.2	0.3
Beans	67	0.4	0.7	2.4
Alfalfa	973	0.4	0.3	0.5
Onions	63	3.0	8.9	0.0
Potatoes	63	2.9	0.0	0.0

the pre-selected sites and counted the number of thistles in designated harvest areas, harvested the thistles and calculated a dry weight yield/A. The crop was harvested from areas infested with thistles and areas in the same field not infested. Four replicated yield samples were taken from weedy and non-weedy sites in each field and the data are reported for barley (Table 5), corn (Table 6) and sugarbeets (Table 7).

Table 5. The effect of Canada thistle on barley yield.

Location	Canada thistle		Barley yield (bu/A)	
	plants/sq yd	yield (lb dw/A)	with Canada thistle	without Canada thistle
B	16	1841	8.8a	25b
E	18	3178	19.0a	41b
M*	11	654	16.0a	20a
Z	13	2826	27.5a	46b
Avg.	14.5	2125	17.8	33

* Also had 27 wild oat plants/sg yd + 10.1 bu of wild oats/A.

Table 6. The effect of Canada thistle on corn yield.

Location	Canada thistle		Corn yield (bu/A)	
	plants/sq yd	yield (lb dw/A)	with Canada thistle	without Canada thistle
Da	13.4	1848	0.23	3.1
Di	9.9	486	0.23	2.3
H	25.0	2574	0.13	3.7
L	12.1	961	1.5	4.4
M	9.6	876	0.5	2.4
S	14.5	2308	1.1	3.3
T	5.6	208	2.8	4.4
Avg.	13.0	1587	0.93	3.4

The barley fields averaged 14 thistles/sq yd and yielded in excess of 1 ton dw/A and caused nearly a 50% reduction in barley yield. If we include only the 3 fields that had significant differences between yield with and without thistles (Locations B, E and Z) the figures are even more impressive. Only 15.7 thistles/sq yd produced 1/3 tons dw/A and reduced barley yield by slightly more than a factor of two. When barley is valued at $3.60/cwt the range of loss in value/A due to Canada thistle was $28 to $38 for the four fields surveyed.

In corn, an average of 13 Canada thistle plants/sq yd produced slightly more than 3/4 ton dw/A. On the average this reduced corn yield nearly three fold (from 3.4 to 0.93 T/A, Table 6). If shelled corn in valued at $4.50/cwt the range of loss in value/A due to Canada thistle was $144 to $321. These results will vary with fertility, soil, variety, irrigation and management techniques in each field. We have not assessed these because our interest was in determining yield loss, not the affect of various management techniques on yield loss.

Table 7. The effect of Canada thistle on sugarbeet yield.

	Canada thistle		Sugarbeet yield (T/A)	
Location	plants/sq yd	yield (lb dw/A)	with Canada thistle	without Canada thistle
B	46	4199	4.8	18.8
H	61	1629	10.2	23.3
K	27	1770	7.6	17.3
S	57	3224	7.3	17.3
Avg.	48	2706	7.5	19.2

The average of density of Canada thistle at four sugarbeet locations was 48/sq yd (Table 7) which was higher than that found in barley or corn. This is not surprising if one considers the fact that barley has a short growing season compared to sugarbeets; and corn, because of its height, is a more effective competitor. In this study, Canada thistle plant was defined as a single shoot. Because of the long growing season for sugarbeets, Canada thistle rhizomes could send up many more shoots late in the season and therefore the average number of shoots per unit area was high. The higher number of shoots produced an average 1.4 tons dw/A which was higher than that found in the other crops and reduced yield about 2.6 times. With a sugarbeet value of $26/T the range in value/A was $252 to $364.

Using the 1976 data for number of irrigated acres of barley, corn and sugarbeets grown in Larimer and Weld counties, the percent infestation found in our 1977 survey and the aforementioned values of each of the crops, we project the total loss on irrigated land in Larimer and Weld Counties was between $2,305,600 and $3,754,500 (Table 8). We recognize that this is an estimate based on a small sample of a large area. Nevertheless, we feel confident that the data do reflect the real situation and farmers in these two counties are suffering significant yield losses due to the presence of this one perennial weed.

Table 8. Projected total loss due to Canada thistle for three crops in Larimer and Weld Counties

	Total loss (1000 $)		
Crop	Low	Avg.	High
Barley	132.0	154.0	179.1
Corn	555.3	848.3	1237.8
Sugarbeets	1618.3	1949.1	2337.6
Total	2305.6	2951.4	3754.5

EFFECT OF SPRINKLER IRRIGATION WATER VOLUME FOR INCORPORATION OF THIOCARBAMATES AND METRIBUZIN HERBICIDES.

R. H. Callihan and P. W. Leino[1]

Abstract: Eptam and Vernam injected into sprinkler irrigation water resulted in better control of shallow and deep germinating wheat in a silt loam when followed immediately by 5 cm of sprinkler water than when followed with 2.5 or 1.25 cm of water. Eptam gave better control and moved slightly deeper than Vernam with slightly less recovery by soil analysis. Metribuzin sprayed on the soil surface before irrigation controlled germination of wheat more rapidly whem incorporated with 3.8 or 5 cm (1.5 or 2 in) of sprinkler irrigation water than with higher or lower amounts. Metribuzin incorporated with water at 7.6 or 10 cm (3 or 4 in) resulted in excellent control, but soil tube bioassays indicated incipient overleaching. Following very light irrigations for incroporationwith a heavier subsequent irrigation within a weed markedly improved control, but eventual control was not as complete as with adequate (3 cm) initial irrigation.

Studies indicate that normal irrigation amounts will not leach these herbicides excessively on silt loam soils, but suggest that heavy irrigations appear likely to do so on lighter soils.

[1]Associate Professor and Research Assoc., University of Idaho Research & Extension Center, Aberdeen, ID 83210.

SELECTIVE ACTIVITY OF DMSO-TRITON X-100 SOLUTIONS ON SEED GERMINATION.

Paul S. Zorner[1], R. L. Zimdahl[1], and E. E. Schweizer[2]

Abstract: Topical application of dimethyl sulfoxide (DSMO) and Triton X-100 prevented seed germination of *Avena fatua* L. (wild oat), *Cirsium arvense* L. (Canada thistle), and *Senecio jacobea* L. (tansy ragwort).

[1]Weed Research Laboratory, Dept. Botany and Plant Pathology, Colorado State University, Fort Collins, CO 80523.

[2]Crops Research Laboratory, USDA, SEA, Fort Collins, CO 80523.

Solutions containing greater than 7% DSMO and 15,000 ppm Triton X-100 completely presented germination of wild oat, Canada thistle, and tansy ragwort seed during a 31-day germination period. Seed germination of wheat (*Triticum aestivum* L.) was not affected when treated in a similar manner.

Foliar application of DSMO-Triton X-100 solutions to point of run-off to wild oat and wheat panicles 10 days after anthesis completely prevented germination of mature, after-ripened wild oat seed. Seed germination of wheat was not affected.

Our evidence suggests application of DSMO-Triton X-100 solutions to mature wild oat, Canada thistle, and tansy ragwort plants may prevent the production of viable seed. Thus, the number of seeds, produced by these species, in soil would decrease each year. The selectivity of DSMO-Triton X-100 solutions may be of use in investigating germination processes.

FLURIDONE: AN EXPERIMENTAL HERBICIDE FOR AQUATIC PLANT MANAGEMENT SYSTEMS.

C. M. Rivera, S. D. West, and J. Perez[1]

Fluridone (1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1*H*)-pryidinone) provided control of a broad spectrum of emerged and submersed aquatic vascular plants when applied to still water ponds at rates of 0.5 lb/A or greater. Phytotoxic effects became apparent over a two- to four-week period during which time the new growth of the aquatic plants became chlorotic, while existing mature vegetation did not. Depending on plant species and chemical rate, complete control was observed to occur between one to two months after treatment. Fluridone provided effective control of spikerush, three-square bulrush, sago pondweed, American pondweed, hollyleaf naiad, and southern naiad. No adverse effect on fish, shoreline vegetation, water quality, or dissolved oxygen content was noted.

Introduction

Fluridone was introduced by Lilly Research Laboratories as a herbicide for preemergence weed control in cotton (5). Subsequent studies have shown fluridone to be active in aquatic systems as well (4). Fluridone has a water solubility of about 12 ppm and a vapor pressure of less than 1×10^{-7} mm Hg at 25C. It is moderately susceptible to decomposition by ultraviolet irradiation in aqueous solution and stable to hydrolysis at pH 3, 6, and 9. Toxicological data for fluridone indicate that it has a low order of toxicity (1).

Preliminary results indicated that when fluridone was applied over or directly under the water surface, or as a bottom-layered treatment, it provided control of a number of submersed and emersed aquatic plant species. It is most effective against root aquatic vascular weeds. Fluridone injury typically causes a bleaching or chlorosis of new tissue due to an inhibition of carotenoid synthesis such that chlorophyll is no longer protected from photodegradation (3).

In 1978 field studies were initiated in California to evaluate fluridone efficacy on several weed species (Table 1) and effect on water

---

[1]Plant Science Representative, Analytical Chemist, Asst. Technician, Lilly Res. Laboratories, Fresno CA, Greenfield IN, and Fresno CA respectively.

quality and non-target organisms in western aquatic systems.

Materials and Methods

Several still water ponds were located and surveyed to determine size, depth, weed population and distribution, proximity of desirable shoreline vegetation and the nature and extent of aquatic life. The latter included, but was not limited to, fish, insects, frogs, tadpoles, ducks and geese. A four lb/gal aqueous suspension (4AS) of fluridone was applied at rates of 0.75, 1, 1.5 and 2 lb/A as a surface treatment or layered bottom acre-foot treatment. A five percent pellet (5P) formulation of fluridone was applied at rates of 0.5, 0.75, 1 and 2 lb/A as a surface treatment. Surface applications were made using a hand-held spray gun for the spray formulation and a hand-held granular spreader for the pellet formulation. Bottom layering applications were made with two weighted trailing hoses set five feet apart and pulled by boat along the bottom of the pond. The pump was operated at 70 psi and delivered 10 gallons per minute. Spray volume was 60 gallons per acre. The treated ponds ranged in size from 0.1 to 1.2 acres with an average depth of 3 to 4 feet. At the time of treatment, all of the weed species were already established.

Table 1. List of aquatic weed species evaluated in this study.

American pondweed	*Potamogeton nodosus*
California bulrush	*Scirpus californicus*
Cattail	*Typha* sp.
Holly leaf naiad	*Najas marina*
Sago pondweed	*Potamogeton pectinatus*
Southern naiad	*Najas guadalupensis*
Spikerush	*Eleocharis palustris*
Three-square bulrush	*Scirpus americanus*
Tule	*Scirpus acutus*

Each of the ponds were monitored to assess any effect by the treatment on non-target organisms and water quality. Measurements and observations included dissolved oxygen, pH, and temperature at several points in the water column. At one of the ponds which was treated with fluridone 4AS at 1 lb/A bottom-layered, water samples were obtained for chemical residue analysis and assessment of the effect on plankton. Hydrosoil samples were also taken from the same pond for chemical residue analysis and effect on benthic organisms. All measurements and monitoring were performed at pretreatment (i.e., prior to treatment), 1, 3, 7, 14, 28 days after treatment and 2, 4, and 6 months after treatment. Each observation was made at three stations within each pond. Individual water and hydrosoil samples were composited for analysis.

Results

Weed control. Fluridone effectively controlled many of the submersed aquatic weeds and provided fair to good control of emergent vegetation when applied at rates of 0.5 lb/A or greater regardless of formulation (Table 2). The initial phytotoxic effects of fluridone were observed three to seven days after treatment and gradually increased over a two-to four-week period (Table 3). Control (85 percent or greater) was generally observed within four to eight weeks after treatment. Initially susceptible plants developed a chlorosis of the new growth, while existing mature vegetation remained unaffected. In time, however, the entire plant would sink to the bottom and rot.

Table 2. Percent control of aquatic vegetation 57 days after treatment.

Weed species	Fluridone (lb/A) 0.5	0.75	1.0	1.5	2.0
Submersed					
Sago pondweed	95	95	90	99	99
American pondweed	99	99	99	--	--
Holly leaf naiad	--[a]	--	--	--	95
Southern naiad	--	--	85	--	90
Emerged					
Tule	--	0	--	--	5
Cattails	--	--	70	--	90
California bulrush	--	75	65	90	95
Spikerush	95	80	85	95	99
Three-square bulrush	--	--	80	--	95

[a]A dash (--) indicates not present or observed in the treatment.

Table 3. Percent control of several aquatic weed species after treatment with fluridone 4AS.

Days after treatment	Sago pondweed		Spikerush		California bulrush	
	1 lb/A	2 lb/A	1 lb/A	2 lb/A	1 lb/A	2 lb/A
3	0	0	0	0	0	0
7	30	5	15	1	1	1
14	50	30	60	20	35	10
27	40	25	75	60	40	85
56	90	99	85	99	65	95
117	85	98	65	80	45	75
169	30	70	50	75	20	0

During the six-month observation period, it was noticed that several weed species appeared to recover from the early effects of fluridone. California bulrush, cattails and common tule initially exhibited the characteristic bleaching injury from fluridone; however, by the fourth month, they had overcome some of the effects and by the sixth month appeared essentially unaffected. At 1 lb/A, complete control of sago pondweed was generally observed for the first three to four months. During the fourth month, a few springs were noted along the perimeter of a couple ponds. This regrowth continued to increase into the sixth month, albeit at a rate slower than plants observed in untreated ponds.

The method of application did not significantly affect fluridone activity. However, there were some early differences in rate of activity due to formulation (Table 4). The 5P formulation was slower acting than the 4AS formulation during the first two weeks after treatment. At comparable rates, initial injury symptoms were more severe with the 4AS formulation, but by the end of the first month little difference could be observed. Later there were essentially no differences.

Table 4. Percent control of three-square bulrush as influenced by fluridone formulation.

Days after treatment	Fluridone 2 lb/A	
	4AS	5P
3	0	0
7	5	1
14	50	25
27	85	65
56	95	95
117	95	90
169	99	99

Environmental data. Fluridone treatments did not appear to have an effect on non-target aquatic life based on empirical observations. Aquatic life included tadpoles, frogs, insect activity, fish activity, snails and wildlife fowl. The dissolved oxygen concentration and pH level of the ponds were also not significantly affected by fluridone treatment.

Desireable turf, bushes, and trees located in close proximity to the treated ponds were also unaffected. The vegetation included bentgrass, pampas grass (*Cortaderia selloana*), pine trees, and willow trees. Most were often found immediately adjacent to the water's edge. In several instances, willow tree roots were clearly visible in the pond. At one location, a willow branch which was partly submerged in the treated water appeared to exhibit fluridone injury; however, the injury was limited to the exposed area.

Water samples taken from a pond treated with fluridone 4AS at 1 lb/A bottom-layered were collected for fluridone analysis and are summarized in Table 5. Samples taken from the top and bottom of the water column were analyzed separately to observe concentration gradients which might be present. However, the concentration of fluridone was not dependent upon the depth of sampling, and an average concentration was thus calculated from the top and bottom sample values on each date.

The maximum concentration of fluridone in the water was observed to be 0.090 ppm at 1 day after treatment, and the concentration steadily decreased with time to 0.003 ppm at 117 days after treatment. The disappearance of fluridone from the treated water was logarithmic with time and followed a first order rate of dissipation (Figure 1). In this trial, fluridone exhibited a half-life of approximately 17 days in the pond water.

Table 5. Dissipation of fluridone from pond water treated at 1 lb/A bottom-layered.

Days after treatment	Fluridone (ppm)			Percent Remaining
	Top	Bottom	Average	
1	.091	.088	.090	100
3	.081	.052	.067	74
7	.054	.059	.057	63
14	.052	.053	.053	59
27	.032	.029	.031	33
56	.013	.012	.013	14
117	.003	.003	.003	3

The accumulation and dissipation pattern for fluridone in the hydrosoil is presented in Table 6. Fluridone residues in the sediment gradually increased to a maximum of 0.5 lb/A at 27 days after treatment. This maximum value represented fifty percent of the initial 1 lb/A application rate. The concentration of fluridone in the hydrosoil then declined to 0.08 lb/A, or 8 percent of the applied fluridone, after 117 days.

Table 6. Accumulation and dissipation of fluridone in hydrosoil from a pond treated at 1 lb/A bottom-layered.

Days after treatment	Residue (lb/A)	Percent of applied
1	0.06	6
3	0.17	17
7	0.15	15
14	0.26	26
27	0.50	50
56	0.16	16
117	0.08	8

The bioaccumulation of fluridone in the edible and nonedible portions of five fish species collected from the treated pond was also determined (Table 7). The bioaccumulation factor ranged from 0 to 18.4 indicating that fluridone did not bioaccumulate in any of the fish species.

Data pertaining to the effect of fluridone on phytoplankton, zooplankton and benthic organisms were not available at this writing. However, previous studies have indicated no detrimental effects with fluridone levels as high as 1 ppm (2, 4).

Summary

Fluridone is a broad spectrum, aquatic herbicide which slowly controls

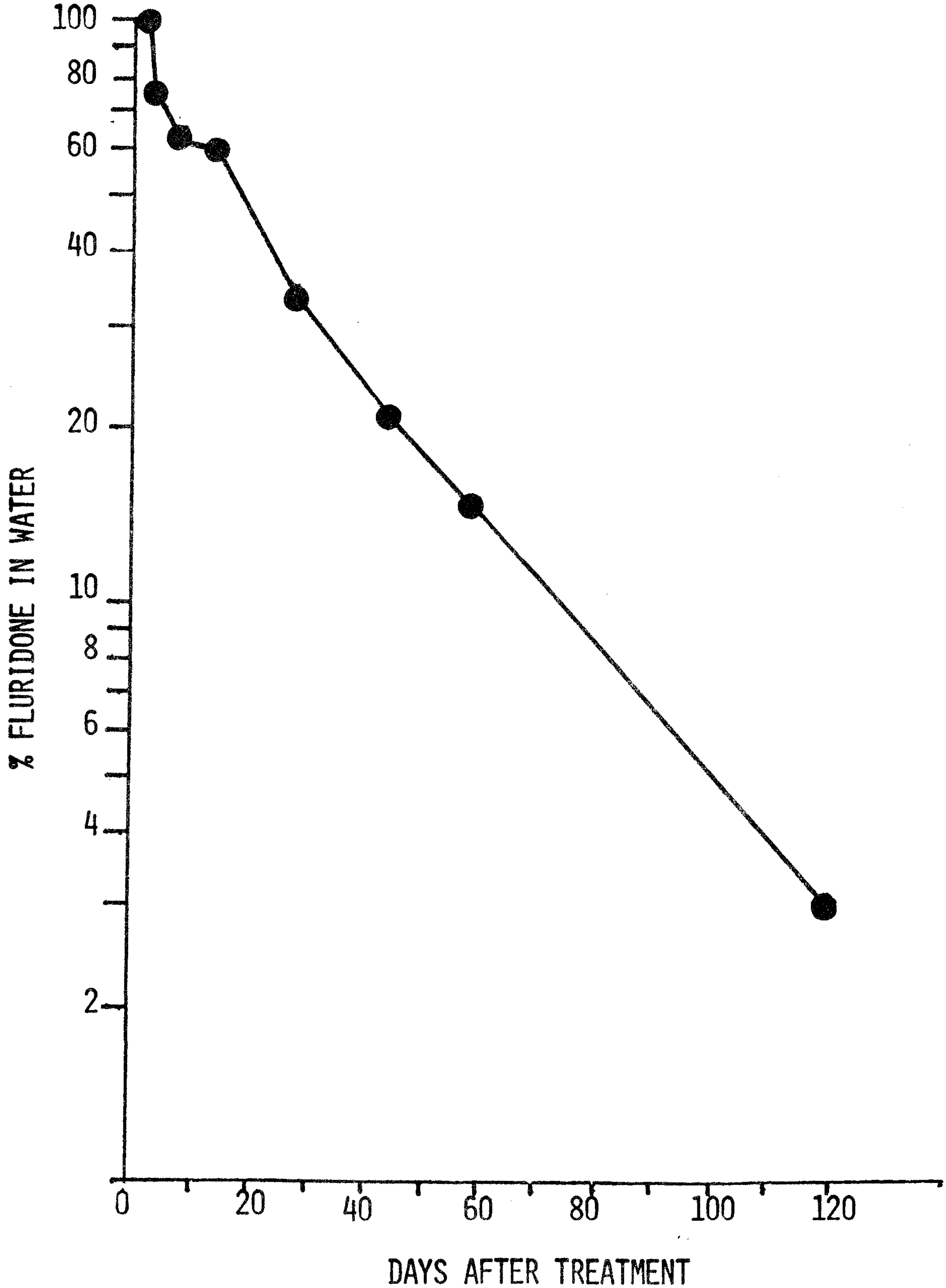


Figure 1. The disappearance of fluridone from treated water.

Table 7. Bioaccumulation of fluridone in fish from a pond treated at 1 lb/A bottom-layered.

Days after treatment	Fish species	ppm in fish		Bioaccumulation factor	
		Edible	Inedible	Edible	Inedible
14	Largemouth bass	NDR[a]	.031	0.0	0.6
28	Bluegill	NDR	NDR	0.0	0.0
	Black bullhead	.016	.016	0.5	0.5
56	Bluegill and Redear	NDR	NDR	0.0	0.0
	Largemouth bass	NDR	NDR	0.0	0.0
	Brown bullhead	.150	.239	11.5	18.4
117	Bluegill and Redear	NDR	NDR	0.0	0.0
	Black Bullhead	NDR	NDR	0.0	0.0

[a]NDR = No detectable residue at a test sensitivity of 0.010 ppm.

the target weeds with little to no disruption of oxygen level or pH. It is apparent from the residue data that as fluridone dissipated from the water column and the hydrosoil, a concurrent reduction in weed control was also being seen. The length of control was dependent upon treatment rate and in these studies control was obtained for about four months for 1 lb/A treatment. The studies conducted also demonstrated that there was little to no effect on non-target organisms, fish, and other aquatic life. Additional research is being conducted to further refine necessary rates, time of application, and method of application.

Literature Cited

1. Anonymous. 1978. Technical report of EL-171, an experimental herbicide for aquatic plant management systems. Lilly Research Laboratories, Indianapolis, IN.

2. Arnold, W. R. 1978. Fluridone - A new aquatic herbicide. Proc. Aquatic Plant Management (in press).

3. Bartels, P. G. and C. W. Watson. 1978. Inhibition of carotenoid synthesis by fluridone and norflurazon. Weed Sci. 26:198-203.

4. Parka, S. J., W. R. Arnold, M. C. McCowen and C. L. Young. 1978. Fluridone: A new herbicide for use in aquatic weed control systems. Proc. EWRS 5:179-187.

5. Waldrep, T. W. and H. M. Taylor. 1976. 1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1*H*)-pyridinone, a new herbicide. Agric. Food Chem. 24:1250-1251.

CHANGES IN THE NUMBER OF WEED SEEDS IN IRRIGATED SOIL UNDER TWO MANAGEMENT SYSTEMS

E. E. Schweizer and R. L. Zimdahl[1]

Abstract: Most annual weeds produce a prolific number of seeds each year. Although dependable seed control results when different weed control methods are applied to specific cropping situations, weeds still reduce U. S. agricultural production 10 to 15% annually. This experiment was designed to assess the impact of a selected combination of weed control techniques (system A) on the yearly weed problem, the weed seed potential of the soil, and crop production. Two crop rotations, i.e., corn-sugarbeet-barley or continuous corn, were employed to produce these crops under two systems of management. In system A, the best established weed control practices and techniques were integrated to reduce quickly the anticipated large weed population in the soil. In system B, practices employed by a typical Colorado farmer were followed. The experiment was initiated in 1975 and all treatments were replicated four times. The average number of weed seeds per hectare found initially in the upper 25 cm of the soil profile was over 1,309 million in the rotational crop plots, and over 1,225 million in the continuous corn plots. Weed seeds from four annual genera--*Amaranthus, Chenopodium, Portulaca,* and *Setaria* --were found in all plots. In addition, *Echinochloa, Kochia,* and *Polygonum convolvulus* were present in most of the rotational crop plots. After three cropping years the greatest depletion in the total number of weed seeds occurred in the continuous corn plots. The overall decline in the total number of weed seeds in both systems of management was 67%. Further, only a few weeds survived the cultural and chemical treatments and produced seed during the first three years. In the rotational cropping system, weed control has been more effective under system A management than under system B management; however, more weeds escaped in the rotational cropping system than in the continuous cropping system. The overall decline in the total number of weed seeds for both systems of management in the rotational cropping system was 49%. To date, significant differences in crop yields have not occurred between management systems.

---

[1]Agricultural Research, Science and Education Admin., U.S. Dep. Agric., and Dep. Bot. & Plant Path., Colorado State University, respectively, Fort Collins, CO 80523.

EVALUATION OF GLYPHOSATE IN COMBINATION WITH VARIOUS HERBICIDES FOR SOD-SEEDING.

V. R. Stewart, L. E. Welty and P. F. Hensleigh[1]

Abstract: Sod-seeding with the use of a minimum-till drill and a non-selective herbicide to control the competing sod offers great potential for pasture renovation. Successful establishment of interseeded species depends upon control of weeds that emerge after the non-selective

---

[1]Montana Agric. Exp. Stn. Northwestern Agric. Res. Cnt., Kalispell, MT

herbicide application. We evaluated various herbicides in combination with glyphosate [*N*-(phosphonomethyl)glycine] for season long weed control when interseeding 'Apollo' alfalfa (*Medicago sativa* L.) into a grass sod.

In 1977 we tested methazole [2-(3,4-dichlorophenyl-4-methyl-1,2,4-oxadiazolidine-3,5-dione], napropamide [2-(α-naphthoxy)-*N*,*N*-diethylpropionamide], and R24315 (chemistry confidential). Glyphosate provided excellent sod control throughout the season. None of the herbicide combinations controlled emerging broadleaved weeds. However, napropamide appeared to reduce competition from emerging grassy weeds. The addition of a herbicide with glyphosate did not affect stand establishment. All herbicide treatments resulted in higher numbers of alfalfa plants/ft^2 than the seeded check. Also, percentage of alfalfa in the 1978 hay crop was greater for all herbicide treatments than for the seeded check.

We tested R40244 [1-(*m*-trifluoromethyl)-3-chloro-4-chloromethyl-2 pyrrolidone], buthidazole (3-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-yl]-4-hydroxy-1-methyl-2-imidazolidinone), EPTC (*S*-ethyl dipropylthiocarbamate) and napropamide in 1978. As in 1977, glyphosate provided excellent sod control. Napropamide controlled germinating grassy weeds. R40244 and buthidazole controlled germinating broadleaved weeds. Buthidazole reduced stands and vigor of interseeded alfalfa, but did not affect first harvest forage yield. First harvest yields the seeding year ranged from 2-2.5 T/A, with no differences occurring among herbicide treatments.

A PORTABLE TERMINAL DATA GATHERING AND MINICOMPUTER PROCESSING SYSTEM

P. W. Leino and R. H. Callihan[1]

Abstract: An electronic data logger (MSI/77) can be used in the field or laboratory to record observations. The data are transferred from the logger to the calculator (HP9825A) via a serial modem through a calculator program and stored on a magnetic disk unit. If desired, an immediate statistical analysis (ANOVA, Duncan's Multiple Range Test, etc.) and a 'hard' copy of the data can be printed.

This system greatly reduces errors and data processing time by elininating all manual transcription and allowing an immediate statistical analysis of the data. Further manipulation of the data is facilitated by the disk storage. Data can be repeatedly called off the disk at any time and again, without manual transcription, manipulated either on the calculator or via telephone interface with more sophisticated computers.

Concern about the lack of a 'hard' copy in the field is eased by the construction of the data logger with line review and modified functions to check suspect data lines in the field together with a liquid crystal display in which the data can be checked before it is physically entered into the memory. Two sets of batteries assure data retention, and a low battery lockout feature prevents data entry and indicated about fifty hours of memory storage left allowing adequate time to transfer data to the calculator.

This system: (1) reduces error by eliminating manual transcription, (2) reduces terminal time by rapid electronic transfer of data to the computer, (3) allows the researcher to rapidly respond to current

---

[1]Research Assoc. & Assoc. Res. Professor, respectively, University of Idaho Res. & Ext. Center, Aberdeen, ID 83210.

experimental data or other conditions because of rapid data processing, (4) encourages adherence to statistically analyzeable forms of recorded data, (5) encourages computerized data storage and retrieval, and (6) allows automated access to large computers.

A SEQUENTIALLY-SWITCHED, SOLENOID CONTROLLED PLOT SPRAYER

P. W. Leino and R. H. Callihan[1]

Abstract: A two-man, three-point hitch-mounted, platform plot sprayer was modified to accept electronically operated solenoid valves. The sprayer initially consisted of a platform on which a hydraulic motor-run compressor, two air storage tanks, a single one-gallon stainless steel chemical holding tank, a series of manual valves, a detachable twelve-foot boom and a five-gallon disposal tank were mounted. Manual valves were replaced with solenoid valves; a second one-gallon stainless steel chemical holding tank was added, allowing one tank to be filled while the other was emptying. The sequential switch consists of a six-position rotary switch with an indicator light on each position. Overrides are possible for all sequence operations. A 'pressure in tank' indicator is on each tank.

The main advantages of this system are: (1) decreased possibility of error permitted by the automatic valve sequencing enabled with electronics, (2) increased speed of chemical application, and (3) better accuracy due to transfer of all time-critical operations to one operator.

[1]Research Assoc. & Assoc. Res. Professor, respectively, University of Idaho Res. & Ext. Center, Aberdeen, ID 83210.

THE EFFECT OF TEMPERATURE AND PHOTOPERIOD ON HERBICIDE TRANSLOCATION IN THREE WOODY PLANT SPECIES

S. R. Radosevich and D. E. Bayer[1]

Abstract: The effect of photoperiod and temperature on the translocation of triclopyr, picloram, and 2,4,5-T were studied on tonoak, snowbush ceanothus, and bigleaf maple. Isolation of ^{14}C and analysis for the radioactive herbicides revealed little metabolism of the herbicides. Regardless of herbicide or plant species, herbicide movement was greatest under warm temperature and long day conditions. Among the herbicides tested, ^{14}C associated with triclopyr was the most mobile in each species.

[1]Dept. of Botany, University of California, Davis, CA 95616

CHEMICAL CONTROL OF ORANGE HAWKWEED ON RANGELAND

W. O. Noel, W. S. Belles, D. W. Wattenbarger and G. A. Lee[1]

Abstract: Orange hawkweed, *Hieracium aurantiacum* L., is a perennial member of the Asteraceae family. It has recently become a problem weed in pasture lands in sections of North Idaho. Field studies were initiated in Benewah County, Idaho to determine methods of control and yield reductions associated with this weed. Control on two locations, a lowland-flat site and an upland site with 20% slope was 85% or better in both locations with five of 16 herbicide treatments. These were all either picloram or picloram + 2,4-D combinations. The 2,4-D + picloram combinations resulted in better control than comparable rates of picloram alone. Forage yields on the upland site were increased by as much as 15 times that of the untreated control. Increases on the lowland site were much smaller with a maximum forage increase of 24% over the untreated control.

[1]Idaho Agricultural Experiment Station, Moscow, ID.

THE CONTROL OF BIG SAGEBRUSH ON CENTRAL IDAHO RANGELAND

D. W. Wattenbarger, W. S. Belles and G. A. Lee[1]

Abstract: Big sagebrush is a troublesome weed that limits productivity of Idaho's rangelands. A study was initiated on rangeland near Donnelly, Idaho on Agril 25, 1977 to evaluate the performance of herbicides applied in oil and water to big sagebrush while still dormant and the subsequent effect on forage yields. Forage consisted of native perennial and annual grasses. Treatments were applied with a three-nozzled boom pack sprayer at a 5 gpa rate using ss 8001 nozzles. Plots were 2 sqaure rods in size (18 x 30 ft) replicated three times in a randomized complete block design. Visual evaluations of percent control were taken on June 6, 1938. Forage was harvested on August 16, 1978 from two 2.5 ft diameter circles, dried and weighed.

Visual evaluations showed significant big sagebrush control with all treatments one year after application. The highest percent control (98%) was obtained with the two 2,4-D LV ester plus niacin treatments with oil as the carrier. The poorest control was obtained with the 2,4-D plus triclopyr at 1.0 plus 1.0 lb ai/A. This treatment with water as a carrier gave poorer control than where applied with oil. The 2,4,5-T oil at 2.0 lb ai/A resulted in poorer big sagebrush control than 2,4-D plus niacin at 2.0 lb ai/A with the oil carrier. No difference was found between the 2,4,5-T-water treatment and the 2,4-D plus niacin-water applications.

Dry forage was significantly increased by six of the eight herbicide treatments. These six treatments averaged 1728 lb of dry forage per acre compared to 520 lb on the untreated control.

[1]Idaho Agricultural Experiment Station, Moscow, ID.

Applications of 2,4-D LV ester and 2,4,5-T LV ester at 2.0 and 3.0 lb ai/A to dormant big sagebrush resulted in acceptable control and substantial forage increases. The experiment has been repeated in a second location in 1978 with additional treatments designed to assess the value of added niacin.

Table 1. The effect of herbicides on big sagebrush control and forage yields.

Herbicide	Carrier	Rate (lb ai/A)	% Control 6/6/78	Dry Forage Yield (lb/A) (8/16/78)
2,4-D (LV ester) + Niacin[1]	oil	2.0	98 a[2]	1590 a[2]
2,4-D (LV ester) + Niacin	oil	3.0	98 a	1530 a
2,4-D (LV ester) + Niacin	H_2O	2.0	89 ab	1630 a
2,4-D (LV ester) + Niacin	H_2O	3.0	93 ab	1650 a
2,4,5-T (LV ester)	oil	2.0	75 bc	1230 ab
2,4,5-T (LV ester)	H_2O	2.0	80 abc	1880 a
2,4-D (LV ester) + triclopyr	oil	1.0 + 1.0	68 c	2090 a
2,4-D (LV ester) + triclopyr	H_2O	1.0 + 1.0	35 d	1310 ab
Untreated control	-	-	0 e	520 b

[1]Niacin at 8.0 gm/A

[2]Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

EFFECTS OF SOIL APPLIED HERBICIDES ON FORAGE PRODUCTION AND BOTANICAL COMPOSITION IN SOUTHERN ARIZONA RANGELANDS

H. L. Morton[1]

Abstract: Tebuthiuron, karbutilate and picloram were applied at rates ranging from 0.5 to 4.0 lb a.i./A for control of woody plants and to determine their effects on forage production. Forage production on the treated plots was estimated by the weight-estimate method. Dry weight of forage produced over at least a 3-year period after treatment with tebuthiuron at 0.0, 0.5, 1.0, 2.0 and 4.0 lb a.i./A averaged 423, 521, 912, 1155 and 1312, respectively. Forage production on plots treated with picloram at 4 lb a.e./A over the same 3-year period average 1455 lb/A. Forage production on plots treated with tebuthiuron at 1 and 2 lb a.i./A yielded an average of 968 and 1166 lb/A, respectively. Untreated check plots yielded 608 lb/A over the same period. Plots treated with karbutilate at 1 and 2 lb/A produced average forage yields for the same 3-year period of 1243 and 1212 lb/A, respectively. Species composition of the

[1]U.S. Department of Agriculture, SEA-AR, 2000 East Allen Road, Tucson, AZ 85719.

forage did not change significantly on plots treated at rates of 2 lb/A or less with tebuthiuron, karbutilate or picloram. However, rates of tebuthiuron above 2 lb/A caused reductions in stands of Arizona cottontop, Rochrock grama, and slender grama but stands of perennial threeawns and Lehmann lovegrass increased. All three herbicides reduced stands of bushmuhly when applied at rates above 2 lb/A.

HERBICIDAL CONTROL OF JUNIPERS

Thomas N. Johnsen, Jr.[1]

Abstract: Attempts to reduce or prevent juniper encroachment on grazing lands have been made since near the beginning of this century. A variety of chemicals were tried, but systematic testing was not begun until the late 1930's. Since then a large number of herbicides have been evaluated for effectiveness in controlling junipers. Most herbicides failed the tests.

The junipers' crown, with its tightly packed foliage and dense branchlets, make it difficult to cover the tree crown uniformly with sprays. The position, shape, and anatomy of the leaves make it difficult for spray droplets to adhere to and penetrate into the leaf. High volume spray applications, adjuvants, or herbicides which would be washed off the foliage by rainfall and absorbed by the tree roots will kill junipers. Junipers have widespread, shallow lateral root systems which readily absorb herbicides from the soil. Regrowth of damaged trees from dormant buds occurs with some juniper species.

Of the few herbicides which control the various juniper species most could not be used. Some, such as arsenic, are too dangerous to use. Others, such as various chlorinated benzoic acids, were excessively expensive or difficult to make. Then others, such as fenuron and karbutilate, were withdrawn from the market for various reasons. There are presently two herbicides which show promise for controlling junipers: picloram and tebuthiuron. Both are effective as either individual plant or as broadcast applications. Tebuthiuron is applied to the soil as a pelleted formulation, being effective with applications of two lb a.i./A. Tebuthiuron is till in the experimental stage of development and is not yet available for juniper control. Picloram controls junipers both as foliage or soil applications. Pelleted picloram has received special local needs registration in several western states.

Herbicides have a place in overall juniper management programs for controlling junipers encroaching on grazing lands and maintaining areas treated by other control methods. Herbicides eliminate half-shrubs in the sucessional patterns following juniper control. In Arizona, areas controlled with herbicides have reached peak forage production in three to five years after treatment. Herbicidal control has been the only control method which has resulted in significant increases of water yield after killing the junipers. Herbicides are the only means of controlling sprouting species such as alligator and red berry juniper.

---

[1]U.S. Department of Agriculture, SEA, AR, 2000 East Allen Road, Tucson, AZ 85719.

DICLOFOP AND ETHOFUMESATE COMBINATIONS FOR ANNUAL WEED CONTROL IN SUGARBEETS

L. B. Jensen and J. O. Evans[1]

The purpose of this experiment was to determine the effect of weed control that could be obtained with different rates of diclofop methyl (methyl 2-[4-(2,4-dichlorophenoxy)phenoxy]-propanoate), ethofumesate (2-ethoxy-2,3-dihydro-3,3-dimethyl-*t*-benzofuranyl methanesulphonate) and their mixtures in sugarbeets. Diclofop has not yet recieved registration for sugarbeet applications, but it does look promising for annual grass control. Other work (1,7) has shown it to be particularly effective on foxtails, barnyardgrass and wild oats. It has very little activity with dicotyledonous plants.

Ethofumesate is a relatively new herbicide that has just recently received full registration for use in sugarbeets. Research (3,4,5) has shown it to be effective on annual grasses and many broadleaved weeds. Mixtures of ethofumesate and other herbicides have been reported (2) to have synergistic activity on certain weed species. Also, ethofumesate in combination with other herbicides has shown more consistant herbicidal activity. High levels of ethofumesate have been reported (6) to decrease the recoverable sugar. This experiment was designed to: 1) observe the weed control of diclofop and ethosumesate alone and in combination with each other, 2) observe the weed control of diclofop and other sugarbeet herbicide combinations, 3) note any synergistic effects upon weed control, 4) measure herbicide injury on the sugarbeets, 5) determine the effect on yield and sugar content, and 6) measure preemergence and postemergence response.

Materials and Methods

The experiment was set up in a randomized block design with three replications. The plots were 50 ft in length by 6 rows wide. Two locations were chosen for the study, one at Logan and one in northern Cache Valley, Utah. Unfortunately, the field conditions ar the north Cache Valley site were so poor that beet and weed emergence was too spotty to evaluate.

Some of the plots were treated preemergence, some postemergence, and some were given a preemergence and a postemergence treatment. Cycloate was used as a reference treatment. The control was kept weed free throughout the growing season. Any weeds still actively growing at the time of thinning were removed to simulate cultural practices followed locally. Soil type was a milville silt loam. The herbicides were applied in 20 gal/A of water with a bicycle plot sprayer. The preemergence herbicides were incorporated immediately after application with a triple-K harrow set to a depth of two inches and double harrowed, the second time diagonally from the first. The postemergence applications were made when the 2nd pair of true leaves were beginning to emerge. The broadleaf weeds were in the 2-4 leaf stage and the grasses in the 1-2 leaf stage.

In addition, a set of postemergence treatments were applied to a field of sugarbeets near Bear River City, that was heavily infested with barnyardgrass. The grass was in the 3-4 leaf stage and the broadleaf weeds were in the 4-6 leaf stage at the time of application. Dalapon was used as a reference treatment.

---

[1]Plant Science Department, Utah State University, Logan, UT 84322.

The weeds present in both plots included barnyardgrass, redroot pigweed, lambsquarter, and kochia.

Results and Discussion

In the preemergence trials, all applications of diclofop gave acceptable barnyardgrass control. In the postemergence trials, the 1.5 lb/A diclofop was inadequate for grass control but the higher rates did give adequate control. As expected, it gave no broadleaf control when applied alone.

Ethofumesate preemergence gave excellent barnyardgrass and broadleaf weed control at both the 3.0 and 6.0 lb/A rates. The control was equal for both rates. No beet injury was noted.

The dichlofop + ethofumesate preemergence combinations gave excellent barnyardgrass and broadleaf weed control at the higher rates. The lower rates gave less grass control but the broadleaf control was not reduced. The postemergence applications of diclofop + ethofumesate did give a slightly reduced broadleaf control but the grass control was enhanced. The diclofop at 1.5 lb/A + the ethofumesate at 2.0 lb/A appeared adequate for weed control when used postemergence but might be weak on grass control in preemergence applications. The highest rate of ethofumesate + diclofop preemergence showed a slight beet injury but none was observed in any of the other preemergence treatments. However, the postemergence combinations showedmuch more beet injury, even at the lower rates. The beets rapidly outgrew the injury symptoms and no significant differences were noted between the preemergence and postemergence applications.

There were no significant differences between the reference treatment, cycloate, and the preemergence ethofumesate or ethofumesate + diclofop treatments.

The postemergence treatments of diclofop + pyrazon, diclofop + dalapon, and dalapon gave inadequate control of either grass or broadleaf weeds. There appeared to be an antagonistic relationship with diclofop and dalapon but further research would need to be done to substantiate it.

Diclofop + phenmedipham + desmedipham postemergence gave good weed control at the Bear River City site but poor broadleaf weed control at the Logan site. The diclofop + ethofumesate sombinations gave good weed control at both sites. The diclofop + ethofumesate combination appears to give more consistent herbicidal activity than diclofop + phenmedipham + desmedipham.

There were no significant differences among yields or sugar content with any of the treatments. This is probably because the treatments were all kept weed-free after thinning. No synergism was noted with ethofumesate and the other herbicides used upon any weed species.

Literature Cited

1. Anderson, R. N. 1976. Response of monocotyledons to HOE 22870 and HOE 23408. Weed Sci. 24:266-269.

2. Eshel, Y., R. L. Zimdahl and E. E. Schweizer. 1976. Basis for interaction of ethofumesate and desmedipham on sugarbeets and weeds. Weed Sci. 24:619-626.

3. Holmes, H. M., R. K. Pfeiffer and W. Griffiths. 1974. Pre-emergence and post-emergence use of ethofumesate in sugarbeet. Proc. 12th Brit. Weed Contr. Conf. pp. 493-501.

An Evaluation of Several Preplant and Postemergence Herbicides for Sugarbeets

Treatment	Method of appl.	Rate (lb/A)	Sugarbeet response: Beets/ 100 in. of row	Beet injury (0-10)	Yield ton/A	Sugar %	Weed response: Broad-leaf	Barnyard-grass
diclofop	PPI	2.0	28 a	0	16.88 a	14.84 a	27 c	86 a
diclofop	PPI	4.0	28 a	0	18.40 a	15.12 a	0 d	74 a
ethofumesate	PPI	3.0	27 a	0	16.68 a	14.55 a	98 a	100 a
ethofumesate	PPI	6.0	25 a	0	16.63 a	14.85 a	99 a	100 a
diclofop + ethofumesate	PPI PPI	1.0 + 1.5	26 a	0	18.94 a	14.23 a	94 a	86 a
diclofop + ethofumesate	PPI PPI	1.5 + 2.0	26 a	0	17.84 a	14.88 a	97 a	74 a
diclofop + ethofumesate	PPI PPI	2.0 + 3.0	25 a	0	17.73 a	14.77 a	97 a	100 a
diclofop + ethofumesate	PPI PPI	4.0 + 6.0	25 a	1	18.75 a	14.77 a	97 a	100 a
diclofop + phenmedipham + desmedipham	PPI POST POST	1.5 + .5 + .5	25 a	0	17.33 a	14.50 a	27 c	100 a
diclofop	POST	2.0	25 a	0	17.38 a	14.25 a	0 d	84 a
diclofop	POST	4.0	25 a	0	17.59 a	14.56 a	26 c	52 a
diclofop + phenmedipham + desmedipham	POST POST POST	1.5 + .5 + .5	29 a	1	16.49 a	14.50 a	23 c	86 a
diclofop + phenmidipham + desmedipham	POST POST POST	2.0 + .5 + .5	28 a	1	15.74 a	14.88 a	50 b	83 a
cycloate	PPI	3.0	27 a	0	18.21 a	14.58 a	89 a	100 a
diclofop + ethofumesate	POST POST	1.5 + 2.0	26 a	2	17.53 a	14.46 a	90 a	93 a
control	.		26 a	0	17.53 a	14.74 a	0 b	0 d

(ratings in the same column followed by the same letter are not significantly different at the 0.5 level)

(Beet injury scale: 0 = no injury, 10 = complete kill)

An Evaluation of Several Post-Emergence Herbicides for Sugarbeets

Treatment	Rate (lb/A)	Sugarbeet Response: Beet injury (1-10)	Sugarbeet Response: Yield Ton/A	Sugarbeet Response: Sugar %	Weed Response (% Control): Broadleaf	Weed Response (% Control): Watergrass
diclofop	1.5	0	25.94 a	16.52 a	53 bcd	61 bcd
diclofop	2.0	1	24.40 a	16.16 a	12 e	86 ac
diclofop	2.5	0	26.47 a	16.40 a	13 de	78 ad
ethofumesate	1.5	2	25.29 a	16.10 a	78 ab	53 cd
ethofumesate	2.0	3	26.33 a	15.91 a	80 a	61 bcd
ethofumesate	2.5	3	26.89 a	15.90 a	81 a	61 bcd
diclofop + ethofumesate	1.0 + 1.0	3	24.75 a	16.55 a	66 ac	82 ac
diclofop + ethofumesate	1.5 + 1.0	3	23.86 a	16.97 a	71 ab	78 ad
diclofop + ethofumesate	1.0 + 2.0	3	24.95 a	15.81 a	86 a	82 ac
diclofop + ethofumesate	1.5 + 2.0	3	26.88 a	16.39 a	82 a	88 ab
diclofop + phenmedipham + desmedipham	1.5 + .5 + .5	2	24.28 a	16.86 a	79 a	91 a
diclofop + phenmedipham + desmedipham	1.5 + .75 + .75	1	25.20 a	16.44 a	86 a	88 ab
dalapon	4.0	0.5	24.99 a	16.40 a	3 e	0 e
diclofop + pyrazon	1.5 + 6.0	0	27.84 a	16.54 a	43 de	63 bcd
diclofop + dalapon	2.0 + 2.0	0.5	28.26 a	16.12 a	31 ce	59 bcd
control		0	27.58 a	16.31 a	0 e	0 e

4. Norris, R. D., J. P. Orr and R. A. Lardelli. 1973. Preplant incorporated herbicides for barnyardgrass control in sugarbeets. West. Soc. Weed Sci. Res. Prog. Rpt. pp. 153-154.

5. Sarpe, N., O. Segarceanu, L. Ciorlaus, I Popovici, I. Clotan and C. Nagy. 1974. The efficiency of herbicides based on pyrazone, ethofumesate, lenacil, and phenmedipham, used alone or in combination, in sugarbeets grown under Romanian conditions. Proc. 12th Brit. Weed Contrl Conf. pp. 477-483.

6. Sullivan, E. F., L. O. Britt and K. W. Chisholm. 1976. Ethofumesate applications on sugarbeets. West. Soc. Weed Sci. Res. Prog. Rpt. pp. 147-149.

7. Wu, C. and P. W. Santelmann. 1976. Phytotoxicity and soil activity of Hoe 23408. Weed Sci. 24:601-604.

WEED CONTROL IN SUNFLOWERS--AN ALTERNATIVE CROP FOR THE PACIFIC NORTHWEST

L. K. Hiller and D. A. Deerkop[1]

Oilseed production has increased substantially in North American agriculture in recent years. Acreage of the major U.S. oilseeds (soybeans, cottonseed, sunflowers, peanuts, and flax) increased from 49 million acres in 1949 to 82 million in 1978; a gain of 33 million acres. Another indicator of growing importance is the crop value--barely $1 billion in 1949, the value climbed steadily to $3 billion in 1969, and then rose dramatically to an estimated $12 billion in 1978. An important reason is the world demand for vegetable protein, fats and oils, not only in industrial nations but also in many of the developing nations.

Tremendous interest has developed in the past two to three years for alternative crops in the Pacific Northwest-specifically directed towards oil crops such as soybeans and sunflowers. Production of sunflowers in the Pacific Northwest in 1978 was on approximately 12,000 acres, with approximately 9 to 10,000 acres in Washington State. Preliminary production studies have shown that culture of sunflower has great potential as an alternative crop; it also shows promise as a succession crop following an early crop such as peas, etc., to growers in the Pacific Northwest, but that weed control programs must be studies and planned for increased yields, quality, and profitability.

There are certain herbicides registered in the U.S. for sunflowers--barban, chloramben, dinitramine, EPTC (Minnesota and North Dakota only), profluralin, and trifluralin. These compounds have not been tested under Washington conditions and soils. The objective of these experiments was to evaluate the registered herbicides and other potential experimental materials for weed control efficacy and crop tolerance (Table 1).

Three experimental plots were established in 1978, one in the light sandy soils of the Columbia Basin and two in the heavier silt loam soils of the Palouse area. The sunflower cultivar 'Master Farmer Oilmaster Hybrid' was used in all three experiments; each plot was six rows wide.

---

[1]Department of Horticulture and Landscape Architecture, Washington State University, Pullman, WA 99164

Table 1. Visual evaluation ratings, yield, and quality results from 1978 sunflower herbicide screening trials.

Treatment No.	Treatment Chemical	Form.	Rate (lbs ai/A)	Timing	Experiment I (Columbia Basin) Days to 50% Bloom	Days to 100% Bloom	Crop Injury	Yield (lbs/A)	Dockage (%)	Moisture (%)	Test wt. (lbs)	Oil Content (%)	Experiment II (Palouse) Yield (lbs/A)	Experiment III (Palouse) Yield (lbs/A)
1.	Chloramben	2EC	3.0	PPI	74	81	0	2388	9.575	8.3	32.0	39.05	NI[z]	NI
2.	Chloramben	2EC	2.5	PPI	79*	85*	4	1123	16.4	8.55	30.9	35.83	NI	NI
	(TM)+EPTC	7EC	3.0	PPI										
3.	Dinitramine	2EC	0.33	PPI	75	81	1	2529	10.825	8.325	32.3	39.93	NI	NI
4.	Pendimethalin	4EC	1.0	PPI	74	81	0	2403	12.625	8.35	32.4	39.87	1933	2509
5.	Profluralin	4EC	1.0	PPI	75	81	0	2313	11.05	8.275	32.3	39.70	2144	2182
6.	Profluralin	4EC	0.75	PPI	78*	85*	5	1350	12.625	8.575	31.2	35.00	1779	2545
	(TM)+EPTC	7EC	3.0	PPI										
7.	Ethalfluralin	3EC	2.0	PPI	76	83	0	2241	8.575	8.5	31.0	40.03	2183	2418
8.	Alachlor	4EC	3.0	PPI	78*	84*	0	2183	8.95	8.425	32.1	38.53	1904	2364
9.	Metolachlor	8EC	3.0	PPI	76	81	0	2162	9.55	8.4	31.4	39.33	2298	2345
10.	Oryzalin	4AS	1.0	PPI	75	81	0	2435	12.525	8.325	31.8	40.10	2000	2509
11.	Vernolate	7EC	3.0	PPI	75	81	2	1973	9.7	8.175	31.4	38.18	2048	2181
12.	EPTC+Safener	6.7EC	3.0	PPI	78*	86*	5	1133	9.55	8.3	31.1	34.68	1894	2400
13.	EPTC	7EC	3.0	PPI	79*	85*	4	1208	12.0	8.425	30.6	35.30	2164	2145
14.	Trifluralin	4EC	0.75	PPI	79*	86*	5	1168	19.0	8.5	31.3	35.48	1837	2181
	(TM)+EPTC	7EC	3.0	PPI										
15.	Trifluralin	4EC	0.75	PPI	75	82	0	2254	8.925	8.425	32.0	39.53	2048	2509
	(TM)+Propham+PCMC	3FL	3.0	PPI										
16.	Trifluralin	4EC	0.75	PPI	76	82	0	2332	8.825	8.1	32.1	39.60	2317	2473
	(TM)+Chlorpropham+PCMC	4EC	3.0	PPI										
17.	Trifluralin	4EC	0.75	PPI	74	81	0	2320	9.9	8.45	32.0	39.03	2144	2364
	+Diclofop	3EC	1.0	PostE										
18.	Trifluralin	4EC	0.75	PPI	76	83	0	2105	8.3	8.325	31.9	39.83	2000	2364
	+Barban	1EC	0.375	PostE										
19.	Trifluralin (check)	4EC	1.0	PPI	75	80	0	2208	20.575	8.5	31.8	39.25	NI	NI
20.	Pendimethalin	4EC	1.0	PreE	NI	NI	0	----	------	-----	-------	-----	1885	2545
21.	Cultivated check	---	-----	-----	75	80	0	----	------	-----	-------	-----	----	----
							LSD 5%	410.0	5.0	0.32 NS	1.4 NS	1.45	454	374

*Significantly different from the check at 5% level.

[z]NI = Not included in this experiment.

All herbicide treatments applied with a CUB tractor-mounted plot sprayer in 20 gpa and 30 psi.

Experiment I. Columbia Basin area--Lind, WA.

Soil: 0.6% OM, pH 6.4, CEC 9.8%, 35.4% sand, 54.8% coarse silt, 1.2% fine silt, and 9.6% clay.

Methods: Normal seedbed preparation and fertilization, sprinkler (hand line "solid set") irrigation, planted May 8 on 22-inch row centers at population of 24,000 plants per acre. Preplant treatments applied May 5 and incorporated immediately with double discing with packer at right angles. Postemergence treatments applied June 5.

Experiment II. Palouse area--Palouse, WA.

Soil: 4.6% OM, pH 5.4, CEC 23.9%, 17.4% sand, 56.2% coarse silt, 3.8% fine silt, and 22.6% clay.

Methods: Fall plowed following wheat harvest; fertilization and seedbed preparation in spring, no irrigation, planted May 26 on 22-inch row centers at final population of 18,000 plants per acre. Preplant treatments applied May 26 and incorporated immediately with springtooth cultivator. Preemergence and postemergence treatments applied June 3 and June 29, respectively.

Experiment III. Palouse area--Farmington, WA.

Soil: 6.4% OM, pH 5.6, CEC 27.4%, 18.4% sand, 56.4% coarse silt, 4.4% fine silt, and 20.8% clay.

Methods: Seedbed preparations same as Experiment II. Sunflowers planted May 21. Preplant treatments applied May 20 and incorporated immediately with springtooth cultivator. Preemergence and postemergence treatments applied June 3 and June 11, respectively.

Results and Conclusions

The critical period for weed control in sunflowers was from planting to the time of "row cover." Once the plants had reached this height and stage of development, they provided a tremendous amount of natural competition to weeds; thus, any late-germinating weeds tended not to be major problems in the plots. All the herbicides provided good to excellent weed control (ratings 8 to 10) and, therefore, were not included in this report. Crop phytotoxicity was caused by EPTC and the other thiocarbamates in the Columbia Basin plot, but not in the Palouse plots (Table 1). This injury was observed approximately five weeks after planting (18 days following full emergence). Plants were stunted and twisted, leaves showed severe marginal necrosis. Plant stand was reduced and multiple heading was observed in those plants which did develop. Yields were reduced in these treatments in the Columbia Basin plots; however, sunflower yields did not differ significantly in either of the Palouse plots.

Additional research is planned to attempt to elucidate factors involved in this differential crop susceptibility to EPTC damage between the two growing areas. These herbicide evaluations must be repeated in other years, but it appears promising that the presently registered compounds and several experimental materials will provided excellent weed control for sunflowers in the Pacific Northwest.

YELLOW AND PURPLE NUTSEDGE VEGETATIVE PROPAGULE PRODUCTION AND THE EFFECT OF MSMA AND GLYPHOSATE

M. Kogan and M. I. Gonzalez[1]

Abstract: The relationship between propagule production, the non-structural carbohydrate content of the tubers throughout the cycle of growth of purple nutsedge (*Cyperus rotundus* L.) and yellow nutsedge (*Cyperus esculentus* L.), is discussed. The effect of MSMA (monosodium methanearsonate) and glyphosate [*N*-(phosphonomethyl) glycine] was also studied. In both species, tuber production began 10 days after emergence. Tuber and new shoot production were more vigorous in purple than in yellow nutsedge. The glyphosate effect on tuber production was greater when it was applied 21 days after emergence than when applied in the pre-flower stage for both species. Twenty-one days after emergence, both species had 9 to 11 leaves and only a few new tubers. The overall herbicidal effect was greater with glyphosate than with MSMA.

Introduction

In Central Chile, perennial weeds represent a major agricultural problem. Yellow and purple nutsedge are particularly important. These two species compete in beans, vegetable crops, orchards, and vineyards in some localities. *Cyperus* species are considered quite efficient utilizers of CO_2 as they are C_4 plants (8). In addition to their competitive effects, tubers of both species have been shown to produce toxic substances which can inhibit the growth of other species (1, 4). Reproduction is mainly by tubers in both species, as sexual reproduction is relatively unimportant due to low seed viability (8). Mechanical tillage favors dissemination of propagules. The objectives of this study were to describe the relationship between vegetative propagule production and the carbohydrate content of the tubers through the growth cycle. The herbicidal effects of MSMA and glyphosate, applied at different rates and timint, were also determined.

Materials and Methods

Vegetative propagule production and total available carbohydrate content of the tubers. Polyethylene bags were placed in the field, above the soil; each bag contained 10 kg of soil and 4 tubers. All bags were irrigated every three days. Shoot emergence occurred 10 days after planting the tubers. Tubers were planted on January first. After shoot

---

[1]Department of Agricultural Production, University of Chile, Casilla 1004, Santiago, Chile

emergence, plants from three bags were harvested every ten days. The number of new shoots, rhizomes and tubers were counted. The tubers were later analyzed for carbohydrate content using the enzymatic method of Weinmann (9) described by Smith et al. (5). Essentially the sample was mixed with water and refluxed in a boiling water bath to gelatinize any starch. The mixture was then incubated at 38C for 44 hours with a buffered takadiatase enzyme preparation. Proteins were removed with neutral lead acetate and the lead was removed with potassium oxalate. A 10 ml aliquot of the filtered solution was hydrolyzed with 0.5 ml of 25% HCl for 30 min in a boiling water bath. The solution was cooled, neutralized with sodium hydroxide solution, and diluted to volume with distilled water. Carbohydrate content of the above solution was determined by analyzing for reducing power with the Shaffer-Somogyi copper-iodometric titration method, using fructose standard solutions. The results were expressed as percent total available carbohydrates on a dry weight basis.

Effect of MSMA and glyphosate. A factorial design experiment with three replications was arranged to study the effect of MSMA and glyphosate on tuber production. MSMA and glyphosate were sprayed at three different rates: 0.5, 1.0 and 1.5 percent of commercial products. (Commercial products contained 35.41 and 36 percent MSMA and glyphosate, respectively). Each herbicide was applied to both yellow and purple nutsedge at two growth stages: 9 to 11 leaf stage (21 days after shoot emergence) and preflower stage (48 and 66 days after shoot emergence for purple and yellow nutsedge, respectively). The herbicides were applied using a laboratory sprayer, each bag received 2.5 ml of herbicide solution. This volume did not produce run-off. One hundred days after shoot emergence the total dry weight (70C for 48 hr) of the subterranean part and the number of tubers per plant were determined. At that time the control plants of both species were producing seeds.

Results and Discussion

Vegetative propagule production. In both species (Figure 1) the initiation of tuber production began 10 days after shoot emergence. After two months, tuberization increased at a greater rate than the production of new shoots. Tumbleson and Kommedahl (7) reported that production of tubers in yellow nutsedge began 56 days after shoot emergence, while Horowitz (2) observed tuberization in purple nutsedge after 28 days. These observed differences are probably due to different environmental conditions. According to Jansen (3) growth is initiated at late spring, probably in response to warming temperatures that do not occur until the photoperiod is longer than 14 hours. Subsequently, increasing day length promotes rapid shooting and rhizome proliferation. After the diminishing photoperiod reaches 14 hr, vegetative growth ceases; and plants initiate flowering. Also, rhizome differentiation into tubers accelerates.

Rhizome production in both species was greater than tuber production, and was initiated before formation of tuber and/or new shoots (Figure 1). Purple nutsedge produced chains of tubers interconnected by rhizomes; each tuber had the potential to produce from one to four new shoots. Yellow nutsedge, however, produced only one terminal tuber per rhizome.

Tuber carbohydrate content. From Figure 1 it can be seen that the parent tubers had 34 percent non-structural carbohydrate. The parent tuber carbohydrate content decreased as the plant growth was initiated. Then days after emergence the parent tuber carbohydrate content was minimum and

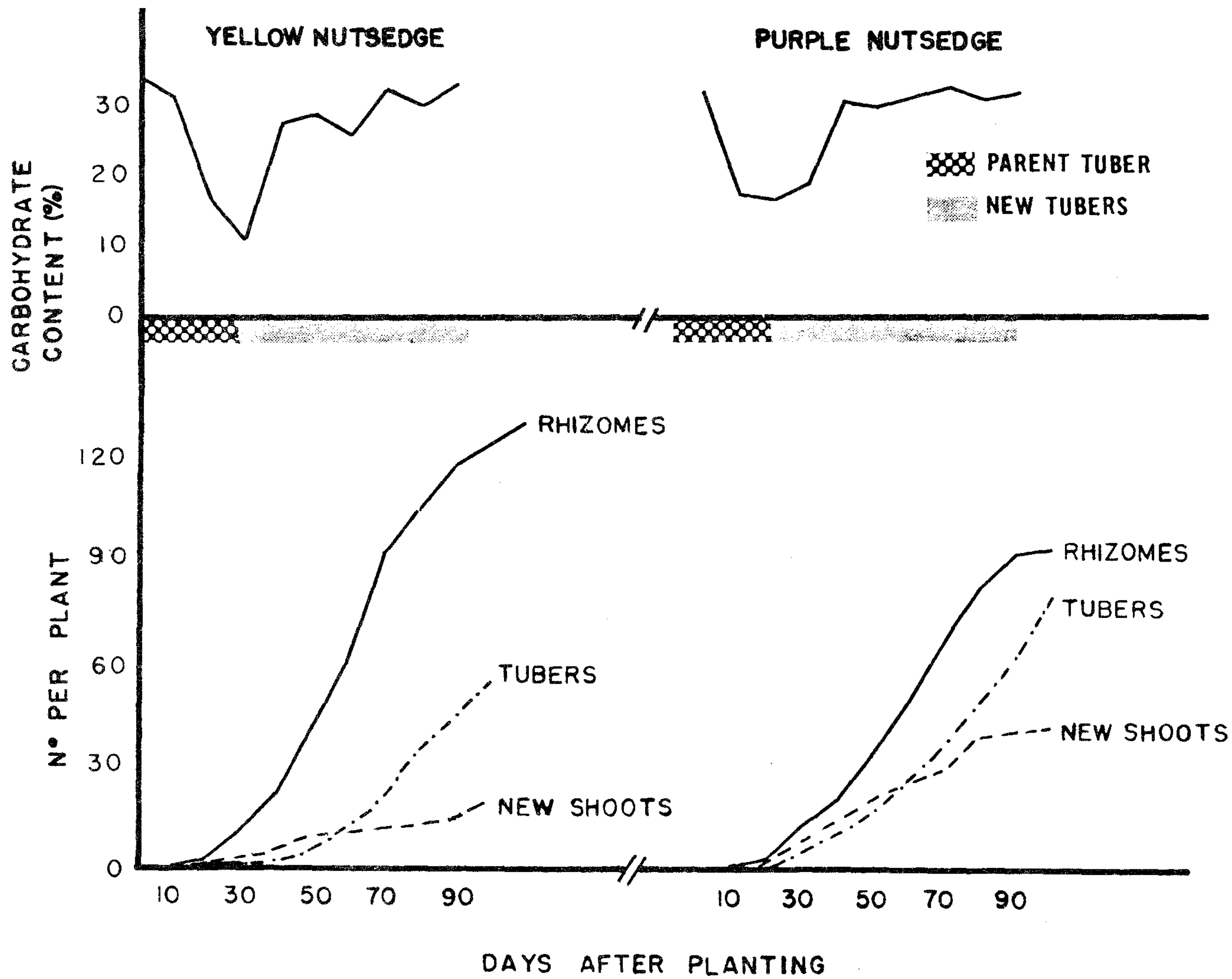


Fig. 1. Rhizomes, tubers, new shoots production and total available carbohydrate content throughout the growth cycle of yellow and purple nutsedge

as the new tubers began to grow the carbohydrate content increased through the whole growth cycle reaching the same carbohydrate content as the initial parent tubers.

Thullen and Keeley (6) determined the influence of yellow nutsedge tuber maturity on the accumulation of ^{14}C from urea and NAA (naphthaleneacetic acid). Radioactive carbon accumulated in tubers in decreasing amounts as tubers become more mature when the plants to which they were attached were treated. Tubers that were young at treatment accumulated the highest concentration of radioactivity which means that at the early stage of growth there is a constant assimulate flow from leaves to the newly developing tubers.

Effect of MSMA and glyphosate. The greatest effect on subterranean dry matter production was observed when the herbicides were applied 21 days after shoot emergence (9 to 11 leaf stage) in both species (Table 1). By this time, the plants had begun to produce tubers and foliar development was advanced sufficiently to retain, absorb, and translocate the herbicide.

Table 1. Effect of MSMA and glyphosate on subterranean dry matter production of yellow and purple nutsedge.

Timing	Herbicide	Rate (%)	Subterranean dry matter (g) per plant[z] Yellow nutsedge	Purple nutsedge
21 days after emergence	MSMA	0.5	6.7 f	5.49 e
		1.0	3.52 c	4.53 d
		1.5	1.62 b	2.86 c
	Glyphosate	0.5	0.23 a	0.72 a
		1.0	0.10 a	0.60 a
		1.5	0.30 a	0.75 a
Pre-flower stage	MSMA	0.5	11.63 h	4.12 d
		1.0	10.27 g	3.87 d
		1.5	5.23 e	2.34 bc
	Glyphosate	0.5	4.13 cd	3.93 d
		1.0	2.40 b	2.56 bc
		1.5	4.75 de	1.97 b
	Untreated control	---	11.52 h	13.90 f

[z]Mean separation by Duncan's multiple range test, 5% level. Means followed by the same letter within a species do not differ significantly.

Both herbicides produced leaf chlorosis which probably affected the rate of photosynthesis and consequently assimilate movement toward the new developing tubers. Purple and yellow nutsedge treated with glyphosate showed chlorosis 3 and 5 days after application respectively regardless of the spray concentration. Chlorosis produced by MSMA was less pronounced.

The effect of glyphosate on subterranean dry matter production (Table 1) was always more pronounced than the effect of MSMA. There was a significant difference between the different rates of MSMA, particularly when applied 21 days after shoot emergence, but there was not significant differences when the various rates of glyphosate were applied at the same stage of growth.

The effect of the herbicides on tuber production followed almost the same pattern (Table 2), since tubers represented about 50 percent of the total below ground dry matter produced. In both species glyphosate almost completely inhibited tuber production when applied 21 days after emergence, regardless of its rate. MSMA applied 21 days after emergence of yellow nutsedge was more effective in reducing the tuber production than when applied at the pre-flower stage. However, this was not true when applied to purple nutsedge.

Table 2. Effect of MSMA and glyphosate on tuber production of yellow and purple nutsedge.

Timing	Herbicide	Rate (%)	Number of tubers per plant[z]	
			Yellow nutsedge	Purple nutsedge
21 days after emergence	MSMA	0.5	33.2 f	36.7 fg
		1.0	15.2 c	37.8 g
		1.5	7.2 b	34.3 fg
	Glyphosate	0.5	0.8 a	4.7 a
		1.0	0.1 a	2.8 a
		1.5	0.2 a	6.5 a
Pre-flower stage	MSMA	0.5	72.3 h	28.8 de
		1.0	56.3 fg	30.7 ef
		1.5	32.7 f	21.7 d
	Glyphosate	0.5	24.2 e	28.8 e
		1.0	17.0 cd	13.8 c
		1.5	19.3 d	11.7 bc
	Untreated control	---	54.8 g	78.7 h

[z]Mean separation by Duncan's multiple range test, 5% level. Means followed by the same letter within a species do not differ significantly.

Literature Cited

1. Friedman, T. and M. Horowitz. 1971. Biologically active substances in subterranean parts of purple nutsedge. Weed Sci. 19:398-401.

2. Horowitz, M. 1972. Growth, tuber formation and spread of *Cyperus rotundus* L. from single tubers. Weed Res. 12:348-363.

3. Jansen, L. L. 1971. Morphology and photoperiodic response of yellow nutsedge. Weed Sci. 19:210-219.

4. Singh, S. P. 1969. Presence of growth inhibitor in the tubers of nutgrass (*Cyperus rotundus* L.). Weed Sci. Soc. Amer. Abstr. 18:815.

5. Smith, D., G. M. Paulsen and C. A. Raguse. 1964. Extraction of total available carbohydrates from grass and legume tissue. Plant Physiol. 39:960-962.

6. Thullen, R. J. and P. E. Keeley. 1978. The effect of *Cyperus esculentus* tuber maturity on ^{14}C accumulation. Weed Sci. 26:270-273.

7. Tumbleson, E. M. and T. Kommedahl. 1961. Reproductive potential of *Cyperus esculentus* by tubers. Weeds 9:646-653.

8. Wills, G. D. and A. G. Briscol. 1970. Anatomy of pruple nutsedge. Weed Sci. 18:631-635.

9. Weinmann, H. 1947. Determination of total available carbohydrates in plants. Plant Physiol. 22:279-290.

PALMER AMARANTH--A POTENTIAL WEED IN UTAH

E. M. Slack and J. L. Anderson[1]

During the autumn of 1977, a new weed record for the state of Utah was established. Palmer amaranth (*Amaranthus palmeri*), which had not previously been documented in Utah, was found growing in the agricultural areas in the southern most region of the state. Palmer amaranth, a robust dioecious species, is generally found in the warmer areas of Mexico, Texas, Southern California, New Mexico and Arizona. This observation in Southern Utah is the farthest north on record. The original plant had a trunk circumference of 16.5 cm, was 210 cm high and had a terminal inflorescence which measured 46 cm.

Although previous reports indicated little tendency for species migration (7), concern was expressed that Palmer amaranth might become a problem in the main agricultural areas of the state. Seeds were gathered and planted along with those of *Amaranthus retroflexus* and other weeds and crops being grown for phenological studies. The purpose of this study was to determine if the growing conditions in Northern Utah matched those required by Palmer amaranth to produce mature seed, as Northern Utah is a much higher and cooler region of the state.

Materials and Methods

The first seeds were planted April 8, 1978 at the Farmington Utah Field Station. This planting date preceded the first flush of spring weeds. Plantings were established every two weeks throughout the summer of 1978 up to and including August 12. Three 1 m^2 replications of Palmer amaranth were established in each of the plantings. Each plot was

[1]Plant Science Department, Utah State University, Logan UT 84322.

separated by 0.5 m intervals to reduce competition. The seeds were planted to a uniform depth of 2.5 cm. Soil moisture was monitored with Irrometers placed in the upper and lower root zones. Plants were irrigated when the Irrometer reading was between 35 and 50. Weeds within the plots were controlled by hand and the space between plot rows was tilled regularly. Daily maximum and minimum temperatures were recorded.

Seeds of test species were planted in a cross configuration to facilitate recognition of test plants. Once emergence was complete, the young plants were thinned to 10 in each replication. One week later, each plot was thinned to four plants and the following week the most robust was selected and allowed to grow to maturity. The first data recorded was date of plant emergence. Successive phenological stages such as date of first flower and date of first anther or yellow pollen were also recorded.

Terminal inflorescences measuring 89 cm were common. In fact, the weight of the inflorescences often caused breakage of lateral branches from the main stem. Data on the date of seed maturity, weekly height and radius measurements were also recorded as was the fresh weight of the plant at seed maturity.

Research at Utah State University led to the development of models that describe rest completion (5) and spring bud development of fruit trees (4, 6). The fruit tree models have been modified to describe the growth and development of tomato (2) and some of its common weeds (1). The growing-degree-hour (GDH) accumulation was correlated with Palmer amaranth phenology. One GDH is defined as one hour per degree C above a characteristic base temperature.

Results and Discussion

Palmer amaranth planted as late as July 1, 1978 produced mature seed. In all cases, female plants exceeded male plants in total biomass production. A summary for the female plants is shown in Table 1, and for male plants in Table 2. The characteristic giving us the most concern was the tremendous capacity for seed production. If the maximum number of seeds produced were evenly dispursed with one seed per square yard,

Table 1. Phenology of female plants reaching maturity at Farmington, Utah.

Observation	Maximum	Minimum	Average
Height (cm)	261	170	217
Radius (cm)	220	137	185
Days, emergence to first flower	71	31	54
Days, emergence to seed shatter	147	107	130
Total seed production/plant	1,946,778	804,272	1,375,525
Fresh weight (g)	8,683	4,200	6,433

one plant has the capacity to infest 402 acres. Utah has 1,349,000 acres under irrigation. If those seeds were distributed, one per acre, one plant has the capacity of producing enough seed to infest every irrigatable

Table 2. Phenology of male plants reaching maturity at Farmington, Utah

Observation	Maximum	Minimum	Average
Height (cm)	203	153	168
Radius (cm)	134	112	122
Days, emergence to first flower	48	22	35
Days, emergence to first anther or yellow pollen	61	39	46
Fresh weight (g)	4201	852	2414

acre in Utah in just one year.

The base temperature for Palmer amaranth growth and development was 10C. When plant growth correlation to GDH accumulation was subjected to coefficient of variation analysis it appeared that the male plants followed a 10/28C model whereas female plant growth was best described by a 10/30C model. One could speculate that the temperature restrictions for the species are less harsh for the male than for the female plants.

Plant height per GDH accumulation was identical for male and female plants until first flower stage occured in the male plants. Female plants required an average of 1515 more GDH to reach first flower than the male plants (Figure 1). Male plants evidently diverted most of its energy into pollin production as the average biomass was only about one-third that of the female plants. Average female plant height exceeded that of the male plants by 1 m.

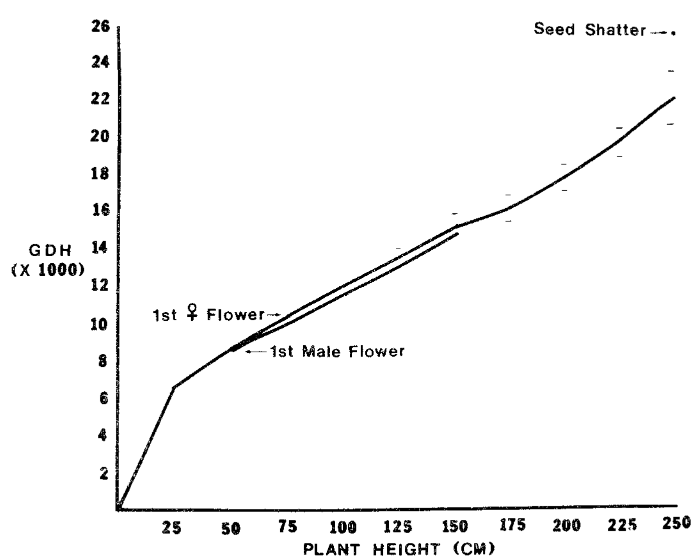


Figure 1. Correlation of Palmer amaranth plant hiehgt with growing-degree-hour accumulation.

Data collected on Palmer amaranth during the summer indicated that a photoperiodic effect was over-riding the temperature effects. There was little or no change in the total number of GDH to first flower among the first three plantings. However, beginning with the planting established on June 1, there was a gradual decrease in the GDH accumulation until flowering (Figure 2). The GDH requirement of planting number eight to reach first flower was just half of the requirement of planting three.

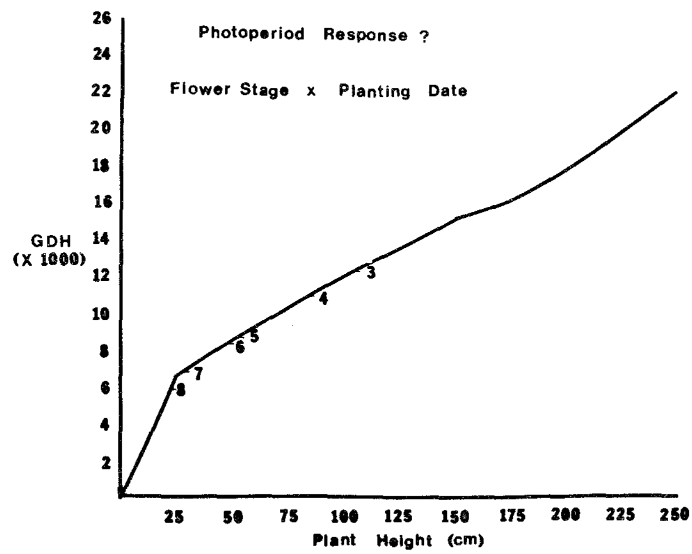


Figure 2. Growing-degree-hour requirements for successive plantings three through eight to reach first flower.

Redroot pigweed (*Amaranthus retroflexus*) has been shown to be a facultative short day plant (3). A photoperiod response could be common throughout the genus.

The competative capability of *Amaranthus palmeri* became obvious when the field data for tomato (*Lycopersicon esculentum*), was analyzed. In six of the tomato plantings, which by chance were planted next to plantings of Palmer amaranth, there was a progressive increase in the fresh weight of tomato with distance from Palmer amaranth (Figure 3).

Conclusions

Amaranthus palmeri has a great competitive and survival potential in Utah. With the average frost free growing season of 220 days for Southern Utah and a range of 135 to 165 days for the major agricultural areas of Northern Utah, the average 130 days from emergence to seed shatter indicates that Palmer amaranth has the potential to move farther north in the state. At Farmington, Utah plantings as late as July 1 produced mature seed.

Comparison of redroot pigweed with Palmer amaranth shows that redroot pigweed reaches seed maturity much sooner. This is probably a major reason why redroot is such a problem in agronomic crops and for the lack of migration of the Palmer amaranth. With reasonable cultural practices, Palmer amaranth should not be much of a threat north of its present location; but if left unattended it could become a problem weed in Utah.

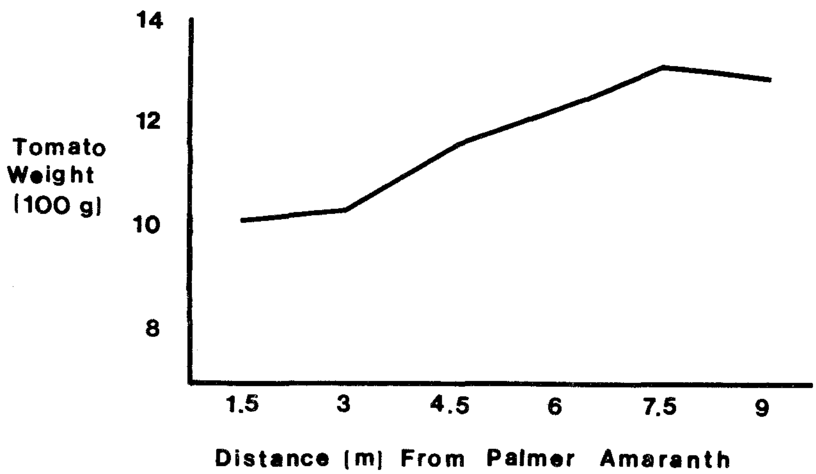


Figure 3. Fresh weight of tomato plants at maturity as affected by proximity to Palmer amaranth.

Literature Cited

1. Anderson, J. L. and E. A. Richardson. 1978. Modeling the growth and development of barnyardgrass [*Echinochloa crusgali* (L.) Beauv.] Abstr. Weed Sci. Soc. Amer. p. 91.

2. Anderson, J. L., E. A. Richardson and F. M. Ashton. 1979. A growth and development model for tomato. Abstr. Amer. Soc. Hort. Sci. HortScience 14:473.

3. Anderson, J. L. and F. B. Salisbury. 1977. Effects of daylength on the flowering of redroot pigweed. Proc. West. Soc. Weed Sci. 30:15-17.

4. Ashcroft, G. L., E. A. Richardson and S. D. Seeley. 1977. A statistical method of determining chill unit and growing degree hour requirements for deciduous fruit trees. HortScience 12:347-348.

5. Richardson, E. A., S. D. Seeley and D. R. Walker. 1974. A model for estimating the completion of rest for 'Redhaven' and 'Elberta' peach trees. HortScience 9:331-332.

6. Richardson, E. A., S. D. Seeley, D. R. Walker, J. L. Anderson, and G. L. Ashcroft. Pheno-climatography of spring peach bud development. HortScience 10:236-237.

7. Sauer, J. 1955. Revision of the dioecious amaranths. Madrono 13: 5-36.

THE INFLUENCE OF SOIL MOISTURE, TEMPERATURE, AND COMPACTION ON THE GERMINATION AND EMERGENCE OF *BROMUS TECTORUM*

D. C. Thill, R. D. Schirman, and A. P. Appleby[1]

Abstract: The influence of soil moisture stress, temperature, and bulk density on germination and emergence of downy borme (*Bromus tectorum* L.) were investigated in the laboratory. The purpose of these studies was to determine the interactive influence of soil moisture and temperature and soil bulk density and soil moisture on the germination and emergence of downy brome. The interactive influence of soil matric potential and temperature on the percent and rate of seedling emergence was determined by germinating caryopses in soil, ranging in matric potential from -2 to -16 bars, and incubated at alternating and constant mean temperatures from 5.1 to 20 C. The interactive effects of soil compaction, ranging from 0.9 to 1.3 g cm^{-3}, and soil matric potentials from -2 to -13 bars on the percent and rate of seedling emergence were also examined.

Reductions in soil matric potential markedly reduced the percent and rate of emergence. Overall, emergence was better at constant than at alternating temperatures. At higher matric potentials, the rate of emergence was accelerated by warmer temperatures (20 C), while at very low matric potentials the percent and rate of seedling emergence were least restricted at cooler temperatures (10 and 15 C). Cold soil temperatures (5.1 and 9.3 C) markedly reduced emergence at all levels of soil moisture. There was no difference in the rate or percent seedling emergence in relation to soil matric potential of different years' seed lots of downy brome, even though the caryopses were produced during climatologically very diverse years. Emergence, but not germination, was inhibited by increased levels of soil compaction. No significant soil compaction x moisture interaction was observed as measured by final seedling emergence.

Under rangeland and waste area conditions, the successful seedling establishment of downy brone is probably most limited by warm, dry soils or very cold soils. All other moisture-temperature conditions appear intermediate to these two extremes. Under cultivated field conditions, soil compaction appears to be the major factor controlling successful seedling establishment. Hence, under cultivated conditons, slight interrow soil compaction may suppress potential downy brome competition, but not adversely influence the establishment of the seeded crop.

[1]Science and Education Adm., Agricultural Research, USDA, Pullman, WA 99164; and Dept. Crop Science, Oregon State University, Corvallis OR 97331, respectively.

PERFORMANCE OF SIX SUBSTITUTED DINITROBENZAMINE HERBICIDES APPLIED AT COTTON LAYBY

John H. Miller and C. H. Carter[1]

1 Agricultural Research, Science and Education, Admin., USDA, U.S. Cotton Research Station, Shafter CA 93263.

Abstract: For three years, six substituted dinitrobenzamine herbicides, including butralin [4-(1,1-dimethylethyl)-*N*-(1-methylpropyl)-2,6-dinitro=benzenamide] at 1.1 and 1.7 kg/ha, dinitramine (N^4, N^4-diethyl-*a,a,a*-trifluoro-3,5-dinitrotoluene-2,4-diamine) at 0.4 and 0.56 kg/ha, and fluchloralin [*N*-(2-chloroethyl)-2,6-dinitro-*N*-propyl-4-(trifluoromethyl) analine], pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine], profluralin [*N*-(cyclopropylmethyl)-*a*,*a*,*a*-trifluoro-2,6-dinitro-*N*-propyl-*p*-toluidine], and trifluralin (*a*,*a*,*a*-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine)at 0.56 and 0.84 kg/ha, were applied as soil-incorporated directed broadcast sprays at time of last cultivation (layby) of cotton (*Gossypium hirsutum* L. 'Acala SJ-2'). The soil was Wasco fine sandy loam (11% clay, 19% silt, 70% sand, <0.5% organic matter, pH 6.8).

At the rates used, all herbicides provided in excess of 90% control of annual grasses but none were significantly different from each other. In 1975, butralin at 1.1 kg/ha did not improve pigweed control when compared to the cultivated control. Other herbicide treatments improved pigweed control but were not significantly different from each other. None of the herbicides consistently controlled American black nightshade. None of the herbicides, except pendimethalin, caused detectable cotton injury. In two of the three years, pendimethalin caused enlarged growth of the cotton stem in the area contacted by the herbicide spray. Stem breakage following wind resulted in 5 to 10% loss of cotton stand, however the injury was not reflected as reduced yield. None of the herbicides differentially influenced cotton yield. Bioassay of soil samples collected four months after herbicide application showed that all herbicide treatments reduced growth of Japanese millet and grain sorghum. Considering both bioassay species and both herbicide rates, growth reductions were as follows: butralin 24%, profluralin 25%, dinitramine 32%, trifluralin 36%, pendimethalin 48%, and fluchloralin 49%.

The experimental results discussed herein constitute a report of research and should not imply endorsement by SEA, USDA of any of the materials used.

EVALUATION OF ANNUAL HERBICIDE APPLICATIONS ON YIELD AND QUALITY OF VEGETABLE CROPS, WEED POPULATIONS AND HERBICIDE RESIDUES IN SOIL

Z. Lipinski, H. Skapski, and St. Gawronski[1]

Abstract: A test for long-term effects of annual herbicide applications in vegetable crops was carried out at the Agricultural University of Warsaw, Poland.

Herbicides used in this experiment were: lenacil in spinach, linuron in carrots, prometrune in leeks and monolinuron in dry beans. Herbicide treatments consisted of the recommended dose of each herbicide 0, 1, and 2 times per year.

Vegetable species were grown in rotation, i.e., crops and herbicides rotated within herbicide treatments. In adjacent monocultureal subblocks,

---

[1]Visiting Research Scientist, University of Idaho Research & Extension Center, Aberdeen 83210, and Professor and Adjunct, respectively, Institute of Horticultural Science, Warsaw Agricultural Univ., Warsaw, Poland.

vegetables were treated with the same herbicide during each of five consecutive years, 1971-1975. Evaluative criteria were crop yield and quality, weed populations and herbicide residues in soil.

Results obtained in carrots are discussed. Carrot plots in rotation treatments produced higher total root yields, more plants, more No. 1 roots (over 2 cm diameter) and higher yeilds of No. 1 roots, except during the initial year of the study. In monoculture, reduction of carrot yield as well as number of roots (20 mm) was observed during the last two years due to a high infestation of nematodes. Linuron treatments did not diminish the dry matter, total sugar, vitamin C and beta carotene in carrots grown in either rotation or monoculture.

Linuron was very effective against *Chenopodium album, Capsella bursa-pastoris, Viola arvensis, Stellaria media* and *Poa annua*; two applications were required to control *Echinochloa crusgalli.* Mustard and lettuce indicator plants detected linuron in soil 30 days after application of a single dose. 165 days after the first spraying, this biotest indicated presence of linuron in plots treated twice.

WEED CONTROL STRATEGIES IN ONIONS AND GARLIC

Harry Agamalian and Edward Kurtz[1]

The growing of onions and garlic have several common denominators. They are both members of the Allium family, they are poor competitors with weeds, and must be kept weed free through maturity for optimum yields.

Onions are normally an early spring sown crop, the seedlings are slow to develop and encounter spring and summer weeds. Garlic, however, is fall planted from cloves, remains in the soil 9-10 months, and thus, competes with fall, winter, and summer weeds.

Onion Strategies

Field selection based on previous crop weed history is often times an essential element in successful weed control. The utilization of a pre-emergence herbicide such as DCPA is important for the ultimate effectiveness of subsequently applied herbicides.

Post emergence herbicides most be applied at critical stages of development for the onion seedlings' selectivity and weed seedling' susceptibility. Current practices include the utilization of nitrofen, sulfuric acid and chloroxuron as post emergence herbicides. The development of bromoxynil as an additional post emergence herbicide would greatly enhance the control of compositae weeds. The currently registered herbicides do not provid effective control of common groundsel (*Senecio vulgaris*) and sow thistle (*Sonchus oleraceus*). The delay in application of weed control practices can result in the loss of onion stands and subsequently affect yield.

The utilization of mid-season pre-emergence application of DCPA and nitrofen can provide season-long weed control.

---

[1]University of California Extension, Salinas, CA and Basic Vegetable Corp., King City, CA.

Garlic Straties

Weed control practices in this long season crop are dependent upon pre-emergence herbicides at planting time, such as DCPA and chlorpropham. Subsequent weed control methods include a post emergent application to weeds, but pre-emergence to garlic of weed oil or paraquat.

These herbicide applications integrated with mechanical cultivation will usually provide fall and early winter weed control. Post emergence applications of nitrofen and dinoseb are utilized to control several early spring weeds. The development of bromoxynil as a post emergence herbicide is essential for the control of cruciferous weeds.

Late spring applications or multiple applications of nitrofen, DCPA, chlorpropham and chloroxuron have resulted in season-long weed control.

Table 1. Weed species sensitivity to onion herbicides.

Treatment	lb/A	S.P.[a]	HNS.	P.W.	C.W.	B.G.	S.T.	C.G.
nitrofen	4	N[b]	C	C	C	N	N	N
nitrofen + chloroxuron	2 + 2	C	C	C	C	C	N	P
nitrogen + chloroxuron	4 + 4	C	C	C	C	C	N	P
bromoxynil	0.3	C	C	N	N	N	C	C
bromoxynil	0.6	C	C	N	N	N	C	C
nitrofen + bromoxynil	4 + 0.3	C	C	C	C	C	C	C
nitrofen + bromoxynil	4 + 0.6	C	C	C	C	C	C	C
chloroxuron	4	C	P	P	P	N	N	C
DCPA	10	N	P	N	N	C	P	N

[a]weed designations: S.P. = shepherds purse, HNS = hairy nightshade, P.W. = pigweed, C.W. = cheeseweed, B.G. = barnyardgrass, S.T. = sow thistle, C.G. = common groundsel.

[b]weed sensitivity: C = control, N = no control, P = partial control.

TREE KILL TRIALS WITH GLYPHOSATE AND OTHER HERBICIDES

H. B. Lagerstedt[1]

Abstract: Trials were established to kill both top and root systems of interplanted trees of cherry and filbert so that subsequent sucker growth would not occur. Cherry tree trunks were injected with 2,4-D, picloram and 2,4-D (Tordon 212), chlorofluorenol (Maintain-125), ammonium ethyl carbamoylphosphonate (Krenite), slyphosate (Roundup), 3-amino-1,2,4-triazole (Cytrol Amitrol-T), and dimethyl arsinic acid (Phytar 138). Injections were made in varying amounts with a Jim-Gem tree trunk injector

[1]Research Horticulturist, USDA. SEA-AR. Corvallis, OR.

during July 1977. None of the products were diluted. Trees were evaluated for symptoms during the growing season and were cut off at the groundline during the winter. During 1978, there no sprounts from stumps of trees treated with 2,4-D, Tordon-212, or Roundup.

Filbert trees were treated with undiluted glyphosate during November and December 1977 and February 1978. Treatment methods included trunk injection and axe frills into which glyphosate was applied. Other trees were cut off the stump and painted.

All November and December treatments were effective regardless of method of glyphosate injection or application. February treatments injured trees, but did not kill them. The amount of undiluted glyphosate applied per tree varied from 3 to 6 ml. Diluting the herbicide with an equal amount of water facilitated brush and spray applications. A comparison of treatment methods was discussed.

The filbert trees were 7 and 10 years old and spaced 3.05 x 4.57 m (10 x 20 ft) apart. Interplant trees had been pruned heavily for several years prior to anticipated removal. All trees were removed during the winter of 1977-78. As the untreated, permanent trees leafed out in the spring, it became apparent that they had sustained injury. This injury only occurred to the 10-year old trees that had root grafted. The 1978 crop was lost, as were some permanent trees, but by the end of the growing season most trees were producing normal leaves.

Mention of a trademark, propietary product, or vendor does not constitute a guarantee or warranty of the product by the USDA, and does not imply its approval to the exclusion of other products or vendors that may also be suitable.

THE IMPORTANCE OF HERBICIDES IN FOREST MANAGEMENT

J. D. Walstad[1]

With the sudden suspension of 2,4,5-T and Silvex by the Environmental Protection Agency (EPA) on February 28, 1979, the use of herbicides in forestry entered a new era. From an optimistic viewpoint, it will stimulate efforts to find new and perhaps better herbicides and other methods of vegetation management. From a pessimistic viewpoint, the unprecedented action by the EPA against 2,4,5-T and Silvex--if allowed to stand--will seriously jeopardize the future productivity of the Nation's commercial forests unless satisfactory alternatives are quickly found and allowed to be used.

This paper summarizes the uses and advantages of herbicides as vegetation management tools in forestry. It also discusses the current status of the 2,4,5-T issue and suggests a future course of chemical silviculture in light of recent events.

<u>Uses and advantages of herbicides in forest management</u>. Herbicides can be used at three different stages in forest management: (1) at the time of regeneration as a method of <u>site preparation</u> to control residual brush and other weeds; (2) at a young stage in the development of a new stand

---

[1]Weyerhaeuser Company, Springfield, OR 97477

or plantation as a method of release from encroaching brush competition; and (3) during the period when the managed stand is approaching maturity as a timber stand improvement measure.

There are several unique attributes of herbicides which make them popular choices in the forester's silvicultural tool kit. First, herbicides are quite effective at supressing the broad array of woody and herbaceous vegetation which competes with commercial timber crops. Second, certain herbicides are selective in that they do not damage valuable coniferous species or other types of non-target vegetation. Third, herbicides are quite versatile. They can be applied in a variety of manners ranging from broadcast aerial application to individual stem or spot treatments. Finally, the use of herbicides is not handicapped by many of the constraints and environmental concerns associated with some of the other methods of vegetation management such as prescribed burning, mechanical equipment or manual operations. All of these attributes combine to make the use of herbicides one of the safest and most cost-effective approaches to enhancing forest productivity.

2,4,5-T Issue: The herbicide 2,4,5-T has historically been the mainstay among various silvicultural treatments to control competing vegetation. Recent efforts during the 2,4,5-T RPAR (Rebuttable Presumption Against Registration) process to document the importance of this particular herbicide indicate that it provides substantial benefits. As indicated in Tables 1 and 2, the estimated economic impact of permanently losing 2,4,5-T amount to billions of dollars in terms of net present value. Even the short-term impacts are estimated to be many millions of dollars, due to increased costs of alternatives and declining growth rates where alternatives are not as feasible or as effective.

Nevertheless, the EPA casually dismissed these economic arguments. A direct quote from the Suspension Order (p. 63) issued on February 28, 1979 is quite revealing:

"The Agency's analysis indicates that the suspension of 2,4,5-T (and silvex) for forestry, rights-of-way, and pasture uses during 1979/80 would not significantly affect U.S. production or prices of major commodities and services from these sectors. Impacts on productivity and costs during the two years would generally be regional in nature but insignificant on the national level. Industry impacts would be nominal..."

I suppose it is relatively easy to consider the economic impact of this as "nominal" so long as you are not the one who has to suffer the loss, or come up with an alternative solution.

The EPA based its Suspension Order on "significant new evidence" which "compelled" the Agency to immediately stop certain uses of 2,4,5-T and silvex. The evidence related to an epidemeology study which supposedly found an "alarming correlation" between miscarriages and 2,4,5-T use in the Alsea, Oregon area. Oddly enough, this evidence was sufficient to suspend the uses of 2,4,5-T and silvex or forests, pastures and right-of-way, but not on rangeland or rice. This is a very interesting paradox if you think about it.

I do not intend to get into a lengthy critique of the Alsea study or the Administrator's decision. I am confident that the merits or the demerits of the study and the decision will be fully disclosed in the legal and administrative processes scheduled to begin shortly. Suffice it to say that the EPA's findings conflict with the consensus of worldwide scientific opinion on the safety of 2,4,5-T and silvex. I, for one, would not want to be in the position of having to defend the Alsea study from the onslaught of criticism it is likely to receive.

One of the major tragedies of this whole affair is that the RPAR process has been scuttled for the sake of what now appears to be pressure politics. Many of us scientists were supportive of the EPA'S efforts to carefully analyze the risks and benefits of 2,4,5-T in hopes that a rational decision could be reached before resorting to legal or formal administrative proceedings. We spent a great deal of time, money, and effort trying to provide the EPA with the best scientific information available on the subject. It now appears that it was all for naught. We are forced into an adversary role, which will be time consuming, expensive, complicated and distasteful to many of us. But it must be done if scientific truth and rational judgement are to ultimately prevail.

Future Course of Chemical Silviculture: While the 2,4,5-T battle runs it course, I believe that scientists and foresters should assess the future of chemical silviculture. The opposition is already levelling its sights at 2,4-D, so we are almost certainly headed for another confrontation of major proportions.

With the collapse of the RPAR process as a rational solution to these kinds of dilemmas, and with the continued adverse publicity in the press, I think we had better find ways to avoid the controversy in the first place. To do this we need to understand why people are opposed to spraying herbicides.

If one sets aside all the selfish motives behind the anti-chemical crusade - the marijuana growers, the individuals wanting lucrative brush cutting jobs, the publicity seekers, the wilderness advocates, etc, - one is left with basically one philosophical argument that is difficult to cope with: These people believe that risks (even though minute or hypothetical) are being imposed upon them against their will. This argument of involuntary exposure (no matter whether it is real or imaginary) has a tremendous moral force to it, which engenders a lot of public sympathy. And this, of course, translates into good news copy.

In the absence of being able to absolutely prove and guarantee the safety of any given chemical or application, I believe that their use, at least in forestry, is in for some trying times. However, I am not suggesting we abandon chemical silviculture altogether. As the early portion of my talk pointed out, the use of chemicals in forestry is important, indeed essential, to enhancing the productivity of our commercial forests.

I believe that we can retain the right to use these modern silvicultural tools, while at the same time defusing or eliminating much of the controversy surrounding them, if we take the following steps.

1. Minimize the number of situations where chemicals are required. In the case of forest weed control, this can be facilitated through the use of good site preparation, followed by rapid reforestation with vigorous planting stock, good vegetation control in the establishment phase of the plantation might preclude the necessity for followup release treatments.
2. Develop methods of chemical application which are strictly confined to the target (not just the target area). The days of broadcast chemical application may be numbered. Our inability to guarantee against drift, water contamination, and long range, not-target impacts may ultimately eliminate this approach, regardless of data proclaiming chemical safety. As broadcast applications are fine-tuned, or even phased out, they should be confined to situations where other approaches are not feasible.

3. Continue to develop chemicals which are safer to use and more compatible with the environment. The recent breakthroughs in insect control brought about by the use of natural pheromones (attractants) come to mind as one example of this approach. Perhaps natural plant hormones, rather than artificial ones, could be used to control vegetation.
4. Encourage research to develop imaginative new methods of vegetation management, which may be more suitable. Some basic work in plant ecology and plant physiology might pay great dividends here.

If we are successful at implementing some or all of these ideas, then I believe the future prospects of chemical silviculture will be much more promising than they are at the moment. If we are unwilling or unable to make these kinds of adjustments, then I think we are headed for one defeat after another, with each one reducing the productivity of one of our most valuable renewable resources.

Table 1. Estimated long-term impact of losing 2,4,5-T for management of industrial forest land in the South and Pacific Coast.[1]

Category/Alternative	Area affected (million acres)	Increased costs	Decreased harvest	Total loss
		--($ millions	in present	value)
Even-aged stands (South)				
Intensive mechanical	6.2	354.8	---	354.8
All-aged stands (South)				
Other herbicides	3.2	52.6	254.0	306.6
Even-aged stands (Pacific Coast)				
Other herbicides	2.6	34.5	---	34.5
Mechanical control plus other herbicides	0.6	18.6	---	18.6
No alternatives	3.2	(41.3)	354.5	311.2
Total impact	15.8	419.2	606.5	1,025.7

[1] Data from: American Paper Institute/National Forest Products Association. 1978. Benefits of 2,4,5-T in Forest Management. 139 p.

Table 2. Estimated short- and long-term economic impacts of losing 2,4,5-T for management of commercial forest land throughout the U.S.[1]

End of year	Annual reduced timber growth	Cumulative				
		Increased management cost	Reduced stumpage income	Net income loss	Reduced timber harvest	Reduced present net worth
	million cu. ft.	million dollars	million dollars	million dollars	million cu. ft.	million dollars
1	15.0	13.5	9.6	23.1	15.0	153.2
5	74.6	67.5	163.8	231.3	223.8	734.0
10	149.3	135.0	666.3	801.3	821.5	1,390.1
50	624.4	675.0	---	---	18,249.5	4,421.4

[1]Data from: USDA-States-EPA 2,4,5-T RPAR Assessment Team. 1979. The biologic and economic assessment of 2,4,5-T.

THE CHOICE

O. K. Baysinger and G. A. Lee[1]

Abstract: The role that pesticides play is directly affected by the opinions of society. This opinion is shaped to a large part by information provided by new sources, rather than by personal experiences.

Pesticides, because of thier very nature as tools used to alter the growth patterns of livng organisms, and because they are potentially dangerous, are subject to sensationalsim. Mention is seldom made by the media regarding the benefits we receive as a result of using pesticides.

"The Choice", is a 15 minute 35 mm slide-tape presentation, designed as an extension educational tool, utilizing two (2) projectors and a disolve unit to explain the necessities and benefits of using pesticides. It is designed to be used in: adult groups, television programs, schools, youth groups, meetings, classes, fairs, and conventions.

[1]Department of Plant and Soil Science, University of Idaho, Moscow ID 83843

THE WEED RESEARCH AND EXTENSION PROGRAM IN MONTANA

M. J. Jackson and P. K. Fay[1]

Benefits from weed control can be expected only if given high priority by farm and ranch managers. Priorities must be dtermined, whether for a farm or ranch, research study or an extension educational program.

Such a decision was necessary to set weed problem priorities in Montana research and demonstration work. Contacts were made with agricultural research centers, MSU weed scientists, and county Extension Service agents to determine the prominent species and their locations.

Dr. Peter Fay on the research weed science staff asked his students to help determine the major weed problems that confront farmers and ranchers. The students sent questionnaires to approximately 400 farmers and ranchers in the students' counties to determine the weeds most troublesome for Montana grain producers.

The major survey questions were: What are the No. 1 and No. 2 weed problems in your farming or ranching operation? What chemical herbicides have you used? Were you satisfied with the results? What type of spray program was used? What production problems need more research?

The undergraduate student participation resulted in a return of 65 percent of the questionnaires. The survey results are being used in the formulation of a new Montana weed research and extension program.

The weed problems listed most frequently on the questionnaire were:

1. Northeastern District--wild oats, wild buckwheat, field bindweed and green foxtail.
2. Southeastern District--wild oats, kockia, field bindweed and Russian thistle.
3. Northcentral District--Wild oats, wild buckwheat, kochia and Canada thistle.
4. Central District--Canada thistle, wild oats, field bindweed and wild buckwheat.
5. Southcentral District--Canada thistle, field bindweed, kochia and wild oats.
6. Southwestern District--Canada thistle, wild oats, Russian thistle and pigweed.
7. Northwestern District--Wild oats, Canada thistle, kochia and field bindweed.

Four districts indicated their major weed problem was wild oats. Two districts reported wild oats as being their second worst weed problem, and one district listed it as fourth. Three districts listed Canada thistle as their major weed problem. Four districts had field bindweed listed as the No. 3 weed problem. Generally, Montana's major weed problems in small grain production respectively are wild oats, Canada thistle, field bindweed, kochia and wild buckwheat.

Rank	Weed	Frequency
1	Wild oats	100
2	Canada thistle	98
3	Field bindweed	66
4	Kochia	44
5	Wild buckwheat	39
6	Russian thistle	24

[1]Montana Extension Service and Agricultural Experiment Station, Montana State University, Mozeman, MT.

7	Green foxtail	13
8	Downy brone	11
9	Cow cockle	6
10	Persian ryegrass	3

Hericide use reports were divided into five categories:

Annual broadleaf weed control
Annual grassy weed control
Weed control in row crops
Perennial weed control
Chemical fallow

Annual broadleaf weeds. The herbicide used most frequently for annual broadleaf weed control was 2,4-D. There were 128 producers who reported using 2,4-D, but did not specify whether they used amine, ester, or both. In addition, 59 reported using amine and 58 reported ester formulations. Although 21 percent of those using 2,4-D were dissatisfied with results, only 12 percent reported dissatisfaction with amine and 15 percent with ester.

A phenoxy, hormone-type herbicide, 2,4-D controls a wide spectrum of annual broadleaf weeds. However, time of application is highly critical, because 2,4-D cannot be applied until the grain crop is in the 4-5 leaf stage and weeds beyond this stage become quite resistant to control. In many instances, weed growth is too far advanced when sprayed to obtain good results.

MCPA was used by five producers, with only one who indicated dissatisfaction. It can be applied on grain in the 3-leaf stage, or earlier than 2,4-D. Again, timing is critical.

Eight producers reported using Banvel plus MCPA (MonDak). Four reported poor results, which could have been caused by time of application and weather.

Six producers used bromoxynil, which should be applied when weeds are in the seedling stage. It is a contact herbicide, so higher volumes of water must be used to get sufficient coverage. Unfavorable spring weather can delay application until weeds become too advanced. Only one producer reported dissatisfaction.

A tank mis of Tordon 22K plus 2,4-D was used by 15 producers, including four who reported dissatisfaction. Poor results may have resulted from a wrong mixture, too-low rate, low water volume or injury to grain because of late application.

Only one of six trifluralin users had poor results. Trifluralin is registered in Montana for control of annual foxtails in spring wheat and cheatgrass in winter wheat. Uniform mixing in the soil and depth of incorporation is highly critical to obtain optimum control.

Annual grassy weed control. Producers reported using four herbicides to control wild oats.

Avadex, an incorporated herbicide, is used to control wild oats in legumes, sugar beets, corn, potatoes and flax. Two of eight producers who used it, indicated poor results. Uniform application and thorough incorporation are important.

Avenge is a newer, post-emergence herbicide that is more costly per acre. It was used by only four producers, who all indicated good results.

Carbyne, a post-emergence herbicide, was used by 29 growers. Time of application, which is critical, may have been the cause of poor results reported by 19. It must be applied when wild oats are in the 2-leaf stage. Spray volume and pressure also are very important.

Fargo, also an incorporated herbicide, was the most popular for wild oat control. Of 54 farmers using it, nine indicated dissatisfaction. It is important to apply and incorporate Fargo according to label recommendations and follow seeding instructions to prevent crop injury.

Herbicides for row crops. A limited number of farmers reported application of herbicides for row crops. Assuming atrazine was used on corn leaves a question why a high percentage reported dissatisfaction. Possibly, farmers had to follow corn with corn because of the residue. Avadex, Bladex and Eradicane users also showed some dissatisfaction. Users of such herbicides as EPTC, Pre-Beta II and Ro-neet reported complete satisfaction.

Perennial weed control. Dicamba and picloram were the major herbicides used for perennial weed control. Of 66 producers who used dicamba, 16 reported poor results. The application rate may have caused the dissatisfaction. Most deep-rooted perennials require 6 to 8 pounds per acre.

Picloram was applied by 71 producers, with six indicating poor results. Its major use is on leafy spurge, Russian knapweed and Canada thistle. Sufficient water is needed to get complete coverage, and retreating is necessary on regrowth. Picloram beads were used only by three producers. Glyphosate was applied by 16 producers with only two dissatisfied.

Chemical fallow. The survey indicated need to determine where these herbicides were used. If the major use of atrazine was for chemical fallow, did the high percentage of dissatisfaction result from poor control of volunteer grains, or did residue injure subsequent crops? Did dissatisfaction from Bladex result from residual effect that wasn't long enough? Did paraquat disappoint 50 percent of the users because they applied it too late to control emerged weeds? Was glyphosate used to control perennial weeds, or was some used at a reduced rate to control annual weeds?

Need for more research. Research requested by the producers were put into grassy, broadleaf and other weed categories.

Grassy weeds. Nineteen (19) percent did not specify any specific species. Wild oats received the greatest attention, followed closely by cheatgrass and perennial foxtail and quackgrass. Wild oats received the greatest attention, followed closely by cheatgrass and perennial foxtail and quackgrass.

Broadleaf weeds. Again 19 percent did not specify any specific weed species. Canada thistle, leafy spurge and field bindweed were listed as species needing additional studies.

Others. Right-of ways, irrigation systems and biological control received equal attention as research needs, just ahead of chemical fallow, minimum tillage and alfalfa.

In summary, broakleaf weeds accounted for 31 percent of the research need requests; grassy weeds 40 precent, and the remaining categories 29 percent.

The 1978 survey information resulted in making 1979 the "Wild Oat Year." Educational programs for 1979 will include:

Demonstration plots at 12 locations will demonstrate chemical herbicide control of wild oats in small graina. Six will be located at Montana Agricultural Research Centers, and six will be located on private farms. Tours will be conducted prior to harvest, and winter meetings will be held in counties that have the demonstration plots.

Four half-day workshops will be held to provide growers wild oat biological information, including germination, dormancy,leaf development and seed production. Preventive measures, post-harvest tillage, seedbed preparation and other cultural control measures will be presented.

News and magazine articles and radio and television programs will help grain producers control wild oats.

Questionnaires are being sent out by MSU agricultural orientation class students to determine the main weed problems of farmers and ranchers. The 1978 information represented only a small sampling of growers. The 1979 information whould further assist Montana research and extension programs aimed at weed problems.

PERSPECTIVES AND ECONOMIC BENEFITS OF INTEGRATED PEST MANAGEMENT

Carl B. Huffaker and R. D. Lacewell[1]

This paper can only briefly trace some of the main questions and historical developments leading to what is known today as integrated pest management (IPM). As a concept and discipline integrated pest management is simply another term for *integrated control*. The newer term (IPM) was urged into adoption by the U. S. government because of its more self-defining content since the word "pest" is included.

Some integration of different methods of managing pests such as weeds, insects and rodents certainly arose in antiquity. Farmers is Europe, Asia and elsewhere have long used combinations of burning, hand removal, residue destruction, hoeing and crop rotation in ways that have reduced their losses to those pests. But since farming in the United States as we know it today has had a recent origin we may in North America readily trace the formal beginnings of an integrated pest control, particularly of insect pest control. Smith et al. (21) and Bottrell and Adkisson (4) traced these early origins, and Table 1 is taken from the latter authors' work.

The great U. S. leaders in entomology, C. V. Riley in Washington and J. H. Comstock at Cornell University, advocated a plurality of attack on various insect pests of their time and C. W. Woodworth in California carried the concepts a substantial degree further (21).

Table 1 lists the major factors and emerging concepts of integrated pest management of the boll weevil, the persons introducing them and the approximate times. Hunter (10) or Hunter and Hinds (11) thus advocated five of the seven recognized major items of importance. Advocacy of community-wide pest suppression for the boll weevil was advocated by Townsend (25) and Malley (13), i.e., near the first appearance of this insect in the United States from Mexico about 1890. The final item, establishing economic thresholds for the weevil was advocated by Coad and Cassidy (6). All this was before the development of substantial use of chemicals.

Chemicals for control of insects and plant diseases in the United States were utilized to some extent before 1900, and increasingly so in

---

[1]Division of Biological Control, University of California, Berkeley CA, and Department of Agricultural Economics, Texas A&M University, College Station.

Table 1. Evolution of an early pest management system for the boll weevil in North America.

Strategy concept or component[1]	Approx. date of accomplishment	Reference
Developing a conceptual model of the pest's life system	1900	11
Recognizing some of the ecological and economic consequences of the primary control tactics	1901-1903	10, 13
Recognizing need for community-wide pest suppression in preference to individual field or farm control measure	Late 1800s	14, 25
Determining economic thresholds (essentially same as used today)	1920	6
Manipulating cotton environment to maximize benefits of natural control constraints; recognizing major natural enemies	1900	11
Outlining total management system based on long-term required needs in an economic perspective	1920	11
Advocating concepts of management as being more realistic than pest eradication attempts	1900	11 and others

[1]Outline of major factors of emerging pest managment strategies as stressed by Rabb (17). [From Bottrell and Adkisson (4). Reproduced with permission from the Annu. Rev. Entomol. Vol. 22, 1977 by Annual Reviews, Inc.]

the late 1920's, 1930's and early 1940's. This is reflected in the amount of insecticide testing done during these years (Figure 1) and this itself reveals the departure from more basic biological research. Nevertheless, the total amount of pesticides produced in the United States up to about 1945 was still very low. There was then, following demonstration of striking successes with use of DDT, a phenomenal elaboration of synthetic broad spectrum insecticides and other pesticides (Figure 2) with herbicides now (1979) representing more than 50 percent of the total.

But this is getting ahead of ourselves. Two main groups of entomologists in North America had continued to investigate non-chemical agencies of insect and mite control. One group centered around A. D. Pickett in Nova Scotia (see 16) began studies to see if they could control the pests of apple without using so much pesticide. The economic picture for apple production in the 1930's together with the increasing costs of chemical programs, was making it unprofitable to produce apples,

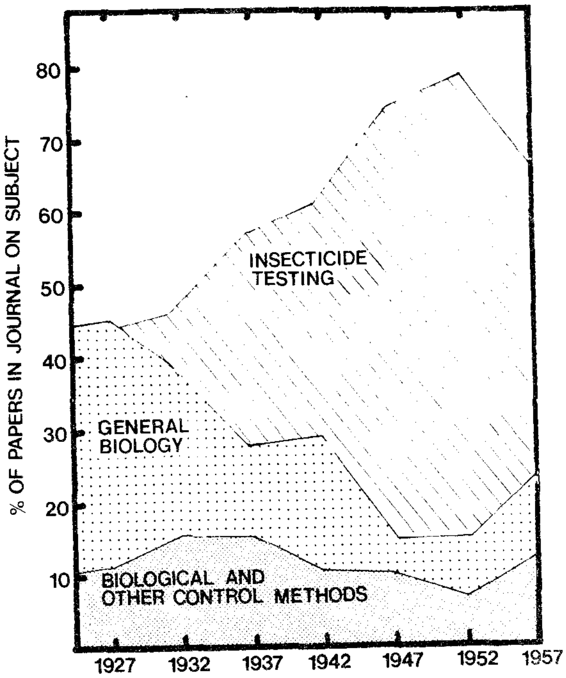


Figure 1. Trends in applied entomological research as reflected in the Journal of Economic Entomology 1927-1957. Note how insect control research increasingly focused on insecticide testing and became less concerned with the biologies of the pests which were controlled over the years. (from 7; data from 12).

a major crop of the area. These workers developed what they referred to as hormonized control wherein they shifted from uses of copper and certain other fungicides to less ecosystem disturbing ones and made other changes, including deletions in their pesticide program, in order to increase the action of natural enemies of certain insect and mite pests. This system too utilized most of the concepts of integrated pest control.

The later, more explicit definition and description of "integrated contro" was by workers in California (23). This more formalized development had been in the cooker also since the 1930's and 1940's as a result primarily, of work of A. E. Michelbacher at Berkeley (general integrated control emphasis) and H. S. Smith and co-workers at Riverside (emphasis specifically on natural enemies). These two groups eventually worked together closely to produce what is now the California effort in "integrated pest management" (3).

This formalized development did not occur, however, until after substantial repercussion had occurred in the unilateral use of insecticides following World War II (15, 19). More recently, Ray F. Smith of the University of California has become sort of a symbol of integrated insect control and is now vigorously seeking to broaden its base to include all classes of farm pests.

> *IPM may be defined as the discipline that deals with analysis of the production system, especially as related to pest impact, analysis of the biological and physical factors and their interactions, and their interactions with production practices that bear upon pest impact, and the combining of appropriate tactics and strategies to optimize net benefits of pest control in the broad sense.*

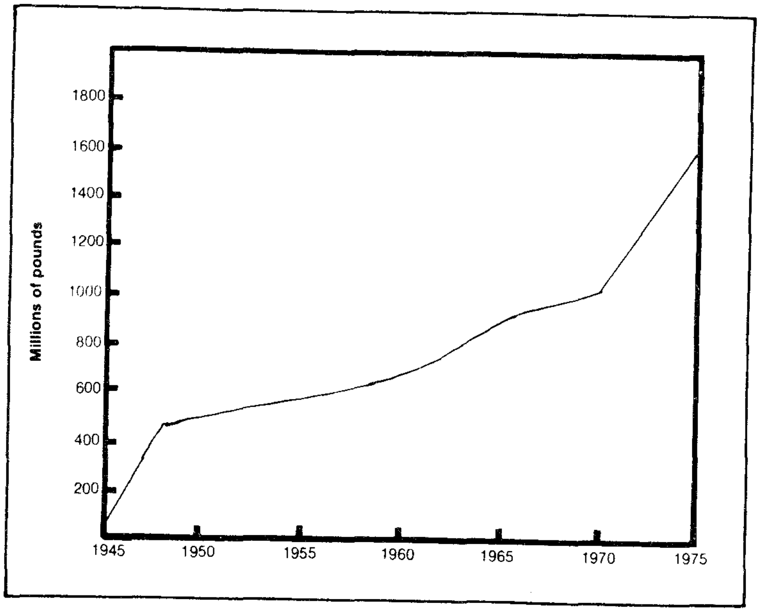


Figure 2. Estimated amount of pesticide produced in the United States (8, 26).

Fortunately, the principal gain to growers from the use of IPM, i.e., lower costs for equal or better, and less risky insect pest control, also means, usually, *less* use of pesticides with its many attendant benefits. There is no question about the need to control insects and other pests. And there is no doubting that pesticides have been a great benefit to mankind in his war against pests.

It has been estimated that about one person in six of the human race suffers from an insect-borne disease and one in five is malnourished while insects alone, not to mention the other pests, devour enough food to meet human needs (22). What all the fuss is about is simply to get more rational, i.e., more explicitly justified and appropriate, use of pesticides. Integrated pest management is a term that implies the use of all measures that are needed and appropriate, with the need and appropriateness more scientifically and economically established than has been common practice.

The Rationale of IPM

It is no longer feasible for the chemist, entomologist, plant pathologist and weed scientist to proceed along his own little path to develop a tactic which, while serving a limited objective, may be detrimental to net gains to the grower, to society or the land itself. One striking example of the latter has been the use of the herbicide atrazine in Illinois to control weeds in corn, which seems to have rendered the soils in about one-fourth of Illinois unsuitable for growing soybeans, a major crop for the area and which offers as *rotation control* the best method of controlling the main insect pests of corn, i.e., *Diabrotica* rootworms (20). Other examples have been accumulations of lead in apple orchard soils in Washington and of copper in Florida citrus soils, with adverse consequences (2, 5).

It has now become clear to our administrators who inherited the old system of strict disciplinary divisions and the filtering down of funds for isolated pieces of work, that a fundamental change is needed. With the vastly increasing use of insecticides, and the decline of biological studies, several problems arose: i.e., resurgence of target insect pests because of destruction of natural enemies, inducement to pest status of species formerly controlled by their enemies, development of resistance in the target species, adverse effects on public health, wildlife and the environment and greatly increased costs of insect control, while in general losses remained as great as ever!

California has decreed that alternatives to chemical pesticides must be used wherever practical alternatives exist. EPA is committed to reducing these health and environmental hazards. And so to replace the mode of insect control "insurance" through calendar date chemical treatments, IPM has been advanced as a more ecologically sound solution. But before any such national solution can be realized, much more needs to be done to increase or improve the research base, the technology of implementation, education of farmers, and pest control advising and regulatory systems. If all this can be done, a longer-lasting, more economically and socially profitable, healthful, and environmentally sound system of pest control can be had.

Integrated pest management requires multidisciplinary research on a variety of *direct tactics* to suppress the pests, and their integration into a system to optimize their combined use in relation, first to the farmer, and secondly to our social and environmental responsibilities. A basic requirement is to marshall together a well funded, organized *team* of researchers and education specialists.

It should be said that the 18-university NSF/EPA project which I directed concentrated on the insect and mite pests, with only a little work on plant diseases. It is now time to consider all these features and classes of pests is selecting problems and planning their solution. This is being done in the new "Adkisson Project." In such an effort central management must have the power to set priorities and allot funds if it is to keep overall progress on a balanced track.

The securing of support for a project which by its very nature departs from traditional federal and state funding and administrative routes is no easy task. When our current project was funded, NSF was in the midst of supporting a large International Biological Program (IBP) effort concentrating on gaining a basic understanding of the major animal-plant communities (biomes) of the world. As part of that broad effort, NSF saw in IBP's program in biological control the opportunity to revise the latter's focus so as to study *agro*ecosystems in a broader, more fundamental way. So NSF was receptive to the idea of an IPM project and a proposal was submitted and funded. The organizers were asked to explain it to USDA and secure, if possible, USDA support, moral if not financial. At the same time a major concern was developing in the United States House and Senate respective of the adverse effects of pesticides on public health and the environment (shades of Rachel Carson and moves to ban DDT). Later, the proposal or its basic concepts, received wide sponsorship by the USDA, including the influential Agircultural Research Policy Advisory Committee (ARPAC). USDA's submittal of the proposal to the President's Office of Science and Technology resulted in an executive order by John Ehrlichman directing, not only that NSF be allowed to support the program, which had already passed technical review, but that EPA and USDA support it as well--

without additional funding. This understandably caused concern and lees than enthusiasm on the part of some in EPA and USDA who had planned other uses of their funds. USDA was not requested to support the program except for the initial year. They did, however, continue to support it in various ways. Thus a series of unlikely events came together to facilitate the funding of the project.

Securing participants in the old project proceeded on the basis of obtaining volunteer services of key researchers. It is desirable that volunteers, therefore persons deeply interested in the goals and team approach, be obtained for these key positions. Experienced people are now available than formerly to fill the needs, especially so in systems analysis and in plant pathology and other biological disciplines besides entomology.

THE GOALS OF IPM

The goal is the development of improved, ecologically-oriented pest management systems that optimize, on a long-term basis, the costs and benefits of crop protection. Thus, the NSF/EPA project strove to develop pest control systems which will return greater profits to the producer, reduce the use of disturbing pesticides, and benefit society in other ways.

The more specific objectives are:

1. Develop an explicit understanding of the biological, ecological and economic processes in crop culture and growth, and the population dynamics of the pests.
2. Develop alternative tactics, especially cultural, biological, and host resistance tactics, for use in suppressing major pests.
3. Develop better methods of collecting, handling and interpreting biological, meteorological, crop production and economic data.
4. Utilize systems analysis as a central unifying and research-guiding tool.
5. Build practical models of the crop production and pest management systems for use in advising producers.

CONDUCT OF THE RESEARCH

The precise pattern of procedures vary with the problem and the situation. They might logically be as follows (9).

1. Develop a conceptual model of the crop growth and pest systems consistent with known facts or probable relationships. Use this model to identify the known and unknowns relative to the system and to make first estimates of the greatest research needs. Continuously move from modeling of various components to biological research on them, and back again, to improve the modeling, etc., in a circular fashion.
2. If not already known and included in (1) above, separate the real pests from those induced by pesticides.
3. Establish economic injury levels, or threatening innocula levels where possible, with attention to the on-site and off-site, short-term and long-term costs of controls.
4. Separate the real pests into those causing regular intolerable losses, i.e., key pests, and those causing only light or sporadic damage controllable by limited use of pesticides.
5. Identify the key factors controlling populations of key pests and measure their effects.
6. Design and test management systems for the whole complex of pests, key ones first.

Such an effort is often too complex for intuitive solutions. What the producer and society needed was a new technology that would utilize the power of computers and operations and systems analysis in the various forms that have been used in engineering, industry and commerce. The crop itself was taken as the central feature and models of plant growth, phenology and yield functions have been developed. Analyses of pest damage have thus been hooked on to processes of plant growth and commodity production.

In our efforts to look at the whole system collectively, we centered on certain key potential tactics. These are economic thresholds, cultural methods, natural enemies, host plant resistance, and selective pesticide use. Moreover, even though modeling is a focal point in development of programs, this by no means implies that basic and applied biological studies on the organisms themselves should be neglected. On the contrary, modeling never controlled any pest. It can help to arrive at the best strategy and tactic to use. Modeling forces us to more carefully plan such studies.

Certainly, IPM does not eliminate need for insecticides. They remain largely our only immediate solution to a sudden problem. But straight conventional pesticide control is not IPM, e.g., we need to use insecticides, but more judiciously and to serve special purposes rather than for broad-spectrum effects sought by regularized applications. We need to utilize all the components of a philosophy which looks at the problem as one of applied ecology rather than as pesticide chemistry or merchandising.

We have emphasized the need for, and the utility of modeling. But, basic biological research and development of specific control tactics (e.g., for disease pathogens, insect pests, and weeds) must proceed hand in hand.

IMPLEMENTATION

In any IPM project the need is great to keep foremost in mind that the research is not an end to itself. The goals of IPM research, however, must be to develop practical, implementable systems--ones that producers will use generally.

Have we done this? From the still incomplete knowledge and technology that has been developed, we think it safe to say that the amounts of insecticides and acaricides formerly used in the U. S. on cotton (14), apples (1) and citrus (18) could be reduced by about half if put into practice, with corresponding savings to growers, reduced insecticide loads and reduced health risks. In Washington, insecticides and acaricides for apple pest control have been more than cut in half, and in Michigan, Pennsylvania and New York by 20-30 percent (1).

For cotton, the program in Texas is showing that a system centering on dwarf-type, fast maturing cottons can maintain or increase yields and profits while reducing insecticides and saving water, fertilizer and energy reserves. In California, it has been found that most of the treatments for cotton insect control in the San Joaquin Valley have just not been necessary except as the need has been induced by largely unneeded treatments for lygus bug.

In 1977 the Coy Community cotton area in Arkansas, some 13,000 acres in cotton, experienced a reduction of conventional insecticides of ca 87% under IPM, i.e., from 9-10 treatments down to 1. This meant $20/acre savings.

In the Texas High Plains an IPM program resulted in a 77 thousand bale increase in cotton production, a cost reduction of $12 million and a profit increase of $27 million.

The short-season IPM cotton system for South Texas has resulted in a 30% yield increase with inputs reduced 33%. Producer profit was increased from $12/acre to $103/acre. Success is demonstrated by complete adoption throughout a 200,000 acre region of cotton.

In a West Texas region natural gas prices increased 450% in a few months around 1973. The impact was to increase cotton production costs by $30 to $100/acre. This area relies heavily on irrigation for crop production, since average annual rainfall is only 9 inches. Thus, without a non-irrigated crop alternative and with the highly priced gas, "profits" from crop production became "negative" and many thousands of acres of irrigated cropland were idled. The IPM cotton production program, bringing in short season varieties, dramatically reduced fertilizer and irrigation requirements, while nearly deleting insecticides because of the shortened growth season and other features.

In some cases where IPM is adopted, unexpected effects, trade-offs, may be experienced. In a study by Taylor et al. (24), the question of IPM and environmental quality was addressed for a Texas Blacklands Prairie watershed. Generally, IPM involves less pesticides than conventional methods. However, across a region or even a farm, other cropping changes associated with IPM adoption for one crop may increase the loads of other pollutants or total use of pesticides in the area.

For the Blacklands watershed, an IPM program for cotton would be expected to reduce pesticide expenditures on cotton by $2.50/acre. Over the area, however, total insecticide use was estimated to <u>increase</u> 4%, herbicides to increase 14%, nitrogen fertilizer to <u>decline</u>, and total soil loss to <u>increase</u> 19%. This is the other side of the coin. The adverse effects were due to lower production costs for cotton via IPM, making it profitable to replace hay and pasture with cotton, thus more soil erosion, more weeds, more troublesome insects and more pesticides for the farm. Even though intensity of insecticide use <u>on cotton</u>, i.e. per acre, <u>declined</u> with IPM, the increased cotton <u>acreage</u> caused a net <u>increase</u> in insecticide use in the environment.

For the main pest of alfalfa in Illinois, the alfalfa weevil, IPM research has led finally to ascertaining the optimal control program for general Extension Service recommendations. Charts are furnished the growers giving temperature accumulations throughout the season.

The <u>decision process</u> is as follows (27): Now, if in the first spring sampling <u>44 weevil larvae</u> were taken (alfalfa about 3" tall), Figure 3 tells you not to spray, but to resample after 50 more degree-days (240-260). But if 47 or more larvae were taken the recommendation would be to spray. If after 50 degree-days later the alfalfa has become 6" tall, then 55 or more larvae would be required to indicate need to spray. The pattern of decision-making at from 540 degree-days to harvest time, during which <u>early harvesting</u> may be an alternative to <u>spraying</u>.

Literature Cited

1. Asquith, D., B. A. Croft. S. C. Hoyt, E. H. Glass and R. E. Rice. In press. Systems approach and general accomplishments toward better insect control in pome and stone fruits. <u>In</u> New Technology of Pest Control. C. B. Huffaker, ed. Wiley-Interscience, New York. pp 285-363.

Alfalfa Weevil Pest Management Recommendation Chart 1
Number of larvae collected from a 30-stem sample

Total degree-days (dd)	Alfalfa height (inches) 2	3	4	5	6	7	8	9	10
190-210									
SPRAY	27	47	67	85	100	115	130		
Resample in 50 dd	0-26	0-46	0-66	0-84	0-99	0-114	0-129		
240-260									
SPRAY	21	30	39	47	55	62	69	69	69
Resample in 50 dd	0-20	0-29	0-38	0-46	0-54	0-61	0-68	0-68	0-68
290-310									
SPRAY		25	37	52	67	75	83	94	105
Resample in 50 dd		0-24	0-36	0-51	0-66	0-74	0-82	0-93	0-104
340-360									
SPRAY					82	82	82	82	82
Resample in 50 dd					14-81	14-81	14-81	14-81	14-81
Resample in 100 dd					0-13	0-13	0-13	0-13	0-13
390-510									
SPRAY									
Resample in 50 dd									
Resample in 100 dd[a]									
540 to harvest	(See Chart 2)								
100 after harvest									
SPRAY[b]	23	33	43	48	53	58	63		
Resample in 50 dd	17-22	17-32	17-42	20-47	23-52	23-57	23-62		
Resample in 100 dd[c]	0-16	0-16	0-16	0-19	0-22	0-22	0-22		
150 or more after harvest	(See Chart 2)								

[a] If this field was sprayed more than 7 days ago, you can wait 200 degree-days to resample.
[b] See comment in text [of original] about windrow effects.
[c] If last preharvest sample had less than 30 larvae, the weevil season is over and you can quit sampling.

Alfalfa Weevil Pest Management Recommendation Chart 2

Total degree-days (dd)	Change in number of larvae since last sample: Decreased 10 or more	Within 10	Increased 10 or more
540 to harvest			
SPRAY or harvest	73	63	53
Resample in 50 dd	23-72	18-62	13-52
Resample in 100 dd[a]	0-22	0-17	0-12
150 or more after harvest			
SPRAY	78	58	48
Resample in 50 dd	28-77	18-57	0-47
Quit sampling	0-27	0-17	

[a] If sprayed more than 7 days ago, you can wait 200 degree-days to resample.

Figure 3. Example of alfalfa weevil pest management recommendation charts for illinois (Adapted from 27).

2. Benson, N. R. 1978. Can profitable orchards be grown on old orchard soils? Wash. State Hort. Assoc. Proc. pp 109-114.

3. Boardman, R. M., ed. 1978. Special Issue: Integrated pest management. Calif. Agric. 32(3):1-34.

4. Bottrell, D. G. and P. L. Adkisson. 1977. Cotton insect pest management. Ann. Rev. Entomol. 22:451-481.

5. Brown, J. C. and W. E. Jones. 1975. Heavy metal toxicity in plants. I. A crisis in embryo. Commun. in Soil Sci. and Plant Analysis 6: 421-438.

6. Coad, B. R. and T. P. Cassidy. 1920. Cotton boll weevil control by the use of poison. USDA Bull. 875. 31pp.

7. Flint, M. L. and R. van den Bosch. 1977. A sourcebook on integrated pest management. International Center for Integrated and Biological Control, Univ. Calif., Berkeley. 392 pp.

8. Fowler, D. L. and J. N. Mahan. 1975. The pesticide review. USDA, Agric. Stab. Conserv. Serv., Washington, D.C.

9. Huffaker, C. B. and R. F. Smith. 1972. The IBP program on the strategies and tactics of pest management. Tall Timbers Conf. on Ecol. Anim. Control by Habitat Manage. 4:219-236.

10. Hunter, W. D. 1904. The most important step in the cultural system of controlling the boll weevil. USDA Bur. Entomol. Circ. 56. 7 pp.

11. Hunter, W. D. and W. E. Harris. 1904. The Mexican cotton boll weevil. USDA, Div. Entomol. Bull. 45 116 pp.

12. Jones, D. P. 1973. Agricultural entomology. In History of Entomology, R. F. Smith, T. E. Mittler and C. N. Smith, eds. Annuals Reviews, Inc., Palo Alto, CA. pp. 307-332.

13. Malley, F. W. 1901. The Mexican cotton-boll weevil. USDA Farmers Bull. 130. 29 pp.

14. Phillips, J. R., A. P. Gutierrez and P. L. Adkisson. In Press. General accomplishments toward better insect control in cotton. In New Technology of Pest Control, C. B. Huffaker, ed. Wiley-Interscience, New York. pp 139-174.

15. Pickett, A. D. and N. A. Patterson. 1953. The influence of spray programs on the faunna of apple orchards in Nova Scotia. IV. A review. Can. Entomol. 85:472-478.

16. Pickett, A. D., W. L. Putman and E. J. LeRoux. 1956. Progress in harmonizing biological and chemical control of orchard pests in eastern Canada. Proc. 10th Int. Cong. Entomol. 3:169-174.

17. Rabb, R. L. 1970. Introduction to the conference. In Concepts of Pest Management, R. L. Rabb and F. E. Guthrie, eds. N. C. State Univ., Raleigh. pp 1-5.

18. Riehl, L. A., R. F. Brooks, C. W. McCoy, T. W. Fisher and H. A. Dean. In press. Accomplishments toward improving integrated pest management for citrus. In New Technology of Pest Control, C. B. Huffaker, ed. Wiley-Interscience, New York. pp 365-419.

19. Ripper, W. E. 1956. Effect of pesticides on balance of arthropod populations. Ann. Rev. Entomol. 1:403-438.

20. Roskamp, G. 1977. Sencor-Lexone and atrazine interactions. 19th Illinois Custom Spray Operator Training School. Summaries of presentations. Univ. Ill. Coop. Ext. Serv., Urbana. pp 174-177.

21. Smith, R. F., J. L. Apple and D. G. Bottrell. 1976. The origins of integrated pest management concepts for agricultural crops. In Integrated Pest Management, J. L. Apple and R. F. Smith, eds. Plenum Press, New York. pp 1-16.

22. Southwood, T. R. E. 1977. Entomology and mankind. Amer. Scientist 65:30-39.

23. Stern, V. M., R. F. Smith, R. van den Bosch and K. S. Hagen. 1959. The integration of chemical and biological control of the spotted alfalfa aphid: The integrated control concept. Hilgardia 29(2): 81-101.

24. Taylor, C. R., D. R. Reneau and B. L. Harris. 1978. An economic analysis of erosion and sedimentation in Lavon Reservoir Watershed. Texas Water Resources Inst., TR-88, March 1978.

25. Townsend, C. H. T. 1894. Report of the Mexican cotton-boll weevil in Texas. USDA, Div. Entomol. Insect Life 7:295-309.

26. U.S. Dept. Agriculture. 1971. The Pesticide Review 1970. USDA, Agric. Stab. Conserv. Serv., Washington, D. C.

27. Wedberg, J. L., W. G. Ruesink, E. J. Armburst and D. P. Bartell. 1977. Alfalfa weevil pest management program. Univ. Ill. at Urbana-Champaign. College of Agric., Coop. Ext. Serv. Circ. 1136. 7 pp.

INTEGRATED PEST MANAGEMENT--INFORMED CHOICE OR MANDATORY REGULATION?

Errett Deck[1]

My subject today, "Integrated Pest Management--Informed choice or mandatory regulation?" is open-ended, controversial, and appropriate for a Jack-of-all trades generalist like I am. I have been a diversified farmer for many years and understand effective ways to influence farmers. I have worked for a State Department of Agriculture, and understand the benefits of cooperation between the Land Grant Universities Research and Cooperative Extension programs and State Departments of Agriculture. I was involved in developing the USDA charter for the Pest Management Work Group and the Secretary's memorandum on USDA Policy on the Management of Pest Problems, and understand the role of USDA versus EPS in the research, demonstration, recommendation and implementation of pest management systems. I was assigned the duty of organizing the USDA/State response to EPA RPAR's, and understand the necessity of retaining a varied arsenal of pesticides, allowing for effective pest management.

Why would I emphasize the problem of retaining pesticide registrations and obtaining new product registrations at a pest management program?

New, effective, specific pesticides, along with exact timing and improved application techniques, are the basis of many of our most promising pest management programs. The registration of new insecticides some years ago made it possible for the Washington State University Experiment Station and Cooperative Extension Service to cooperatively develop and implement an integrated pest management system in apple production. This system had been widely adopted in the state, and orchardists and others consider it a successful program.

For this apple pest management system new selective insecticides are used along with improved application techniques and timing. This has made it possible to hold mite populations in check with a native predator. The program also adequately controlled other insect pests, and reduced the application of insecticides by more than half. The training, testing and licensing of commercial applicators and commercial consultants in Washington State has provided a resource of well trained people in *private* sector that has helped to make the field implementation a success.

One of the first chemicals announced by EPA for RPAR review was chlorbenzilate, a miticide used primarily on citrus in Florida. This miticide has not built up a resistance factor with mites over the past 20 years, an unusual characteristic for miticides. Chlorbenzilate has been particularly useful in pest monagement projects in Florida. This was a significant factor in the determination by EPA to retain the use of chlorbenzilate on citrus.

---

[1]Deputy Director, Washington State Department of Agriculture, Olympia WA 98504.

In order to deter treatment for many pests until the infestation is at the "threshold level", one must be able to use a pesticide that will effectively control the pest when it begins to get out of hand. You can't wait until you see the "whites of their eyes" before firing if you don't have bullets to fire.

In the initial implementation of amended FIFRA, under the authority of Unlawful Acts, EPA took a strict interpretation of "to use any registered pesticide in a manner inconsistent with its labeling" that was in direct conflict with the Congressional intest. The Senate Report No. 92-838, of June, 1972 pointed out:

> "It is not the intention of the Committee to prohibit any use which is in no way harmful, and which has only beneficial effects on man and his environment. The Committee considered an amendment to the bill to assure that such use would not be prohibited, but concluded that this was a matter which would have to be left to the good sense of the Administrator, the manufacturers, and the users. It is the hope of the Committee that by proper administration of the labeling requirements and administrative interpretations of the law and the labels approved by him, the Administrator will be able to make it clear to users that such uses are not prohibited. Further, it is the belief of the Committee that the use of the word 'Inconsistent' should be read and administered in a way so as to visit penalties only upon those individuals who have disregarded instructions on a label that would indicate to a man of ordinary intelligence that use not in accordance with such instructions might endanger the safety of others or the environment. Thus, for example, it would be expected that use of a general, unrestricted pesticide registered for use on enumerated household pests to exterminate a pest not specified on the label would not be inconsistent with the labeling. On the other hand, the use of a general use pesticide in a manner inconsistent with a specified caution or restriction on the label should be considered inconsistent with the labeling. For example, the use in the home of a general use pesticide labeled 'for use outdoors,' or 'Not for use in enclosed areas,' would be prohibited under this provision."

With this straightforward Congressional direction, research and extension personnel publishing spray bulletins and state regulatory officials responsible for enforcement thought there would be no problem with continuing to use commonly accepted practices that had provided for the many minor variations for local needs not covered by the label. On the contrary, the Office of General Consul of EPA sent out policy letters a few years ago stating that the use of a pesticide at less than its recommended rate would be a violation of the Act, as would be the use of a pesticide to control an unlisted pest. This presented a serious threat to some effective pest management programs. The matter was somewhat cleared up through the issuance of Pesticide Enforcement Policy Statements (PEPS). Congress accepted the recommendations of the Association of American Pest Control Officials' Advisory Committee and defined "inconsistent" in the 1979 Amendments to the Act. This clarified the ability to apply at less than the recommended rate, apply for control of an unlisted pest, use methods of application not prohibited, etc.

A number of other 1978 amendments to FIFRA can improve the registration ability of EPA. Examples are the proposal for conditional registrations, the generic registration concept, the minor use registrations amendment, and the amendments to Sec. 24(c) that broaden the State's registration authority to register pesticides for special local needs.

The 1978 Amendments also direct the Administrator to consider restricting the use of a pesticide as an alternative to cancellation. This can lead to some resonable restrictions that will increase the benefits and reduce the risks of a specific use of a pesticide at the regional or local level. Also the Amendments provide for coordination between the Secretary of Agriculture and the Administrator of EPA on many issues, including a new responsibility:

> "The Administrator, in coordination with the Secretary of Agriculture, shall establish and maintain, according to agricultural products and geographic area, a list of pests in order of priority, that need to be brought under control to assure an adequate supply of quality and economical agricultural products. The Administrator shall also coordinate and cooperate with the Secretary of Agriculture's research and implementation programs to develop and improve the safe use of and effectiveness of chemical, biological, and alternative methods to combat and control pests that reduce the quality and economic production and distribution of agricultural products to domestic and foreign consumers."

If this provision is funded and implemented, we will have an opportunity to develop good basic information on essential pest control. Also, we will have a better understanding of the relationship of various alternative methods of control to the economic production of quality agricultural products.

While working as the Environmental Coordinator for USDA, I was aware of and understood the needs and pressures confronting EPA officials. However, while cooperating with and working with them, I never lost sight of the fact that the farmer in Indiana, California, Alabama or Washington needs advocates who fully understand his needs and represent him. It was the farmer who was, and is, concerned about his environment in which he lives, the health and welfare of his livestock, pets, and wildlife, and the conservation of his soil resources. USDA and Land Grant University scientists, in developing new and improved methods of pest management should continue to recognize that any program that allows the farmer to grow a marketable crop at less cost by eliminating the amount of pesticides needed for pest control will join the bandwagon in a hurry. The commercial farmer of today doesn't fit the stereotype continuing image of the farmer of the twenties. Personally knowing commercial farm operators, such as those specializing in potatoes, wheat, or seed crops, I believe operators today do not apply pesticides without the need for pest control. Economics, competition and education have eliminated the prior "cook book" scheduling of pesticide application.

I believe we would all agree that the education and certification program to certify applicators is a useful means of encouraging good pest management practices. Unfortunately the Office of Management and Budget, and to a certain extent EPA, has looked upon this as a one-time program. They failed to understand that there is a constant turnover of applicators; that additional applicators will have to qualify for certification because of a growing list of restricted-use pesticides; that there is a need for upgrading from the initial training standards--in other words, there is a need for a continuing program. The current federal legislation provides for cost sharing with the states for the certified applicator program and for instructional material on integrated pest management. This will assist is the technology transfer to the farmer.

The question of regulating pest management by legislation continually comes up. At the U.S. Senate hearings on pest management, IPM, Senator Leahy of Vermont and Senator Lugar of Indiana, well versed on the subject, accepted and agreed with repeated testimony that additional legislation and authority were not needed. The main thrust of the informal discussions of October 31 and November 11, 1977, was the need for additional research to develop improved technology on pest management, accelerated transfer of information on adequately tested and proven successful programs, and additional funding of those projects that required government assistance such as some of Animal Plant Health Inspection Service (APHIS) programs of USDA.

Pest management systems generally have not been refined quatitatively to the point where they lend themselves to national Federal requirements in the regulatory sense. We do not have the resources or expertise to regulate the need for and use of pesticides on a field by field basis. I have never interpreted the acronym "IPM" to stand for "International Police Methods."

In late 1977 EPA distributed a draft titled "National Strategy for Integrated Pest Management" which recommended the regulatory potential of IPM being incorporated into Emergency Use Exemptions (Sec. 18); Experimental Use Permits (Sec. 5); Special Local Needs Registration (Sec. 24(c)); appropriate registration, reregistration, and label approval actions, as well as all classification actions (Sec. 3); and extending Federal mandates through use of additional State authority.

One suggestion that has occasionally surfaced is to develop an integrated pest management fund. This insurance fund could compensate for crop losses of farmers involved in a controlled IPM program. Farmers historically have had to accept natural disasters such as the drought of 1977 and the great freeze of 1956 that caused unavoidable crop losses in the Northwest. However it would seem counter-productive to suggest that the risk of crop loss from a regulated IPM system is great enough that a specific crop insurance program is warranted while praising the merits and results of integrated pest management by the best proven techniques available.

The Council on Environmental Quality (CEQ) in February, 1978 issued a draft report titled "Integrated Pest Management, Status and Prospects in the United States". In Chapter 12 of this voluminous report the same regulatory approaches were proposed.

Listed below is an interesting quote from a recent publication:

> "The Environmental Defense Fund (EDF) still insists that IPM should be mandated in some form of regulatory process to force growers away from pesticides. Congress's Office of Technology Assessment held meetings recently to discuss the present status of IPM and concluded that IPM must pay its own way and be cost-beneficial to farmers. Environmentalists objected continuing that the goal of IPM should simply be the reduction in pesticide use and not economic benefit. According to Ed Smith, Cornell University, "Never in the history of human endeavor has such great expectations hinged on so little development." The logic of IPM is "absolutely overwhelming," he said but many vague aspects still surround it and many questions remain. We must ask environmentalists to bear with us, recognizing it can't be done overnight."

While I do not agree with the concept of regulating the use of pesticides on a mandatory prescription basis such as the provision so forcefully opposed in the development of the 1972 amendments to FIFRA, I do believe certain types of regulation are essential.

Control of the spread of noxious weeds through the enforcement of State Commercial feed laws, Federal and State weed laws, and State plant nursery laws is an essential component of pest management.

Other regulatory related programs that have resulted in successful pest management are the near eradication of barberry, the alternate host of grain rusts; the mandatory spraying of abandoned host fruit trees; the interception, quarantine, and fumigation for Kapra beetle; and the cooperative but regulatory grasshopper control program we have in Washington State.

You may know about the major loss of crops in the Midwest in 1978 from a grasshopper infestation that got out of control. In the Northwest we have a type of integrated pest management grasshopper program that is a success story. This cooperative federal, state and grower program has eliminated the cyclic grasshopper plagues of the past. Accurate population surveys of incubation areas determine the heavily infested locations. Control programs are restricted to these areas, usually scab or rangelands. This has resulted in applications being made on relatively small acreages before the pest has exploded into croplands. Control is accomplished in the early nymphal stages of the insect when low application rates are effective. It would be impossible to organize such a program on the basis of independent landowner responsibility without government assistance. Timing is critical and treatment has to cover <u>all</u> the highly infested areas. It would not be reasonable to expect the owners of generally low value rangelands to pay the full cost for a program benefiting the total agricultural region and, ultimately, the consumer.

Many biological control programs being studied or implemented today are regulatory in the sense that government is involved in area controls that could not be effectively handled with grower by grower decision making processes.

The cooperative USDA-APHIS, Maryland Department of Agriculture predator control program for Mexican Bean Beetle on soybeans required greenhouse and field rearing of predators on an area rather than farm by farm basis. No doubt this program will eventually be taken over and funded by soybean producers on a per acre assessment.

Currently in Washington, Oregon and Idaho we have funded, through the Pacific Northwest Regional Commission, research and demonstration projects on the control of tansy ragwort and skeleton weed by insect predators and plant diseases. Should these biological systems prove effective, continuing weed control projects will require government involvement because infestations are not limited to crop lands and major control will be required in cutover forested, range and scab lands.

According to the July, 1898 newsletter of the Weed Science Society of America, weed control in part began in the Northwest with $100 and $50 appropriations from seven counties in Washington to survey the distribution of Russian thistle. Work was directed by C. W. Piper. This broadly-based botanist is also remembered for his promotion of a new crop, soybeans, and for having written the flora of Washington State. If we in the Northwest are a leader in developing new weed control techniques today, it may be because we had an early beginning.

AN INTERDISCIPLINARY APPROACH TO RESEARCH IN INTEGRATED PEST MANAGEMENT

Robert F. Norris[1]

Integrated pest management (IPM) has, in recent years, been equated almost universally with insect control, with only token consideration of the role of weed or disease suppression in the management of a crop. For IPM to achieve its full potential it is recognized, however, that weed control, disease control, crop management, etc., will have to be included in addition to insect management (4, 5). All recent difinitions of IPM, including that accepted by the Intersociety Consortium for Plant Protection, note the interdisciplinary nature of pest management. The interaction between the various pest 'disciplines' and crop production research has traditionally been fairly good, but interaction between pest disciplines has been poor or non-existent. In order that pest management he integrated this latter situation must be changed.

The question might be asked "Why has weed control not been included in most IPM programs up to this time?" There are probably several reasons, which include:

1. Weeds are often pretty wildflowers [e.g. Larkspurs (*Delphinium* sp.], which are poisoness to livestock); nobody wants to kill wildflowers!
2. Lack of negative image. Insects create a reaction of revulsion (entomophobia) in most people and thus must be killed; diseases cause plants to look bad or to die, and therefore must be controlled. Weeds are just plants, and do not create strong negative feelings, so people can just take them or leave them.
3. Weeds do not cause cosmetic injury. Insects cause superficial damage in some cases or even show up themselves, and diseases causes blemishes or rots, in produce at the retail market. The modern shopper demands (expects?) blemish and insect free produce. The damage done by weeds is not visible at the retail level; so why worry about weed control?
4. Weed control is effective. Due to the obligatory nature of weed control in crop production the fields are necessarily kept essentially free of weeds. The general public therefore only sees fields of weed free crops, and does not appreciate the amount of time, effort, money, etc. that the farmer used to achieve the weed free status, and thus does not perceive there to be a weed problem.

For these, and probably other reasons, weed control has not received any emphasis in IPM programs. Control of weeds is, however, a mandatory component in the management of any crop; it has to be practiced. Integration of weed control into IPM programs is therefore essential as it does have impacts on the management of other pests.

Development of interdisciplinary research is essential if practical pest management that integrates all aspects of pest control into cohesive programs is to be worked out. There are several factors that weed scientists should consider in terms of an interdisciplinary approach to pest management. The following are not necessarily in order of importance:

a. Holier than thou attitude. This author has heard the following type of statement made many times: "Weed control has always been

---

[1]Botany Department, University of California, Davis, CA 95616.

integrated; we use cultivation, crop rotation, and herbicides in a program." Nothing will turn off a potential cooperator faster than being told that you are somehow better than he is. I have also heard entomologists involved in current IPM projects state that weed scientists are not interested in getting involved in cross-disciplinary research; we had better get our act together if we wish to be part of pest managment.

b. Learn the other person's problems. Weed scientists must make the effort to learn about insects, diseases and nematodes that attack the crop and/or weeds that one is working on; not just the names, but also the life-cycles, population dynamics, epidemiology, etc. Only when one can talk the other person's language intelligently will the needed credibility be gained. This may take extra effort, but it will be well worth it.

c. Take a positive attitude. When weeds are controlled, by whatever means (hand pulling to herbicides), the environment for other organisms is altered. These alterations influence populations of insects (1, 12, 13), mites (2), diseases (6), and nematodes (3). The effects of weed control may be useful, of no significance, or detrimental to an IPM program: such interactions must be known in order to make the best management decisions. When herbicides are used for weed control another level of complexity is introduced; herbicides can have direct effects on other pest organisms (7, 11) or may alter the physiology of the host plants and thus alter pest populations (10). These, and many other examples, show why weed control is an integral component of pest management.

d. Financial. If money is made available for weed science research within IPM programs then weed scientists will no doubt conduct such research. This funding could be at the Federal, State, or institutional level. This author believes that the "carrot" incentive for weed science in IPM is not ideal; unless the interest in the multidisciplinary research was there in the first place the "carrot" may not accomplish much.

e. Mandate. Administrative decisions could require cooperation in research between departments/disciplines. This will, again, lead to uninspired research, unless the individuals involved can develop a mutual interest in the project.

f. Mutual interest. Interdisciplinary research can be initiated by researchers in different pest disciplines (e.g. weed control and insect control) when researchers perceive a problem to exist that requires an interdisciplinary approach in order to arrive at a satisfactory solution. This type of approach probably has the greatest chance for success. A sympathetic or even encouraging administration is helpful, and augmentation of funding is likely to accelerate the pace of the research.

g. An exciting cross-disciplinary problem. If a problem has been noted that shows interactions between two types of pests [e.g. winter weeds and the Egyptian alfalfa weevil (8, 9)] then the chance of initiating a project are increased. Positive results showing the nature of the interaction will help to maintain interest in the project.

I believe the last two points are the most important to making a multidisciplinary project successful. There are many interactions between weeds and other pests waiting to be researched. It is up to us to go out there and get on with the job.

Literature Cited.

1. Dempster, J. P. 1969. Some effects of weed control on the numbers of small cabbage white (*Pieris rapae* L.) on brussels sprouts. J. Appl. Ecol. 6:339-345.

2. Flaherty, D. L. 1969. Ecosystem trophic complexity and densities of the Willamette mite, *Eutetranchychus willamettei* Ewing (Acarine: Tetranychidae). Ecology 50:911-916.

3. Franklin, M. T. 1970. Interrelationships of nematodes, weeds, herbicides and crops. Proc. 10th Brit. Weed Cont. Conf., pp. 927-933.

4. Glass, E. H. (Coordinator) 1975. Integrated pest management: rationale, potential, needs, and improvement. Ent. Soc. Amer., Spec. Publ. 75-2, 141 pp.

5. Huffaker, C. B. and B. A. Croft. 1978. Integrated pest management in the United States. Calif. Agric. 32(2):6-7.

6. Mantle, P. G., S. Shaw and D. A. Doling. 1977. Role of weed grasses in the etiology of ergot disease in wheat. Ann. Appl. Biol. 86:339-351.

7. Moffett, J. O., H. L. Morton and R. H. Macdonald. 1972. Toxicity of some herbicidal sprays to honeybees. J. Econ. Ent. 65:32-36.

8. Norris, R. F. and V. E. Burton. 1979. Integrating pest management in alfalfa: Complex interactions between weeds and weevils. Weed Sci. Soc. Amer., Abstr. #79, p. 38.

9. Norris, R. F. and W. R. Cothran. 1974. Interactions of weed and/or weevil control on weed growth and weevil populations in established alfalfa. Proc. West. Soc. Weed Sci. 27:74.

10. Oka, I. N. and D. Pimentel. 1976. Herbicide (2,4-D) increases insect and pathogen pests on corn. Science 193:239-240.

11. Rock, G. C. and D. R. Yeargan. 1973. Toxicity of apple orchard herbicides and growth regulating chemicals to *Neoseiulus fallacis* and two-spotted mite. J. Econ. Ent. 66:1342-1343.

12. Smith, J. G. 1969. Some effects of crop background on populations of aphids and their natural enemies on brussels sprouts. Ann. Appl. Biol. 63:326-330.

13. Tamaki, G., H. R. Moffitt and J. E. Turner. 1975. The influence of perennial weeds on the abundance of the redback cutworm on asparagus. Env. Ent. 4:274-276.

Minutes of the WSWS Business Meeting
Boise, Idaho
March 22, 1979

President R. Comes convened the meeting at 11:22 a.m. with approximately 75 members in attendance - 246 members, 25 graduate students and 7 old timers were registered.

Minutes were approved as published.

The necrology report was presented by J. W. Whitworth. A report on H. Fred Arle's career was read as follows: A moment of silence was observed in his memory.

> Fred Arle was born November 13, 1913 in Norwood, Minnesota. He received his B.S. in Forestry from the University of Minnesota in 1936. In 1946, Fred joined the Bureau of Plant Industry (later the Agricultural Research Service of the U.S. Department of Agriculture) working in Weed Research in Mississippi. On April 10, 1943, he was transferred to Phoenix, Arizona to work on control of weeds in irrigation systems. His early reasearch developed aromatic solvents for the control of submerged weeds and petroleum oils for the control of weeds on ditchbanks. He returned to the University of Minnesota in 1953 to earn his M.S.
>
> Fred's greatest contribution to Weed Science was the development of modern weed control programs in cotton. Working with the University of Arizona he developed "layby" herbicides for late-season weed control, then preplant applications for early-season control, and finally herbicide combinations for season-long control of annual weeds. In his research and the extension of his ideas, Fred showed a rare ability to work with farmers and industry, extension and research personnel. Fred conducted weed research in alfalfa, barley, corn, safflower, sorghum, sugarbeets, wheat, lettuce, -elons, potatoes, and citrus. He adapted many agricultural herbicides for use on weed control published by the University of Arizona, the U.S. Department of Agriculture, the Western Society of Weed Science, and the Weed Science Society of America.
>
> When the U.S. Department of Agriculture moved Fred's research position from Arizona in 1975 he joined the University of Arizona to continue his research at the Cotton Research Center. In 1972 the Western Society of Weed Science made Fred an Honorary Member in recognition of his research. H. Fred Arle died in Phoenix, Arizona on April 7, 1978

The nominations committee report was presented by W. Anliker for G. Lee and E. Schweizer. A slate of qualified candidates was selected and submitted to the membership for a vote. A ballot deadline of Dec. 20 was extended to Jan. 1, due to holiday mail problems. One hundred fifty members voted before the deadline and there were only three late ballots.

All match-ups were good as indicated by relatively close votes. The number of votes separating the candidates ranged from 1 to 44 votes.

The elected candidates were:

President-Elect	L. E. (Jack) Warren
Secretary	Alex Ogg, Jr.
Chairman-Elect, Research Section	Phillip D. Olson
Chairman-Elect, Education and Regulatory Section	Eugene P. Ross
WSSA Representative	Harold P. Alley

Fellows and Honorary Members. L. Jordan presented the report on selection of honorary members and fellows for C. Elmore and W. Anliker. Two fellows were elected and thier biographical sketches follow:

Louis A. Jensen

Louis Jensen grew up on a combination dryland farm and cattle ranch in Idaho. He obtained a B.S. and M.S. in Agronomy at Utah State University and did further graduate work at Colorado State University. He has been a staff member of Utah State University for 33 years, serving as Extension agent for 7 years, 18 years as State Extension Agronomist and 8 years as Extension Weed Specialist at Logan, Utah.

Lou is a charter member of WSSA, an active member of WSWS for 26 years, attending all meetings of the society during that time except two. He has served in every elective office, including that of President from 1965-1967.

He recently completed a series of weed control seminars throughout Utah, visiting every county except one, holding 1 to 3 sessions in each county for a total of 57 meetings. He has published a bi-monthly newsletter continuously for 10 years, called "The Weeder's Digest," which now has a circulation of over 1200 copies.

Louis Jensen is a member of Epsilon Sigma Phi, national honorary Extension fraternity, Crop Science Society of America, Utah Seed Council (seving as President in 1968 and 1978), Utah State Weed Control Committee (serving as Executive Secretary from 1955 to present), and Utah State Extension Specialist Assn. (serving as President in 1968).

Lou has been active in civic and church service. He has been a member of the Lions Club, served as Scoutmaster for the Boy Scouts of America, and has had numerous leadership and teaching positions in the LDS Church. He and his wife, Alberta, have a son, three daughters and six grandchildren. He thoroughly enjoys his work and likes people. He enjoys jogging, hiking, camping, photography, gardening, playing with grandchildren and writing family histories.

Gary Albert Lee

Gary Lee was born is Scottsbluff, Nebraska, May 18, 1941. He attended Chadron State College and the University of Wyoming where he obtained his Ph.D. in 1971. During a ten year tenure with the University of Wyoming he was promoted from Instructor to Associate Professor. Since 1975 he has been Professor of Weed Science at the University of Idaho in Moscow where he and his wife Georgia make their home.

Gary has been a willing and effected officer of WSWS, serving as Chairman of the Research Section, Secretary, President-Elect and Program Chairman, President and Representative to WSSA. He was also our Local

Arrangments Chairman in 1979. As a member of WSSA Gary has served on the Losses Due to Weeds and Associate Membership committees and on the Executive Board as WSSA Representative.

Gary is also a member of Alpha Zeta, Sigma Xi, Gamma Sigma Delta (serving as President in Wyoming in 1975 and in Idaho in 1979), Society of Range Management, and American Society of Sugarbeet Technologists. He is active in presentations at various grower and research meetings and a has submitted many reports to our Research Progress Reports.

Gary has served on the National Assessment team for RPAR of diallate and triallate.

Financial statement. The Treasurer-Business Manager's report was presented by J. L. Anderson who observed that the society is breaking even on its two publications and has operated primarily on the registration fee and dues of its members.

Western Society of Weed Science Financial Statement
March 1, 1978 - March 10, 1979

Income:	
Registration, Reno Meeting (362)	$5,080.00
Dues, members not attending Reno Meetings (59)	118.00
Lucheon ticket sales for wives	90.00
1978 Research Progress Report sales	2,013.56
1978 Proceedings sales	2,724.64
Sale of old publications	184.85
Payment of past due accounts	20.00
Advance order payments	64.50
Interest of savings	72.52
Total fiscal year income	10,368.07
Assets, March 1, 1978	9,401.45
	$19,769.52
Expenditures:	
1978 Annual meeting incidnetal expenses	43.24
Luncheon, 1978 annual meeting	2,052.60
Graduate Student housing, Reno	554.00
Invited speaker expenses, Reno	428.62
1978 Research Progress Report	1,976.75
1978 Proceedings	2,037.27
Dues, CAST	400.00
Business Manager honorarium	500.00
Postage	678.99
Office Supplies	284.31
Refunds	13.00
Membership mailings printing costs	134.68
1979 annual meeting incidental expenses	322.37
1979 invited speaker expenses	400.00
Total expenditures	$9,825.83
Assets	
Savings certificates	7,000.00
Checking account balance	2,893.69
Cash on hand	50.00
	$9,943.69

Finance Committee Report. The Finance Committee report was presented by K. Dunster. No problems in the immediate financial status nor in operating procedures were noted. Finance committee will propose suggestions for future management of the society's finances to the Executive Committee at the their summer meeting.

It was moved by K. Dunster and seconded that the Treasurer-Business Manager's report be accepted, carried.

Site Selection. C. Prochnow reported for the Site Selection Committee consisting of C. Prochnow, W. Gould and P. Heikes that the Del Webb Townhouse in Poenix, Arizona will be the site of the 1982 meeting to be held March 16, 17, and 18, 1982.

Placement Committee. T. Wright presented the report of the Placement Committee for D. Colbert. The committee has operated successfully in this and past years.

WSSA Representative Report. The 1979 meeting of the Weed Science Society of America was held February 6-8, 1979 at the St. Francis Hotel, San Francisco, CA. There were approximately 930 members in attendance which was a substantial increase in participation compared to the 1978 meetings.

The Board of Directors of WSSA met with incumbent President P. W. Santlemann on February 6. A final Board meeting was held with the new President J. R. Hay on February 8 at which time the new Board members assumed their duties. New Officers and Board members of WSSA are:

President	J. R. Hay
President-Elect	W. D. Carpenter
Vice President	D. E. Davis
Secretary	J. D. Nalewaja
Treasurer	G. H. Bayer
Member-at-Large	J. D. Riggleman
Past President	P. W. Santlemann
SWSS Representative	H. R. Hurst
NEWSS Representative	Dean Linscott
NCWCC Representative	R. N. Andersen
WSWS Representative	H. P. Alley
CWC Representative	W. J. Saidahk

The Society is enjoying a steady financial growth with a present net worth of $305,712.15 compared to $289,223.76 at the close of last year. WSSA now had $286,084.36 on deposit as investments for emergency funds for future needs. Because of WSSA's financial status, dues will remain at $15.00 for at least one more year. WSSA will provide $3000 to the International Weed Science Society to help publish Proceedings of the 1980 Rome, Italy meetings.

WEEDS TODAY will be financially supported by WSSA so that the popular publication can continue to serve an important function of informing the public about weed science. Ellery Knake has taken the responsibility of publishing the magazine and plans 4 issues in 1979. WSSA will supply up to $3000.00 per issue in addition to advertising sales to assure continuation.

A fourth edition of the HERBICIDE HANDBOOK has been long awaited and should be available by mid-May should no unforseen publishing problems arise. The book will sell for $7.50. The WSSA bulletin on weed seedling identification will be published under a grant from EPA and each state will receive 100 copies.

There were 150 manuscripts appearing in Volume 26 of Weed Science with 731 pages published. The rejection rate for submitted papers was 17% for 1978.

The Western Society of Weed Science can be proud of its many nationally distinguished members. Dr. H. P. Alley and Dr. K. C. Hamilton received WSSA's highest honor as being elected Fellow members. Other WSSA members so honored were R. E. Frans, Univ. of Arkansas, T. J. Sheets, North Carolina State Univ., and A. F. Wiese, Texas Agric. Experiment Station. Dr. D. E. Bayer received the Outstanding Teacher Award and Dr. P. G. Bartels and C. W. Watson received the Outstanding Publication Award. Other WSSA award recipients were G.R. Miller, Outstanding Extension Award; O. C. Burnside, Outstanding Research Award; and Paul Boldt (Michigan State University) and Joe Street (Auburn), Outstanding Graduate Awards.

The Weed Science Society of America will meet at the Sheraton Centre, Toronto, Canada on February 5-8, 1980.

Respectfully submitted,
G. A. Lee (1978) and H. P. Alley (1979)

CAST Report. WSWS joined CAST in July of 1978. L. Jordan is the first WSWS representative and submitted the following report:

The Council for Agricultural Science and Technology (CAST) is a consortium of food and agricultural scientific societies established to call on the nation's best qualified scientists to summarize the available scientific information on critical national issues in food and agriculture as a resource for decision-makers, the news media, and the public. The consortium includes 26 scientific societies representing fields ranging from veterinary toxicology to weed science to food science. There are about 3,000 individual members.

CAST concerns itself with fundamental food and agricultural problems confronting society, including many facets of agricultural production, resource management, environmental control, energy, waste disposal, water, food processing, human health, and nutrition.

The CAST budget for its 1978-1979 Fiscal Year is $265,000 covered by income from membership fees, grants, and contributions. Funds are used for travel and subsistence of scientists at Board and Task Force meetings, printing, mailing, and administrative expense.

The policies and activities of CAST are under the control of a Board of Directors representing the 26 scientific society members. Each society pays an annual fee of up to $5,000 based on its membership. Individual members (over 3,000) pay $10 per year. This is the only membership classification, other than the societies, to have representation on the Board of Directors. Subscriber members are 120 libraries and other information centers which pay $25 per year. Sustaining members, primarily trade association groups, pay annual fees of $50 to $100 each. Supporting members, of which there are 124 corporations and organizations, pay annual fees ranging from $200 to $5.000 based on their sales of agricultural products or of products to agriculture. There are two associate society members representing nonprofit agricultural-related societies that do not qualify for regular society membership. They pay $50 per year. All membership fees will be increased by 20 percent.

The main activity of CAST is the production of consensus reports on agricultural issues by prominent scientists organized as multi-disciplinary task forces. Objectivity of CAST's task force reports is protected by important safeguards. No single source of financial support is as much as two percent of the budget. No wrok has been done on a contract basis.

Task force members are repaid for official travel expenses on request but receive no honorarium. All task force expenses are paid from a general fund made up of all membership fees. No industry scientists are included on task forces when conflict of interest might be charged. Task forces meet independently to prepare their reports. No industry-related member has the privilege of placing a representative on the Board of Directors. Task force members are chosen who have shown professional integrity and devotion to public service.

Education and Regulatory Session. J. Hill reported that there were two submitted papers and a special session with four papers on Integrated Pest Management.

Research Section. Robert Norris reported on the 1979 Research Progress Report; 148 reports were received of which 137 were published and 11 were rejected. The Report contained 261 pages. The adoption of camera-ready copy apparently did not deter researchers from sending in reports. Even with the change to camera-ready reports the cost of reproducing the Research Progress Report continued to increase; up from $2000 in 1978 to $2400 in 1979.

The utilization of camera-ready copy presented several editorial problems, which were discussed at the general meeting with the aid of slides. The problems included such items as poor formating, style variations in the text, tables not set-up according to WSWS style, variations in typing and type-face, etc. Close attention to the editorial rules will be required of authors if the report is to be as consistent as possible. The adoption of camera-ready copy by the Society permits the inclusion of graphs and line drawings in the Research Progress Report at no additional cost; future Reports could include data presented this way.

R. Callihan, University of Idaho, is the Research Section Chairman for 1980, and P. Olson, American Hoechst is the chairman-elect.

The individual research project meetings' oral reports were presented briefly at the business meeting by Robert Norris. The project reports are included, in full, herein.

Project 1: Perennial Herbaceous Weeds. W. S. Belles, Chairman. The project session lasted 1 hour and 15 minutes. Seventy five persons signed the register.

Stan Heathman, Bart Brinkman, Alex Ogg and Jack Warren led an informal discussion concerning crop losses caused by perennial weeds. The need for and definition of an "economic threshold" of perennial weeds was discussed. Quantitative data on the economic impact of many perennial weeds in agronomic and horticultural crops and range areas is needed to inform the general public of the impact of these weeds.

George Hittle (Wyoming State Department of Agriculture) is the Chairman for 1980. Ralph Whiteside (Oregon State University) was elected Chairman-Elect for 1981.

Project 2: Herbaceous Weeds on Range and Forest. P. M. Ritty, Chairman. Several topics were discussed, including:

1. Are specific herbaceous weed problems getting worse? W. B. Mc Henry discussed artichoke thistle and the use of picloram and 2,4-D for its control. Musk thistle was also mentioned as an expanding problem.

R. L. Zimdahl, Colorado State University, gave a thumbnail sketch of survey methods taken in two counties in Colorado, wherein economic losses were calculated. It was considered that this approach would enhance our understanding of economic weed problems and losses if his work were used as a model for additional herbaceous weed spread evaluations.

John Evans, Utah State University, commented on the spread of weedy species. Ornamentals have been intrumental in weed introductions into the state of Utah. Dyers Woad is being gathered and spread by flower lovers. This species, in particular, is rapidly spreading through various means; also spreading are two species of poppy, and goatsrue.

George Hittle discussed the spread of leafy spurge in the state of Wyoming. Three million acres have been surveyed in Wyoming for noxious weeds, specifically leafy spurge. He compared the spread of noxious weeds on private and federal lands, and estimated that in the state of Wyoming, between 26 and 30 thousand acres of leafy spurge are now present.

Zimdahl also commented that spurges are being looked at as a source of latex by Colorado and by the University of Idaho.

L. E. Warren expressed a need for determination of density of infestation of noxious weeds, along with the acres infested. The possibility of sattelite photographs were discussed briefly, and it was indicated that NASA and Lanset projects may help in determining density as well as spread of noxious weeds. Mr. Tovey of Idaho, indicated that a crash program was needed for a number of weeds, such as rush skeleton weed, diffuse and spotted knapweed, yellow star thistle, and others, in order to check the spread of these noxious weeds.

2. Where are we heading in control of herbaceous poisonous plants?

This subject was not discussed since the spread of herbaceous weeds and how to make control programs effective and useful seemed to capture the attention of the audience.

3. How do we "sell" control methods to the user?

Art Sunderland, Columbia County, Washington, discussed the "crash" program for the control of yellow star thistle. He indicated that federal cost sharing was helful, but working with weed districts was absolutely necessary.

Tovey also indicated that the state weed laws should be made use of through committees and a continued education of the state government presonnel in charge of the state weed laws.

Sharon Clay, a custom applicator-weed control supervisor, stated she had had success by informing growers of the cost of weed infestations and the cost of control. Approaching them with the benefits to be derived from weed control was useful.

Art Sunderland then indicated that a film had been made on the control of yellow star thistle and that this was available for use.

Tovey discussed some history on how to make people aware of programs that were effective in the control of herbaceous weeds. He held weed tours in seven counties to inform growers of the speed of spread, and the areas of infestation. Then, as action committee was formed, a slide story was developed to show the problems to legislators and this resulted in a state weed program and coordinator.

Other discussions included the fact that funds on federal lands are in jeopardy. Requests for ACP cost share should be included for 1979.

Don Lancaster of Modoc County, California, indicated brush conversion programs by ASC have been vetoed by the California Fish and Game Commission.

Also discussed was the fact that some states have regulated their own restrictions on the use of 2,4,5-T, such as in Wisconsin, Connecticut, Arkansas and Missouri, where attempts to climb onto the 2,4,5-T emergency suspension is beginning to become apparent in those states.

Steve Cockreham of Elanco Products Company, in Lariamie, Wyoming, was elected as chairman-elect to serve during the 1981 meeting of WSWS with Dr. W. S. Belles, University of Idaho, Moscow, Idaho, who will be chairman of Project 2 - Herbaceous Weeds of Range and Forest at the next annual meeting of the Western Society of Weed Science (1980).

Project 3: Undesirable Wood Plants. Walter L. Gould, Chairman. Chariman for 1980 is W. B. (Jim) McHenry (University of California, Davis), and David Wattenbarger (University of Idaho) was elected vice-chairman. Approximately 35 people attended the Project session with 32 people registering. Three topics were presented.

1. Importance of herbicides in forestry. John Walstad, Weyerhaeuser Company, discussed the timber inventory and the acreage of commercial forests in the various regions of the United States. Herbicides are used primarily in the Southern and Pacific-Northwest Regions. A very small portion of forested land will normally need vegetation manipulation. Mechanical methods are appropriate in some situations and herbicides are needed in some cases. The most used herbicide for release of conifers overgrown by broadleaf species is 2,4,5-T. The monetary impact to the forest industy without 2,4,5-T for forest management was presented.

2. Herbicide tolerance of forest species. Kerry Howard, Oregon State University, discussed the tolerance of conifer species to soil-applied and foliage applied herbicides in Oregon. Steve Radosovich, University of California, Davis, discussed the results of two studies on the tolerance of six conifer species threated at three application dates.

3. Control of conifer mortality by pocket gophers. Glen Crouch, Rocky Mountain Forest and Range Experiment Station, presented results of studies to control the mortality of newly planted conifers by pocket gophers. Eliminating pocket gopher by controlling herbaceous vegetation with atrazine resulted in significantly higher conifer survival.

Project 4: Weeds in Horticultural Crops. P. Olson, Chairman. Subjects:

1. What can be done about annual weeds escaping present weed control methods? Farms should be monitored to determine weed problems and severity to make proper applications of herbicide(s). Correct selection of herbicide(s) and/or combinations need to be made to get good weed control. Black nightshade is becoming a serious problem in many horticultural crops. Proper crop rotation will help in keeping down the problem annual and perennial weeds. This is often a problem because the banks often dictate what croping systems they will finanace.

There is a shift of weed species because of removal of one weed lends the introduction or good growing conditions for another weed. There is some resistence building up of certain weeds (e.g. groundsel) to some herbicides.

2. Comparing methods of herbicide application. The rope wick application is a growing potential method for certain herbicide applications, i.e. removal of volunteer or cover crop small grains in vegetables. This is a new way to selectively remove weeds from a crop with non-selective contact herbicides (foliage active herbicides).

Herbigation is becoming popular in irrigation center pivot systems. There was a question of uniformity with this method of application.

3. New weed control developments and herbicides in horticultural crops. Pronamide is a good looking herbicide in many crops. Combinations of pronamide + CDEC is helping in overcoming the groundsel problem in many crops. Registration of old materials--bromoxynil (garlic and onions), TOK (garlic), chloroxuron (garlic), trifluralin (asparagus), and napropamide (strawberries)--are some new developments in horticultural crops.

Changes in cultural practices, such as transplant lettuce, is opening up new ways to help control weeds.

State and emergency federal registrations are becoming more prevelant in combating weed problems in horticultural crops.

The chairman for 1980 is Garvin Crabtree of Oregon State University. Charles Stanger was elected chairman-elect.

Project 5: Weeds in Agronomic Crops. J. W. Whitworth, Chairman. Subjects of concern in the control of weeds in agronomic crops were presented, with discussion and commentary from the floor.

1. Have we placed too much reliance on herbicides? Misleading herbicide advertizing can result in excessive reliance on magical cures for weed problems. Retail dealers of herbicides, consultants and others who work directly with producers can often be more effective than university extension personnel in promoting proper total management practices for controlling weeds. There will be a greater reliance on herbicides in the future.

2. Should minimum or no-till methods which are dependent on herbicides be restricted to a one-year rotation? An increase in acreage of infestation of many weed species has occurred as a result of reduced tillage as a management practice. Reduction of tillage operations is becoming widespread. Knowledge of herbicide use with minimum tillage practices is improving. Proper timing of application of herbicides can reduce water loss due to weeds and reduce the number of spring tillage operations in wheat production. The increase in yield resulting from soil-stored moisture can more than pay for the herbicide and application. There can be difficulties with reduced soil temperatures, perennial weeds, diseases, and rodents. In certain situations no-till practices are successful, especially when combinations of herbicides are used. Engineering problems related to care and harvest of narrow-row crops have not been solved.

3. Have we made any real progress in the past 20 years in controlling weeds in sugarbeets? Sugarbeets are becoming increasingly attractive to growers because weed control can now be accomplished without hand labor. New postemergence herbicides are providing control of grassy weeds.

4. With all the newly developed herbicides for the control of wild oats, why are they an ever increasing problem? Crop seed contaminated with wild oat is a major problem. Low prices received by farmers discourages expenditures for herbicides, thus many acres go untreated. Planting of the new short varieties of wheat and other small grains has resulted in increased weed problems. Controlling grassy weeds in small grain often results in reduced crop yields.

N. Humburg will be chairman for the 1980 meetings. Richard Gibson was elected project chairman for 1981.

Project 6. Aquatic and Ditchbank Weeds. Con Seaman, chairman. Lars Anderson, USDA, Denver is chairman for 1980, and Nate Dechoretz of the USDA at the University of California, Davis was elected chairman-elect.

Approximately 50 to 60 people attended the meeting. Two films were shown followed by an active discussion.

Project 7. Chemical and Physiological Studies. H. L. Morton, Chairman. The meeting, held on March 22, 1979, was attended by about 60 with 54 signing the attendance sheet. J. W. Whitworth, New Mexico State University, is chairman for 1980 and Steve Radosevich, University of California, Davis, is chairman-elect. J. W. Whitworth lead a provacative discussion on the subject: "Mode of Action Studies--Where Have They Gone?" Several reasons were given why mode of action and other biochemical-physiological studies were not reported in the WSWS Progress Report and Proceedings. The research on biochemistry of herbicides and herbicide mode of action must compete with other kinds of research. To do a thorough study, more funds are needed than are readily available. Biochemists and physiologists usually prefer to report their findings in more "prestigious" publications. Tom Wright indicated that companies are interested in knowing more about the mode of action of their herbicides.

T. H. Wright lead the discussion, "Effects of Herbicides on Crop Quality." He pointed out that many people have observed an increase in animal preference for grasses which have been treated with tebuthiuron. Dale Shaner pointed out that it is possible to get large increases of protein in wheat by application of dicamba, but yields usually dicrease. Alden Crafts and Tom Johnsen pointed out several instances of increased animal preference for treated plants but indicated that we do not know why primarily because no one has studied why due to the pressure to find herbicides that work. Alex Ogg and John Miller discussed quality of vegetable and field crops when exposed to herbicides. Generally, quality is lowered, but this is not necessarily always the case. Jack Warren pointed out that the effects of mixtures of pesticides are much more complicated than single pesticides.

Bob Zimdahl led a lively discussion on weed seed germination and levels in the soil. Several participants measured the depth of our ignorance about seed dormancy, periodicity of germination and our ability to predict weed populations based on weed seed populations in the soil.

Roland Schirman raised several questions concerning our ability to detect plant stress and the effects of stress on control measures. While stress is difficult to measure at a single point in a plant's life cycle, there are new methods which may aid in determining when stress occurs in plants and permit monitoring of plants through their growth and development so that stress can be detected.

Project Chairmen for 1979

Project 1. Perennial Herbaceous Weeds--George Hittle, Wyoming Dept. of Agriculture, 2219 Cary Avenue, Cheyenne, WY 82202. Chairman-elect: Ralph Whitesides, Crop Science Department, Oregon State University, Corvallis, OR 97331.

Project 2. Herbaceous Weeds of Range and Forest--Wayne S. Belles, Plant and Soil Science Department, University of Idaho, Moscow ID 83843. Chairman-elect: Steve Cochreham, Lilly Research Labs, Box 3482, University Station, Laramie WY 82071.

Project 3. Undesirable Woody Plants--W. B. McHenry, Department of Botany, University of California, Davis CA 95616. Chairman-elect: David Wattenburger, Plant & Soil Science Department, University of Idaho, Moscow ID 83843.

Project 4. Weeds in Horticultural Crops--Garvin Crabtree, Department of Horticulture, Oregon State University, Corvallis OR 97331. Chairman-elect: Charles Stanger, Melheur Experiment Station, Route 1, Box 620, Ontario OR 97914.

Project 5. Weeds in Agronomic Crops--Neil Humburg, University of Wyoming, P. O. Box 3354, University Station, Laramie WY 82071. Chairman-elect: Richard (Rick) Gibson, Plant Science Department, Utah State University, Logan, UT 84322.

Project 6. Aquatic and Ditchbank Weeds--Lars Anderson, USDA Aquatic Weed Lab., P. O. Box 25007, Denver, CO 80225. Chairman-elect: Nathen Dechortez, USDA, Botany Department, University of California, Davis, CA 95616.

Project 7. Chemical and Physiologicla Studies--J. Wayne Whitworth, New Mexico State University, P. O. Box 3965, Las Cruces, NM 88003. Chairman-elect: Steve Radosevich, Botany Department, University of California, Davis, CA 95616.

Resolutions Committee Report. D. Shaner presented the report of the resolutions committee. J. Alldredge and L. Morrow were members of the committee.

Proposed resolution:

WHEREAS the facilities and arrangements for the 1979 annual meeting of the Western Society of Weed Science are of satisfactory quality and well organized, and

WHEREAS the organization and content of the program have been of good quality,

THEREFORE BE IT RESOLVED that the membership of the Western Society of Weed Science in conference assembled, express its appreciation to Chairman Gary A. Lee and members of the 1979 Local Arrangements Committee and to the staff of the Rodeway Inn and Chairman Larry, C. Burrill and members of the Program Committee.

D. L. Shaner moved adoption of the resolution. The motion was seconded and carried unanimously.

The second proposed resolution dealt with internal procedures of the National Cancer Institute and their assessment of human risks of compounds alleged to be carcinogens. D. L. Shaner moved adoption of the resolution. The motion was seconded. Discussion followed. Motion to table by J. W. Whitworth. The motion was seconded and carried. The complete text of the resolution is in the March 19 minutes of the Executive Committee meeting.

The third proposed resolution dealt with future actions regarding removal of herbicides with potentially harmful contaminants from the market. D. L. Shaner moved adoption and the motion was seconded. Discussion followed. The resolution was defeated by a wide margin.

Proposed resolution #4:

WHEREAS the Federal Agriculture Stabilization and Conservation Service has dropped its A.C.P. cost share program for weed control, the Western Society of Weed Science, in conference assembled asks for the restoration of this A.C.P. cost share program for the balance of 1979 and that it be put into the 1980 handbook.

D. L. Shaner moved adoption and the motion was seconded. R. Fosse moved to table and the motion was seconded. After discussion the motion to table and second were withdrawn. The original resolution was carried unanimously.

A straw vote was taken on the question of whether or not WSWS should continue to prepare annual resolutions. The consensus of the group was that resolutions should be prepared.

Constitution and By-laws Committee. R. Comes presented the report for W. Anliker.

Article IV - Officers and Executive Committee

Section 2. The Executive Committee shall be composed of.... ...., The Resentative to WSSA, the Representative to the Council for Agricultural Science and Technoligy, Chairman of the Research Section, ...

Section 3. .... Other members of the Executive Committee shall begin their term at the close of the meeting at which they are installed, except the Respresentatives to WSSA and CAST whose terms are described in Article IV, Section 5 of the Constitution.

Section 5. Add: The Soceity Representative to the Council for Agricultural Science and Technology shall serve three years, beginning after the CAST winter meeting at which the election is announced.

By-Laws

Article II - Duties of Standing Committees

Section 5. The Nominations Committee shall nominate at the annual meeting candidates for the officers of ....and WSSA and CAST Representatives when necessary.

Article I - Duties of Officers

Section 1. The President shall................. He may confer if, in his opinion, a member of the Society has demonstrated distinguished service, the Presidential Award of Merit. This Award will be presented solely at the discretion of the President.

Article V - Fellows and Honorary Members

Section 3. Persons selected as Honorary Members prior to 1974 shall continue to receive publications of the Society. They shall be listed annually in the Program and in the Proceedings under the heading Fellows (formerly Honorary Members).

revise this section to read:

All Fellows, upon retirement, and Honorary Members shall receive publications of the Society and complimentary registration and luncheon privileges at all Society meetings which they attend. Persons selected as Honorary Members prior to 1974 shall be listed annually in the Program and in the Proceedings under the heading, Fellow (formerly Honorary Members).

It was moved by J. Hill and seconded that the proposed changes be adopted concerning the CAST representative in Article 4 and Article 2. R. Fosse moved to table and the motion was seconded and carried 21 to 5.

It was moved by R. Comes and seconded that the change in Article 1 be accepted. Carried. It was moved by R. Comes and seconded that the changed is Article 5 be accepted. Carried. The dues for members who do not attend the annual meeting have been raised from $2 to $5.00.

R. Comes turned the meeting over to L. Burrill who adjourned the meeting 1:02 p.m.

FELLOWS AND HONORARY MEMBERS OF THE WESTERN SOCIETY OF WEED SCIENCE

HONORARY MEMBERS

Dick Beeler, 1976
Dale H. Bohmont, 1978

FELLOWS (FORMERLY HONORARY MEMBERS)

Robert B. Balcom, 1968
*Walter S. Ball, 1968
Alden S. Crafts, 1968
F. L. Timmons, 1968
D. C. Tingey, 1968
Lambert C. Erickson, 1969
*Jesse M. Hodgson, 1969
Lee Burge, 1970
Bruce Thornton, 1970
Virgil M. Freed, 1971
W. A. Harvey, 1971
*H. Fred Arle, 1972
Boysie E. Day, 1972
Harold P. Alley, 1973
K. C. Hamilton, 1973
William R. Furtick, 1974
*Oliver A. Leonard, 1974
Richard A. Fossee, 1975
Clarence I. Seeley, 1975
Arnold P. Appleby, 1976
J. LaMar Anderson, 1977
Arthur H. Lange, 1977
David E. Bayer, 1978
Kenneth W. Dunster, 1978
Louis A. Jensen, 1979
Gary A. Lee, 1979

*Deceased.

Membership List of the Western Society of Weed Science, July 1, 1979

Walter W. Abramitis
ARMAK
1315 59th Street
Downers Grove, IL 60515

Timm R. Adams
Adams AgriSpray Inc.
Rt. 3
Rupert, ID 83350

Harry S. Agamalian
California Extension Service
118 Wilgart Way
Salinas, CA 93901

Jerome V. Alanko
Union Carbide Corp.
1960 Mayflower Way
Meridian, ID 83642

W. E. Albeke
PPG Industries
16107 S. Wilson Road
Oregon City, OR 97045

Jack Aldridge
Nor-Am Agric. Products
P. O. Box 4322
Fresno, CA 93744

Harold P. Alley
Plant Science Division
University of Wyoming
Laramie, WY 82071

Clark R. Amen
American Cyanamid Company
1445 N.W. 14th Place
Corvallis, OR 97330

Don Anderson
Washington Co. Weed Control
1114 E. Court
Weiser, ID 83672

J. LaMar Anderson
Plant Science Dept., UMC 48
Utah State University
Logan, UT 84322

W. Powell Anderson
New Mexico State University
Agronomy Dept. Box 3Q
Las Cruces, NM 88003

W. L. Anliker
Ciba-Geigy Corp.
811 S.E. 97th Ave.
Vancouver, WA 98664

Arnold P. Appleby
Crop Science Department
Oregon State University
Corvallis, OR 97331

Tom Armstrong
Monsanto
11414 W. Center Road
Omaha, NB 68144

Floyd M. Ashton
Botany Department
University of California
Davis, CA 95616

David G. Austin
P. O. Box 3276
Thousand Oaks, CA 91359

Alvin A. Baber
DuPont Company
2180 Sand Hill Rd, Suite 240
Menlo Park, CA 94025

Richard W. Bagley
HLR Sciences, Inc.
P. O. Box X
Vero Beach, FL 32960

Richard B. Bahme
Agridevelopment Company
3 Fleetwood Court
Orinda, CA 94563

Laurence O. Baker
Plant and Soil Science Dept.
Montana State University
Bozeman, MT 59715

Robert B. Balcom
4720 44th St. N.W.
Washington, DC 20000

Don Baldridge
Montana Agri. Exp. Station
Box 131
Huntley, MT 59037

Edward Bals
Micron Sprayers Ltd.
8582 Katy Frwy - 200
Houston, TX 77024

Paul B. Bartels
Dept. of Plant Sciences
University of Arizona, Bldg 36
Tucson, AZ 85721

Sam N. Bartee
Kalo Laboratories, Inc.
9233 Ward Parkway
Kansas City, MO 64114

A. E. Bartholomu
Jerome County Court House
Jerome, ID 83338

Brooks Bauer
Zoecon Corp.
20592 Ayers Ave.
Escalon, CA 95320

Orrie Baysinger
University of Idaho
1013 Deakin #6
Moscow, ID 83843

Dick Beeler
Agrichemical Age
83 Stevenson Street
San Francisco, CA 94105

Wayne S. Belles
Plant & Soil Science Dept.
University of Idaho
Moscow, ID 83843

Larry Bennett
Chemonics Industries
P. O. Box 21568
Phoenix, AZ 85036

E. Ray Bigler
Chemonics industries
P. O. Box 21568
Phoenix, AZ 85036

Carl W. Bigeman
E. I. duPont de Nemours & Co.
Biochem. Dept., 1007 Market
Wilmington, DE 19898

J. Russell Bishop
Union Carbide Agr. Products
500 Brookside Ave.
Ambler, PA 19002

Lynne Bixler
604 Lewis Ave.
Woodland, CA 95695

Sheldon Blank
Monsanto Company
454 Ridgeway Drive
Twin Falls, ID 83301

Bert L. Bohmont
Extension Service
127 Shepardson Bldg
Colorado State University
Fort Collins, CO 80523

Dale W. Bohmont
College of Agriculture
University of Nevada
Reno, NV 89507

Patrick Boren
Crop Science Department
Oregon State University
Corvallis, OR 97331

R. C. Bowers
The Upjohn Company
Agri. Div. 9700-50-1
Kalamazoo, MI 49001

E. J. Bowles
Pennwalt Corp.
6830 N. Chateau Fresno
Fresno, CA 93711

Ray J. Boyd
U.S. Forest Service
1221 S. Main Street
Moscow, ID 83843

Bob Brattain
Montana State University
1000 N. 17th, Box 190
Bozeman, MT 59715

Bill D. Brewster
Crop Science Department
Oregon State University
Corvallis, OR 97331

Larry Bridge
USDA Crops Research Lab
Colorado State University
Fort Collins, CO 80523

Ronald J. Brinker
Monsanto Company
800 N. Lindbergh Blve.
St. Louis, MO 63166

Bart Brinkman
Velsicol Chemical Corp.
5130 2nd Ave. S.E.
Salem, OR 97302

David L. Bruce
Stauffer Chemical Company
220 S. Clovis Ave., Apt. 240
Fresno, CA 93727

Ronald J. Broda
Field & Lab. Inc.
513 Sunrise Lane
Fort Collins, CO 80521

Lee Burge
1625 California Avenue
Reno, NV 89507

Ronald J. Burr
Rhone-Poulenc Inc.
5835 Basil St. N.E.
Salem, OR 97301

Larry C. Burrill
IPPC, Gilmore Annex
Oregon State University
Corvallis, OR 97331

Ray Burtenshaw
Utah State Univ. Extension
179 N. Main Street
Logan, UT 84321

Dale A. Bush
Union Carbide Agri. Products
2845 Delhay Drive
Lincoln, NB 68567

Jim L. Bushnell
Utah State Univ. Extension
P. O. Box 812
Fillmore, UT 84631

Tim Butler
Pacoast Chemical
P. O. Box 28626
Sacramento, CA 95828

Robert H. Callihan
University of Idaho
Aberdeen Exp. Sta., Box AA
Aberdeen, ID 83210

Will D. Carpenter
Monsanto Company
800 N. Lindbergh Blvd.
St. Louis, MO 63166

Tom Cheney
University of Idaho
1315 Linda Lane #2
Moscow, ID 83843

Chuck Carter
BASF Wyandotte Corp.
1796 Margo Drive
Concord, CA 94519

Richard L. Chase
Utah State Univ. Extension
Courthouse
St. George, UT 84770

M. Dale Christensen
Ciba-Geigy Corp.
1951 Chateau Ct.
Walnut Creek, CA 94598

Bill Clark
Nevada State Dept. Agri.
350 Capitol Hill
Reno, NV 89504

R. F. Clark
Ethyl Corp.
451 Florida Street
Baton Rouge, LA 70801

Sharon Clay
Idaho County Weed Control
Courthouse
Grangeville, ID 83530

Jimmie Cobb
Monsanto Company
17925 S.W. Yaquinto Court
Tualatin, OR 97062

William T. Cobb
Lilly Research Labs
815 S. Kellogg
Kennewick, WA 99336

Steve Cochreham
Lilly Research Labs.
Box 3482, University Station
Laramie, WY 82071

Donald R. Colbert
American Cyanamid Company
2133 Jackson Street
Lodi, CA 95240

J. Wayne Cole
Univ. of Idaho Extension Serv.
Box 427
Preston, ID 83263

Quentin C. Coleman
Oregon State University
410 N.W. 8th Street, #209
Corvallis, OR 97332

Michael E. Collier
Spokane County Weed Coordinat.
N 222 Havana
Spokane, WA 99202

Don M Collins
Monsanto Company
800 N. Lindbergh Blvd. C35D
St. Louis, MO 63166

Ron Collins
Consulting Entomologist
Route 2, Box 81 - C
Hillsboro, OR 97123

Richard D. Comes
SEA FR USDA, Box 30
Irr. Agri. Res. & Ext. Center
Prosser, WA 99350

Susan G. Conrad
Botany Department
University of California
Davis, CA 95616

Robert J. Conner
Ciba Geigy Corp.
P. O. Box 11422
Greensboro, NC 27409

A. Wayne Cooley
Rhone Poulenc
P. O. Box 125
Monmouth Junction, NJ 08852

Howard P. Cords
Div. Plant, Soil & Water Sci.
University of Nevada
Reno, NV 89557

Garvin Crabtree
Department of Horticulture
Oregon State University
Corvallis, OR 97331

A. S. Crafts
Department of Botany
University of California
Davis, CA 95616

Eugene H. Cronin
USDA SEA
Poisoness Plant Greenhouse
Utah State Univ. UMC 63
Logan, UT 84322

Glenn L. Crouch
U.S. Forest Service
240 W. Prospect
Fort Collins, CO 80526

Cecil Crutchfield
Chevron Chemical Company
940 Hensley Street
Richmond, CA 94804

Dave Cudney
Department Botany & Plant Sci.
University of California
Riverside, CA 92521

Edwin A. Davis
Forest Sciences Lab.
8022 E. Whitton Ave.
Scottsdale, AZ 85251

Boysie E. Day
Dept. of Plant Pathology
University of California
Berkeley, CA 96720

Mike Day
Fisons Corp.
11364 Peconic Drive
Boise, ID 83705

Delvan W. Dean
932 Singingwood Road
Sacramento, CA 95825

Nathan Dechortez
Botany Dept., USDA-SEA
University of California
Davis, CA 95616

Bud Deerkop
Department of Hort. & LA
Washington State Univ.
Pullman, WA 99164

Donald L. DeLay
Nor-Am Ag. Products, Inc.
35462 Road 150
Visalia, CA 93277

Steven A. Dewey
Oregon State University
3435 N.W. Orchard Ave.
Corvallis, OR 97330

George W. Dickerson
Dept. Agricultural Services
New Mexico State Univ. Box 3E
Las Cruces, NM 99003

Edward Dimock II
Forest Sciences Laboratory
3200 Jefferson Way
Corvallis, OR 97330

William W. Donald
Weed Research Lab.
Colorado State Univ.
Fort Collins, CO 80523

Joseph E. Dorr
Ciba-Geigy Corp.
100 S. Citrus Ave., Suite 2C
Covina, CA 91723

Charles H. Doty
Univ. Ariz. Cotton Res. Center
4201 East Broadway
Phoenix, AZ 85040

Ray Downs
Utah State Dept. Agriculture
147 N. 200 West
Salt Lake City, UT 84103

Robert G. Duncan
Velsicol Chemical Corp.
3502 Slide Rd., Suite A 18-B
Lubbock, TX 79414

Allen Dunlap
Arizona Agrochemical Co.
P. O. Box 21537
Phoenix, AZ 85036

Kenneth W. Dunster
Union Carbide Agri. Products
P. O. Box 2698
Fremont, CA 94536

John W. Durfee
Union Carbide
7825 Baymerdous Way
Jacksonville, FL 32216

Donal P. Dwyer
Nor-Am
4190 N. Sherman
Fresno, CA 93726

Matthew Eblhardt
American Hoechst Corp.
P. O. Box 425
Palouse, WA 99161

W. Leo Ekins
Fisons Corp.
2 Preston Ct.
Redford, MA 01730

Eric Eldredge
Dept. Plant & Soil Science
University of Idaho
Moscow, ID 83843

Harold C. Elg
Minidoka County Weed Control
Rt. 2
Rupert, ID 83350

Clyde Elmore
Botany Department
University of California
Davis, CA 95616

Lambert C. Erickson
Plant Science Dept.
University of Idaho
Moscow, ID 83843

John O. Evans
Plant Science Dept., UMC 48
Utah State University
Logan, UT 84322

Larry L. Evetts
Monsanto Company
800 N. Lindbergh Ave.
St. Louis, MO 63166

Peter Fay
Plant & Soil Science Dept.
Montany State University
Bozeman, MT 59717

Allen D. Fechtig
Beaver Spray Service, Inc.
P. O. Box 337
Albany, OR 97321

Stanford N. Fertig
USDA, SEA, AR
16919 Melbourne Drive
Laurel, MD 20810

Richardo Victoria Filho
Oregon State University
2160 N.W. Jansse, Apt. 16
Corvallis, OR 97330

Lou Flanagan
Ramsey Seed Incl
435 Palomino Ct.
Manteca, CA 95336

Samuel A. Fluetsch
Canyon County Weed Control
Rt # 5, Box 5385
Caldwell, ID 83605

John Fortino
Mobay
P. O. Box 4913
Kansas City, MO 64120

Richard A. Fosse
Union Carbide
10144 E. Fr. Cmp. Rd.
Monteca, CA 95336

Gus Foster
Velsicol Chemical Corp.
1024 Glenmoor
Fort Collins, CO 80521

Richard Fox
Ciba-Geigy
3925 Crocus Drive
Modesto, CA 95350

Gordon Frank
Crop Science Department
Oregon State University
Corvallis, OR 97331

Peter A. Frank
USDA-SEA-FR
Botany Dept, Robbins Hall
University of California
Davis, CA 95616

Virgil H. Freed
Dept. of Agricultural Chem.
Oregon State University
Corvallis, OR 97331

R. Mark Frazier
American Hoechst
Rt 202-206 North
Somerville, NJ 08876

Fred Gagnon
Ciba Geigy Corp.
38520 Mesa Raod
Temecula, CA 92390

Alvin F. Gale
University of Wyoming
Pl. Sci. Div, P. O. Box 3354
Laramie, WY 82071

Tad H. Gantenbein
John Taylor Fertilizer Co.
1727 Brier Way
Carmichael, CA 95813

Don Gates
3M Company
Ag. Chem, 223-6, 3M Center
St. Paul, MN 55082

Stanistaw Gawronski
02-766 Warsaw
Hort. Crop Dept, Univ. of Agr.
St. Nowoursynowska 166
Warsaw, POLAND

G. Pat Gentry
BASF
P. O. Box 625
Corte Madera, CA 94925

Joseph Geronimo
Dow Chemical Co, Ag. Products
P. O. Box 1706
Midland, MI 48640

John M. Gibson
Ciba-Geigy Corp.
Rt. 3, Vallejo Road
Boise, ID 83705

Richard Gibson
Plant Science Department
Utah State Univ, UMC 46
Logan, UT 84322

Jess Gilbert
Nevada State Highway Dept.
P. O. Box 930
Reno, NV 89503

Gilroy Foods, Inc.
1350 Pacheco Pass Highway
P. O. Bos 1088
Gilroy, CA 95020

Keith Glenn
Botany Department
University of California
Davis, CA 95616

Frank J. Gonzales
Union Carbide Corp.
5717 E. Mulberry Ridge Road
Camarillo, CA 93010

Walter L. Gould
New Mexico State University
Agronomy Dept. Box 3-Q
Las Cruces, NM 88003

Jess Grisham
Siskiyou County Dept. Agri.
525 S. Foothill Drive
Yreka, CA 96097

Harry K. Groger
Stauffer Chemical Company
850 Lake Elmo Drive
Billings, MT 79101

Eugene A. Gruenberg
Wilbur-Ellis Company
462 Washington Street
Calexico, CA 92231

Harry Guenthner
University of Idaho
Rt. 8, Box 8478
Caldwell, ID 83605

Frank P. Guerrero
Chemagro Div., Mobay Corp.
2921 Anza Ave.
Davis, CA 95616

Ercan Guneyli
P. O. Box 262
Corvallis, OR 97330

R. L. Haag
U.S. Forest Service
P. O. Box 7669
Missoula, MT 59807

K. C. Hamilton
Department of Plant Sciences
University of Arizona
Tucson, AZ 85721

M Dean Hammond
Lilly Research Lab.
7521 W. California Ave.
Fresno, CA 93726

Gary W. Hansen
Bureau of Reclamation
E&R Center, Bldg #67, Rm 1140
Mail Code 410, DFC
Denver, CO 80224

Charles A. Hanson
American Hoechst Corp.
11312 Hartland Street
North Hollywood, CA 91605

Richard Harle
Stauffer Chemical Company
717 Dahlia
Moses Lake, WA 98837

Mike Coleman-Harrell
Plant & Soil Science Dept.
University of Idaho
Moscow, ID 83843

William E. Hartman
Ada County Weed Control
P.O. Box 476, 517 Meridian St.
Meridian, ID 83642

W. A. Harvey
14 Parkside Drive
Davis, CA 95616

Bob Hasness
Fallek-Lankro Corp.
P. O. Box H
Tuscaloosa, AL 35401

E. A. Hayes
Texas Pride Inc., Suite 202
10405 Town & Country Way
Houston, TX 77024

Stanley Heathman
Plant Sciences Department
University of Arizona
Tucson, AZ 85721

Eugene Heikes
Extension Service
Colorado State University
Fort Collins, CO 80521

Robert H. Heilmann
Nestle Enterprises, Inc.
Read Road, Route 3
Janesville, WI 53545

James D. Helmer
Eli Lilly & Company
7521 W. California Ave.
Fresno, CA 93706

Ray Henning
Chevron Chemical Company
5910 North Monroe
Fresno, CA 93711

Charles E. Henry
Stauffer Chemical Company
P. O. Box 44
Stayton, OR 97383

Robert Higgins
161 Crestview Road
Twin Falls, ID 83301

Jim Hill
Botany Department
University of California
Davis, CA 95616

Larry K. Hiller
Horticulture Department
Washington State University
Pullman, WA 99164

Russell Hillman
University of Idaho
Box 328
St. Anthony, ID 83445

George F. Hittle
Wyoming Dept. of Agriculture
P. O. Box 5001
Cheyenne, WY 82001

M. C. Hogge
Weber County
1374 25th Street
Ogden, UT 84401

Russell Hollenback
Camas County
Box 381
Fairfield, ID 83327

Ivan C. Hopkins
Univ. of Idaho Extension
Box 608
Shoshone, ID 83352

Ralphe H. Horne
Utah State Univ. Extension
10 South 200 East
Provo, UT 84601

Tom Hovenden
Idaho Cattle Feeders
Box 5755
Boise, ID 83705

Kerry Howard
OSU Forest Science Dept.
30th & Western Blvd.
Corvallis, OR 97331

Don R. Howell
University of Arizona
1047 4th Avenue
Yuma, AZ 85364

A. E. Huckabee
Agrichem Div, Mobay Chem.Corp.
7000 S.W. Hampton St. S.W.
Portland, OR 97223

Clair W. Hull
Franklin County Weed Sup.
Box 47, Courthouse
Preston, ID 83263

Herbert M. Hull
Renewable Nat. Resources
325 Bioscience East
University of Arizona
Tucson, AZ 95721

Neil Humburg
University of Wyoming
P. O. Box 3354 Univ. Station
Laramie, WY 82071

David Humphrey
Oregon Dept. of Agriculture
Salem, OR 97310

John Jachetta
916 Eureka Ave.
Davis, CA 95616

Mike Jackson
Montana Extension Service
Johnson Hall, Mont. State Univ
Bozeman, MT 58717

Frank H. Jacobs
University of Idaho Extension
Box 580
Rexburg, ID 83440

W. Jarvis
PPG Industries, Inc.
1860 El Camino Real
Burlingame, CA 94010

Arthur O. Jensen
American Cyanamid Company
106 Las Vegas Road
Orinda, CA 94563

Louis A. Jensen
Cooperative Extension Serv.
Utah State Univ. UMC 48
Logan, UT 84322

Lynn B. Jensen
Plant Science Dept.
Utah State Univ. UMC 48
Logan, UT 84322

James I. Jessen
Stauffer Chemical Company
Route 3, Box 187
Jerome, ID 83338

Thomas N. Johnsen, Jr.
USDA SEA
2000 E. Allen Road
Tucson, AZ 85719

Glen Johnson
American Cyanamid Company
2101 W. McNair Street
Chandler, AZ 85224

Dan Jones
Gem County
6836 West Black Canyon
Emmett, ID 83617

Ivan Blaine Jones
Utah State Univ. Extension
Box 76
Nephi, UT 84648

Lowell S. Jordan
Botany & Plant Science Dept.
University of California
Riverside, CA 92521

Donald N. Joy
Uniroyal Chemical
4205 Barge Street
Yakima, WA 98908

Larry K. Justesen
Blaine County Weed Control
P. O. Box 255
Carey, ID 83320

J. Philip Keathley
Gulf Oil Chemicals Company
3602 Dumbarton Street
Concord, CA 94519

Paul E. Keeley
U.S. Cotton Research Station
17053 Shafter Ave.
Shafter, CA 93263

Harold M. Kempen
Univ. California Extension
P. O. Box 2509
Bakersfield, CA 93303

A. D. Kern
Monsanto Company
800 North Lindbergh Blvd. 5270
St. Louis, MO 63166

George S. Kido
3636 Brunell Drive
Oakland, CA 94602

Mike Kilpatrick
Univ. Nevada RNR Center
1000 Valley Road
Reno, NV 84512

Steven L. Kimball
Monsanto Company
Rt. 3, Box 3781
Selah, WA 98942

Michael G. King
Botany Department
University of California
Davis, CA 95616

Mary M. Kleis
American Hoechst
2011 24th St. West, #14
Billings, MT 59102

Marcelo Kogan
Botany Department
University of California
Davis, CA 95616

Francis Kopp
P. O. Box 988
Caldwell, ID 83605

Lester B. Kreps
California Dept. Agriculture
2135 Akard Ave., Rm 8-D
Redding, CA 96001

J. Kumamoto
Dept. Botany & Plant Sciences
University of California
Riverside, CA 92521

Harry B. Lagerstedt
USDA, SEA, Horticulture Dept.
Oregon State University
Corvallis, OR 97331

Gale Lamb
Sweetwater Weed & Pest Control
McKinnon, WY 82938

Margareta Lambert
Nor-Am Ag. Products, Inc.
1275 Lake Ave.
Woodstock, IL 60098

Don Lansaster
Modoc County Farm Advisor
P.O.Box 571, 202 W. 4th St.
Alturas, CA 96101

Gary A. Lee
Dept. of Plant & Soil Science
University of Idaho
Moscow, ID 83843

Richard E. Lee
Plant Science Department
Utah State University
Logan, UT 84322

Philip W. Leino
University of Idaho
P. O. Box AA
Aberdeen, ID 83210

Ted Lewton
PBI - Gordon Corp.
300 S. 3rd Street
Kansas City, KS 66118

D. T. Lillie
Rhone Poulenc, Inc.
P. O. Box 5416
Fresno, CA 93655

LeRoy Lim
Del Monte
Rt. 3, Box 3890
Toppenish, WA 98948

Harold G. Lindsay
Utah State Univ. Extension
927 East 100 North
Brigham City, UT 84302

Earl E. Lukkes
Big Horn Weed & Pest Control
290 Shoshone Ave.
Lovell, WY 82431

Bud Markham
Rhone Poulenc, Inc.
307 W. 27th
Kennewick, WA 99336

Bert C. Marley
Bannock County Weed Control
P. O. Box 4228
Pocatello, ID 83201

Louis Y. Marquis
USDA, SEA
Irrigated Agr. Res. Ext. Cent.
Prosser, WA 99350

Garry Massey
3M Company
653 E. Dovewood
Fresno, CA 93710

Terry W. Mayberry
Nor-Am Inc.
Rt. 1, Box 218
Pendleton, OR 97801

Paul Mayland
American Hoechst
2962 Southgate Drive
Fargo, ND 58103

Tom McCaffrey
Stauffer Chemical Company
700 N.E. Mulrnomah
Portland, OR 97232

Dave McAuliffe
Oregon State University
190 NW 33rd
Corvallis, OR 97330

Peter J. McCabe
Haney Seed Company
Rt. L
Fruitland, ID 83619

Frank X. McGarvey
Micron West, Inc.
8582 Katy Freeway - 200
Houston, TX 77024

Kristi McGehee
Univ. Idaho Parma Ext. Center
1015 11th Street South
Nampa, ID 83651

Robert F. McGowan
Hooker Chemical Corp.
M.P.O. Box 8
Niagara Falls, NY 14302

W. B. McHenry
Department of Botany
University of California
Davis, CA 95616

James R. McKinley
Union Carbide
1452 N.W. Skyline Drive
Albany, OR 97321

Stanley R. McLane
Union Carbide Agr. Products
Brookside Ave.
Ambler, PA 19002

C. David McNeal
University of Idaho
634 Addison Ave. West
Twin Falls, ID 83301

Jan C. Meneley
Boots Hercules Agrochemicals
562 E. Vassar
Fresno, CA 93704

Robert M. Menges
USDA, SEA, FR, So. Region
Post Office Box 267
Weslaco, TX 78596

Louis J. Meyer
Monsanto Company C3NE
800 N. Lindbergh Blvd.
St. Louis, MO 63166

Raymond W. Meyer
Washington State Univ. Ext.
Rt. 3, Box 85C
Moscow, ID 83843

Robert J. Meyer
Weed Control Consultant
156 Pasatiempo Drive
Baskefield, CA 93350

John H. Miller
USDA
U.S. Cotton Research Station
Shafter, CA 93263

John R. Monnich
Interlink Ag. Chem, Inc.
2020 Coffee Rd, Suite G-1
Modesto, CA 95355

Janet L Moore
Mobay Chem. Corp.
Rt. 1
Wilder, ID 83676

Sud Morishita
Bonneville County Weed Control
605 N. Capital
Idaho Falls, ID 83401

Doyle Morrill
Western Farm Service
P. O. Box 47
Jerome, ID 83338

Larry Morrow
USDA, SEA, AR, Agronomy Dept.
Washington State University
Pullman, WA 99164

Howard L. Morton
USDA, SEA, AR
2000 E. Allen Road
Tucson, AZ 85719

Glen A. Mundt
American Hoechst
317 North Adams
Moscow, ID 83843

T. J. Muzik
Department of Agronomy
Washington State University
Pullman, WA 99163

Tom Neidlinger
Rohm & Haas Company
13016 N.E. Pacific Court
Portland, OR 97230

Marlyn J. Nelson
Bingham County
P. O. Box 583
Blackfoot, ID 83221

Fred L. Nibling, Jr.
U.S. Bureau of Reclamation
1245 Chase Court
Lakewood, CO 80226

David F. Nichols
Occidental Chemical Co.
2712 Stoneridge Drive
Modesto, CA 95355

Richard S. Nielsen
American Cyanamid Company
1140 W. Escalon
Fresno, CA 93711

Roy K. Nishimoto
University of Hawaii
Hort. Dept., 3190 Maile Way
Honolulu, HI 96822

Wesley O. Noel
Plant & Soil Science Dept.
University of Idaho
Moscow, ID 83843

Majid Nojavan
Plant Science Department
Utah State Univ. UMC 48
Logan, UT 84322

Robert F. Norris
Botany Department
University of California
Davis, CA 95616

Alex Ogg, Jr.
USDA SEA AR, Box 30
Irr. Agr. Res. & Ext. Center
Prosser, WA 99350

Paul J. Ogg
American Cyanamid Company
3619 Mountain View
Longmont, CO 80501

G. Ron Oliver
Velsicol Chem. Corp.
3495 S. Maple Ave.
Fresno, CA 93725

Ben Oller
Mobay
1900 N. Gateway Blvd #153
Fresno, CA 93727

H. C. Olson
DuPont Company
2180 Sand Hill Rd., Suite 240
Menlo Park, CA 94025

Phil Olson
American Hoechst
9331 W. Prairie Ave.
Post Falls, ID 83854

John E. Orr
BASF Wyandotte Corp.
P. O. Box 7562
Boise, ID 83707

Justin P. Patanella
Hooker Chemicals & Plastics
4635 Lake Trail Dr., Apt # 5
Lisle, IL 60532

Bob Park
DuPont Co., Biochem Dept.
2180 Sand Hill Road
Menlo Park, CA 94025

Robert Parker
Washington State University
Irr. Agr. Res. Ext. Center
99350

Warren Passey
Bear Lake County Weed Control
Ovid, ID 83260

Dwight V. Peabody
N.W. Wash. Res. & Ext. Unit
1468 Memorial Highway
Mt. Vernon, WA 98273

Doran A. Peterson
Idaho Extension Service
5115 Fairview Ave.
Boise, ID 83704

Wallace A. Peterson
Stauffer Chemical Company
1755 Westgate Drive 115
Boise, ID 83704

E. K. Plant
PPG Industries, Suite 305
1860 El Camino Real
Burlingame, CA 94010

Richard Pocock
Mobay
Rt. 1
Sugar City, ID 83448

John Poku
Colorado State University
905 W. Laurel St. # 104
Fort Collins, CO 80521

Pat L. Pontoriero
Shell Chemical Company
2401 Crow Canyon Road
San Ramon, CA 94583

Bill Pope
Potlatch Corp.
P. O. Box 1016
Lewiston, ID 83501

Clasdia Powers
Crop Science Department
Oregon State University
Corvallis, OR 97371

C. L. Prochnow
Stauffer Chemical Company
11509 N.E. 3rd Ave.
Vancouver, WA 98665

Product Development Library
Union Carbide Agric. Products
Research Farm
Ambler, PA 19002

Mike Qualls
Stauffer Chemical Company
374 Dodson Road
Ephrata, WS 98823

Steve Radosevitch
Botany Department
University of California
Davis, CA 95616

Dan W. Ragsdale
Zoecon
975 California Ave.
Palo Alto, CA 94304

Patrick L. Rardon
Montana State University
Experiment Station
Moccasin, MT 59462

Thomas A. Reeve
Utah State Univ. Extension
453 South 100 East
Manti, UT 84642

Alvin H. Rekow
Gem County
402 N. Hayes
Emmett, ID 83617

Howard Rhoads
962 West Street
San Luis Obispo, CA 93401

Robert P. Rice, Jr.
Ornamental Horticulture Dept.
Calif. Poly. State Univ.
San Luis Obispo, CA 93402

Richard S. Riddle
Stauffer Chemical Company
3729 Oak Ridge Drive
Yuba City, CA 95991

Paul M. Ritty
Dow Chemical, U.S.A.
10890 Denson Drive, Suite 160
Shawnee Mission, KS 66210

Chuck Rivera
Eli Lilly & Company
7521 W. California
Fresno, CA 93706

Laren R. Robison
Dept. Agronomy & Horticulture
Brigham Young University
Provo, UT 84601

James E. Rodebush
Stauffer Chemical Company
Box 73
Swan Lake, ID 83281

Glenn Rohde
Montana State University
2219 West College # 108
Bozeman, MT 59717

Jack Root
ICI Americas, Inc.
6447 E. Camino Santo
Scottsdale, AZ 85254

Cheryl Ross
Elanco
7031 Hummel Drive
Boise, ID 83705

Eugene Ross
Idaho State Dept. Agriculture
Box 790
Boise, ID 83642

Larry Rupp
Plant Science Dept., UMC 48
Utah State University
Logan, UT 84322

Pat Ryan
Payette County
1839 1st Ave. N.
Payette, ID 83661

Donald J. Rydrych
Oregon State University
Box 370
Pendleton, OR 97801

Joseph N. Sagaser
Chemagro Chemical Company
6197 N. Millbrook Ave.
Fresno, CA 93710

Merle D. Samson
Univ. Idaho Coop. Extension
Box 1058
Caldwell, ID 83605

W. G. Savage
Twin Falls County Weed Bureau
450 6th Ave. W.
Twin Falls, ID 83301

John F. Saylor
Stauffer Chemical Company
Westport CT 04686

Jim Schell
Mobay
7000 S.W. Hampton # 213
Portland, OR 97223

Roland Schirman
USDA, SEA, Agronomy Dept.
Washington State University
Pullman, WA 99164

Walter A. Schlabes
1410 Clara Lane
Davis, CA 95616

John T. Schlesselman
Univ. Calif. Agri. Extension
9240 S. Riverbend
Parlier, CA 93648

R. A. Schnackenberg
Agri-Turf Supplies, Inc.
P. O. Box 4191
Santa Barbara, CA 93103

Heinz Schramm
Nor Am
20th N. Wacker Drive
Chicago, IL 60606

Richard W. Schumacher
Monsanto Chemical Company
12898 W. Adriatic Ave.
Lakewood, CO 80228

Wayne Schumacker
Dept. Plant & Soil Science
University Of Idaho
Moscow, ID 83843

Thomas K. Schwartz
Univ. Wyoming Ext. Pest Mgt.
Box 3354 University Station
Laramie, WY 82070

R. A. Schwartzbeck
Gulf Oil Chemicals
9009 W. 67th Street
Merriam, KS 66202

Edward E. Schweizer
Crops Research Laboratory
Colorado State University
Fort Collins, CO 80523

Allen C. Scoggan
Mobay Ag. Div.
8075 Boulder Drive
Boise, ID 83705

Donald E. Seaman
Rice Experiment Station
University of California
P. O. Box 306
Bigg, CA 95917

Roger B. Sebek
Diamond Shamrock
1100 Superior Ave.
Cleveland, OH 44100

Dale L. Shaner
Dept. of Botany & Plant Sci.
University of California
Riverside, CA 92521

Clay Shelton
Stauffer Chemical Company
700 N.E. Multnomah
Portland, OR 97232

Samuel J. Sherman
DuPont
10950 Oneida
Boise, ID 83705

Thomas H. Shrader
Bureau Reclam., Rio Grande
Post Office Drawer P
El Paso, TX 79952

Willard Shropshire
Jerome County Weed Dept.
Jerome, ID 83338

Vince Shutt
Rhone Poulenc
809 Ranch Road
Boise, ID 83702

H. G. Simkover
Shell Development Company
Box 4248
Modesto, CA 95352

Ralph Simnacher
Sweetwater County Weed & Pest
Box 73
Farson, WY 82937

J. S. Skaptason
PBI - Gordon Corp.
300 S. 3rd Street
Kansas City, MO 66118

Earl M. Slack
Plant Science Department
Utah State University, UMC 48
Logan, UT 84322

F. Lyman Smalley
Valley County Weed Control
Box 337
Donneley, ID 83615

Fred A. Smith
American Cyanamid Company
1232 W. Palo Verde Drive
Phoenix, AZ 80513

Leslie W. Sonder
Calif. Dept. Food & Agriculture
1220 N Street
Acramento, CA 95814

Veldon Sorensen
Utah State Univ. Extension
444 South 300 West
Salt Lake City, UT 84101

Ralph Spilsbury
Wilbur-Ellis Company
P. O. Box 695
Glendale, AZ 85311

J. Dan Stallings
The Amalgamated Sugar Company
Box 127
Twin Falls, ID 83301

Charles E. Stanger
Malheur Exp. Station, OSU
Rt. 1, Box 620
Ontario, OR 97914

Sam Stedman
Univ. Arizona Extension Service
820 E. Cottonwood Lane
Casa Grande, AZ 85222

James Mark Sterling
Latah County
Courthouse, Room 209
Moscow, ID 83843

Jim Stewart
University of Idaho
Rt. 2
Rupert, ID 83350

Vern R. Stewart
N.W. Agr. Res. Center
1570-Montana 35
Kalispell, MT 59901

Loyd L. Stitt
Univ. of Nevada
1085 Johnson Place
Reno, NV 89509

Herb Stroud
Gooding County
Box 413
Gooding, ID 83330

Art Sunderland
Wash. State Univ. Coop. Ext.
Rt #3, Box 82
Dayton, WA 99328

Anthony Tafuro
American Cyanamid Company
P. O. Box 400
Princeton, NJ 08540

Fred R. Taylor
PPG Industries
12920 Fillmore CT
Thornton, CA 80241

Fred E. Temby
Pennwalt Corp.
6830 N. Chateau Fresno
Fresno, CA 93711

Shoshone-Bannock Tribes, Inc.
Attn: Emory Tendoy
P. O. Box 306
Fort Hall, ID 83203

Carlyle R. Tennis
U.S. Bureau of Reclamation
2800 Cottage Way
Sacramento, CA 95825

Gerald H. Thiele
Stauffer Chemical Company
P. O. Box 760
Mountain View, CA 94042

Donald C. Thill
PPG Industries
NW 524 Sunset Drive
Pullman, WA 99163

Joe W. Thompson, Jr.
Caribou County
P. O. Box 638
Soda Springs, ID 83276

Larry Thompson
Eli Lilly & Company
7521 W. California, Ave
Fresno, CA 93706

W. T. Thomson
Monterey Chemical Company
5100 N. 6th 93710
P. O. Box 5224
Fresno, CA 93755

Bruce Thornton
1507 Peterson
Fort Collins, CO 80521

Tom Threewitt
Ciba-Geigy Corp.
RR 1
Larned, KS 67550

F. L. Timmons
1047 North Caribe
Tucson, AZ 85710

D. C. Tingey
653 East 400 North
Logan, UT 84321

Robert F. Tisch
Union Carbide
P. O. Box 2698
Fremont, CA 94536

DeVere Tovey
80 North 400 West
Preston, ID 83263

Harvey D. Tripple
Monsanto Company
15211 4th Ave, Suite 231
Aurora, CO 80011

Stuart W. Turner
Turner & Company, Inc.
P. O. Box 12679 Main P.O.
Seattle, WA 98111

Richard A. Van Deusen
Flag Farm Consultants
Rt 1
Wilder, ID 83676

Tim C. Vargas
Stauffer Chemical Company
1943 Riting Ct. SE
Salem OR 97302

Dr. A. D. Venter
South African Embassy, Ag-Sci.
Suite 300
2555 "M" Street, N.W.
Washington, D.C. 20037

Karen E. Wagner Ott
Stauffer Chemical Company
P. O. Box 760
Mountain View, CA 94042

John D. Walker
Farm Crops Department
Ricks College
Rexburg, ID 83440

Keith E. Wallace
WSU Area Extension Agent
N 222 Havana
Spokane, WA 99202

Jack Walstad
Weyerhaeuser Company
P. O. Box 275
Springfield, OR 97477

David A. Warman
Ciba-Geigy Corp.
4654 Sunstone Road, Apt. E
Salt Lake City, UT 84107

J. Warnock
Western Farm Service, Inc.
P. O. Box 1228
Walla Walla, WA 99362

Jack Warren
Mobay Chemical Corp.
P. O. Box 97
Beavercreek, OR 97004

L. E. Warren
Dow Chemical Company
Rt. 1, Box 1313
Davis, CA 95616

David Wattenburger
Plant & Soil Science Dept.
University of Idaho
Moscow, ID 83843

Leonard L. Welch
Diamond Shamrock Corp.
2744 West Acacia
Fresno, CA 93705

Drew Wenner
American Hoechst Corp.
W. 5542 Pacific Park Drive
Spokane, WA 99208

Doug West
Velsicol Chemical Corp.
10043 R Street, # 2
Omaha, NB 68127

Louis Whitendale
ICI Americas, Inc.
498 North Mariposa Ave.
Visalia, CA 93277

Ralph E. Whitesides
Crop Science Department
Oregon State University
Corvallis, OR 97331

J. Wayne Whitworth
New Mexico State University
P. O. Box 3 Q
Las Cruces, NM 88003

David Wichman
Montana State University
Southern Research Center
Huntley, MT 59037

James A. Wilkerson
Thompson-Hayward Chem. Company
P. O. Box 3530
Visalia, CA 93278

Walter E. Willard
Wheatland Ag. Chemicals
P. O. Box 3434
Spokane, WA 99220

Clarence Frank Williams
Agronomy & Horticulture Dept.
Box 122, Widstoe Bldg.
Brigham Young University
Provo, UT 84601

M. Coburn Williams
USDA, SEA, Biology Dept.
Utah State Univeristy, UMC 45
Logan, UT 84322

Clyde L. Wilson
Monsanto Company
1530 Lynkirk Lane
St. Louis, MO 63122

C. Barry Wingfield
Field & Lab. Ins.
P. O. Box 1297
Fort Collins, CO 80522

Winn Winkyaw
Salt River Project, X Cut
P. O. Box 1980 Water C & M
Phoenix, AZ 85001

Randall Wittie
Ciba-Geigy Corp.
Rt. 4, Box 4008-D
Wapata, WA 98951

Lawrence E. Wittsell
Shell Development Company
P. O. Box 4248
Modesto, CA 95352

Tom H. Wright
Eli Lilly & Company
7521 W. California Ave.
Fresno, CA 93706

Wesley E. Yates
Ag. Eng. Dept.
University of California
Davis, CA 95616

Stanford A. Young
PPG Industries
5279 S. Clovis Ave.
Fresno, CA 93725

Lipinski Zbigniew
02-766 Warsaw
Univ. of Agr., Hort Crops Dept.
St. Nowoursynowska 166
Warsaw, POLAND

Robert L. Zimdahl
Weed Research Lab.
Colorado State University
Fort Collins, CO 80523

Paul S. Zorner
Weed Research Lab.
Colorado State University
Fort Collins, CO 80523

WESTERN SOCIETY OF WEED SCIENCE COMMITTEES AND PROJECT CHAIRMEN

STANDING COMMITTEES

Finance Committee:	K.W. Dunster—Chairman, L. L. Whitendale, R.W. Schumacher
Resolutions Committee:	D.L. Shaner—Chairman, Jack Aldridge, L. A. Morrow
Nominations Committee:	W.L. Anliker—Chairman, E. E. Schweizer, G. A. Lee
Placement Committee:	D.R. Colbert—Chairman, Phil Olson, T.H. Wright
Nomination of Fellows and Honorary Members Committee:	C.L. Elmore—Chairman, W. L. Anliker, L.S. Jordan
Public Relations Committee:	B.L. Bohmont
Program Committee:	L.C. Burrill—Chairman, R.F. Norris, J.E. Hill
Local Arrangements Committee, 1979:	G.A. Lee—Chairman
Local Arrangements Committee, 1980:	L.A. Jensen—Chairman
Local Arrangements Committee, 1981:	C.L. Elmore—Chairman

SPECIAL COMMITTEES

Site Selection Committee, 1982:	C.L. Prochnow—Chairman, W.L. Gould, P.E. Heikes
Graduate Student Committee:	R.D. Comes—Chairman, G.A. Lee